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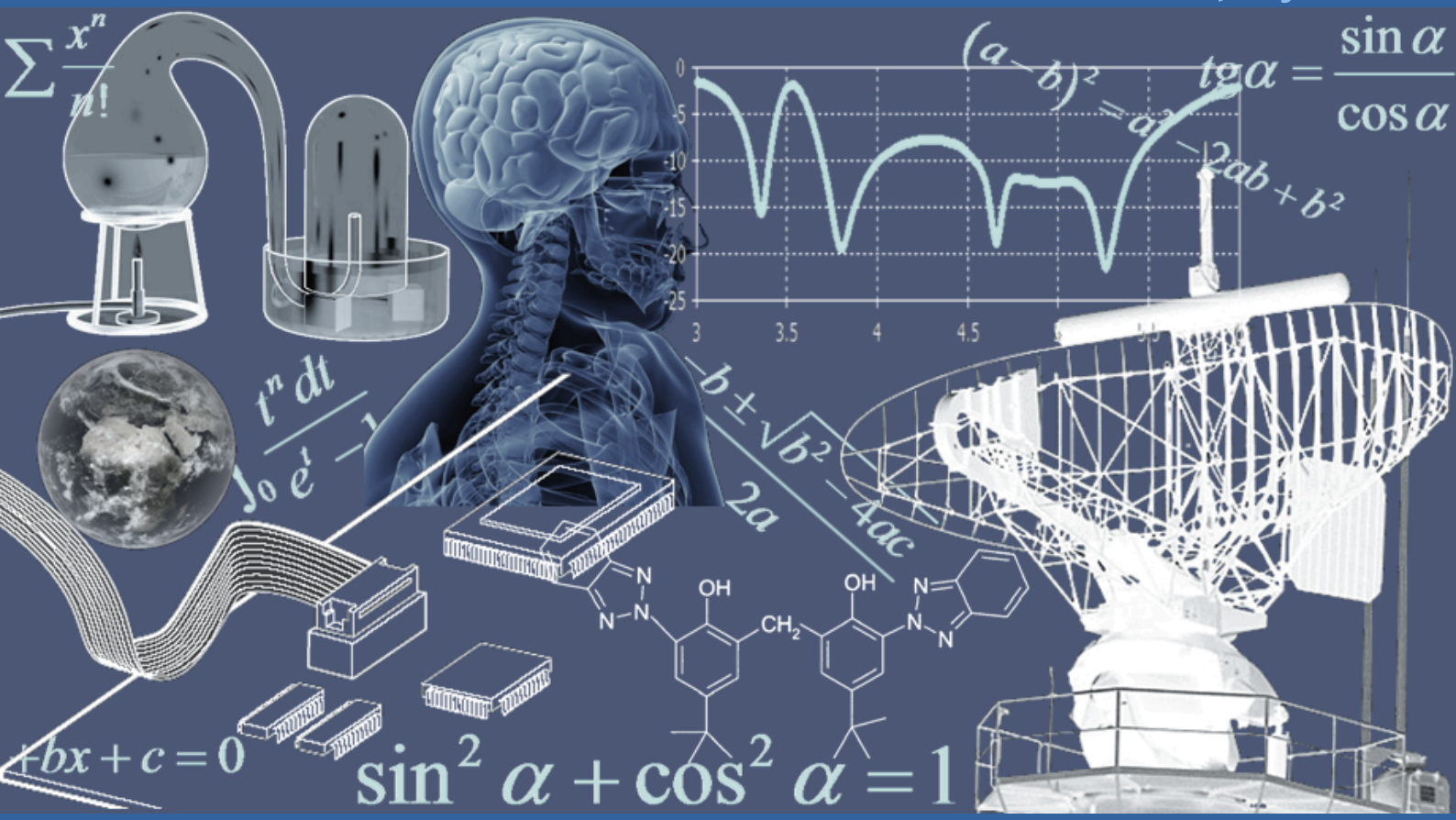

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Improved E-modulus-reconstruction by considering the spatially non-stationary errors of ultrasonic displacement estimation

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ABSTRACT: Ultrasound elastography is a promising imaging modality for the differentiation between benign and malignant tissue, such as the detection of stiff tumors in the (female) breast. In order to deduce the elastic tissue properties and reconstruct the spatial distribution of Young's modulus (E-modulus), the inverse problem governed by the equilibrium equations of linear elastostatics must be solved using internal tissue displacement estimates which are, in practice, subject to spatially non-stationary measurement errors.

In this paper we investigate the novel E-modulus reconstruction approach of taking into account the spatially non-stationary errors of ultrasonic displacement estimates within the field-of-view. The application of spatially adaptive weight factors derived from the mean-square displacement estimation errors by means of an appropriate confidence measure leads to an improved reconstruction quality that strikes the best balance between the two opposing reconstruction goals of "achieving high image homogeneity" and "keeping high-frequency spatial information", which both are diagnostically important. We demonstrate that over- and under-regularization within the field-of-view can be significantly reduced leading to an improved image quality. The results presented here are derived from extensive simulations and phantom experiments. The simulation results will be compared to those of an earlier study.

KEYWORDS: Ultrasound, elastography, displacement estimation, measurement errors, inverse problem, reconstruction.

1 INTRODUCTION

The improvement of the sensitivity and specificity of medical imaging methods is of paramount diagnostic interest because the early detection and treatment of cancer is crucial for the survival rate. A promising imaging method is elastography, which just like manual palpation makes use of the fact that tumors often show an increased stiffness compared to the surrounding healthy tissue [2]. The measured response, i.e. the internal tissue displacements, of e.g. breast tissue to a mechanical stimulus is utilized to determine the spatial distribution of mechanical (elastic) tissue properties like Young's modulus (E-modulus). Even small tumors which are not located close to the skin surface might be detected because elastography is not restricted by the limited human tactile abilities to sense stress and strain. In practice, two medical imaging modalities – ultrasound (US) and magnetic resonance imaging (MRI) – are applied and several static and dynamic elastography approaches exist [3–8]. Medical US examinations do not pose health risks and compared to MRI can be easily performed at the bedside, are cost effective and widely available even in rural areas.

In ultrasound elastography – first proposed in the early 1990s [3] – soft breast tissue is objected to a (uniaxial) compression force which is applied externally using the transducer of a medical ultrasound scanner. Ultrasound echo data is

acquired from the tissue before and after quasi-static compression steps and one, two or even all three components of the internal tissue displacement vectors are determined using suitable displacement estimation methods [9–12]. In the original approach the two-dimensional (2D) spatial distribution of the axial (defined as the direction of compression and ultrasound wave propagation) strain is derived from the gradient of the estimated axial displacement estimates [13] and displayed as a qualitative (inverse) measure for the E-modulus distribution in the tissue as a so-called strain image. The principle diagnostic benefit of strain imaging was demonstrated in several studies (e.g. [4], [14]). Nevertheless, the interpretation of the internal strain distribution as a measure for the E-modulus has certain drawbacks, such as the amplification of high-frequency displacement estimation noise requiring methods with low displacement estimation variance [15]. Another serious drawback is the necessary assumption of a uniform stress distribution throughout the observed tissue region. Since this uniformity condition can hardly be met in an *in-vivo* situation, there may be substantial strain image artifacts and diagnostic misinterpretations.

A more sophisticated approach is the reconstruction of the spatial E-modulus distribution from the internal displacement distribution using elasto-mechanic models based on the generalized Hooke's law [16]. Although this model-based approach incorporates serious problems like the unknown *in-vivo* boundary conditions and the general ill-posedness of the inverse problem to be solved, several groups have successfully developed reconstruction approaches using one, two or even three components of estimated displacement vectors (e.g. in [11, 17–19]). The inverse reconstruction problem is generally formulated as regularized nonlinear optimization problem, where a finite element method (FEM) [20] is applied in order to solve the forward problem, i.e. calculating the internal displacement vectors for a particular spatial E-modulus distribution and a given set of mechanical boundary conditions.

In practice, noise-free displacement data is not available. In order to achieve reconstruction results (elastograms) with a quality sufficient for diagnostic purposes, regularization of the optimization problem using an appropriate regularity measure must thus be introduced. However, the applied regularization inevitably induces a loss of high-frequency spatial information, which might be diagnostically important. For example, sharp edges between soft healthy tissue and an inclusion with increased E-modulus in an elastogram might be evidence for an *in-situ* rather than an invasive carcinoma [2]. For a high diagnostic value of the reconstruction results, regularization must optimally balance the conflicting goals of reducing the negative influences of displacement estimation errors and achieving high spatial resolution in elastograms. Under-regularized (i.e. the influences of the displacement estimation errors degrade the elastogram homogeneity) or over-regularized (i.e. the regularization leads to an unnecessary loss of high-frequency spatial information) elastograms are clearly suboptimal.

Finding the best amount of regularization is not straightforward because the displacement estimation errors have different magnitudes in axial, lateral and elevational direction and they have a non-stationary (or at best cyclo-stationary) character within the field of view (FOV) of the ultrasound transducer. For example, the signal-to-noise-ratio (SNR) of the echo signals in a typical breast-ultrasound examination can easily change by up to 30 dB within the FOV. Depending on the displacement estimators applied, this may lead to displacement estimation variances that spatially differ in the FOV by several hundred percent.

Richards et al. [11] have recently proposed the use of 3 different - but constant - weight factors in the reconstruction for the axial, lateral and elevational displacement components in order to account for the different displacement estimation variances in the respective directions. This approach does not solve the problem that is caused by the spatially varying displacement estimation variances such that within the FOV there are still regions where the reconstruction result is under-regularized or over-regularized.

In this paper we propose a 2D reconstruction approach with adaptive weight factors for the axial and lateral displacement estimates that fully takes into consideration the non-stationary displacement estimation errors. The adaptive weight factors are derived based upon a confidence measure for the displacement estimates.

2 METHODS

2.1 DISPLACEMENT ESTIMATION

Subjecting a material to a small external compression force leads to a deformation, where each point inside the material defined by its Cartesian coordinates $\boldsymbol{x} = [x, y, z]^T$ is shifted by a displacement vector $\boldsymbol{u} = \boldsymbol{u}(x, y, z) = [u_x, u_y, u_z]^T$ to its new position $\boldsymbol{x}' = \boldsymbol{x} + \mathbf{u}$. The resulting displacement vector field $\mathbf{u}$ for a linear-elastic material is thereby given by the generalized Hooke's law in 3D.

Different algorithms for the estimation of internal tissue displacement vectors using ultrasound echo signals have been proposed and described in literature for the estimation of axial, u_z [3] [9] [12], axial and lateral (u_z, u_x) [10] [19] [21] and even all three [11] components of the displacement vector **u**.

For the estimation of the axial u_z and lateral u_x displacement vector components we use block-matching [4] applied to the envelopes of the pre-compressed $A[n, m]$ and postcompressed $A'[n, m]$ digital ultrasound echo signals. The best match, as depicted in principle in Fig. 1, of a small block (= envelope data from a small tissue region) of the pre-compressed envelope data (i.e. template block, $T[k,\ell] \in A[n, m]$ with $k = 1 \ldots K$ and $\ell = 1 \ldots L$) is to be found in a certain region of the post-compressed envelope data (i.e. search region, $S[i, j] \in A'[n, m]$ with $i = 1 \ldots I$ and $j = 1 \ldots J$).

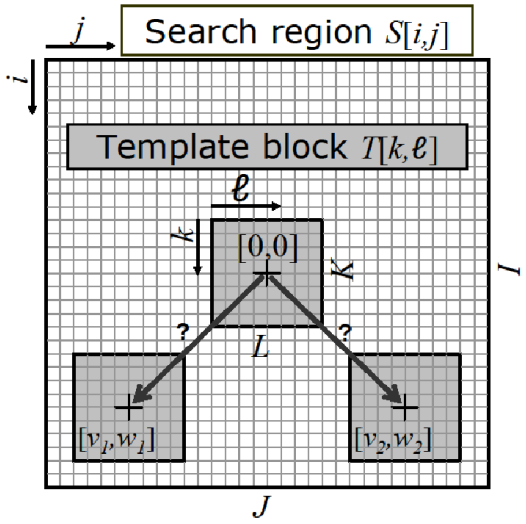


Fig. 1. Principle of 2D block-matching, with the template block T[k,ℓ] for which the best-match is to be found within the search region S[i, j].

The best-match of T in S is indicated by the extremum of the matching-function $f_{MF}[\upsilon, \omega]$ using $T[k,\ell]$ and $S[i, j]$. For the investigations shown in this paper we chose the mean-squared-differences (MSD) function for $f_{MF}[\upsilon, \omega]$ [4]:

$$f_{MF}[\upsilon,\omega] = \frac{1}{KL}\sum_{k=1}^{K}\sum_{\ell=1}^{L}\left(T[k,\ell] - S[k+\upsilon,\ell+\omega]\right)^2 \tag{1}$$

where $\upsilon = 0 \ldots I - K$ and $\omega = 0 \ldots J - L$. The 2D displacement estimate $\hat{\mathbf{u}}$ for the tissue region represented by $T[k,\ell]$ is then determined from the location of the minimum of $f_{MF}[\upsilon, \omega]$:

$$\hat{\mathbf{u}} = [\hat{u}_z, \hat{u}_x]^T = arg\ min\{ f_{MF}[\upsilon,\omega] \} \tag{2}$$

For the E-modulus reconstruction, spatial resolutions in the sub-sample range are needed for the axial and lateral displacement estimates because most commercial ultrasound scanners provide echo signal sampling rates of approximately 30-40 MS/s. To achieve this goal, a polynomial fitting function $f_{Fit}(z, x)$ of 2nd order in the 2 variables z (axial) and x (lateral) is used to approximate the matching function:

$$f_{Fit}(z,x) = a_0 + a_1 z + a_2 x + a_3 zx + a_4 z^2 + a_5 x^2 \tag{3}$$

In order to find the coefficients of the polynomial function that fits best to $f_{MF}[\upsilon, \omega]$, an equation system deduced from at minimum 6 full-sample values of $f_{MF}[\upsilon, \omega]$ including the full-sample minimum is solved in a least-squares sense using the pseudo-inverse matrix. The location of the minimum $[z_{min}, x_{min}]^T$ of the resulting $f_{Fit}(z, x)$ is then calculated analytically in order to determine the displacement estimate $\hat{\mathbf{u}}$ with sub-sample resolution.

According to the definition of $f_{MF}[\upsilon, \omega]$, the minimum $f_{Fit}(z_{min}, x_{min})$ is an estimate for the mean-square-error between the template block $T[k,\ell]$ and the search region $S[i, j]$, and thus an indicator for the quality of the displacement estimate (i.e. the displacement estimation error). In order to obtain an applicable confidence measure C for each displacement estimate, $f_{Fit}(z_{min}, x_{min})$ is normalized using the signal power of $T[k,\ell]$:

$$C = \frac{f_{Fit}(z_{min}, x_{min})}{\frac{1}{K \cdot L} \sum_{k=1}^{K} \sum_{\ell=1}^{L} T^2[k, \ell]} \tag{4}$$

C will later be utilized to estimate the displacement estimation error, which in turn is used to calculate the adaptive weight factors for the E-modulus reconstruction (see section 4.3).

2.2 E-MODULUS RECONSTRUCTION

The E-modulus distribution which is sought within a field of view $\Omega \subset \mathbb{R}^d$ can be mathematically described as a function $E : \Omega \rightarrow \mathbb{R}$, where $d = 2$ in the two-dimensional case considered here. Since there is no method available to measure E directly, it needs to be inferred from internal tissue displacements (e.g. when the tissue is subjected to an external compression). The relationship between applied mechanical stress and resulting mechanical strain (and vice versa) is given by Hooke's law, which for homogenous, isotropic and linear elastic material can be simplified and written in tensor notation as follows [14]:

$$\sigma_{ij} = 2\mu\varepsilon_{ij} + \lambda\delta_{ij}\left(\sum_{k=1}^{d} \varepsilon_{kk}\right), \qquad i, j = 1, \ldots, d. \tag{5}$$

Here, σ_{ij} and ε_{ij} are the second order symmetric stress and strain tensors and δ_{ij} is Kronecker's delta. The strain tensor ε_{ij} is calculated from the internal displacement **u** by [14]:

$$\varepsilon_{ij} = \frac{1}{2}\left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i}\right) \tag{6}$$

Note that the indices 1 or z and 2 or x are used interchangeably in order to designate axial and lateral components of **u** and ε_{ij}, respectively. For example in (6), $\varepsilon_{zz} = \partial u_z/\partial z$ can also be used to express the plane strain in axial direction.

Further, μ and λ are the Lamé coefficients, which are related to the E-modulus via Poisson's ratio υ as follows:

$$\mu = \frac{E}{2(1+\upsilon)}, \tag{7}$$

$$\lambda = \frac{E\upsilon}{(1+\upsilon)(1+2\upsilon)}. \tag{8}$$

Following e.g. Kallel *et al.* [17] in relaxing the incompressibility condition for soft tissue, Poisson's ratio is set to a constant value of $\upsilon = 0.495$.

For static equilibrium, σ_{ij} must fulfill:

$$\sum_{j=1}^{d} \frac{\partial \sigma_{ij}}{\partial x_j} + f_i = 0, \quad i = \ell, \ldots, d, \tag{9}$$

with f_i being the body forces associated to gravity. For small deformations, f_i may and will be neglected.

(9) is a system of second order elliptic partial differential equations for $u : \Omega \rightarrow \mathbb{R}^d$. For a given E and additionally at the boundary of Ω given either displacements **u** (so-called Dirichlet boundary conditions) or external compression forces (so-called Neumann boundary conditions), system (9) may be solved for **u**. In fact, both types of boundary conditions usually coexist on disjoint components of the boundary. Assuming fixed boundary conditions, solving (9) for given E yields a mapping $E \quad \mathbf{u}$. Computing **u** from E is called the "forward problem".

Since the forward problem can not be solved analytically, one must turn to numerical approximation. We choose to approximate E by a piecewise constant function on a uniform rectangular grid with mesh sizes h_z and h_x, comprising n_z grid points in axial and n_x grid points in lateral direction (including grid points on the boundary of Ω). Thus, the approximation is defined by $m = (n_x - 1)(n_z - 1)$ nonnegative function values. These m values are assembled into a vector and the notation E is reused to designate it such that $\boldsymbol{E} \in \mathbb{R}_+^m$. **u** is approximated on the same grid by a piecewise bilinear vector field, i.e. bilinear scalar functions for both, axial (u_z) and lateral (u_x) displacements. This piecewise linear vector field can be represented by $d \cdot n$ nodal values, where $n = n_x n_z$. From now on, $\mathbf{u} \in \mathbb{R}^{dn}$ refers to this vector of nodal values. Finally, the approximate solution of (the weak form of) (9) by the finite element method means to solve the linear system of equations [20]:

$$K\mathbf{u} = F \tag{10}$$

with so-called stiffness matrix K and load vector F. Since both K and F depend on E, the solution of (10) ultimately defines a nonlinear mapping $\Phi : \mathbb{R}_+^m \rightarrow \mathbb{R}^{dn}$, $E \mapsto \Phi(E) = \mathbf{u}$.

E is not available in practice. However, from ultrasound echo data acquired from the tissue before and after compression (see section 2.1) estimates $\hat{\mathbf{u}}$ of the actual displacements **u** can be derived and one could now ask for a solution of the "inverse problem": find E such that $\Phi(E) = \hat{\mathbf{u}}$. But even if the solution of this system of nonlinear equations existed, it would hardly be useful in practice because every displacement estimation method involves an estimation error. Regularization theory [22, 23] now suggests to find $E = E_\rho$ as the solution of

$$\begin{aligned} E_\rho &= \arg\min\{ G_\rho(E); E \in \mathbb{R}_+^m \} \text{ with} \\ G_\rho(E) &= \left\| W \cdot \left(\Phi(E) - \hat{\mathbf{u}}\right\|_2^2 + \rho R(E)\right). \end{aligned} \tag{11}$$

Here, $G_\rho(E)$ is the cost-function which is to be minimized and W is a dn-dimensional diagonal matrix of positive weight factors W. $\left\| W\left(\Phi(E) - \hat{\mathbf{u}}\right)\right\|_2^2$ measures "data fidelity" of E: the smaller the quadratic L_2-norm $\left\| W\left(\Phi(E) - \hat{\mathbf{u}}\right)\right\|_2^2$ is, the better the reconstructed E "fits" to the measured displacements $\hat{\mathbf{u}}$. Every single measurement can be treated individually: the larger a specific weight factor W_i (component of W) in relation to other weight factors is, the more importance gets attributed to

$\Phi_I(E)$ being close to the specific measurement $\hat{\mathbf{u}}_i$ (*i*th component of $\hat{\mathbf{u}}$). Specifically, we choose W_i depending on the root-mean-square-error $\delta_{\Delta\hat{\mathbf{u}}_i}$ (also see (18)) for the displacement estimates $\hat{\mathbf{u}}_i$

$$W_i = 1 / \delta_{\Delta\hat{\mathbf{u}}_i}, \quad i = 1, \ldots, d \cdot n \tag{12}$$

forcing an optimal E_ρ that approximates the measured displacement values $\hat{\mathbf{u}}$ the better, the more reliable they are in the sense of $\delta_{\Delta\hat{\mathbf{u}}_i}$ being small. (12) means that weight factors are inverse measures of how much the measurement of $\hat{\mathbf{u}}_i$ can be trusted. The better a measurement value $\hat{\mathbf{u}}_i$ is, the more we will strive to reproduce it.

$R(E) \geq 0$ measures "regularity" of the reconstructed E, which becomes smaller with increasing similarity of E with some meaningful *a-priori* notion of it. As proposed in [11] and by others, we quantify the regularity of a continuously differentiable (∇ denotes the Nabla operator) function $f : \Omega \to \mathbb{R}$ by its total variation

$$\tau(f) = \int_\Omega \left\| \nabla f(x) \right\|_2 dx = \int_\Omega \sqrt{\nabla f(x) \cdot \nabla f(x)}\, dx \tag{13}$$

Here, the total variation $\tau(E)$ of an E-modulus $E : \Omega \to \mathbb{R}$ is approximated using its approximate representation $E \in \mathbb{R}^m$ by

$$R(E) := \sum_i h^{d-1} \sqrt{\sum_{ij} \left(E_{ij} - E_i\right)^2 + h^2 \beta^2} \tag{14}$$

β is a small positive number, which is introduced to make $R(E)$ a differentiable function of $E \in \mathbb{R}^m$. The gradient ∇E of function E is approximated by finite differences based on the discrete approximated values $E \in \mathbb{R}^m$. Thus, $\sum_{ij}$ means summation over one lateral and one axial neighbor element of E_i. Furthermore, for ease of notation $h = h_x = h_z$ has been used in (14). In practice, h_x and h_z may differ.

Finally, ρ determines the mutual importance of "data fidelity" versus "regularity" when seeking a minimum of $G_\rho(E)$ (see (11)). In the one extreme case $\rho = 0$, there is no regularization at all and only the weighted squared differences between $\Phi_i(E)$ and $\hat{\mathbf{u}}$ are to be minimized. In the other extreme case $\rho = \infty$, a perfectly regular E - not at all affected by the measurements $\hat{\mathbf{u}}$ - will result.

The iterative approach applied here in order to find E_ρ is illustrated as a block diagram in Fig. 2.

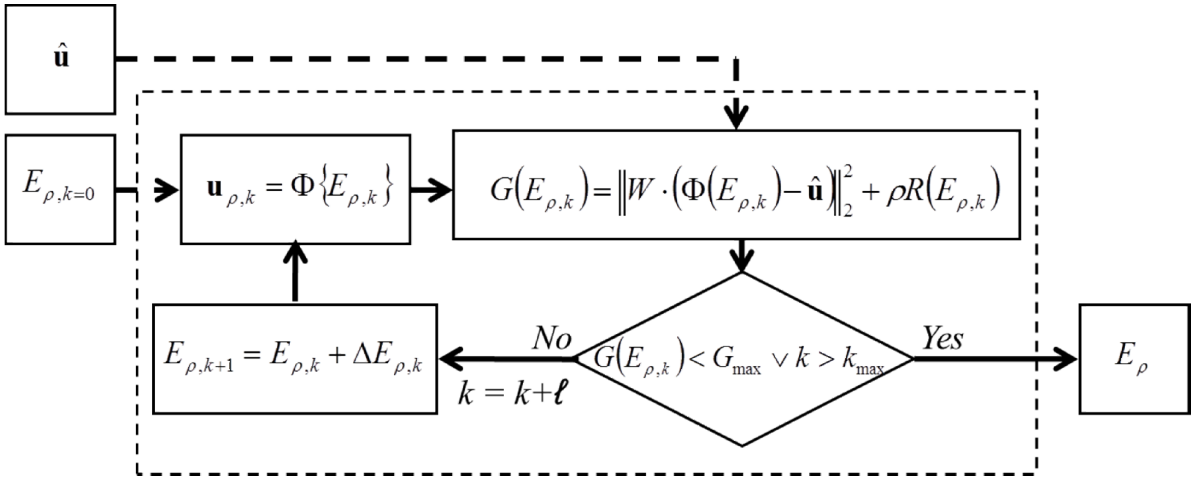


Fig. 2. Block diagram of the E-modulus reconstruction.

According to Fig. 2 the iteration is terminated if a maximum of k_{max} steps is exceeded. Additional termination conditions (not explicitly listed) are an insufficient relative decrease in the value of $\| G(E) \|_2^2$ between two iterates and an insufficient change $\|E_k - E_{k-1}\|_2$. In order to determine the search direction ΔE_k, Gauss-Newton type algorithms - like the one implemented in Matlab's iterative solver lsqnonlin - require computation of $\Delta G(E) \cdot \mathbf{v}$ and $\Delta G(E)^T \cdot \mathbf{v}$ for vectors $\mathbf{v} \in \mathbb{R}^m$, where $\Delta G(E)$ is the Jacobian of $G(E)$. We achieve computation of $\Delta G(E) \cdot \mathbf{v}$ in a way similar to the "adjoint method" described in [18].

For a numerical solution of (11), we relied on MATLAB's function *lsqnonlin* which employs a trust region Newton method and requires (11) to be cast into the equivalent form

$$E_\rho = arg\ min\left\{ \left\| W(\Phi(E) - \mathbf{u}); \sqrt{p}\mathbf{R}\{E\} \right\|_2^2 \right\} \tag{15}$$

where $\mathbf{R}\{E\}$ is a vector with i^{th} component

$$\mathbf{R}_i\{E\} = \left(\sum_{ij} (E_i - E_{ij})^2 + h^2\beta^2 \right)^{0.25} \tag{16}$$

3 DISPLACEMENT ESTIMATION SIMULATIONS

In order to find the relationship between the confidence measure C defined in (4) and the displacement estimation errors expressed by the root-mean-square-error $\delta_{\Delta\hat{u}}$ (see also (12)) of the 2D displacement estimator described in section 2.1, detailed statistical investigations were carried out using simulated ultrasound echo signals from strained software-phantoms. The goal of these simulations is to determine analytic functions to be then used for the calculation of $\delta_{\Delta\hat{u}}$ from the confidence measure C.

3.1 SIGNAL GENERATION

Synthetic ultrasound echo signals were generated for strained software-phantoms containing $k = 1 \ldots K$ point scatterers, each of which being defined by its 3D position $\boldsymbol{x}_k$ and a factor $-1 \leq R_k \leq +1$ representing the individual amplitude contribution to the echo signals. Different values of uniaxial strain $\varepsilon_{zz} = \partial u_z / \partial z$ in the range of 0.5% to 4% were applied in 0.5% steps to the K scatterer positions using the following simplified elasto-mechanical model:

$$x_{k,\varepsilon_{zz}} = x_k \cdot \begin{pmatrix} 1-\upsilon\cdot\varepsilon_{zz} & 0 & 0 \\ 0 & 1-\upsilon\cdot\varepsilon_{zz} & 0 \\ 0 & 0 & 1+\varepsilon_{zz} \end{pmatrix} \tag{17}$$

where the *Poisson's ratio* υ was chosen to be 0.495 (virtually incompressible soft tissue).

The echo signals from the homogenous software-phantoms were generated with ultrasonic pulse properties listed in Tab. 1 in order to emulate the characteristics of the ultrasound transducer (linear array) and scanner used for the experimental data acquisition. Frequency-dependent attenuation was not taken into consideration.

Table 1: Echo signal parameters: center frequency f_c; relative FWHM bandwidth B_r; axial $\ell_{R,z}$, lateral $\ell_{R,x}$ and elevational $\ell_{R,y}$ auto-correlation lengths. Simulation results shown in this paper are based on the sampling frequency f_s of the applied ultrasound scanner VOLUSON 730 (GE Kretztechnik) which is equipped with a digital research interface in order to access the beamformed radio-frequency echo data.

f_c MHz	B_r %	$\ell_{R,z}$ µm	$\ell_{R,x}$ µm	$\ell_{R,y}$ µm	f_s MS/s
7.82	47	175	309	558	30

The following process was implemented in order to derive statistically meaningful results: echo signals at 16 laterally adjacent parallel lines of sight (LOS) were generated for different compression steps (i.e. strain values) and for a large number of realizations of the software-phantom. The boundary conditions at the top and bottom surfaces of the phantom were assumed to be “free slip”. The LOS were symmetrically aligned around the lateral (and elevational) symmetry axes (x = 0 µm, y = 0 µm) of the software-phantom with the same pitch (100 µm) of the later applied linear array transducer, such that the mean displacements within a centered template block in lateral (and elevational) direction is zero. This simulation set-up allows the detailed investigation of signal decorrelation effects due to compression independently from a lateral (and elevational) net displacement of the template block. To quantify the axial displacement estimation errors due to lateral displacements induced by the (uni-)axial compression, various rigid lateral displacements u_x in the range of ±50 µm (i.e. ±0.5 LOS) were applied to the phantom (see Tab. 2). In this paper we limit the presentation of results to the situation with zero-mean elevational displacement inside the template block and focus on those estimation errors that are caused by (uni-)axial compressions as well as the associated lateral displacements.

Table 2: Values of axial strain ε_{zz} and lateral displacement u_x applied to the software-phantoms. Different SNR levels were generated by adding zero-mean white Gaussian noise to the echo signals.

	Value	Unit
ε_{zz}	0 : 0.5 : 4.0	%
u_x	-50 : 5 : 50	µm
SNR	40,35,30,25,20,18,16,14,12,10,8,6	dB

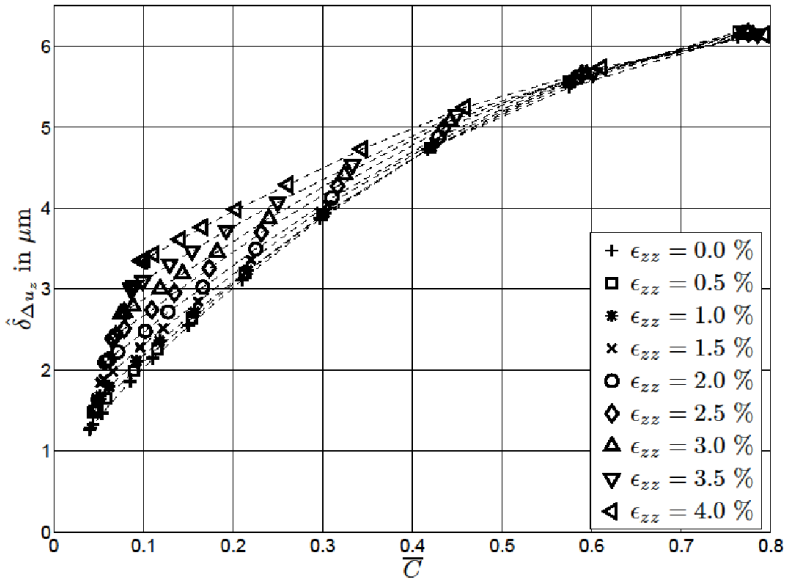
3.2 DISPLACEMENT ESTIMATION RESULTS

The 2D displacement estimation described in section 2.1 was carried out on the echo signal envelopes *A[m,n]* and *A´[m,n]*, which were calculated from the noisy synthetic radio-frequency (RF) echo signals $s_e[m,n]$ and $s'_e[m,n]$ using the Hilbert transform [24]. A template-block-size $T[k,\ell]$ of 24 samples x 12 samples (approx. 600 µm axially x 1200 µm laterally) was chosen, which was found in earlier investigations [21] to be the best choice for typical situations and parameters.

The displacement estimation errors $\Delta u_z = \hat{u}_z - u_z$ (axial) and $\Delta u_x = \hat{u}_x - u_x$ (lateral) of the displacement estimates $\hat{u}_z$ and $\hat{u}_x$ were derived using the true displacements u_z and u_x, which in turn were deduced from (17) for the center position of each template block $T[k,\ell]$. The root-mean-square (RMS) displacement errors $\hat{\delta}_{\Delta u_Z}$ and $\hat{\delta}_{\Delta u_X}$ (including estimation bias and estimation variance) derived from *N* displacement estimates (shown here only for Δu_z)

$$\hat{\delta}_{\Delta u_Z} = \sqrt{\frac{1}{N}\sum_{n=1}^{N}\left(\hat{u}_z - u_z\right)^2} \tag{18}$$

are shown in Fig. 3 as a function of the confidence measure *C* for different values of axial strain ε_{zz}, where the confidence measure in fact corresponds to the mean value $\overline{C}$ of *C* defined in (4). $\overline{C}$ was calculated from all 2D displacement estimates in the lateral range -50 µm ≤ u_x ≤ +50 µm and the respective echo SNR levels (range: 40 to 6 dB) that occur at the corresponding depth locations. As a result, the $\overline{C}$ -value of each data point in Fig. 3 represents a particular SNR level.



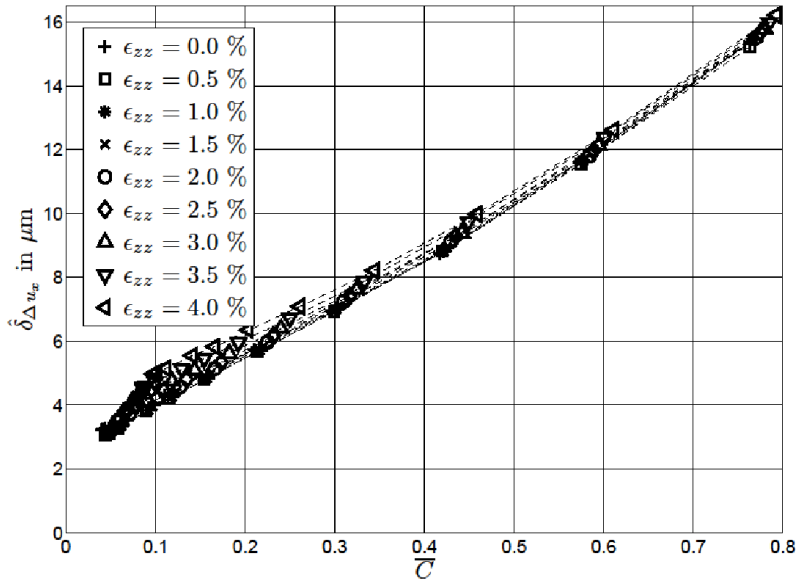


Fig. 3. RMS displacement errors $\hat{\delta}_{\Delta u_Z}$ (top) an $\hat{\delta}_{\Delta u_X}$ (bottom) as a function of the confidence measure $\overline{C}$ for different values of ε_{zz} (depicted here for u_y = const. = 0 μm). If $u_y \neq 0$ microns (not shown), the values for $\hat{\delta}_{\Delta u_Z}$ and $\hat{\delta}_{\Delta u_X}$ increase and their dependence on $\overline{C}$ is less strongly pronounced compared to u_y = const. = 0 μm .

It can be easily seen that the strain value ε_{zz} does not appreciably influence $\hat{\delta}_{\Delta u_Z}$ as a function of $\overline{C}$. However, the relation between $\hat{\delta}_{\Delta u_Z}$ and lower values of $\overline{C}$ more strongly depends on ε_{zz}, and thus a single analytic approximation for this relation does not exist. However, in most practical cases of static ultrasound elastography the mean strain value within certain regions of interest (ROI) might be applicable as a good approximation. Thus, analytical representations (cubic fits) for different values of ε_{zz} were implemented for $\hat{\delta}_{\Delta u_Z}$ as well as for $\hat{\delta}_{\Delta u_X}$ as functions of $\overline{C}$:

$$f_{\delta_{\Delta u_Z}}(\overline{C}) = a_{z,0} + a_{z,1}\,\overline{C} + a_{z,2}\,\overline{C}^2 + a_{z,3}\,\overline{C}^3$$
$$f_{\delta_{\Delta u_X}}(\overline{C}) = a_{x,0} + a_{x,1}\,\overline{C} + a_{x,2}\,\overline{C}^2 + a_{x,3}\,\overline{C}^3 \qquad (19)$$

The coefficients $a_{z,1}$ to $a_{z,3}$ and $a_{x,1}$ to $a_{x,3}$ were determined in a least-squares sense from the data shown in Fig. 3. Estimates of the root-mean-square (RMS) displacement errors for each and every displacement estimate can be now calculated individually from their respective confidence measure $\overline{C}$ using the analytical approximations $f_{\delta_{\Delta u_Z}}(\overline{C})$ and $f_{\delta_{\Delta ux}}(\overline{C})$. These RMS displacement errors are then used to calculate the adaptive weight factors *W* for the E-modulus reconstruction as shown in the next section.

4 EXPERIMENTAL RESULTS

Based upon the promising simulation results already published in [1], we performed compressions experiments on self-made agar phantoms in order to evaluate the proposed reconstruction approach in practice with experimental echo data.

4.1 EXPERIMENTAL SETUP AND DATA ACQUISITION

The experimental setup for the data acquisition from a uniaxially compressed ultrasound phantom with a soft(er) homogeneous background and 3 hard(er) cylindrical inclusions is shown in Fig. 4. The self-made phantom was made of agar-

agar with cornstarch as additional scatterers [25]. Indentor measurements [26] using samples with particular geometry of the phantom material (8 independent measurements) yielded E-modulus values for the homogenous background of E_B = 92.0 ± 1.0 kPa and for the cylindrical inclusions of E_1 = 254 ± 5.1 kPa. The phantom was placed between two parallel compressions plates (also made of agar-agar, E_C = 390 ± 13.5 kPa) with a moderate pre-compression mainly in order to avoid that ultrasonic reveberations lie inside the region of interest. A TPX® [27] plate of 1 mm thickness was flush mounted to the upper polycarbonate plate in order to ensure stable conditions during compression and avoid the bending of the phantom material into the acoustic window. Before and after small compression steps applied to the phantom by lifting it with an automated elevational table controlled by LabVIEW® from below against the fixed upper polycarbonate plate, digital RF echo data were acquired through the acoustic window using a linear array transducer attached to the VOLUSON 730 ultrasound scanner with settings typical for breast ultrasound examinations.

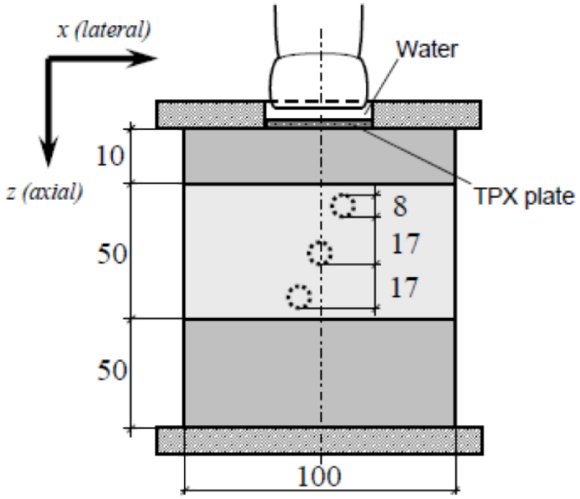


Fig. 4. Experimental setup: the ultrasound transducer acquires echo signals through an acoustic window (1 mm TPX® plate) in the upper polycarbonate compression plate from an agar-agar phantom (100 mm x 100 mm x 50 mm) with 3 hard cylindrical inclusions of 8 mm diameter each at different uniaxial compression steps applied from below by an elevational table. Two stiff plates also made of agar-agar were used in order to avoid that strong reverberations occur in the region of interest. All measures are given in mm.

4.2 DISPLACEMENT ESTIMATION

2D displacement estimates were calculated from the acquired echo signals with the algorithm described in section 2.1 using a template block size of 24 samples x 12 samples ≈ 600 μm x 1200 μm (axial x lateral). A lateral block-overlap of 50% was applied in order to achieve the same spatial resolutions in axial and lateral direction. Consequently, *I x J* 2D displacement vector estimates $\hat{\boldsymbol{u}}[i,j]$ are available on the rectangular grid with a mesh size of approximately 600 μm x 600 μm.

In Fig. 5 the spatial distributions of the axial $\hat{u}_z$ (left) and lateral $\hat{u}_x$ (right) components of $\hat{\boldsymbol{u}}[i,j]$ are illustrated. The horizontal dashed lines indicate the upper (z = 15.6 mm) and lower (z = 58.2mm) boundaries of the phantom. Within the region of approximately 42.6 mm x 31.2 mm inside the phantom, 73 x 52 2D displacement vector estimates $\hat{\boldsymbol{u}}[i,j]$ are available for the E-modulus reconstruction.

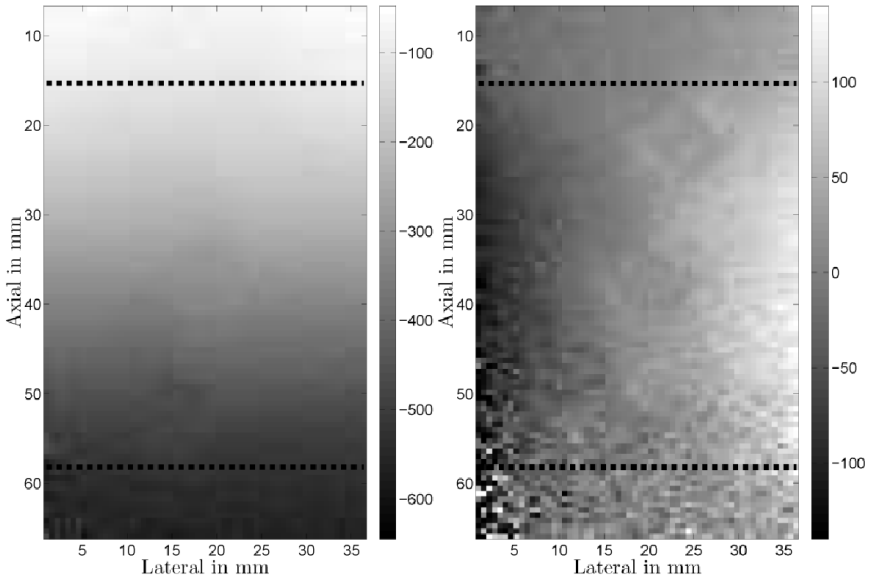


Fig. 5. Spatial distributions of the axial $\hat{u}_z$ (left) and lateral $\hat{u}_x$ (right) components of the 2D displacement vector estimates $\hat{u}[i, j]$ for an applied strain of 1%. The horizontal dashed lines indicate the upper and lower boundaries of the phantom. Color maps are in μm.

In Fig. 6 the spatial mean echo SNR of the acquired signals within laterally centered regions of 2.5 mm x 32 mm (axial x lateral) and 50% axial overlap as well as the mean values $\overline{C}$ of the confidence measure C for all 52 lateral displacement estimates are shown as a function of depth z (axial) inside the phantom (15.6 mm $\leq z \leq$ 58.2 mm). Each SNR value was estimated from 400 independent realizations of the echo signals.

Within the first 15 mm in the phantom, the SNR remains relatively constant at approx. 30 dB. The slight increase at approx. 25 mm depth is due to the focal length setting. For z > 30 mm a virtually linear decrease of the echo SNR occurs, with a degradation of the SNR value down to 9 dB at the bottom of the phantom (at $z \approx 58$ mm). It can be seen that $\overline{C}$ - similar to the echo SNR - remains relatively constant at a value of approximately 0.1 in the axial range 15 mm $\leq z \leq$ 30 mm. For z > 30 mm, $\overline{C}$ steadily increases to a value of approximately 0.65 due to the rising displacement estimation errors.

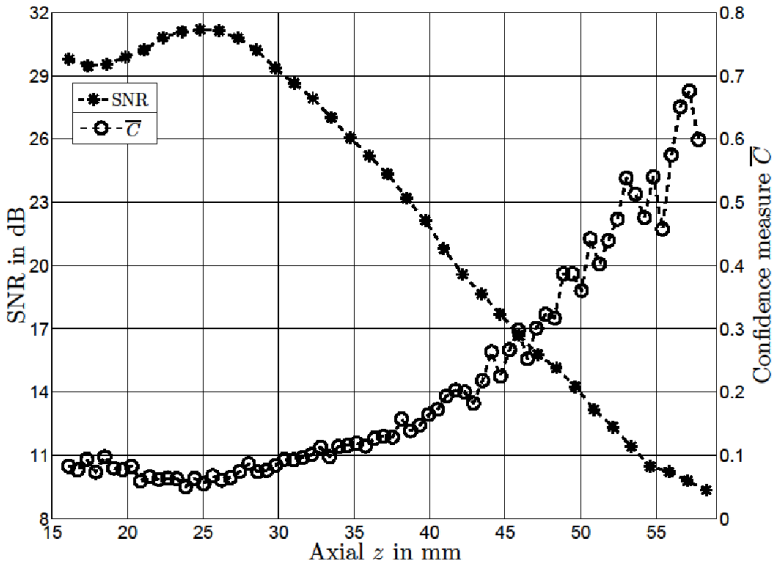


Fig. 6. SNR in dB of the echo signals acquired from the phantom and mean value $\overline{C}$ of the confidence measure C of all 52 lateral displacement estimates in the phantom as a function of depth z (axial).

4.3 E-MODULUS RECONSTRUCTION

As described in section 2.2, the true spatial E-modulus distribution was modeled as a spatially piecewise constant function *E[m,n]* on the same rectangular grid as used for the displacement estimation (mesh size $h_z = h_x = 600$ µm). For the reconstruction, Dirichlet boundary conditions were chosen for *F* (see (10)) from the estimated displacements $\hat{\boldsymbol{u}}[i,j]$ at the upper and the lower boundaries of the phantom. The assigned displacement values were those from the first ($i = 1$) and the last ($i = 73$) row of $\hat{\boldsymbol{u}}[i,j]$, see dashed lines in Fig. 5. On the left and right boundaries of the phantom Neumann boundary conditions were chosen for *F* (see (10)) with $\sum_{j=1}^{2} \sigma_{ij} \cdot n_j = 0$, i.e. no external forces occur, where σ_{ij} and n_j denote the mechanical stress tensor and the outward normal vector on the boundary edge, respectively. The E-modulus reconstruction model comprises 71 x 52 *(I x J)* displacement values/nodes $\boldsymbol{u}[i,j]$, and thus 70 x 50 (*M x N*) E-modulus nodes $E_\rho[m,n]$ on a rectangular region Ω of size 42 x 30 mm^2 (ℓ_z x ℓ_x).

The reconstruction process was then carried out by approximately solving (15) using $\hat{\boldsymbol{u}}[i,j]$ and different values of the regularization coefficient ρ (see also Fig. 2). The weight factors $W_1[i,j] = [W_{1,z}, W_{1,x}]^T$ for the individual displacement estimates $\hat{\boldsymbol{u}}[i,j]$ were determined using (12). The RMS errors $\hat{\delta}_{\Delta u_z}$ and $\hat{\delta}_{\Delta u_x}$ were derived from the values of $\overline{C}$ using $f_{\delta_{\Delta u_z}}(\overline{C})$ and $f_{\delta_{\Delta u_x}}(\overline{C})$ from (19). For reasons of comparison, the reconstructions were also carried out with spatially ([*i,j*]) constant weight factors $W_2[i,j] = [W_{2,z}; W_{2,x}]^T$. Based on the fact that the displacement estimation errors in lateral direction are approximately ≈ 1.7 times larger than those in axial direction, $W_2[i,j] = [W_{2,z}; W_{2,x}]^T = [1; 1/1,7]^T$ was applied. The indices of the two-dimensional quantities $\hat{\boldsymbol{u}}[i,j]$, $W_1[i,j]$ and $W_2[i,j]$ were linearized to $\hat{\boldsymbol{u}}[p]$, $W_1[p]$ and $W_2[p]$ with $p = i + I \cdot (j - 1)$, such that (15) can be applied.

In Fig. 7, the weight factors $W_{1,z}$, $W_{1,x}$, $W_{2,z}$ and $W_{2,x}$ of the axial and lateral displacement estimates are shown as function of the axial depth *z*. The existing increase of the displacement estimation errors with *z* leads to a decrease of the weight factors $W_{1,z}$ and $W_{1,x}$ down to values of approximately 0.2-0.3. Recall, that a local decrease of weight factors will lead to a local increase of regularization in the reconstructed elastogram. This effect will be demonstrated in section 4.4.

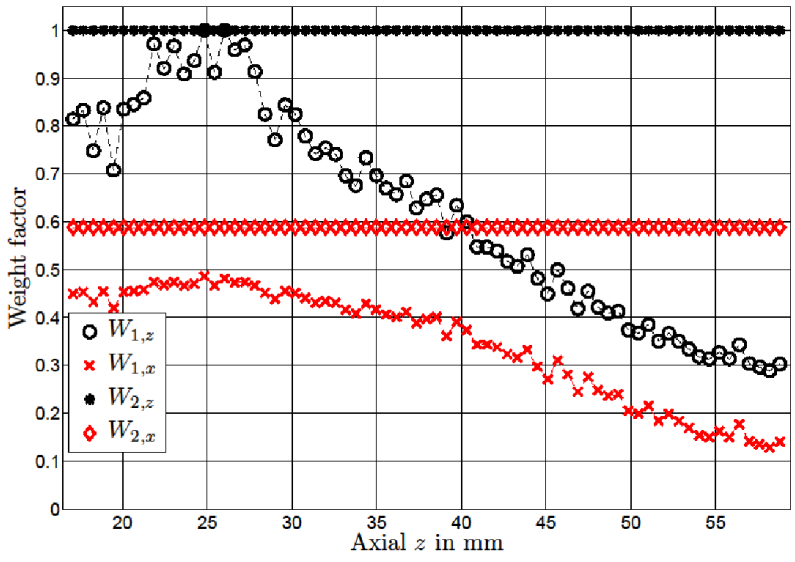


Fig. 7. Adaptive weight factors $W_1 = [W_{1,z}, W_{1,x}]$ and constant weight factors $W_2 = [W_{2,z}, W_{2,x}]$ used for the reconstruction depicted as a function of axial depth z.

4.4 RECONSTRUCTION RESULTS

Reconstructed elastograms are depicted in Fig. 8 for two different regularization coefficients $\rho_1 : \rho_2 = 1 : 3.6$ when either the adaptive weight factors $W_1[i,j]$ or the spatially constant weight factors $W_2[i,j]$ are applied. For demonstration purposes, the regularization coefficients ρ_1 and ρ_2 were determined such that in the reconstructed elastograms the best visual differentiation between the background and inclusions exists when using $W_1[i,j]$ and $W_2[i,j]$, respectively. It specifically needs to be pointed out here, that Fig. 8 depicts the "raw" reconstruction data, i.e. neither the displacement estimates nor the reconstructed elastograms were filtered, averaged or "visually improved" in any kind.

For the smaller regularization coefficient ρ_1 (i.e. low(er) degree of regularization), the increasing displacement estimation errors towards the bottom regions lead to significant artifacts (under-regularization) in the reconstructed elastogram when constant weight factors $W_2[i,j]$ are used. However, the reconstructed elastogram for the adaptive weight factors $W_1[i,j]$ appears sufficiently regularized even at the bottom regions. For the larger regularization coefficient ρ_2 (i.e. higher degree of regularization) the elastograms for both weight factors $W_1[i,j]$ (adaptive) and $W_2[i,j]$ (constant) appear to be sufficiently regularized (with some advantages with regard to the bottom regions when appyling the adaptive weight factors). However, in both cases ($W_1[i,j]$ and $W_2[i,j]$) the spatial resolution is worse compared to the reconstruction results obtained with the smaller regularization coefficient ρ_1. The effects of over-regularization are most clearly pronounced at the edges between the background and the inclusion(s), which are more difficult to define in structure and size when ρ_2 is applied. It can be concluded from the visual appearance of the elastograms that the use of adaptive weight factors $W_1[i,j]$ and an appropriate regularization coefficient results in a superior quality of the reconstructed elastograms.

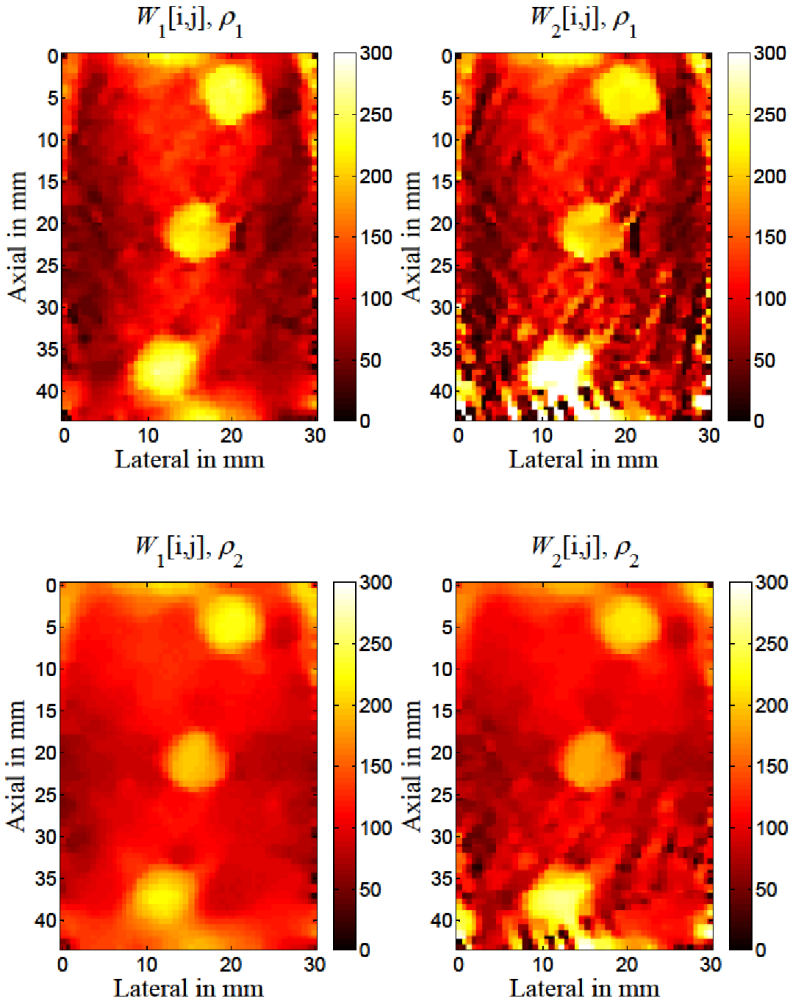


Fig. 8. Reconstruction results $E_\rho[m,n]$ using displacement estimates derived from experimental ultrasound echo data for adaptive weight factors $W_1[i,j]$ (left column) and constant weight factors $W_2[i,j]$ (right column) and the two "best" values of ρ (see text).

In order to compare the quality of the reconstructed elastograms on a quantitative basis, the two measures "contrast" and "background homogeneity" were used. The elastogram contrast

$$C_I = \frac{\bar{E}_{\rho,I}}{\bar{E}_{\rho,B}} \cdot \tag{20}$$

of the 3 inclusions ($\bar{E}_{\rho,I}$)and the background ($\bar{E}_{\rho,B}$)was calculated for the reconstruction results E_ρ shown in Fig. 8. The respective mean values $\bar{E}_{\rho,B}$ and $\bar{E}_{\rho,I}$ were derived from the elastograms for 3 equally-sized "depth regions" (indicated by the 2 dashed straight lines in Fig. 9) each of which comprises one inclusion. According to the indentor measurements performed using samples of the inclusion and background materials (see also section 4.1), the (true) contrast is C_I = 254 kPa/92 kPa = 2.8.

In order to quantify the background homogeneity, the empirical standard deviation $\sigma_{E_{\rho,B}}$ of E_ρ was calculated inside the 3 background regions shown in Fig. 9. This measure might be also of diagnostic importance since a small inclusion even at a large contrast can be easily overlooked in a reconstructed elastogram with spatially (too) inhomogeneous background.

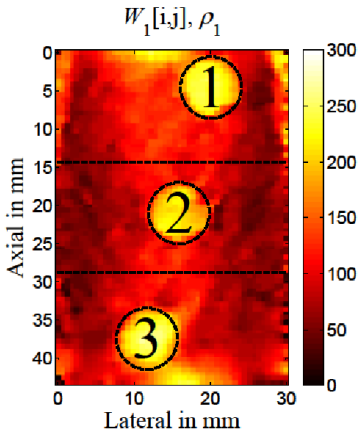


Fig. 9. Reconstructed elastogram E_ρ[m,n] for W_1[i,j] and ρ_1 also shown in Fig. 8. The dashed lines and circles indicate the 3 regions of E-modulus nodes inside which the spatial mean values $\bar{E}_{\rho,B}(\sigma_{E_{\rho,1}})$ and $\bar{E}_{\rho,I}$ were calculated.

In Tab. 3 the values of $\sigma_{E_{\rho,B}}$ and C_I are shown for all 3 regions when using either W_1[*i, j*] or W_2[*i, j*] and for both values ρ_1 and ρ_2 of the reconstruction coefficient. The contrast C_I in all 3 regions is higher - for both W_1[*i, j*] and W_2[*i, j*] - when the smaller regularization coefficient ρ_1 is used. With an increasing elastogram contrast that approaches the true value, the homogeneity of the in fact completely homogenous background significantly degrades. This degration expressed by an increase in $\sigma_{E_{\rho,B}}$ is much less pronounced when the adaptive weight factors W_1[*i,j*] instead of the constant weight factors W_2[*i,j*] are applied. For example, $\sigma_{E_{\rho,B}}$ in region 3 with W_1[*i,j*] is less than half (38.4 kPa) of the value (80.5 kPa) obtained with W_2[*i,j*]. This can also be (visually) observed in Fig. 8.

Table 3: Values of $\sigma_{E_{\rho},B}$ and C_l for the 3 regions (each of which with one cylindrical inclusion) and the 2 values of ρ. The true value for C_l is 2.76, the best value for $\sigma_{E_{\rho},B}$ is 0.

Inclusion #	ρ	$\sigma_{E_{\rho},B}$ in kPa		C_l	
		$W_1[i,j]$	$W_2[i,j]$	$W_1[i,j]$	$W_2[i,j]$
1	ρ_1	40.3	42.9	1.8	1.8
1	ρ_2	27.0	26.9	1.5	1.5
2	ρ_1	26.2	32.6	2.4	2.3
2	ρ_2	15.4	15.8	1.8	1.8
3	ρ_1	38.4	80.5	2.2	2.4
3	ρ_2	27.1	48.9	1.7	2.0

In Fig. 10 the reconstructed elastogram for ρ_1 and $W_1[i,j]$ is directly compared to a conventional strain image (axial strain). The strain image was derived from the same axial displacement estimates that were used for the E-modulus reconstruction by applying a least-squares strain filter with 11 filter taps as described in [13].

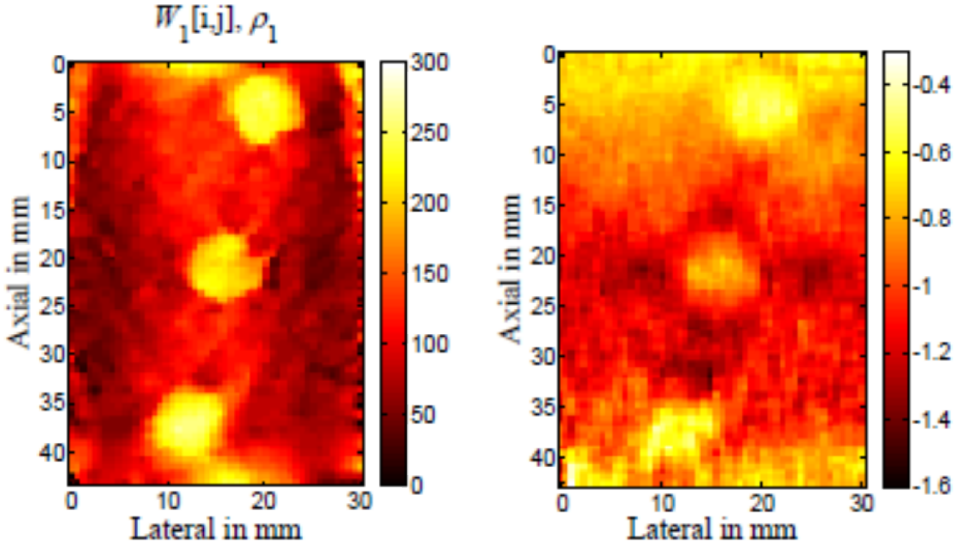


Fig. 10. Left: reconstructed E-modulus distribution $E_\rho[m, n]$ when using ρ_1 and $W_1[i,j]$. Right: corresponding conventional image of the axial strain derived from the same displacement data. The applied strain is 1.0 %, the color maps are scaled in kPa (left) and % (right).

The superior quality of the reconstructed elastogram is obvious. While the reconstructed elastogram clearly depicts all 3 inclusions on a relatively homogenous background, the strain image is not quite as clear: inclusions 1 and 3 are difficult to (diagnostically) assess, and even in the region with inclusion 2 a rather low strain contrast exists.

5 CONCLUSIONS

In elastography, internal tissue displacements must be estimated. The unavoidable displacement estimation errors are governed by the applied estimator, the ultrasound imaging parameters, and the coherence of the (digital) echo signals; the latter is influenced by tissue compression and noise. Depending on the displacement estimation method, the estimation errors might also depend on the displacement value (e.g. with full-sample displacement cyclo-stationarity). Since the signal-to-noise ratio in the field-of-view (FOV) is spatially non-stationary, the displacement estimation errors are also of non-

stationary character. As a result, the displacement estimation errors are always spatially dependent within the ultrasonic field-of-view.

E-modulus reconstruction processes applicable in practice most often employ regularization. If the amount of regularization is too small (under-regularization), a loss of homogeneity in regions with in fact homogenous E-modulus distribution occurs. If the amount of regularization is too large (over-regularization), diagnostically important high-frequency spatial information is lost. The optimal amount of regularization strikes the best balance between these two opposing effects and provides the best elastogram quality possible.

The conventional approach to solve the inverse problem is to apply equal regularization to the entire FOV, i.e. using (spatially) constant weight factors $W_2[i, j]$ = const. As we have demonstrated for a typical breast elastography situation, this approach inevitably leads to under- and over-regularization in different depth regions of the FOV at the same time. The approach proposed in this paper applies (spatially) adaptive weight factors $W_1[i, j]$, which are derived from the mean square displacement estimation errors by means of an appropriate confidence measure C. As a result, over- and under-regularization at the top and bottom regions within the FOV are significantly reduced because the weight factors are adapted as a function of depth. This leads to superior E-modulus reconstruction results and elastogram quality that might help improve the diagnostic value of ultrasound elastography. An even more sophisticated - but computationally also more expensive - approach that we currently investigate is to fully adapt the weight factors in both, the axial and lateral directions.

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Étude théorique de la chimio-, régio- et stéréosélectivité de l'interaction entre l'α-trans-himachalène et le dichlorocarbène par la méthode de la théorie de la fonctionnelle de la densité (DFT) B3LYP/6-311G (d, p)

[Theoretical study of the chemo-, regio- and stereoselectivity of the interaction between dichlorocarbene and α-trans-himachalene using density functional theory (DFT) B3LYP/6-31G (d, p)]

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ABSTRACT: The reaction between α-trans-himachalene and dichlorocarbene has been studied using density functional theory (DFT) B3LYP/6-311G (d, p). The global electrophilicity and global nucleophilicity indices indicate that α-trans-himachalene behaves as a nucleophile while dichlorocarbene behaves as an electrophile. The majority product obtained by stoichiometric reaction between dichlorocarbene and α-trans-himachalene is (1R, 2S, 4R, 7S)-3,3-dichloro-8-methylene-4,12,12-trimethyl-tricyclo [5.5.0.$0^{2,4}$] dodecane (referred to here as $P_1(\alpha)$): in this reaction the attack takes place at the endocyclic double bond at the α side of α-trans-himachalene. The majority product obtained by the reaction between two equivalents of dichlorocarbene with α-trans-himachalene is (1R, 2S, 4R, 7S, 8R)-3,3,13,13-tetrachloro-4,12,12-trimethyl-tricyclo [5.5.0.$0^{2,4}$] -spiro[2^8] tetradecane (referred to here as $P_2(\beta)$): here the attack takes place at the β side of the exocyclic double bond. $P_2(\beta)$ is also obtained by the equimolar reaction of $P_1(\alpha)$ with dichlorocarbene. $P_1(\alpha)$ and $P_2(\beta)$ are both exothermic. Analysis of local electrophilicity and local nucleophilicity indices demonstrates the chemo-, regio- and stereoselectivity of the reaction. Analysis of the potential energy surface shows that this reaction follows an asynchronous concerted mechanism. Calculating the intrinsic reaction coordinate (IRC) shows that the reaction mechanism can be characterized as "one-step" and "two-stage". Stationary points were characterized by frequency calculations in order to verify that the transition states had one and only one imaginary frequency.

KEYWORDS: asynchronous concerted mechanism, electrophilicity, frontier molecular orbital theory, nucleophilicity, reactivity index, transition state theory.

RESUME: L'étude de la réaction entre l'α-trans-himachalène et le dichlorocarbène a été étudiée par la méthode de la théorie de la fonctionnelle de la densité DFT B3LYP/6-311G (d, p). L'analyse des indices globaux d'électrophilie et de nucléophilie montre que l'α-trans-himachalène se comporte comme nucléophile, alors que le dichlorocarbène se comporte comme électrophile. La réaction stœchiométrique de l'α-trans-himachalène avec le dichlorocarbène donne comme produit majoritaire le (1R, 2S, 4R, 7S)-3,3-dichloro-8-méthylène-4,12,12-trimethyl-tricyclo [5.5.0.$0^{2,4}$] dodécane (noté $P_1(\alpha)$) : ce produit résulte de l'attaque de la double liaison endocyclique de l'α-trans-himachalène en face α. La réaction de l'α-trans-

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himachalène avec deux équivalents du dichlorocarbène donne comme produit majoritaire le (1R, 2S, 4R, 7S, 8R)-3,3,13,13-tetrachloro-4,12,12-triméthyl-tricyclo[5.5.0.$0^{2,4}$]spiro[2^{8}]tetradécane (noté $P_2(\beta)$) : ce produit résulte de l'attaque de la double liaison exocyclique de l'α-trans-himachalène en face β. Le produit $P_2(\beta)$ est aussi obtenu par la réaction équimolaire du $P_1(\alpha)$ avec le dichlorocarbène. Les deux produits $P_1(\alpha)$ et $P_2(\beta)$ sont exothermiques. L'analyse des indices locaux d'électrophilie et de nucléophilie nous permettent d'expliquer la chimio-, régio- et stéréosélectivité de la réaction. L'analyse de la surface d'énergie potentielle montre que cette réaction suit un mécanisme asynchrone concerté. Le calcul IRC (Intrinsic Reaction Coordinate) de la réaction met en évidence la nature "une étape" (one-step) en "deux phases" (two-stage) du mécanisme de cette réaction. Les points stationnaires ont été caractérisés par des calculs de fréquence afin de vérifier que les états de transitions ont une et une seule fréquence imaginaire.

MOTS-CLEFS: Électrophilie, nucléophilie, indice de réactivité, mécanisme asynchrone concerté, théorie des orbitales moléculaires frontières, théorie de l'état de transition.

1 INTRODUCTION

Ce travail fait suite à notre étude sur la réactivité de l'huile essentielle du cèdre de l'Atlas (*Cedrus atlantica*) qui est une des matières premières utilisées dans l'industrie de la parfumerie. Cette huile a été l'objet de diverses études consacrées à l'isolement, à l'identification et à la réactivité de ses constituants [1], [2], [3], [4], [5].

L'huile essentielle du cèdre de l'Atlas est constituée principalement (75%) de trois hydrocarbures bicycliques sesquiterpéniques, à savoir l'α-cis-himachalène, le β-himachalène et le γ-cis-himachalène. Son traitement avec l'acide chlorhydrique dans l'acide acétique suivi de la déshydrohalogénation en milieu basique conduit à la formation de l'α-trans-himachalène [6], [7], [8]. La réactivité de ces sesquiterpènes a été largement étudiée [9], [10], [11], [12]. En plus, des études ont été réalisées sur la réactivité des himachalènes (hémisynthèse) afin d'obtenir de nouveaux composés ayant des propriétés olfactives intéressantes dans la parfumerie [13], [14], [15]. Nous avons étudié l'action de deux quantités différentes de dichlorocarbène sur α-trans-himachalène en analysant la chimiosélectivité et la régiosélectivité de ces réactions. L'attaque d'un équivalent de dichlorocarbène s'effectue sur la double liaison la plus substituée de la face α de l'α-trans-himachalène, tandis que la deuxième attaque en présence de deux équivalents de dichlorocarbène s'effectue sur la double liaison exocyclique de la face β. Par conséquent, la double liaison endocyclique de l'α-trans- et l'α-cis-himachalène se comporte de la même façon que la double liaison exocyclique.

L'étude du comportement de l'α-trans-himachalène en présence du dichlorocarbène par des calculs théoriques nous a permis d'analyser la chimiosélectivité en utilisant l'indice local d'électrophilie du dichlorocarbène et l'indice local de nucléophilie pour l'α-trans-himachalène. Expérimentalement, il a été trouvé que l'action d'une quantité stœchiométrique du dichlorocarbène sur l'α-trans-himachalène donne le régioisomère α, noté $P_1(\alpha)$, et le régioisomère β, noté $P_1(\beta)$, respectivement majoritaire et minoritaire. L'excès de dichlorocarbène sur l'α-trans-himachalène donne le régioisomère α, noté $P_2(\alpha)$, et le régioisomère β, noté $P_2(\beta)$, respectivement minoritaire et majoritaire (Figure 1).

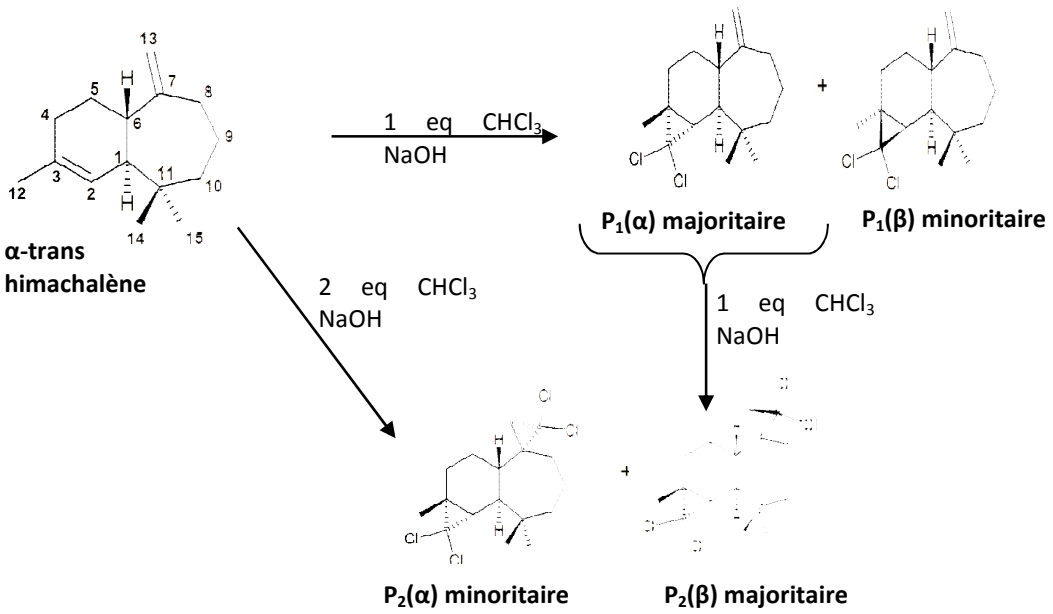


Fig. 1. Réaction de l'action du dichlorocarbène sur α-trans-himachalène

2 MÉTHODOLOGIE DE CALCUL

Le mécanisme et les géométries d'équilibre de la réaction de l'α-trans-himachalène avec le dichlorocarbène, ainsi que les états de transition correspondant aux deux approches α et β, ont été étudiés par la méthode DFT B3LYP/6-311G (d, p) [16], [17]. Les états de transition ont été localisés. Leur existence a été confirmée par la présence d'une seule fréquence imaginaire dans la matrice hessienne. L'IRC (Intrinsic Reaction Coordinate) [18] a été calculée et tracée afin de montrer que l'état de transition est bien relié aux deux minima (réactifs et produit). Les structures électroniques des points stationnaires et les ordres de liaison (indices de Wiberg) [19] ont été analysés par la méthode NBO (Natural Bond Orbital) [20], [21]. Les valeurs des enthalpies, des entropies et des énergies libres ont été calculées par la thermodynamique statistique standard. Tous les calculs ont été effectués par la méthode DFTB3LYP/6-311G (d, p), implantée dans le programme Gaussian 09 [22].

Afin de mettre en évidence le caractère électrophile/nucléophile des réactifs, nous avons calculé le potentiel chimique électronique μ et la dureté globale η. Ces deux grandeurs statistiques peuvent être calculées à partir des énergies des orbitales moléculaires frontières HOMO et LUMO. Elles sont données sous la forme $\mu=(E_{HOMO}+E_{LUMO})/2$ et $\eta=(E_{LUMO}-E_{HOMO})$ respectivement [23]. L'indice d'électrophilie global $\omega=(\mu^2/2\eta)$ [24] est aussi défini comme la stabilisation énergétique due au transfert de charge. La référence [25] a démontré que le caractère nucléophile d'une molécule peut être relié à son aptitude de négliger sa densité électronique. L'indice de nucléophilie N est exprimé en fonction de l'énergie HOMO du tétracyanoéthylène (TCE) sous la forme $N=E_{HOMO}(Nu)–E_{HOMO}(TCE)$ [26].

Les indices de réactivité ont été calculés à partir des énergies HOMO et LUMO à l'état fondamental des molécules par la méthode DFT B3LYP/6-311G (d, p). Les indices statiques d'électrophilie locale ω_k [27] et de nucléophilie locale N_k [28] sont des descripteurs fiables pour la prédiction de l'interaction électrophilie-nucléophilie la plus favorisée pour la formation d'une liaison chimique entre deux atomes. Les expressions $\omega_k = \omega.P_{k+}$ et $N_k=N.P_{k-}$ [29] sont respectivement les indices d'électrophilie locale ω_k et de nucléophilie locale N_k. P_{k+} et P_{k-} sont obtenus par l'analyse de la densité atomique de spin Mulliken de l'anion et du cation [29].

3 RÉSULTATS ET DISCUSSION: ANALYSE DES INDICES DE LA RÉACTIVITÉ DES RÉACTIFS À L'ÉTAT FONDAMENTAL

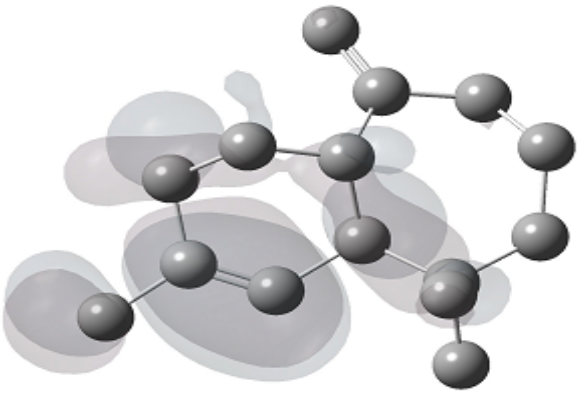
3.1 PRÉDICTION DU CARACTÈRE NED (NORMAL ELECTRON DEMAND) / IED (INVERSE ELECTRON DEMAND)

L'étude théorique consacrée au calcul des écarts d'énergie HOMO/LUMO des réactifs α-trans-himachalène et dichlorocarbène nous a permis de prédire le caractère NED (Normal Electron Demand) ou IED (Inverse Electron Demand) de l'interaction entre ces réactifs. Les indices globaux et locaux définis dans le cadre de la DFT conceptuelle [30] sont des outils efficaces pour étudier la réactivité des interactions polaires.

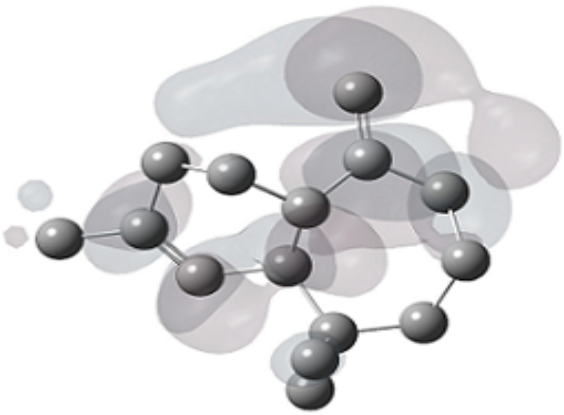
Les propriétés globales statiques: le potentiel chimique électronique μ, la dureté chimique η, l'indice d'électrophilie globale ω et l'indice de nucléophilie globale N de l'α-trans-himachalène et du dichlorocarbène sont des propriétés chimiques qui nous ont permis d'analyser la réactivité des sites des réactifs. Il s'avère que l'écart énergétique entre HOMO de l'α-trans-himachalène et LUMO du dichlorocarbène est de 2,5005 eV, bien que l'écart énergétique entre HOMO du dichlorocarbène et LUMO de l'α-trans-himachalène est de 7,9610 eV (Tableau 1). Ce résultat montre que l'α-trans-himachalène se comporte comme nucléophile, alors que le dichlorocarbène se comporte comme électrophile. La localisation des orbitales moléculaires HOMO de l'α-trans-himachalène et LUMO du dichlorocarbène sont représentés sur la Figure 2.

Tableau 1. Différence des énergies entre HOMO et LUMO de la réaction de l'α-trans-himachalène avec le dichlorocarbène (en eV)

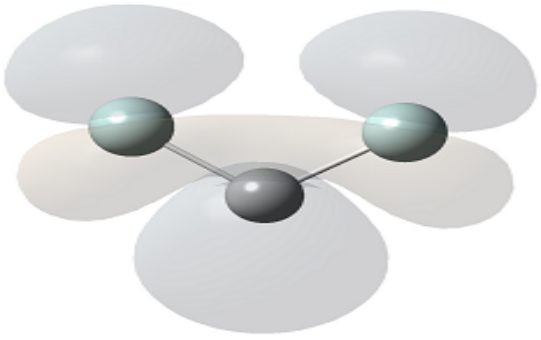
	HOMO	**LUMO**	**E_{HOMO}(α-trans-himachalène) – E_{LUMO}(dichlorocarbène)**	**E_{LUMO}(dichlorocarbène) – E_{HOMO}(α-trans-himachalène**
α-trans-himachalène	-6,2801	0,4058	2,5005	7,9610
Dichlorocarbène	-7,5552	-3,7796		



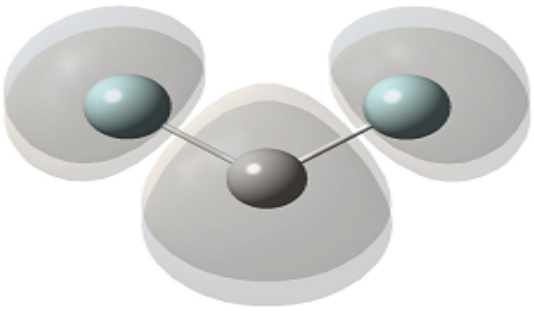
Les orbitales moléculaires HOMO
de l'α-trans-himachalène



Les orbitales moléculaires LUMO
de l'α-trans-himachalène



Les orbitales moléculaires HOMO
du dichlorocarbène



Les orbitales moléculaires LUMO
du dichlorocarbène

Fig. 2. Carte d'isodensité des orbitales moléculaires HOMO et LIMO de l'α-trans-himachalène et du dichlorocarbène

Le Tableau 2 montre que le potentiel chimique électronique μ de l'α-trans-himachalène est supérieur à celui du dichlorocarbène, tandis que l'indice d'électrophilie globale ω du dichlorocarbène est supérieur à celui de l'α-trans-himachalène. Ces résultats ont bien confirmé la nucléophilie de l'α-trans-himachalène et l'électrophilie du dichlorocarbène,

ce qui implique que le transfert de charge a lieu du α-trans-himachalène vers le dichlorocarbène. La grande différence d'électrophilie (Δω = 3,6085 eV) entre l'α-trans-himachalène et le dichlorocarbene indique une haute polarité du caractère NED pour cette réaction.

Tableau 2. ***Potentiel chimique électronique μ (eV), dureté η (eV), électrophilie global ω (eV) et nucléophilie global N (eV) de l'α-trans-himachalène et du dichlorocarbène***

	μ	η	ω	N
α-trans-himachalène	-2,9372	6,6858	0,6452	0,1135
Dichlorocarbène	-5,6675	3,7756	4,2537	0,0666

3.2 PRÉDICTION DE LA RÉGIOSÉLECTIVITÉ DE LA RÉACTION PAR LA DÉTERMINATION DES INDICES DE L'ÉLECTROPHILIE ET DE LA NUCLÉOPHILIE

Selon le modèle polaire de Chattaraj [31], [32], les indices locaux de philicité (ω_k et N_k) sont des indicateurs fiables pour la prédiction de l'interaction la plus favorisée entre deux centres polaires. Le régioisomère le plus favorable est celui associé au plus grand indice d'électrophilie locale ω_k de l'électrophile et le plus grand indice de nucléophilie local N_k du nucléophile. Nous avons analysé la valeur N_k pour l'α-trans-himachalène et la valeur ω_k pour le dichlorocarbène afin de prédire l'interaction électrophile/nucléophile la plus probable le long du chemin réactionnel pour expliquer la chimio- et la régiosélectivité de la réaction. Le carbone C du dichlorocarbène est le site le plus électrophile actif, ω_C=4.1208 eV. Les atomes de carbone C_2 et C_3 de la double liaison endocyclique de l'α-trans-himachalène sont plus nucléophiles et plus actifs que les atomes C_7 et C_{13} de la double liaison exocyclique. Par ailleurs, l'atome de carbone C_3 est le site le plus nucléophile de l'α-trans-himachalène (N_{C3}=0,2729 eV). La Figure 3 représente les sites les plus actifs des réactifs. On peut déduire que l'interaction la plus favorable a lieu entre l'atome de carbone C_3 de l'α-trans-himachalène et l'atome de carbone C du dichlorocarbène, suivie d'une fermeture de cycle concomitante par la formation de la seconde liaison C-C_2. L'interaction entre le nucléophile α-trans-himachalène et l'électrophile dichlorocarbène est donc compétitive.

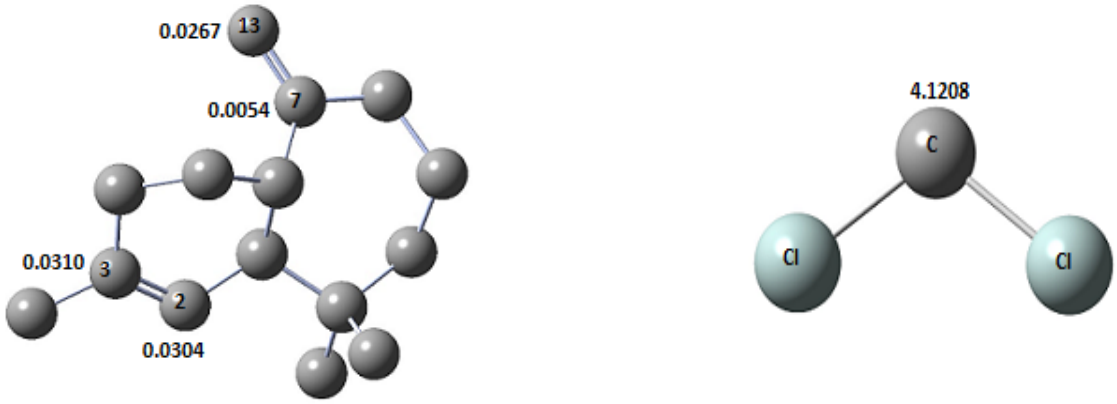


Fig. 3. ***La nucléophilie locale N_k (eV) de l'α-trans-himachalène et l'électrophilie locale ω_k (eV) du dichlorocarbène***

Les produits majoritaires obtenus de cette réaction sont bien liés aux deux sites actifs C=C de l'α-trans-himachalène. La figure 4 montre que l'attaque conduit à la formation de deux chemoisomères, dont chacun comporte deux régioisomères α et β.

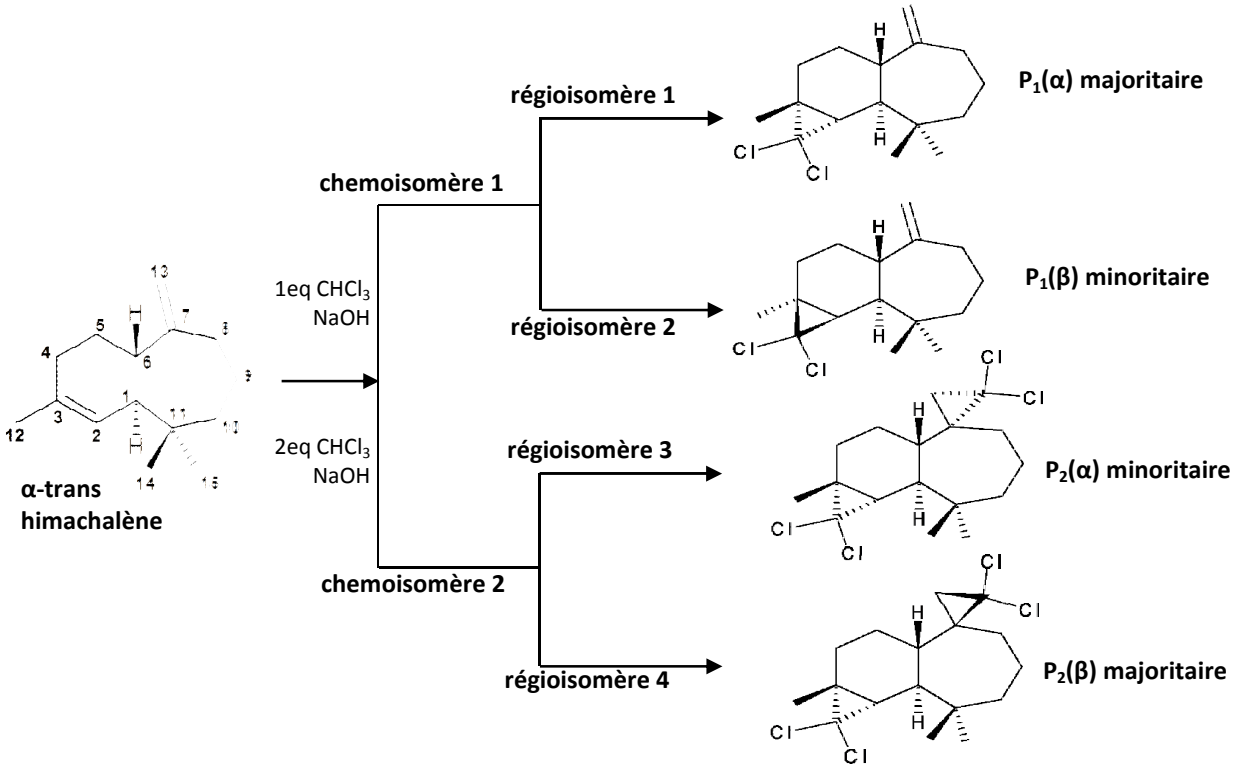


Fig. 4. La réaction de l'α-trans-himachalène avec le dichlorocarbène suivant la chimiosélectivité

4 ÉTUDE DU MÉCANISME DE LA RÉACTION ENTRE L'A-TRANS-HIMACHALÈNE ET LE DICHLOROCARBÈNE

4.1 ANALYSE DE LA SURFACE D'ÉNERGIE POTENTIELLE ET PRÉDICTION DU MÉCANISME RÉACTIONNEL

La surface d'énergie potentielle (SEP) correspondant aux deux chemoisomères de la réaction entre l'α-trans-himachalène et le dichlorocarbène (réaction stœchiométrique et en excès) schématisée dans la figure 5 montre que l'état de transition TS_1 (correspondant à l'approche de la face α) pour une énergie d'activation de 0,7925 kcal/mol est situé à 8,496 kcal/mol au dessous de TS_2 (correspondant à l'approche β). Par conséquent, le régioisomère correspondant à l'approche α est cinétiquement plus favorisé que le régioisomère β dans la réaction stœchiométrique. La réaction avec un excès du dichlorocarbène donne lieu à deux états de transition: TS_3 (correspondant à l'approche α) avec une énergie d'activation de 6,4067 kcal/mol est situé à 3,9634 kcal/mol au-dessus de TS_4 (correspondant à l'approche β), ce qui implique que le régio-isomère correspondant à l'approche β est cinétiquement plus favorisé que le régioisomère α.

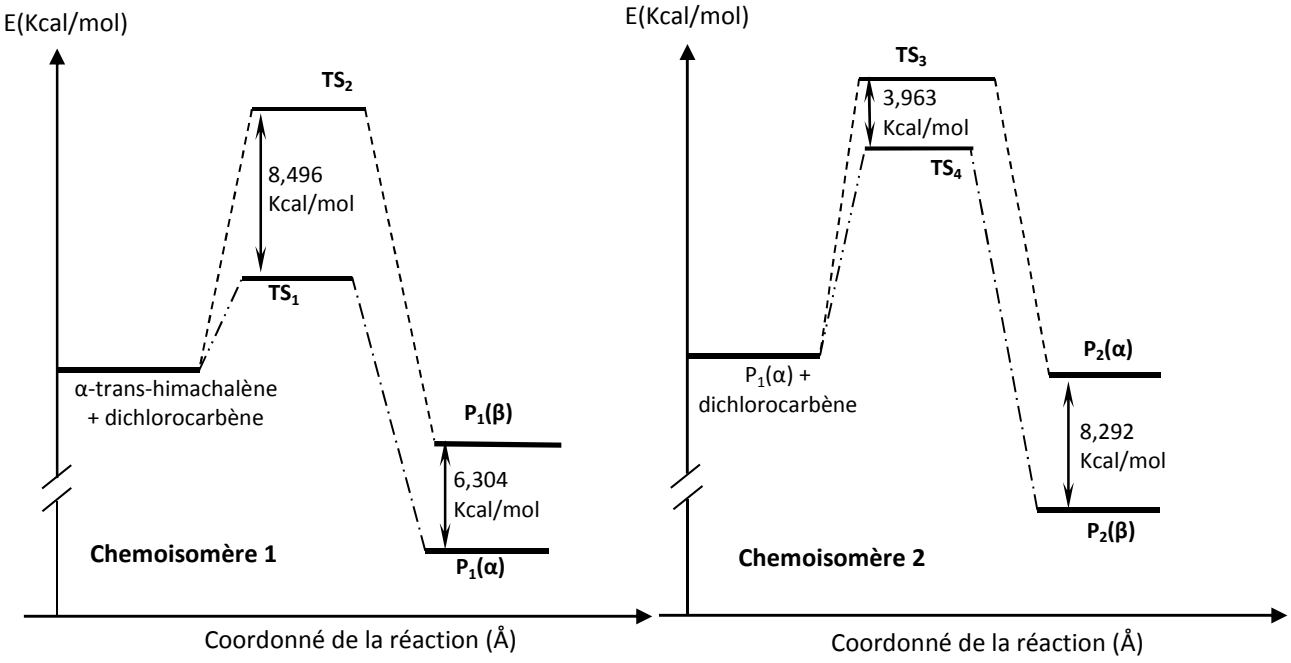


Fig. 5. Profil énergétique en kcal/mol pour la réaction de l'α-trans-himachalène avec le dichlorocarbène suivant la chimiosélectivité

4.2 ANALYSE DE L'IRC DE LA RÉACTION DE L'A-TRANS-HIMACHALÈNE AVEC LE DICHLOROCARBÈNE

La réaction de cyclo-addition peut avoir deux principaux mécanismes, soit concerté, soit par étapes. Dans le cas du mécanisme concerté, il s'effectue soit par une seule étape avec formation simultanée et asynchrone (vitesses différentes) de deux liaisons, ou par une seule étape mais avec deux phases caractérisées par la formation de la première liaison σ suivie par la fermeture du cycle sans passage par un intermédiaire stable, tandis que le mécanisme réalisé en deux étapes passe par un intermédiaire réactionnel. L'étude de l'évolution du système moléculaire le long du chemin réactionnel entre l'α-trans-himachalène et le dichlorocarbène a été effectuée par le calcul IRC afin de montrer que l'état de transition est bien relié aux deux minima (réactifs et produit).

Les courbes E=f (RC) correspondant à tous les chemins réactionnels possibles sont données dans la figure 6. Le calcul IRC indique que cette réaction suit un mécanisme concerté en une seule étape mais en deux phases [33]. Le chemoisomère 1 correspond à la formation de la liaison C-C_3, suivie par la fermeture du cycle par la liaison C-C_2, tandis que le chemoisomère 2 correspond à la formation de la liaison C-C_{13}, suivie par la fermeture du cycle par la liaison C-C_7. L'analyse de l'IRC calculée par la méthode DFT B3LYP/6-311G (d, p) montre que quelque soit la quantité utilisée du dichlorocarbène pour l'interaction avec l'α-trans-himachalène, les états de transition sont atteints sans passage par un intermédiaire stable.

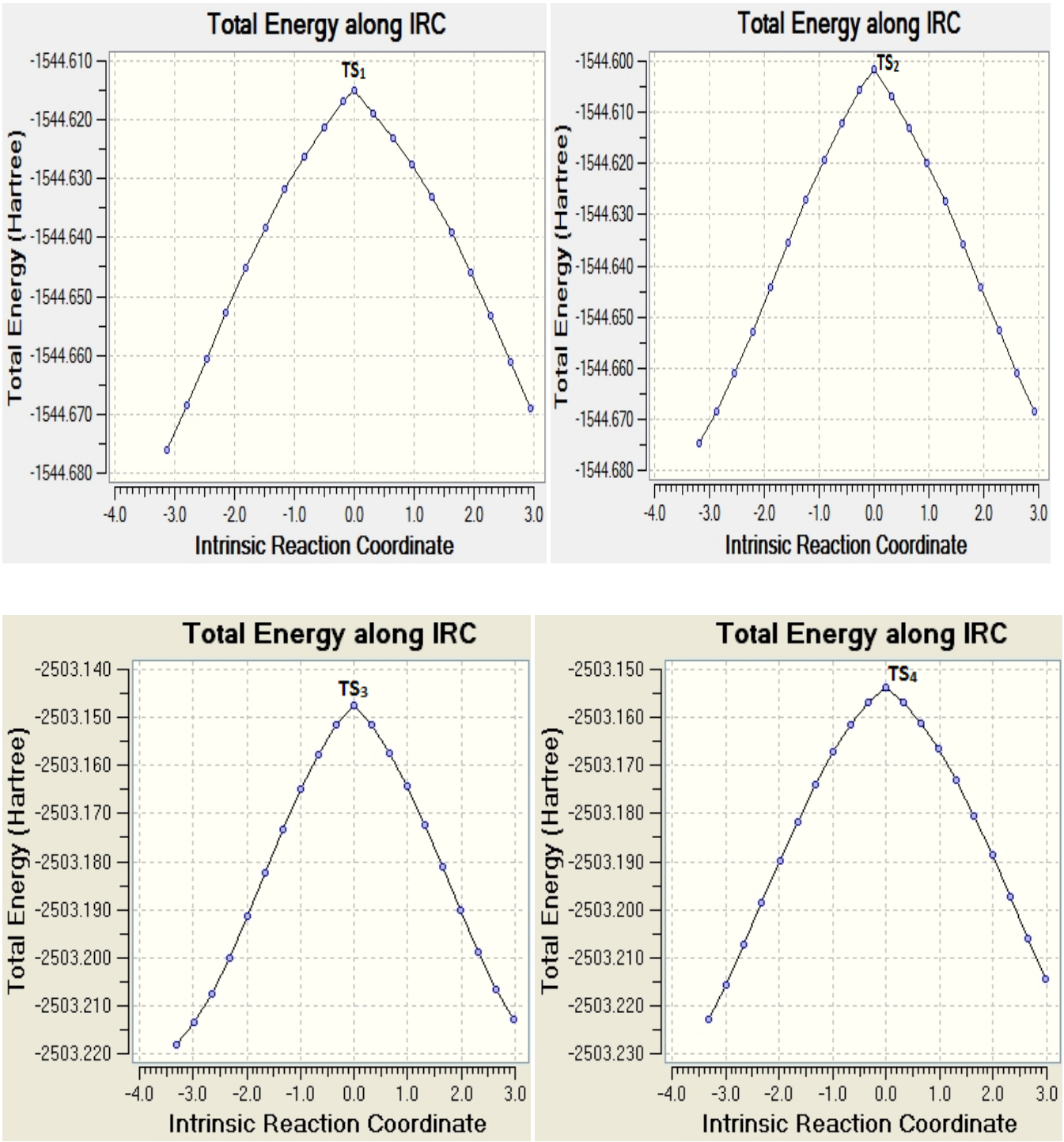


Fig. 6. IRC de la réaction entre l'α-trans-himachalène et le dichlorocarbène calculé par B3LYP/6-311G (d, p)

Les tableaux 3 et 4 montrent qu'après l'inclusion des corrections thermiques pour les énergies thermodynamiques, les enthalpies libres d'activation de TS_1 et TS_2 augmentent respectivement de 14,9655 kcal/mol et de 23,3283 kcal/mol, alors que les enthalpies libres d'activation de TS_3 et TS_4 augmentent respectivement de 20,6181 kcal/mol et de 16,9227 kcal/mol (tableau 4). Ces valeurs élevées sont une conséquence des entropies d'activation défavorables associées à ce processus.

Tableau 3. Les énergies thermodynamiques de la réaction de l'α-trans-himachalène avec un équivalent de dichlorocarbene calculées par DFT B3LYP/6-311G (d, p)

		Réactifs		TS_1	TS_2	$P_1(\alpha)$	$P_1(\beta)$
		α-trans-himachalène	Dichloro-carbène				
E	**(u.a.)**	-586,1680	-958,4483	-1544,6151	-1544,6015	-1544,7092	-1544,6992
ΔE	**(Kcal/mol)**			0,7925	9,2885	-58,3077	-52,0037
H	**(u.a.)**	-585,7965	958,4400	-1544,2335	-1544,2200	-1544,3241	-1544,3135
ΔH	**(Kcal/mol)**			1,8173	10,2974	-55,0200	-48,3578
S	**(cal/mol.K)**	119,1160	63,4860	138,5000	138,8940	135,0520	133,6640
ΔS	**(cal/mol.K)**			-44,1020	-43,7080	-47,5500	-48,9380
G	**(u.a.)**	-585,8531	-958,4701	-1544,2993	-1544,2860	-1544,3883	-1544,3770
ΔG	**(Kcal/mol)**			14,9655	23,3283	-40,8433	-33,7675
υ	**(cm^{-1})**			-570,922	-687,793		

Les produits $P_1(\alpha)$ et $P_1(\beta)$ obtenus pour une quantité stœchiométrique des réactifs sont fortement exothermiques, par -58,3077 kcal/mol et -52,0037 kcal/mol respectivement. Par conséquent, le $P_1(\alpha)$ est thermodynamiquement plus favorisé que le $P_1(\beta)$. Dans la deuxième réaction (utilisation d'un excès du dichlorocarbène) les produits $P_2(\alpha)$ et $P_2(\beta)$ sont aussi exothermiques par -49,6879 kcal/mol et -57,9802 kcal/mol respectivement, ce qui implique que le produit $P_2(\beta)$ est thermodynamiquement plus favorisé que le produit $P_2(\alpha)$.

Tableau 4. Les énergies thermodynamiques de la réaction de l'α-trans-himachalène avec deux équivalents de dichlorocarbene calculées par DFT B3LYP/6-311G (d, p)

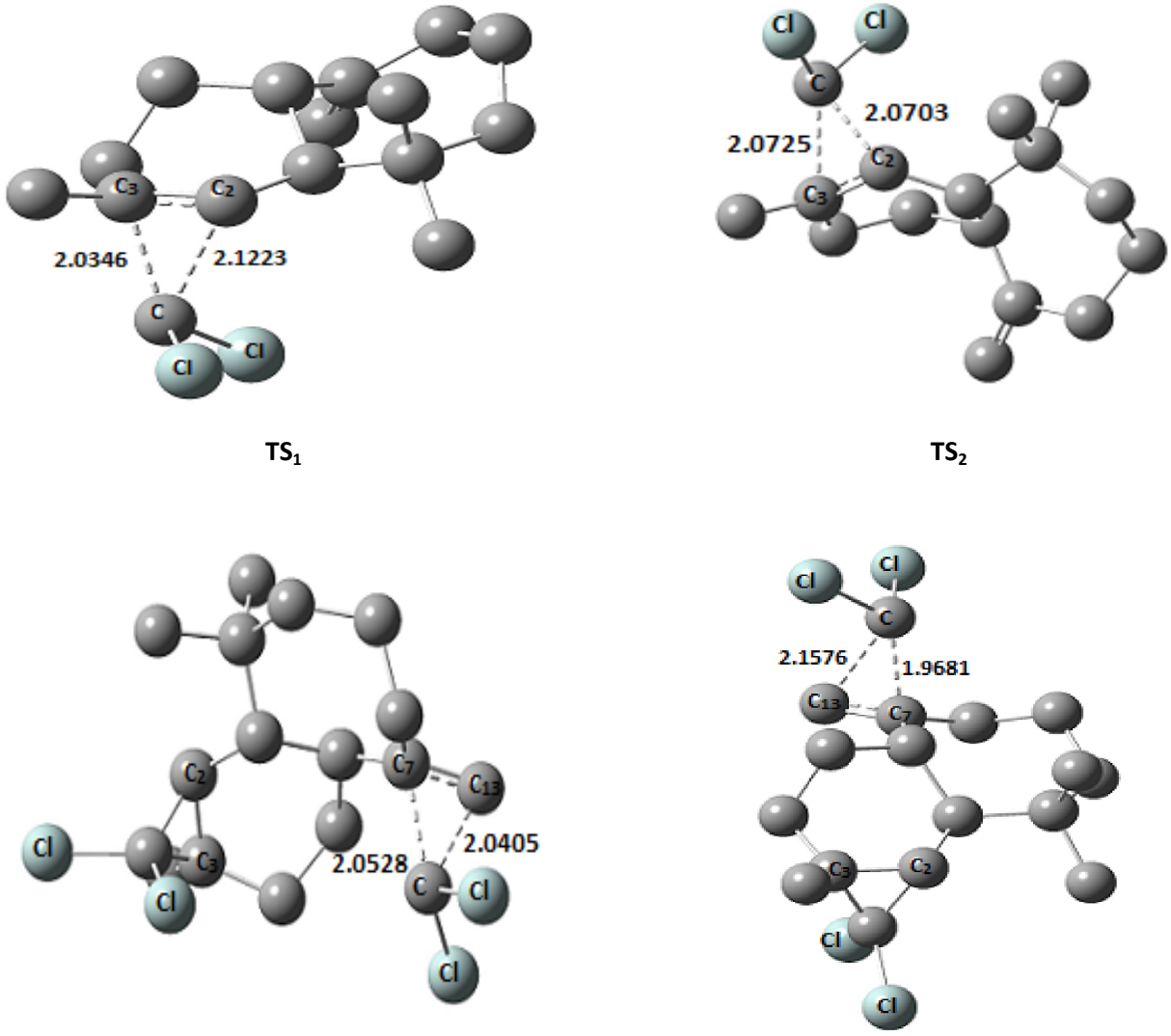
		Réactifs		TS_3	TS_4	$P_2(\alpha)$	$P_2(\beta)$
		$P_1(\alpha)$	Dichloro-carbène				
E	**(u.a.)**	-1544,7092	-958,4483	-2503,1473	-2503,1536	-2503,2367	-2503,2499
ΔE	**(Kcal/mol)**	-58,3077		6,4067	2,4433	-49,6879	-57,9802
H	**(u.a.)**	-1544,3241	958,4400	-2502,7523	-2502,7585	-2502,880	-2502,8452
ΔH	**(Kcal/mol)**	-55,0200		7,3688	3,5216	-46,3968	-50,8879
S	**(cal/mol.K)**	135,0520	63,4860	154,0990	153,5870	150,1970	149,7380
ΔS	**(cal/mol. K)**	-47,5500		-44,4390	-44,9510	-48,4310	-48,8000
G	**(u.a.)**	-1544,3883	-958,4701	-2502,8256	-2502,8315	-2502,9094	-2502,9163
ΔG	**(Kcal/mol)**	-40,8433		20,6181	16,9277	-31,9848	-36,3385
υ	**(cm^{-1})**			-653,290	-547,533		

Une légère modification de la stéréosélectivité se produit en conséquence de l'entropie d'activation élevée associée aux états de transition. Les calculs effectués montrent clairement que cette réaction est caractérisée par une faible stéréosélectivité [34].

4.3 ANALYSE STRUCTURALE DES ÉTATS DE TRANSITION DE LA RÉACTION

L'analyse des géométries des états de transition associées à la réaction de l'α-trans-himachalène avec le dichlorocarbène représentées dans la Figure 7 montre que les longueurs des liaisons formées par le chemo-isomère 1 sont de 2,1223 Å à d_1(C-C_2) et de 2,0346 Å à d_2(C-C_3) pour TS_1, et de 2,0703 Å à d_1(C-C_2) et de 2,0725 Å à d_2(C-C_3) pour TS_2, alors que celles formées par le chemoisomère 2 sont de 2,0528 Å à d_1(C- C_7) et de 2,0405 Å à d_2(C-C_{13}) pour TS_3 et de 1,9681 Å à d_2(C- C_7) et de 2,1576 Å à d_1(C_4-C_{13}) pour TS_4.

L'étude de l'asynchronicité de la formation d'une liaison de cette réaction peut être mesurée par la différence entre les deux longueurs de liaison formées σ, c'est-à-dire $\Delta d=d_1-d_2$. L'asynchronicité du chemoisomère 1 est de $\Delta d=0{,}0877$ Å à TS_1 et de $\Delta d=0{,}0022$ Å à TS_2, tandis que l'asynchronicité du chemoisomère 2 est de $\Delta d=0{,}0123$ Å à TS_3 et de $\Delta d=0{,}1895$ Å à TS_4. Par conséquent, les états de transition associés aux deux chemins chemoisomériques montrent que les régioisomères les plus favorisés sont plus asynchrones que les autres.



TS_1 **TS_2**

TS_3 **TS_4**

Fig. 7. Les longueurs des liaisons pour les états de transition de la réaction de l'α-trans-himachalène avec le dichlorocarbène (Å)

5 CONCLUSION

Le mécanisme et la chimio- et régiosélectivité de la réaction de l'α-trans-himachalène avec le dichlorocarbène ont été étudiés par la méthode DFT B3LYP/6-311G (d, p). L'analyse des indices globaux d'électrophilie et de nucléophilie montre que l'α-trans-himachalène a un caractère nucléophile, tandis que le dichlorocarbène a un caractère électrophile. La régiosélectivité expérimentale a été également confirmée par les indices locaux d'électrophilie et de nucléophilie ω_k et N_k.

Le calcul des énergies d'activation, l'analyse de la surface d'énergie potentielle et le calcul IRC montrent que cette réaction suit un mécanisme concerté asynchrone pour les produits majoritaires. L'interaction électrophile-nucléophile la plus favorisée pour un équivalent du dichlorocarbène a lieu à la face α de la double liaison la plus substituée de l'α-trans-himachalène conduisant à un produit dichloré, alors qu'en présence d'un excès du dichlorocarbène, l'interaction électrophile-nucléophile la plus favorisée a lieu à la face β de la double liaison exocyclique de l'α-trans-himachalène conduisant à un produit tetrachloré.

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Evaluating the effect of crystal field and transverse field on a 3/2 spin system using the Ising model

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ABSTRACT: In the work reported here we looked at the magnetic behaviour of a 3/2 spin system with crystalline anisotropy and transverse field. The spin Hamiltonian considered here contains terms which cannot be commuted further, giving rise to important quantum effects: quantum fluctuations and thermal fluctuations. We used the mean field approximation method to determine the expressions of magnetization along the z (longitudinal) axis and the x (transverse) axis, as well as the partition function. The thermal variations mz and mx for different values of the transverse field show that the latter inhibits order along the z axis and encourages spin confinement in the transverse plane.

KEYWORDS: crystal anisotropy, Ising model, magnetization, spin system, transverse field.

1 INTRODUCTION

Solid state chemists and physicists have long been interested in exchange interactions between transition ions within materials, because of their significance at a fundamental level. When these interactions affect all the magnetic sites of a crystal lattice, quantum models have to be used and numerous approximations are necessary. These quantum models have given theoretical results which are in good agreement with experimental results.

Application of altered spin chain models to αFe_2PO_5 compounds (ignoring interchain reactions) has shown that the behavior of this compound is ferromagnetic [1]. We have previously used the dimer and chain models to determine the magnetic sensitivity, specific heat and entropy of the compound $MnFePO_5$ [2]. The Fisher, dimer and Ising models have been used to determine the magnetic behaviour and certain thermodynamic properties of low dimensionality systems [3] [4]. Several authors have studied the critical behavior of the Ising Hamiltonian in the presence of the transverse field exactly in one dimension [5]. This model shows a quantum transition at T=0 when the transverse field tends towards a specific value (critical value Ω=Ωc). This transition is due essentially to quantum fluctuations [6]. This Hamiltonian has also been studied at higher dimensions using various approximation methods, e.g. development in series, development in 1/p where p is the coordination number [7], effective field methods [8].

In the work presented here, we have used the Ising model to study the effects of crystalline anisotropy and of the transverse field on the magnetic properties of a quantum system of spin 3/2.

2 EFFECT OF CRYSTAL FIELD AND TRANSVERSE FIELD ON A SYSTEM OF SPIN 3/2

2.1 SPIN HAMILTONIAN

The Hamiltonian of a given spin system, under the action of the transverse field and in the presence of the crystal field, is given by the following equation:

$$H = -\sum_{\langle ij \rangle} J_{ij} S_i^z S_i^z - \Omega \sum S_i^x - D \sum_i (S_i^z)^2 \quad (1)$$

where Ω is the transverse field, J_{ij} the exchange coupling constant, which is equal to J for the first near neighbours and to 0 for non-neighbours, and D is the crystalline anisotropy constant.

2.2 PARTITION FUNCTION

Let S_i^z and S_i^x be the matrices of the system of spin S = 3/2. They are written in the eigenvector base S_i^z as:

$$S_i^z = \begin{pmatrix} 3/2 & 0 & 0 & 0 \\ 0 & 1/2 & 0 & 0 \\ 0 & 0 & -1/2 & 0 \\ 0 & 0 & 0 & -3/2 \end{pmatrix} \quad (2)$$

$$S_i^x = \begin{pmatrix} 0 & \sqrt{3/2} & 0 & 0 \\ \sqrt{3/2} & 0 & 1 & 0 \\ 0 & 1 & 0 & \sqrt{3/2} \\ 0 & 0 & \sqrt{3/2} & 0 \end{pmatrix} \quad (3)$$

$$(S_i^z)^2 = \begin{pmatrix} 9/4 & 0 & 0 & 0 \\ 0 & 1/4 & 0 & 0 \\ 0 & 0 & 1/4 & 0 \\ 0 & 0 & 0 & 9/4 \end{pmatrix} \quad (4)$$

Using the mean field approximation method, the Hamiltonian (1) is reduced for a given spin system to the following equation:

$$-\beta H_1 = \lambda' S_1^z + \Gamma S_1^z + \Delta (S_1^z)^2 \quad (5)$$

Replacing the matrices S_i^x, S_j^z and $\left(S_j^z\right)^2$ in equation (5), the Hamiltonian (-βH1) can be written out as the following matrix:

$$-\beta H_1 = \begin{pmatrix} \left(\frac{3\lambda'}{2} + \frac{9\Delta}{4}\right) & \frac{\sqrt{3}\Gamma}{2} & 0 & 0 \\ \frac{\sqrt{3}\Gamma}{2} & \left(\frac{\lambda'}{2} + \frac{\Delta}{4}\right) & \Gamma & 0 \\ 0 & \Gamma & \left(-\frac{\lambda'}{2} + \frac{\Delta}{4}\right) & \frac{\sqrt{3}\Gamma}{2} \\ 0 & 0 & \frac{\sqrt{3}\Gamma}{2} & \left(-\frac{3\lambda'}{2} + \frac{9\Delta}{4}\right) \end{pmatrix} \quad (6)$$

Let $P_{3/2}$ be the characteristic polynomial of the matrix (6):

$$P_{3/2} = \det((-\beta H_1) - xI_4) = x^4 - Px^3 + Qx^2 + Rx + S \quad (7)$$

This polynomial is of degree 4 and allows four roots as solutions (x_1, x_2, x_3 and x_4). These roots are the eigenvalues of matrix (6) and the parameters P, Q, R and S of the polynomial $P_{3/2}$ are given by the following:

$$P = 5\Delta$$

$$Q = \frac{59}{8}\Delta^2 - \frac{5}{2}\lambda'^2 - \frac{5}{2}\Gamma^2$$

$$R = \frac{33}{3}\Delta\Gamma^2 - \frac{45}{16}\Delta^3 + \frac{9}{4}\Delta\lambda'^2$$

$$S = \frac{9}{8}\left(\frac{9}{32}\Delta^4 + \frac{1}{2}\lambda'^4 + \frac{1}{2}\Gamma^4 - \frac{21}{1}\Delta^2\Gamma^2 - \frac{5}{4}\Delta^2\lambda'^2 + \Gamma^2\lambda'^2\right)$$

To find the eigenvalues of matrix (6), we need to solve the equation $P_{3/2} = 0$, i.e.:

$$x^4 - Px^3 + Qx^2 + Rx + S = 0 \tag{8}$$

The variable $x = Y + P/4$ is exchanged in order to eliminate the order 3 term. Equation (8) then becomes:

$$Y^4 + aY^2 + bY + c = 0 \tag{9}$$

where:

$$a = Q^2 - \frac{3}{8}p^2$$

$$b = R + \frac{1}{2}QP - \frac{1}{8}P^3$$

$$c = \frac{1}{4}PR + \frac{1}{16}QP^2 - \frac{3}{256}P^4 + S$$

Equation (9) can also be written as follows:

$$(Y^2 + tY + \mu)(Y^2 - tY + \eta) = 0 \tag{10}$$

where *t*, μ and η are coefficients other than zero.

Equation (10) is equal to zero, which implies that:

$$Y^2 + tY + \mu = 0 \tag{11}$$

where

$$Y^2 - tY + \eta = 0 \tag{12}$$

Equations (11) and (12) both admit two square roots as solution, and these can be written as:

$$Y_{1,2} = \frac{1}{2}t \pm \frac{1}{2}\sqrt{t^2 - 4\mu} \tag{13}$$

and:

$$Y_{3,4} = \frac{1}{2}t \pm \frac{1}{2}\sqrt{t^2 - 4\eta} \tag{14}$$

On the basis of equations (13) and (14), we can deduce the four square roots (x_1, x_2, x_3 and x_4) of equation (7).

$$x_1 = \frac{P}{4} - \frac{2t}{4} + \frac{1}{4}\sqrt{4t^2 - 16\mu} \tag{15}$$

$$x_2 = \frac{P}{4} - \frac{2t}{4} - \frac{1}{4}\sqrt{4t^2 - 16\mu} \tag{16}$$

$$x_3 = \frac{P}{4} + \frac{2t}{4} + \frac{1}{4}\sqrt{4t^2 - 16\eta} \tag{17}$$

$$x_4 = \frac{P}{4} + \frac{2t}{4} - \frac{1}{4}\sqrt{4t^2 - 16\eta} \tag{18}$$

We need to find *t*, η and μ in order to determine x_1, x_2, x_3 and x_4.

$$\mu = \frac{1}{2}\left(a + t^2 - \frac{b}{t}\right) \tag{19}$$

Combining equations (9) and (10) we find:

$$\eta = \frac{1}{2}\left(a + t^2 + \frac{b}{t}\right) \tag{20}$$

$$\eta\mu = c \tag{21}$$

To calculate μ and η, we need to find t. Equation (21) is equivalent to:

$$t^6 + 2at^4 + (a^2 - 4c)t^2 - b^2 = 0 \tag{22}$$

In order to solve equation (22), we replace the variable with $t^2 = Z$, and equation (22) becomes:

$$Z^3 + AZ^2 + BZ + C = 0 \tag{23}$$

where:

$$A = 2a$$
$$B = a^2 - 4c$$
$$C = -b^2$$

When the variable is replaced with $X = Z + \frac{A}{3}\alpha\exp$, equation (23) becomes:

$$X^3 + p_0X + q_0 = 0 \tag{24}$$

where:

$$p_0 = B - \frac{A^2}{3}$$

$$q_0 = C - \frac{BA}{3} + \frac{2}{27}A^3$$

Let $\Delta_0 = \left(\frac{q_0}{2}\right)^2 + \left(\frac{p_0}{3}\right)^3$ be the discriminant of equation (24):

$$\begin{aligned}\Delta_0 = {} & \frac{16}{3}\lambda'^8\Gamma^2\Delta^2 - \frac{196}{3}\lambda'^6\Gamma^4\Delta^2 - \frac{392}{3}\lambda'^2\Gamma^6\Delta^4 - 72\lambda'^6\Gamma^6\Delta^2 - \frac{284}{3}\lambda'^4\Gamma^6\Delta^2 - 160\lambda'^4\Gamma^2\Delta^6 - \frac{256}{3}\lambda'^2\Gamma^2\Delta^8 - \frac{116}{3}\lambda'^2\Gamma^8\Delta^2 \\ & - \frac{500}{3}\lambda'^4\Gamma^4\Delta^4 - \frac{352}{3}\lambda'^2\Gamma^4\Delta^6 - \frac{64}{3}\lambda'^4\Delta^8 - 44\lambda'^8\Delta^8 - \frac{160}{3}\lambda'^6\Delta^6 + \frac{40}{3}\lambda'^{10}\Delta^2 - \frac{4}{3}\Gamma^8\Delta^4 - \frac{4}{3}\Gamma^{10}\Delta^2 \\ & - 8\Gamma^{10}\lambda'^2 - 20\lambda'^4\Gamma^8 - \frac{80}{3}\lambda'^6\Gamma^6 - 20\lambda'^8\Gamma^4 - 8\lambda'^{10}\Gamma^2 - \frac{4}{3}\Gamma^{12} - \frac{4}{3}\lambda'^{12}\end{aligned}$$

Whatever the values of λ', Γ and Δ, the sign of Δ_0 is negative, which means that the solutions of equation (24) are real, and are expressed as:

$$X = \alpha'\cos(\theta) \tag{25}$$

Parameters α' and ϑ are given by the following:

$$\alpha' = 2\sqrt{-\frac{p_0}{3}}$$

$$\theta = \frac{1}{3}\arccos\left(\frac{q_0}{2\sqrt{\left(-\frac{P_0}{3}\right)^3}}\right) = \frac{1}{3}\arccos(\psi)$$

where:

$$\psi = \frac{q_0}{2\sqrt{\left(-\frac{P_0}{3}\right)^3}} \tag{26}$$

The parameter *t* is given by:

$$t = \sqrt{Z} = \sqrt{X - \frac{A}{3}} = \sqrt{\alpha' \cos(\theta) - \frac{A}{3}} \tag{27}$$

Using equations (19) and (20) the eigenvalues (x_1, x_2, x_3 and x_4) of matrix (6) become:

$$x_{1,2} = \frac{P}{4} - \frac{2t}{4} \pm \frac{1}{4}\sqrt{-4t^2 - 8a + \frac{16}{2t}b} \tag{28}$$

and:

$$x_{3,4} = \frac{P}{4} + \frac{2t}{4} \pm \frac{1}{4}\sqrt{-4t^2 - 8a - \frac{16}{2t}b} \tag{29}$$

When *t*, *a* and *b* are replaced by their expressions, equations (28) and (29) become:

$$x_{1,2} = \frac{P}{4} - \frac{W}{4} \pm \frac{1}{4}\sqrt{\frac{(W-P)^2W - 16(W-P)y - 16R}{W}} \tag{30}$$

$$x_{3,4} = \frac{P}{4} + \frac{W}{4} \pm \frac{1}{4}\sqrt{\frac{(W-P)^2W - 16(W-P)y + 16R}{W}} \tag{31}$$

where *W* is given by:

$$W = 2t$$

$$= \sqrt{\frac{8}{3}\sqrt{3}(Q^2 + 3RP + 12S)^{1/2}\cos(\theta) - \frac{8}{3}Q + P^2} = \sqrt{8\left(\frac{\sqrt{3}}{3}(Q^2 + 3RP + 12S)^{1/2}\cos(\theta) + \frac{1}{6}Q\right) - 4Q + P^2}$$

or:

$$W = \sqrt{8y - 4Q + P^2} \tag{32}$$

and *y* and *r* by:

$$y = r\cos(\theta) + \frac{1}{6}Q$$

$$r = \left(\frac{Q^2 + 3RP + 12S}{3}\right)^{1/2} \tag{33}$$

Let:

$$\alpha = \frac{P - W}{4}$$

$$\delta = \frac{P + W}{4}$$

$$v = \frac{1}{4}\sqrt{\frac{(W-P)^2W - 16(W-P)y + 16R}{W}}$$

and

$$\gamma = \frac{1}{4}\sqrt{\frac{(W-P)^2W-16(W+P)y-16R}{W}}$$

The eigenvalues x_i (i =1 to 4) of matrix (6) become:

$$x_{1,2} = \alpha \pm v \tag{34}$$

$$x_{3,4} = \delta \pm \gamma \tag{35}$$

We can now determine the expression of the partition function $Z_{3/2}$:

$$Z_{3/2} = Tr\,\exp(-\beta H_1) = e^{x_1} + e^{x_2} + e^{x_3} + e^{x_4}$$

Finally, when equations (31) and (32) are taken into account the partition function $Z_{3/2}$ becomes:

$$Z_{3/2} = 2\exp(\alpha)\cosh(v) + 2\exp(\delta)\cosh(\gamma) \tag{36}$$

2.3 MAGNETIZATION

2.3.1 MAGNETIZATION ALONG THE Z AXIS

According to equation (4), longitudinal magnetization m_z is given by the following expression:

$$m_z = \langle S_i^z \rangle = \frac{TrS_i^z\exp(-\beta H_1)}{Z_{3/2}} = \frac{\partial \ln(\mathrm{Tre}^{-\beta H_1})}{\partial \lambda'} = \frac{\partial \ln(Z_{3/2})}{\partial \lambda'} \tag{37}$$

After calculation the final expression of magnetization is given by:

$$m_Z = \frac{1}{\exp(\alpha)\cosh(v)+\exp(\delta)\cosh(\gamma)}[G_{11}\exp(\alpha)\cosh(v) + G_{12}\exp(\alpha)\sinh(v) + G_{11}\exp(\alpha)\cosh(v) + G_{13}\exp(\delta)\cosh(\gamma) + G_{14}\exp(\delta)\sinh(\gamma)] \tag{38}$$

where G_{11}, G_{12}, G_{13} and G_{14} are given by the following expressions.

- For G_{11} we have:

$$G_{11} = \frac{\partial \alpha}{\partial \lambda'} = \frac{\partial (P-W)}{4\partial \lambda'} = -\frac{\partial W}{4\partial \lambda'}$$

(since P is not dependent on λ').

Applying equation (32), we obtain:

$$\frac{\partial W}{\partial \lambda'} = \left[\frac{1}{2}(8y + P^2 - 4Q)^{-1/2}\ \frac{\partial (8y+P^2-4Q)}{\partial \lambda'}\right] = \frac{4\partial y}{W\partial \lambda'} - \frac{2\partial Q}{W\partial \lambda'}$$

Similarly:

$$\frac{\partial Q}{\partial \lambda'} = -5\lambda'$$

Thus the final expression of $G_{11}$is:

$$G_{11} = -\frac{1}{4}\left[\frac{4\partial y}{W\partial\lambda'} + \frac{10}{W}\lambda'\right]$$

- For G_{12} we have:

$$G_{12} = \frac{\partial y}{\partial\lambda'} = \frac{1}{32v}\left[2(W-P)\frac{\partial W}{\partial\lambda'} - 16\frac{\partial y}{\partial\lambda'} + \frac{16P\partial y}{W\partial\lambda'} + \frac{16\partial R}{W\partial\lambda'} - \frac{16R\partial W}{W^2\partial\lambda'} - \frac{16Py\partial W}{W^2\partial\lambda'}\right]$$

Also:

$$\alpha = \frac{P-W}{4} \rightarrow P - W = 4\alpha$$

$$\frac{\partial y}{\partial\lambda'} = \frac{9}{2}\Delta\lambda'$$

and

$$\frac{\partial W}{\partial\lambda'} = \frac{4\partial y}{W\partial\lambda'} + \frac{10}{W}\lambda'$$

So the final expression of G_{12} is:

$$G_{12} = \frac{1}{4vW^3}\left\{4[\alpha W^2 - 2(R+Py)]\frac{\vartheta y}{\vartheta\lambda'} - 10[\alpha W^2 + 2(R+Py)\lambda' + 9\Delta W^2\lambda']\right\} = \frac{1}{4W^3v}\left[4(M-2N)\frac{\vartheta y}{\vartheta\lambda'} - 10(M-2N)\lambda' + P\Delta W^2\lambda'\right] \quad (39)$$

where:

$$M = \alpha W^2$$

and

$$N = R + Py$$

- For G_{13} we have:

$$G_{13} = \frac{\partial y}{\partial\lambda'} = \frac{\partial(P+W)}{4\partial\lambda'} = \frac{\partial W}{4\partial\lambda'}$$

The final expression of G_{13} is:

$$G_{13} = \frac{1}{4}\left[\frac{4}{W}\frac{\partial y}{\partial\lambda'} + \frac{10}{W}\lambda'\right] \quad (40)$$

- Finally, for G_{14} we have:

$$G_{14} = \frac{\partial y}{\partial\lambda'} = \frac{1}{4\gamma W^3}\left\{4[\delta W^2 - 2(R+Py)]\frac{\partial y}{\partial\lambda'} + 10[\delta W^2 + 2(R+Py)]\lambda' - 9\Delta W^2\lambda'\right\}$$

The final expression of G_{14} is:

$$G_{14} = \frac{1}{4\lambda W^3}\left[4(M-2N)\frac{\partial y}{\partial\lambda'} + 10(M+2N)\lambda' - 9W^2\lambda'\right] \quad (41)$$

Since:

$$\frac{\partial y}{\partial \lambda'} = r_{11}\cos(\theta) + rr_{12} - \frac{5}{6}\lambda' \quad (42)$$

with:

$$r_{11} = \frac{\partial y}{\partial \lambda'} = \frac{52\lambda'^3 + 52\lambda'\Gamma^2 - 40\lambda'\Delta^2}{6r}$$

and

$$r_{12} = \frac{\partial \cos(\theta)}{\partial \lambda'} = \theta_{11}\sin(\theta)$$

it follows that θ_{11} is given by:

$$\theta_{11} = -\frac{\frac{\partial \Psi}{\partial \lambda'}}{3\sqrt{1-\Psi^2}} = \frac{3\sqrt{3}}{2}\frac{\frac{\frac{3q_0 p_{11}}{2} + p_0 q_{11}}{(-p_0)^{5/2}}}{3\sqrt{1-\Psi^2}}$$

where:

$$q_{11} = \frac{\partial q_0}{\partial \lambda'} = \frac{160}{9}\lambda'\Delta^4 + \frac{16}{9}\lambda^3\Delta^2 + \frac{520}{9}\lambda'\Delta^2\Gamma^2 - \frac{140}{9}\lambda^3\Gamma^2 - \frac{140}{9}\lambda'\Gamma^4$$

$$p_{11} = \frac{\partial(-p_0)}{\partial \lambda'} = \frac{40}{3}\lambda'\Delta^2 + \frac{52}{3}\lambda'^3 + \frac{52}{3}\lambda'\Gamma^2$$

And

$$\Psi^2 = \frac{27q_0^2}{4(-p_0)^3}$$

By solving equation (38) numerically we can trace the variation in longitudinal magnetization m_z as a function of temperature for different values of the transverse field (Ω/J) and the crystal field (D/J).

Figure 1 shows thermal variation of longitudinal magnetization for a fixed value of the crystal field (D/J=0.1) and with arbitrary values of the transverse field (Ω/J = 1, 2 and 3). We see that as the value of the transverse field (Ω/J) increases, longitudinal magnetization declines and the system moves to a lower critical temperature, showing the role of the transverse field in confining spins within the x,y plane. Figure 2 shows the thermal variation of longitudinal magnetization of the same system with a fixed value of the transverse field $(\Omega/J = 3)$ and for arbitrary values of crystalline anisotropy (D/J=1, 2 and 3). Here, as the value (D/J) increases the transition temperature of the system also increases.

2.3.2 MAGNETIZATION ALONG THE X AXIS

Transverse magnetization is calculated in the same way as longitudinal magnetization. Using equation (5) magnetization m_x is expressed as:

$$m_x = \langle S_i^x \rangle = \frac{Tr S_i^x \exp(\beta H_1)}{Z_{3/2}} = \frac{\partial \ln(Tre^{-\beta H_1})}{\partial \Gamma} = \frac{\partial \ln(Z_{3/2})}{\partial \Gamma} \quad (43)$$

The final expression of m_x is:

$$m_x = \frac{1}{\exp(\alpha)\cosh(v) + \exp(\delta)\cosh(\gamma)}[G_{21}\exp(\alpha)\cosh(v) + G_{22}\exp(\alpha)\sinh(v) + G_{23}\exp(\delta)\cosh(\gamma) + G_{24}\exp(\delta)\sinh(\gamma)] \quad (44)$$

where G_{21}, G_{22}, G_{23} and G_{24} are given by the following equations:

For G_{21}:

$$G_{21} = \frac{\partial \alpha}{\partial \Gamma} = \frac{\partial (p-W)}{4\partial \Gamma} = \frac{\partial w}{4\partial \Gamma}$$

since *p* does not depend on *Γ*.

$$G_{21} = -\frac{1}{4}\left[\frac{4\partial y}{W\partial \Gamma} + \frac{10}{W}\Gamma\right] \quad (45)$$

For G_{22}:

$$G_{22} = \frac{\partial v}{\partial \Gamma} = \frac{1}{32v}\left[2(W-P)\frac{\partial W}{\partial \Gamma} - \frac{16\partial y}{\partial \Gamma} + \frac{16p\partial y}{W\partial \Gamma} - \frac{16py\partial R}{W^2\partial \Gamma} + \frac{16\partial R}{W\partial \Gamma} - \frac{16R\partial W}{W^2\partial \Gamma}\right]$$

Replacing $(W-P)$, $\frac{\partial R}{\partial \Gamma}$ and $\frac{\partial W}{\partial \Gamma}$ by their expression we obtain the final expression of

G_{22}:

$$G_{22} = \frac{1}{4vw^3}\left\{4[\alpha W^2 - 2(Py+R)]\frac{\partial y}{\partial \Gamma} - 10[\alpha W^2 + 2(Py+R)]\Gamma + 33\Delta W^2\Gamma\right\}$$
$$= \frac{1}{4Wv}\left[4(M-2N)\frac{\partial y}{\partial \Gamma} - 10(M+2N)\Gamma + 33\Delta\Gamma W^2\right] \quad (46)$$

For G_{23}:

$$G_{23} = \frac{\partial \delta}{\partial \Gamma} = \frac{1}{4}\frac{\partial (p+W)}{\partial \Gamma} = \frac{1}{4}\frac{\partial W}{\partial \Gamma} \quad (47)$$

The final expression of $G_{23}$is given by:

$$G_{23} = \frac{1}{4}\left[\frac{4}{W}\frac{\partial Y}{\partial \Gamma} + \frac{10}{W}\Gamma\right]$$

For G_{24}:

$$G_{24} = \frac{\partial y}{\partial \Gamma} = \frac{1}{4\gamma W^3}\left\{-4[\delta W^2 - 2(R+Py)]\frac{\partial y}{\partial \Gamma} + 10[\delta W^2 + 2(R+Py)]\Gamma - 33\Delta\Gamma W^2\right\}$$
$$= \frac{1}{4\gamma W^3}\left[-4(M'-2N)\frac{\partial y}{\partial \Gamma} + 10(M'+2N)\Gamma - 33\Delta W^2\Gamma\right] \quad (48)$$

where:

$$M' = \delta W^2 \quad (49)$$

By solving equation (44) numerically we can trace the variation in transverse magnetization m_x as a function of temperature, for various values of the crystal field and the transverse field.

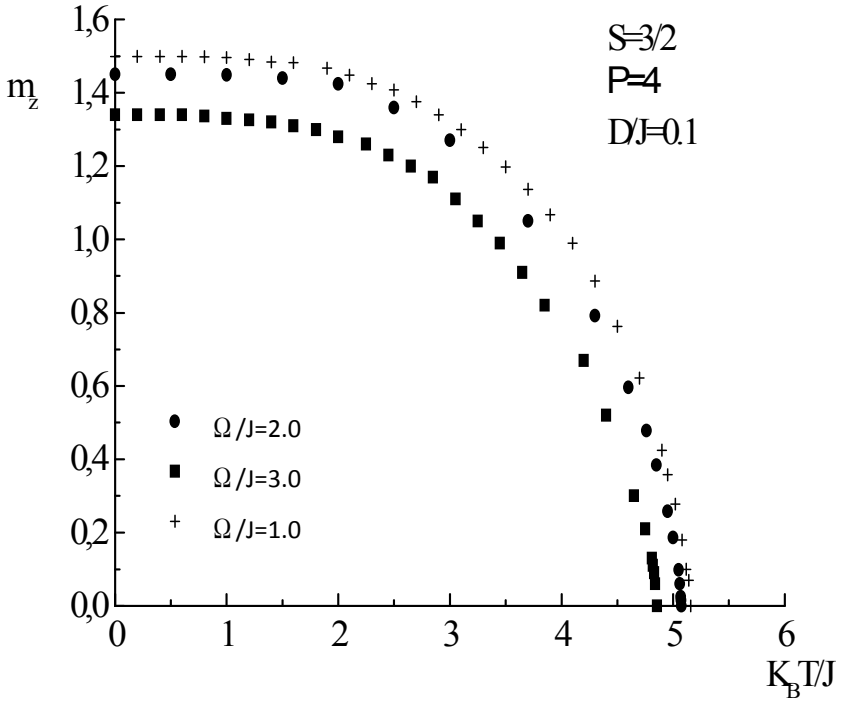

Fig. 1. Thermal variation of longitudinal magnetization of a 3/2 spin system for a fixed value of crystalline anisotropy and various values of the transverse field

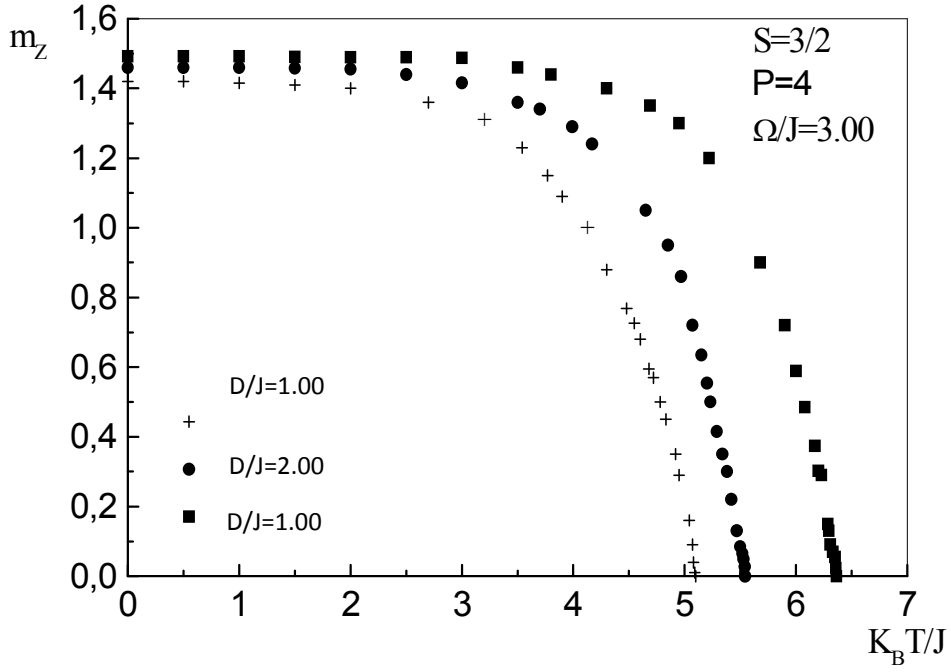

Fig. 2. Thermal variation of longitudinal magnetization of a 3/2 spin system for a fixed value of the transverse field and various values of crystalline anisotropy

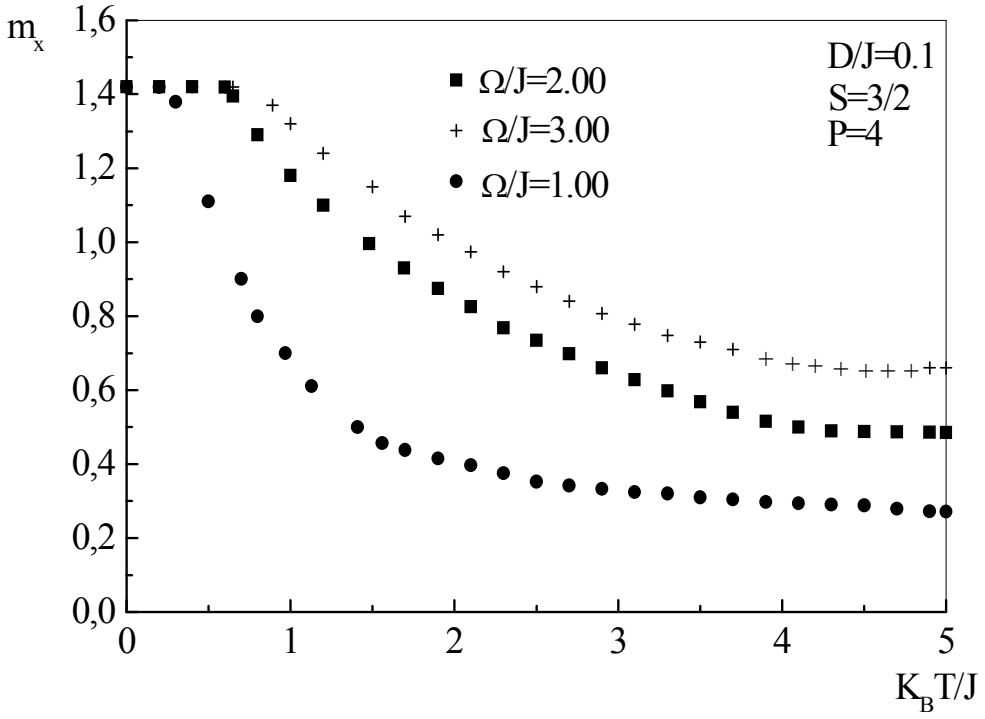

Fig. 3. Thermal variation of transverse magnetization of a 3/2 spin system for a fixed value of crystalline anisotropy and various values of the transverse field.

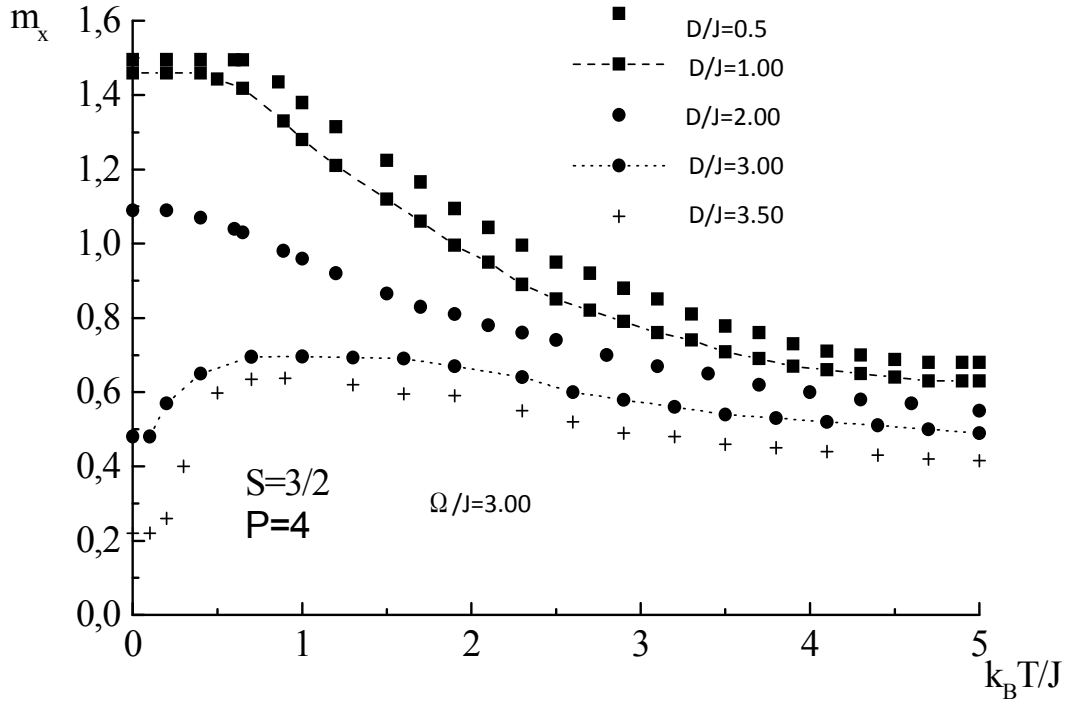

Fig. 4. Thermal variation of transverse magnetization of a 3/2 spin system for a fixed value of the transverse field and various values of crystalline anisotropy.

Figure 3 shows the thermal evolution of transverse magnetization of the 3/2 spin system, for a fixed value of the constant of crystalline anisotropy ($D/J = 0.1$) and with arbitrary values of the transverse field ($\Omega/J = 1$; 2 and 3). No transition is seen and transverse magnetization continues to decline asymptotically without reaching zero (within the temperature range examined). Figure 4 shows the thermal evolution of transverse magnetization for a fixed value of the transverse field ($\Omega/J = 3$) and arbitrary values for the constant of crystalline anisotropy ($D/J = 0.5$; 1; 2; 3 and 3.5). We see that for high values of crystalline anisotropy, magnetization declines at low temperatures. This behavior indicates competition between the direction of quantification (z axis) and the energy associated with the transverse field.

3 CONCLUSION

Study of longitudinal magnetization of a 3/2 spin system as a function of temperature shows that:

- With a constant crystal field and a transverse field with increasing variable values, magnetization decreases and the system transits at a critical temperature value.
- With a constant transverse field and a crystal field with increasing variable values, the transition temperature increases.

Study of transverse magnetization of the same 3/2 spin system as a function of temperature shows that:

- With a constant crystal field and a transverse field with increasing variable values, no transition is observed.
- With a constant transverse field and a crystal field with increasing variable values, magnetization decreases asymptotically.

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Competency of commercially available medicaments on treatment of chicken cryptosporidiosis

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ABSTRACT: In the present study the anticryptosporidial efficacy in chickens of two commercially available antibiotics, norfloxacin and spiramycin, in the drinking water alone or in combinations with one commercially available anticoccidial (clopidol) treatment in ration were used. At day 6 of chicken life, 210, male, white Hy-Line chicks were divided into 7 groups (1-7), 30 in each group. Chickens of first group (G1) served as negative control uninfected-untreated group (UUC). Birds of the second group (G2) were inoculated orally with inoculum containing $5X10^5$ *Cryptosporidia baileyi* (*C. baileyi*) oocysts/chick and served as infected-untreated positive control group (IUC). All birds of groups 3 to 7 infected with $5X10^5$ *C. baileyi* oocysts/ chick and treated with 12mg/kg BW norfloxacin (G3), 1gm/10kg BW spiramycin (G4) from 1st to 5th days post-infection (DPI) and 0.5 gm/kg ration (125ppm) Clopidol (G5) from one day old chick up to one week PI. Last two groups were infected similarly and treated with both of norfloxacin+clopidol (G6) or spiramycin+clopidol (G7) with the same previous dose and course of each treatment. The efficacy of the tested medicaments were evaluated by daily count of *cryptosporidia* oocysts in the feces of chicks, mortality percentage, body weight gain, the degree of histopathological changes of Bursa of Fabricius and lesions score. The results showed that the mortality rate reached 10% in (spiramycin and/or clopidol) treated groups, 6.7% in norfloxacin treated group and 3.3% in norfloxacin+ clopidol treated group while it reached 13.3% in infected-untreated control group. High bursal lesion score was recorded in infected-untreated group followed by infected treated chicken groups regardless the type of medicated drugs. Total oocyst per gram feces of experimentally infected chicks with *C. baileyi* was reduced significantly in all infected treated groups regardless the type of used medicaments when compared with other infected-untreated control chicken group. The recommended dose of norfloxacin and norfloxacin + clopidol decreased the oocyst output of birds by 62% and 63%, respectively. While, other groups showed lower efficiency percentages 43% (spiramycin + clopidol), 40 % (spiramycin) and 35 % (clopidol). Also, non significant differences were observed in body weight gain on day 28 of chicken life between uninfected control and infected groups. Finally, none of these drugs alone can be entirely suggested for the chemotherapy of avian cryptosporidiosis. While, in addition to application of good sanitary measures and disinfection, the present study may conclude that the administration of both norfloxacin in drinking water at 1st to 5th DPI and clopidol in ration one week before and after infection may be helpful in prevention and treatment of *cryptosporidiosis* in chickens.

KEYWORDS: Competency, Cryptosporidiosis, chickens, norfloxacin, spiramycin, clopidol.

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INTRODUCTION

Cryptosporidia are related to coccidia, but much smaller (typically oocysts are less than ¼ of the size of an *E. acervulina* oocyst). They replicate in the brush border of epithelial cells. They also differ from coccidia in being poorly host specific, although bird strains do not infect mammals very well, and vice versa. *Cryptosporidium baileyi* causes infection of the hindgut and cloacal bursa in chickens, turkeys, and ducks. The oocysts are excreted ready sporulated in the feces and infection occurs by inhalation and ingestion. Unfortunately there is currently no known effective treatment in poultry. If other disease processes are complicating the situation (e.g. coli-septicemia) there may be benefit in medicating for these (**Fujino *et al*., 2002 and McMullin, 2004).** Because enrofloxacin and related compounds are widely used drugs in the poultry industry and a preliminary trial indicated some anticryptosporidial efficacy, this drug was included in study presented by **Sréter *et al.* (2002)** who showed that enrofloxacin when added to drinking water at the recommended level (50 mg/L) from day 1 post-infection (PI) decreased the oocyst output of birds by approximately 50%. However dose increase to 2 times the recommended level did not improve the efficacy or substantially reduce the length of patency. Nevertheless, because some fluoroquinolones seem to be active against apicomplexan parasites, further studies should be undertaken to test the anticryptosporidial activity of fourth-generation fluoroquinolones (**Sréter *et al.,* 2002)**. Many authors reported that oral treatment of spiramycin to cryptosporidiosis in human was effective (**Saez-Liorens, 1989; Current and Garcia, 1991 and Ortega, 2007).** The sensitivity of field isolates of turkey coccidia from the United States to the anticoccidial drugs amprolium, clopidol, diclazuril, and monensin were investigated by **Rathinam and Chapman (2009)** who indicated that clopidol and diclazuril were the most effective, followed by monensin and amprolium**.** Also, efficacy of commonly used anticoccidial drugs in broiler chickens were studied by **Hamed and Eladl (2011)** who concluded that the administration of toltrazuril in drinking water at 4^{th} to 6^{th} DPI and Clopidol in ration one week, at least, before and after infection was highly effective in treatment and prevention of coccidiosis. They mixed clopidol in ration at a dose of 125ppm equal to 0.5 gm/kg ration at day 14 of chicken life up to one week post challenge with sporulated mixed species of *Eimeria***.**

In the present study the anticryptosporidial efficacy of two commercially available antibiotics, norfloxacin and spiramycin**,** in the drinking water alone or in combinations with one commercially available anticoccidial (clopidol) treatment in ration was evaluated by daily count of *Cryptosporidia* oocysts in the dropping of the experimentally infected chicks. Also, body weight gain, the degree of histopathological changes of bursa of fabricius and lesions score were studied.

MATERIALS AND METHODS

1- Experimental Chicks

A total number of 210, one day old, male, white Hy-Line chicks were supplied by Misr Company for Poultry Production. All birds were reared in cages, kept in strictly isolated room, and were provided with a commercial starter, balanced ration free from any medications, feed and water were provided ad-libitum to all the birds. Lighting was provided for 24 hr throughout the experiment.

2- Preparation of the inoculum and cryptosporidium oocysts

Oocysts of *Cryptosporidium bailey* were isolated from the bursa of Fabricius (BF) taken from large commercial broiler flock in Dakahlia province and identified as described by **Hamed (1997).** To obtain fresh culture of *Cryptosporidium* oocysts, the isolated oocyts were inoculated orally into twelve of two days old coccidia free chicks, then feces were collected from day 5 to 14 post inoculation as well as mucosal scrapings were obtained from the bursa of Fabricius at the day 14 post inoculation. Oocysts were isolated and purified of from feces and scrapings. Estimation of number of oocysts in the concentrated stock and the infected dose was carried out using the hemocytometer and the light microscope at 40X (**Current *et al.,* 1986)**. Six-day old chicks in this experiment were inoculated orally with inoculum containing $5X10^5$ oocysts / chick.

3- Tested medicaments

The following drugs were used as recommended by the manufacturer.

-Norfloxacin: Norfloxacin 20% (Mycomas®) produced by Univet, Ireland and was imported by AM trading Company–Egypt. The recommended therapeutic dose is 50mg/Liter drinking water equal to 12mg/kg BW from day-1 up to 5 days post-infection (PI).

-Spiramycin: Spiramycin (Suanovil 50®) produced by Coophavet, France and was imported by Tradempex Company–Egypt. The recommended therapeutic dose is 0.4-0.8 gm/Liter drinking water equal to 1gm/10kg BW given from day 1 (PI) up to 5 days PI.

- **Clopidol (Clopidad®):** was obtained from Intercova Company-Egypt. The recommended therapeutic dose is 125- 200 ppm, given mixed in ration at a dose equal to 0.5 gm/kg ration from one day old chick up to one week post-infection.

4- Grouping and Experimental design (Table, 1)

A total number of 210, six-day old chicks were divided into 7 groups (1-7), 30 chicks in each group then subdivided into two replicates (15X2). Chickens of first group (G1) served as negative control uninfected-untreated group (UUC). Birds of the second group (G2) were inoculated orally with inoculum containing $5X10^5$ *C. baileyi* oocysts/chick and served as infected-untreated positive control group (IUC). All birds in groups 3 to 7 infected with $5X10^5$ *C. baileyi* oocysts/ chick. G3 treated with 0.25 ml /liter (12mg/kg BW) norfloxacin . G4 treated with 0.5gm /liter (1gm/10kg BW) spiramycin from day 1 post-infection (DPI) up to 5 DPI ,and G5 treated with 0.5 gm/kg ration clopidol from one day old chick up to one week PI. Chickens in last two groups were infected similarly and treated with both of norfloxacin + clopidol (G6) and spiramycin + clopidol (G7) with the same dose and course of each treatment.

All groups were kept under daily observation for signs, the length of the prepatent and patent periods, body weight, weight gain from day 1 to 21 DPI, mean body weight gain which expressed as relative body weight gain (RBWG), at the beginning of 4^{th} day PI to the 21^{th} DPI total feces were collected daily from each group, weighed and oocysts were counted. Three chicks from each group were sacrificed at 7, 14 and 21 DPI and their bursae were collected for histopathological examination and tissue sections of the bursa of Fabricius were scored.

5- Measuring the efficacy of the tested medicaments

5.1. Clinical symptoms, gross lesions and mortality rates

Signs, gross lesions and number of dead birds were observed according to **Lindsay *et al.* (1987).**

5.2. Bursa lesions score

Histologically, the severity of bursa lesion was evaluated according to **Lindsay *et al.* (1987);** the score was adopted between 0 and **+**2. 0=no *Cryptosporidia* present; 1=*Cryptosporidia* lesions present in small or moderate numbers; 2=*Cryptosporidia* lesions present in large numbers.

5.3. Body weight, body weight gain and relative body gain

The body weight and the weight gain were measured from day -1 to 21 DPI to obtain the mean gain which expressed as relative body weight gain (RBWG). Mean body weight values were compared using analysis of variance. Relative body gain was determined according to the method described by **Sréter *et al.* (2002).**

5.4. Oocysts count

Beginning day 4 PI (day 4), total feces were collected daily from each group and weighed. The daily output of oocysts in the feces per gram (OPG) of the infected chicks was counted from the 4^{th} to the 21^{th} day post infection by using Mc-Master counting slide (**Current *et al.,* 1986)**. Oocysts present in each 24-hr collection of feces were determined by a quantitative method based on the rather slow sedimentation speed of oocysts **(Varga *et al.,* 1995a).** If there were negative results by this method, the fecal samples were examined using Sheather's sugar flotation method **(Current, 1990).**

5.5. Histopathology

It was carried out according to **Tanimura *et al.* (1995).** Selected bursae were fixed in 10% neutral formalin, dehydrated in graded alcohol concentrations, cleared with xylene and embedded in paraffin. Embedded tissues were sectioned at 3 µm and stained with Hematoxyline and Eosin (H&E). Electron Transmission miscroscopy (E/M) studies were carried out for the detail description of the developmental stages as mentioned by **Lindsay *et al.* (1986).**

5.6. Statistical analysis

The obtained data in the present study were statistically analyzed for analysis of variance (ANOVA) and least significant difference (LSD) as described by **Snedecor and Cochran (1981)**.

RESULTS AND DISCUSSION

Control of cryptosporidiosis remains a global challenge in both veterinary and human medicine. Therefore, extensive research has been performed on suitable drugs and disinfectants **(Shahiduzzamana and Arwid, 2012).** The efficacy of the tested medicaments were evaluated by the length of the prepatent and patent periods, daily count of *Cryptosporidia* oocysts

in the feces of the experimentally infected chicks, mortality percentage, body weight gain, the degree of histopathological changes of bursa of Fabricius and lesions score.

1- Effects of the tested medications on Clinical signs, mortality rate and bursal lesion score of experimentally infected chicks with C. baileyi.

The results showed that Mortality percentages ranged from 3.3% to 13.3% (1 to 4 dead out of 30 chicks in each infected group) where the mortality rate reached 10% (clopidol) treated group, 10% (spiramycin) treated group, 10 % (spiramycin + clopidol) treated group and 6.7% (norfloxacin)treated group , 3.3% (norfloxacin + clopidol) treated group while it reached 13.3% in infected-untreated control group. The negative control (UUC) group was apparently healthy and showed good appetite, good feathering and normal feces. In this group, no mortalities were recorded and showed mortality rate 0%. While, the infected untreated (IUC) group was affected and general symptoms of depression, anorexia, loss of appetite, ruffled feather, nasal discharge and the mortality rate was 13.3% as indicated in Table (2). Similar results were obtained by **Tumova *et al.* (2002)** who showed that mortality percentages were approximately 10% after infection orally with 5 x 10^5 oocysts of *C. baileyi*. On the other hand, **Lindsay *et al.* (1987)** mentioned that deaths not occur; signs or gross lesions were not observed in chicks inoculated orally with oocysts. Concerning to the bursal score lesion our results recorded high bursal lesion score in infected-untreated group (2, 2 and 1) followed by infected treated chicken groups regardless the type of medicated drugs at 7, 14 and 21 DPI, respectively. Lesion scores were recorded lower (1, 1 and 0) in Norfloxacin and Norfloxacin + Clopidol groups than other treated groups (2, 1 and1) in Clopidol or spiramycin or Spiramycin + Clopidol at 7, 14 and 21 DPI, respectively.

None of the used drugs in this study prevented establishment of *C. baileyi* infections. This lack of efficacy against *C. baileyi* in chickens is similar to that reported for chemoprophylaxis of *C. baileyi* infections in chickens using halofuginone, salinomycin, lasalocid, or monensin **(Lindsay *et al,* 1987).** clopidol used in the present study was chosen because it was highly effective against *Eimeria* species in chickens **(Hamed and Eladl, 2011).** Although the biochemical mode of action of both Norfloxacin and clopidol is unknown on C. baileyi infections, the Clopidol completely controlled the infection with *Eimeria* species on different point of evaluation, mortality percentages, weight gain and oocyst count (**Nicole *et al.,* 1979)**. Moreover, clopidol and diclazuril were the most effective anticoccidial drugs against field isolates of turkey coccidia from the United States **(Rathinam and Chapman, 2009).** Because of some fluoroquinolones including norfloxacin seem to be active against apicomplexan parasites, further studies should be undertaken to test the anticryptosporidial activity of fourth-generation fluoroquinolones (**Sréter *et al.,* 2002).**

Enrofloxacin and related compounds are widely used drugs in the poultry industry and a preliminary trial indicated some anticryptosporidial efficacy, this drug was included in study presented by **Sréter *et al.* (2002)** who revealed that enrofloxacin was added to drinking water at the recommended level (50 mg/L) from day -1 post-infection (PI). The efficacy of enrofloxacin was 52% at the recommended level, although it was not effective against *Cryptosporidium* parvum in neonatal mice **(Blagburn *et al.,* 1991). Saez-Liorens (1989)** stated that spiramycin can be used for treatment of intestinal *Cryptosporidiosis* in human. Also, many authors reported that oral treatment of spiramycin to *Cryptosporidiosis* in human was effective (**Current and Garcia, 1991and Ortega, 2007).**

2-Effects of the tested medications on prepatent, patent periods and total oocysts output in feces of experimentally infected chicks with C. baileyi.

The results showed the extension of prepatent period to 5 DPI in groups of spiramycin and/or clopidol, while no extension (4DPI) in groups of norfloxacin and norfloxacin +clopidol when compared with IUC group (4DPI). Also, the results showed the reduction of patent period to 27 DPI in groups of spiramycin and/or clopidol, while the reduction was lower (26DPI) in groups of norfloxacin and norfloxacin +clopidol when compared with IUC (28DPI) group (Table, 3).

Total oocysts per gram (OPG) feces of experimentally infected chicks with *C. baileyi* was reduced significantly in all infected treated groups regardless the type of used medicaments when compared with other infected-untreated control chicken group. The recommended dose of norfloxacin and norfloxacin +clopidol groups decreased the OPG in feces of birds by 62% and 63%, respectively. While, other groups showed lower drug efficiency percentages 43% (spiramycin + clopidol), 40% (spiramycin) and 35 % (clopidol) (Table, 3).

These results were confirmed by **Saez-Liorens *et al.* (1989**) who showed that spiramycin may shorten duration of oocysts excretion and diarrhoea. **Rhee *et al.* (1998)** found that the pattern of oocysts shedding in chickens inoculated with 5X 10^5 oocysts of *C. baileyi* showed that the prepatent period of the protozoa was 2 days and peak oocyst production (10^6 /day/head) occurred between days 8 and 11 PI with a patent period of 30 days while, the oocysts did not show up in the fecal sample of uninfected chickens during this period. Also, **Hao *et al.* (2008)** showed that the total oocysts excretion levels of *C. baileyi* were detected consistently in feces from the infected chicks but were not observed in the control group. On a similar

ground, **Sréter *et al.* (1999)** showed that the recommended dose of toltrazuril decreased the oocyst output of birds by 52.1%. The recommended antieimerian dose of diclazuril did not reduce significantly the *Cryptosporidium* oocysts output of birds (14.6%). Similarly, **Sréter *et al.* (2002)** calculated the extension of prepatent period on the basis of the prepatent period of the IUC birds (5days) and found that extension of prepatent period 0% in enrofloxacin and 10% or 30% in paromomycin according to dose. But the reduction of patent period calculated on the basis of the patency of the IUC birds (13 or 14 days on 2 experiments) and found that the reduction of patent period 8 and 15% in enrofloxacin and 12 and 23% in paromomycin. They also calculated the efficacy percentages on the basis of the total oocysts output of the IUC birds (29.3-33.8X10^6) and found that the recommended antibacterial dose of enrofloxacin decreased the oocyst output of birds by approximately 50%. They added that dose increase did not improve the efficacy or substantially reduce the length of patency. At the recommended levels, paromomycin decreased output of oocyst by 67-82%, showing the highest efficacy of all drugs tested against avian cryptosporidiosis thus far. Moreover, the patent period was shortened by 12-23 % (**Sréter *et al.,* 2002).** Moreover, they showed that the longer prepatent and shorter patent periods in paromomycin-treated group when compared to control group. On the other hand, several commonly used disinfectants were tested for their ability to kill *C. baileyi* or *C. parvum* oocysts, but only a few of them were effective at concentrations recommended by the manufacturers **(O'Donoghue, 1995).** Potentiation of ionophorous anticoccidials with Duokvin (antioxidant) against *C. baileyi* in chickens was studied by **Varga *et al.* (1995b)** who showed that none of the treatments represented a major progress in the total oocyst output in the different groups used for the comparison of the anticryptosporidial efficacy. These relative efficacies confirm poor salinomycin, lasalocid, and monensin activity against *C. baileyi* **(Lindsay *et al.*, 1987).** Therefore, **Varga *et al.* (1995b)** concluded that none of the polyether ionophores or their combinations with duokvin (antioxidant) can be recommended for the chemotherapy or control of avian cryptosporidiosis. This study also confirmed the unusual incompetency of *Cryptosporidium* spp. to various drugs **(Fayer, 1993).**

3-Effects of medications on average body weight (gm), body weight gain (gm), RBWG, bursa weight and BBI of experimentally infected chicks with C. bailey.

Average bodyweight, Body weight gain (gm), RBWG, Bursa weight, BBI at 28 day old of experimentally infected chicks with C. bailey were summarized in Table (4). There were no significant differences were observed in final live weight on day 28 of chicken life between uninfected control and infected groups. Similar results were obtained by **Tumova *et al.* (2002)** who studied the effects of experimental cryptosporidiosis, broiler chickens were infected *per os* with 5 x 10^5 oocysts of *C. baileyi*. They showed that although the clinical signs of infection were apparent, neither final live weight nor mortality was significantly influenced in chickens infected with a single *Cryptosporidium* species.

In this study, there was no significant difference in the body weight gain between UUC and IUC and also no significant differences were observed in Body weight gain on day 28 of chicken life between uninfected control and infected-treated groups. Based on the past literatures the *C. baileyi* did not cause a weight gain reduction in orally inoculated birds, so no weight gain reduction in IUC group compared to UUC group **(Varga *et al.*, 1995b; Hornok *et al.,* 1996; and Sréter *et al.*, 1996)**. Similarly, this is in line with other observations confirmed a lack of weight gain reduction in chickens orally infected with C. baileyi **(Lindsay and Blagburn, 1990). Sréter *et al.* (1999)** found that the efficacy of toltrazuril was 52.1% at the recommended level, which could be moderately increased using 5 or 10 times the recommended dose. However, these doses resulted in significant weight gain reduction. Similar results were also obtained by **Sréter *et al.* (2002)** who found that the body weight gain of paromomycin-treated chickens was almost identical with that of uninfected, untreated control birds irrespective of dosage, indicating the lack of toxicity of the drug for chickens. That drug exhibited the highest efficacy of all drugs tested against avian cryptosporidiosis so far.

Results of bursa weight and bursa body weight index (BBI) on day 28 of chicken life showed that chicks infected with *C. baileyi* had lower bursa weights, leading to significantly lower BBI in IUC(0.14±0.07), than UUC (0.35±0.06) and infected treated groups (Table, 4). Similarly, **Varga *et al.* (1995b)** found that the co-administration of ionophores with duokvin resulted in increased efficacies but showed significant growth depression and bursa weight reduction in all groups. They also stated that there was a close negative correlation between the efficacy of drugs and the relative weight of the bursa of Fabricius of the experimental groups. Thus, the reduced oocysts production might be explained by the diminished area of the site of *Cryptosporidium* multiplication, which is known to be the bursa of Fabricius.

4- Histopathological findings

Plate (1) showed histopathological changes. Bursa of Fabricius smear stained with Modified Ziehl-Neelsen stain from treated group with norfloxacin+clopidol at 14 DPI showed little stained *Cryptosporidial* oocysts and other obvious oocysts remained unstained. The stained oocysts appear ovoid or rounded acid fast bodies with internal granules against green background (**Fig. A).** Infected untreated group (IUC) at 14 DPI showed more *Cryptosporidial* oocysts stained with Modified Ziehl-Neelsen stain **(Fig. B)**, if it compared with that in **Fig A.** Sections for transmission E/M were applied to get more and fine

details about the effect of treatment used in this experiment. Exactly the picture of the examined sections showed different size of vacuoles and little endogenous stages on the brush border of the epithelium in which may be revealed to degeneration of these stages leaving free vacuoles or was hidden. Parallel finding was showed the stained bursal smear in treated group **(Fig. A).** While more oocysts do not take the stain rather than that was showed in **Fig. B.** The previous above mentioned observations may be a result of success to the combination of drug used in this treated group. Transmission E/M of spiramycin treated group at 14 DPI contained many vacuoles and little undeveloped endogenous stages on the epithelial brush border (**Fig. T1).** Transmission E/M of Clopidol treated group at 14 DPI showing little stages like microgamete, zygote, free sporozoites and vacuoles (**Fig. T2)** Infected untreated group (IUC) at 14 DPI revealed endogenous developmental stages stained with toluidine blue (**Fig. U1).** Also**,** infected untreated group (IUC) at 14 DPI with E/M showed freshly multiple endogenous developmental stages on the brush border **(Fig. U2).**

Rhee *et al.* (1997) found that the most parasites occurred between days 4 and 16 PI**.** No *Cryptosporidia* were observed from the 28th day PI downward. They also showed that the prepatent period was 2 days and peak oocyst production occurred between 7 and 10 days. Infiltration of heterophils was first observed on day 4 PI. It increased to high numbers between days 12 and 16 PI and disappeared from the 28th day PI downward. On day 24 PI**,** a great deal of characteristic feature of *Cryptosporidium*-infected BF was visualized. The hyperplastic alteraions were pronounced from the 44th to 68th days PI. It is interesting that hyerplasia of the epithelial cells and thickening of the epithelium were not repaired normally until day 100 PI. **Banai *et al.* (2002)** showed that *C. baileyi* is a primary pathogen and can induce clinical respiratory disease and other pathogens can enhance the severity of *C.baileyi*-induced disease in chickens**.** Because of immunosuppressive agents, the course of infection may last more, most cryptosporidia infections in broiler flocks occurs in the last weeks of their life. Morover, **Banai *et al.* (2002)** showed that examination of fresh mucosal scrapings revealed endogenous stages of *Cryptosporidium* sp. in apical portion of the epithelium of the BF and cloaca**.** Oocysts concentrated by Sheater's sugar flotation and viewed with light microscopy, appeared as translucent ovoid to spherical bodies containing one to four dark granules**.** In acid fast staining, oocysts showed red staining against a green or blue background. Histopathological sections of the BF revealed *Cryptosporidia* of various sizes adherent to the surface of lining epithelial cells. Based on the parasite localization, hosts, size and shape of the oocysts it was concluded that the parasite appeared to be *C.baileyi*. The average size of oocysts measured by micrometry was 4.5-6.5µm. *C. baileyi* differs in site of development from *C. meleagridis.*

CONCLUSION

None of norfloxacin, spiramycin or clopidol alone can be entirely suggested for the chemotherapy or chemoprophylaxis of avian cryptosporidiosis. While, in addition to application of good sanitary measures and disinfection, it may be concluded that the administration of both norfloxacin in drinking water at 1st to 5th DPI and clopidol in ration one week before and after infection may be helpful in prevention and treatment of cryptosporidiosis.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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APPENDIX

Table 1. Grouping and Experimental design

Group		Number of birds	Infection orally with $5X10^5$ *C. baileyi* oocysts/chick **(6days)**	Treatment (dose & course)
G1	**Uninfected-untreated negative control (UUC)**	**30 (15X2 replicates)**	**-**	_
G2	**Infected-untreated positive control (IUC)**	**30 (15X2 replicates)**	**+**	**_**
G3	**Norfloxacin**	**30 (15X2 replicates)**	**+**	0.25 ml /Liter equal to 12mg/kg BW, from 1-5DPI
G4	**Spiramycin**	**30 (15X2 replicates)**	**+**	0.5gm /Liter equal to 1gm/10kg BW, from 1-5DPI
G5	**Clopidol**	**30 (15X2 replicates)**	**+**	0.5 gm/kg ration equal to 125ppm, from one day old chick up to one week PI
G6	**Norfloxacin+Clopidol**	**30 (15X2 replicates)**	**+**	Similar dose and course for each one
G7	**Spiramycin+Clopidol**	**30 (15X2 replicates)**	**+**	Similar dose and course for each one

Table 2. Effect of Norfloxacin, Spiramycin, Clopidol, Norfloxacin+Clopidol and Spiramycin+Clopidol on mortality percentage and bursal lesion score in experimentally infected chicks with C. baileyi.

Group		Mortality percentage*		Lesion score (n=3)		
		Dead/total	Mortality percentage	7 DPI	14 DPI	21 DPI
G1	**Negative control (UUC)**	**0/30**	**0%**	**0**	**0**	**0**
G2	**Positive control (IUC)**	**4/30**	**13.3%**	**2**	**2**	**1**
G3	**Norfloxacin**	**2/30**	**6.7%**	**1**	**1**	**0**
G4	**spiramycin**	**3/30**	**10%**	**2**	**1**	**1**
G5	**Clopidol**	**3/30**	**10%**	**2**	**1**	**1**
G6	**Norfloxacin+Clopidol**	**1/30**	**3.3%**	**1**	**1**	**0**
G7	**Spiramycin+Clopidol**	**3/30**	**10%**	**2**	**1**	**1**

**Mortality percentages ranged from 3.3% to 13.3% (1 to 4 dead out of 30 chicks in each infected group). 0=no cryptosporidia present; 1=cryptosporidia present in small number or moderate numbers; 2=cryptosporidia present in large numbers. UUC = Uninfected-untreated control; IUC=Infected-untreated control; DPI= Day Post Infection*

Table 3. Effect of Norfloxacin, Spiramycin, Clopidol, Norfloxacin+Clopidol and Spiramycin+Clopidol on prepatent, patent periods and total oocyst output in feces of experimentally infected chicks with C. baileyi. (Mean ±SE) X10^6 , n=5.

Group		Prepatent Period (DPI)	Patent Period (DPI)	Total oocyst output and drug efficiency%		
				oocyst per gram feces(OPG)	Percentages to IUC	Drug Efficiency%
G1	**Negative control (**UUC**)**	0.0	0.0	0.0^d	0.0	0.0
G2	**Positive control (**IUC**)**	4	28	124±1.6^a	100	0.0
G3	**norfloxacin**	4	26	47.1±1.1^c	38	62
G4	**spiramycin**	5	27	74.4±2.1^b	60	40
G5	**Clopidol**	5	27	80.6±1.8^b	65	35
G6	**Norfloxacin+Clopidol**	4	26	45.9±0.9^c	37	63
G7	**Spiramycin+Clopidol**	5	27	70.7±1.5^b	57	43

UUC = Uninfected-untreated control; IUC=Infected-untreated control

The different letters at the same column mean that there was a significant change at p<0.05.

Table 4. Effect of norfloxacin, spiramycin, clopidol, norfloxacin+clopidol and spiramycin+clopidol on average body weight (gm), Body weight gain (gm), RBWG, bursa weight, BBI at 28 day old of experimentally infected chicks with C. baileyi. (Mean ±SE) n=10

Group		Average body weight at 7days	Average body weight at 28days	Body weight gain (gm)	RBWG (%)	Bursa weight* at 28days (n=3)	BBI*
G1	**Negative control (**UUC**)**	80±2.1	231±4.1	151±0.6	100	0.82±0.13^a	0.35±0.06^a
G2	**Positive control (**IUC**)**	79±1.4	228±3.6	149±0.8	98.7	0.31±0.11^e	0.14±0.07^d
G3	**Norfloxacin**	77±1.3	227±2.7	150±0.2	99.3	0.62±0.10^b	0.27±0.01^b
G4	**spiramycin**	76±2.4	226±3.4	150±0.3	99.3	0.51±0.19^c	0.23±0.02^{bc}
G5	**Clopidol**	76±1.9	225±2.9	149±0.4	98.7	0.45±0.16^d	0.20±0.05^c
G6	**Norfloxacin+Clopidol**	77±2.9	227±3.1	150±0.5	99.3	0.56±0.18^b	0.27±0.09^b
G7	**Spiramycin+Clopidol**	77±3.1	225±3.9	148±0.1	98.0	0.54±0.11^b	0.24±0.08^{bc}

RBWG= Relative body weight gain expressed as a percentage of the uninfected, untreated control. RBWG =body weight gain/UUC body weight gain X100. BBI= Bursa Body weight index=Bursa weight/Body weightX100 UUC = Uninfected-untreated control; IUC=Infected-untreated control; the different letters at the same column mean that there was a significant change at p<0.05.

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Plate (I) showed the histopathological lesions as follows:

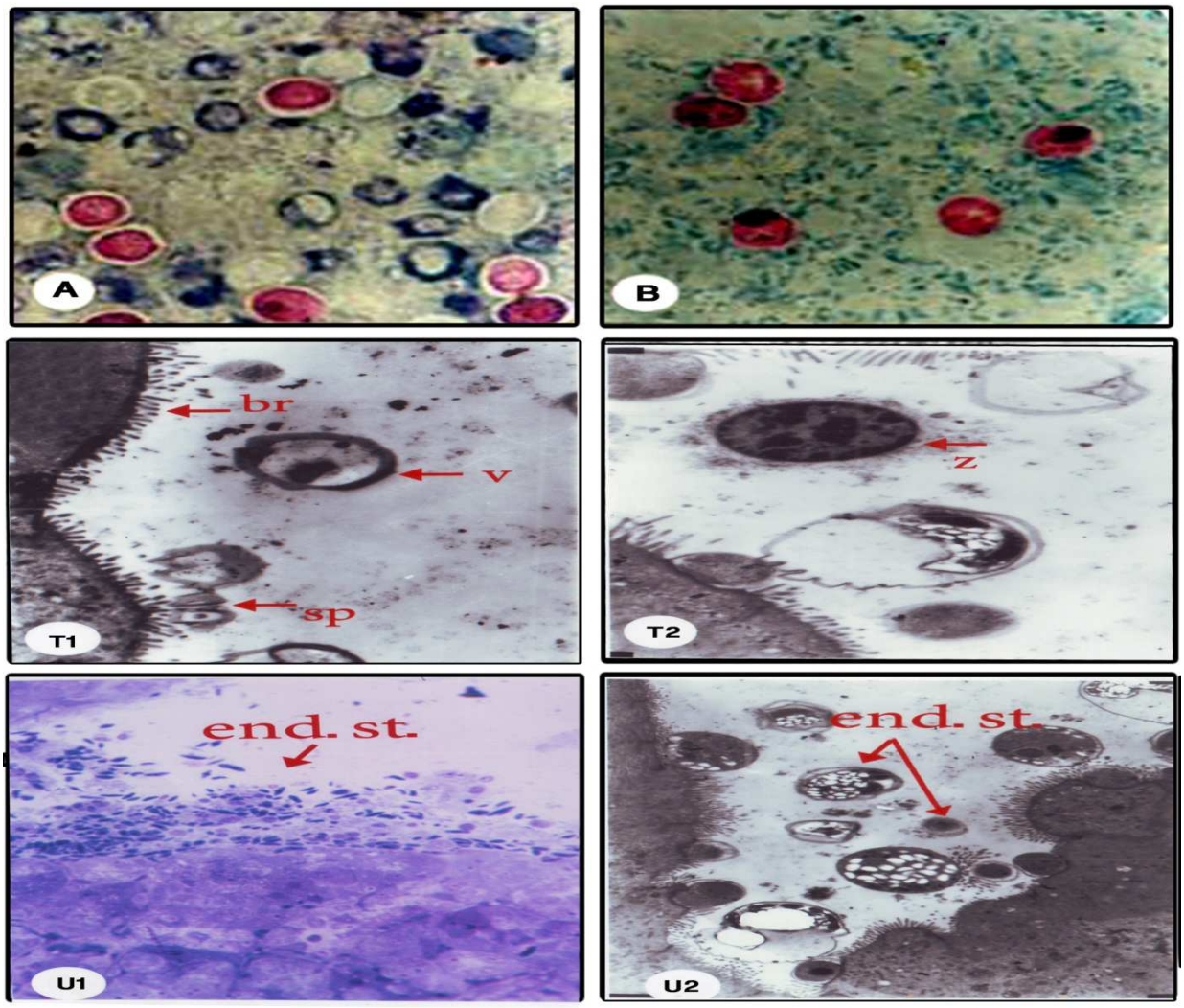

Fig (A): Bursal smear stained with Modified Ziehl-Neelsen stain from treated group with norfloxacin+clopidol at 14 DPI: showed little stained *Cryptosporidial* oocysts and other obvious oocysts remained unstained. The stained oocysts appear ovoid or rounded acid fast bodies with internal granules against green background X1000.

Fig (B): Infected Untreated group (IUC) at 14 DPI showed more *Cryptosporidial* oocysts stained with Modified Ziehl-Neelsen stain, If it compared with that in Fig A. X1000

Fig T1: **Transmission E/M of spiramycin treated group at 14 DPI** showing contained many vacuoles and little undeveloped endogenous stages on the epithelial brush border.

Fig T2: Transmission E/M of Clopidol treated group at 14 DPI showing stages little stages like microgamete, zygote, free sporozoites and vacuoles.

Fig U1: Infected Untreated group (IUC) at 14 DPI revealed endogenous developmental stages stained with toluidine blue. X1000

Fig U2: Infected Untreated group (IUC) at 14 DPI with E/M showed freshly multiple endogenous developmental stages on the brush border.

br= brush border V= vacuole sp= sporozoites Z= zygote end.st= endogenous stages

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Contribution à l'étude géologique du gisement à Cu, Zn, Pb et Ag-Au d'Amensif (District minier d'Amizmiz, Haut Atlas occidental, Maroc)

[Contribution to geological study of Amensif Cu, Zn, Pb & Ag-Au deposit (Amizmiz mining district, Western High Atlas, Morocco]

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ABSTRACT: The geological, magnetic and mineralogical studies have uncovered a polymetallic mineralization deposit at Amensif in the Amezmiz mining district (western High Atlas, Morocco). The Cu, Pb, Zn, Ag and Au mineralizations are hosted in the Lower Cambrian volcano-carbonate formations. These formations are structurally controlled by Hercynian faults (NE-SW, ENE-WSW, E-W and NW-SE). These hercynian faults were facilitated the circulation of hydrothermal fluid that responsible for the implementation of the economically mineralization. The hydrothermal alterations having affected the Lower Cambrian volcano-carbonate formations of Amensif are in mutual relations with the genesis of the Cu, Pb, Zn, Ag and Au polymetallic mineralizations. Mineralogical study of this deposit reveals the presence of a particular and characteristic mineral assemblages composed of chalcopyrite, sphalerite, galena, arsenopyrite, pyrite, grey copper, minor amount of silver, gold and bismuth. Microtextural relationship between the sulphides indicates sulphureted these mineralizations result from two distinct stages paragenetic: (I) an arseno-ferriferous stage and (II) a polymetallic stage. The estimated reserves based on the analyses of samples collected from 25 drill cores established in the sector go back to 568 110 Tons of ore with 3.79% Zn, 0.69% Pb, 1.02% Cu, 98.30ppm Ag and 0.48 ppm Au. The geological setting, lithofacies, mineral assemblages, geochemical analyses and a mode of hydrothermal alteration remind those described in certain "High-temperature polymetallic Carbonate Replacement Deposits" type worldwide.

KEYWORDS: Polymetallic mineralization, veins, Carbonate Replacement deposit, textures, Cambrian, Amensif, western High Atlas, Morocco

RESUME: Les études géologiques, magnétiques et minéralogiques ont permis de découvrir un gisement à minéralisation polymétallique dans le district minier d'Amizmiz (Haut Atlas occidental). Il s'agit du gisement d'Amensif à Cu, Zn, Pb, Ag et Au encaissé dans les formations volcano-carbonatées d'âge Cambrien inférieur. Ces formations sont structuralement contrôlées par des failles hercyniennes (NE-SW, ENE-WSW, E-W et NW-SE) qui ont facilité la circulation des fluides hydrothermaux responsables de la mise en place de cette minéralisation à intérêt économique. Les altérations hydrothermales ayant affectées les formations volcano-carbonatées du Cambrien inférieur d'Amensif (Haut Atlas occidental) sont en relations mutuelles avec la genèse des minéralisations polymétalliques à Cu, Pb, Zn, Ag et Au. L'étude minéralogique de ce gisement révèle la présence d'une paragenèse particulière et caractéristique composée de chalcopyrite, sphalérite, galène, arsénopyrite, pyrite, cuivre gris, minéraux d'argent et or. Les relations microtexturales entre les phases sulfurées mettent indiquent que ces minéralisations résultent de deux stades paragénétiques distincts ; (i) un stade arséno-ferrifère ; et (ii) un stade polymétallique. Les réserves estimées à ce stade en se basant sur les données de 25 sondages carottés implantés dans le secteur remontent à 568 110 Tonnes de minerai à 3.79 % Zn ; 0.69 % Pb ; 1.02 % Cu avec 98.30 ppm Ag et 0.48 ppm Au. Le

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contexte géologique, les lithofaciès, la paragenèse minérale, les analyses géochimiques et le mode d'altération rappellent ceux décrits dans certains gisements de type « High-temperature polymetallic Carbonate Replacement Deposits » à travers le monde.

MOTS-CLEFS: Minéralisations polymétalliques, veines, Carbonate Replacement deposit, textures, Cambrien, Amensif, Haut Atlas Occidental, Maroc

1 INTRODUCTION

La région d'Amezmiz localisée à 60 km au sud-ouest de la ville de Marrakech est connue par son potentiel minier, attesté par de nombreux gisements métallifères qu'elle abrite dans son territoire (Azegour, Erdouz, Assif El Mal, Tiqlit, Amensif, Talat n'Imjjad, etc.). Ces gisements découvert depuis les années vingt du 20ème siècle ont permis de bien étudier la géologie de la région. La mine d'Azegour est une exception dans la région et même dans la géologie du Maroc. Cette mine polymétallique est restée comme référence en minéralogie, gîtologie et métallogénie des skarns. Elle extrayait, au départ, le molybdène et le tungstène avant de passer au cuivre.

Le district minier d'Amizmiz est localisé dans le massif ancien du Haut Atlas est caractérisée par son socle paléozoïque, qui a fait l'objet de nombreuses études académiques ([1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20]). Récemment, la région connaitra une importante concurrence entre les compagnies minières nationales et internationales en vue d'obtention des permis miniers pour une éventuelle exploitation des gisements déjà découverts ou en mettant des programmes de recherche et d'exploration minière pour les nouveaux gisements.

Le district minier d'Amezmiz couvert d'une superficie de 500 km^2 renferme plusieurs gisements (Fig. 1). L'ancienne mine d'Azegour a été le siège d'une exploitation entre 1921 et 1971 d'une minéralisation polymétallique à Cu, Mo et W. Cette minéralisation encaissée dans les barres dolomitiques du Cambrien inférieur qui sont métasomatisées au contact du granite d'âge Permien d'Azegour. Cette mine polymétallique est restée comme référence en minéralogie, gîtologie et métallogénie des skarns. La mine d'Erdouz a fait objet d'une exploitation de zinc, plomb, argent et de cuivre. Les premiers travaux ont commencé en 1925 et continueront jusqu'à l'année de sa fermeture en 1972. Dans la partie NW du district se trouve l'ancienne mine d'Assif El Mal. Cette mine découverte en 1923 a fait l'objet d'une exploitation du minerai à Pb-Zn jusqu'à l'année de sa clôture en 1959. Dans la partie NE du district se localise la mine de Tighardine à Cu-Pb-Zn-(Ag et Au). Cette mine est en cours d'exploitation et présente les mêmes caractéristiques gîtologiques et minéralogiques que celles du gisement d'Amensif objet de cette étude.

La présente étude s'intéresse au gisement polymétallique d'Amensif. Il se localise à 5 km à vol d'oiseau au sud de la mine d'Azegour (GPS : N 31°06'20" et W08°17'54"). La minéralisation à Cu, Pb, Zn est encaissée dans les barres dolomitiques du Cambrien inférieur. Ce gisement nouvellement découvert ([19], [20]) est caractérisé par son contexte géologique, sa paragenèse minéralogique, son alteration hydrothermale et ses relations géométriques très étroites établies entre la minéralisation et la tectonique. Cette étude se base sur l'étude de trois aspects : (1) lithologique ; (2) structural et (3) relation entre la minéralisation et le fluide magmatique.

2 CADRE GEOLOGIQUE ET STRUCTURAL

Le massif ancien du Haut Atlas occidental est un vaste domaine formé de terrains précambriens et paléozoïques structurés pendant l'orogenèse hercynienne. Ces terrains sont compris dans une large shear zone dextre de direction N70° ([13], [21]) et limitée au sud par l'accident de Tizi-n-Test de direction N70°E et qui se prolonge vers le massif hercynien des Jebilet selon une direction NNE-SSW ([13]) et au Nord par l'accident d'Imi-n'Tanout de direction N70°E. Au Cambrien, le massif ancien correspondrait à une vaste plate-forme subsidente où s'est accumulée de puissantes séries sédimentaires intercalées de puissantes coulées volcaniques et produits pyroclastiques. Les formations paléozoïques du Haut Atlas ont été affectées par une déformation ductile dans un climat métamorphique anchi à épizonal. La déformation hercynienne se traduit principalement par des plissements et une schistosité de plan axial de direction NNE-SSW ([8], [9], [17]). Trois évènements tectoniques ont structuré cette région ; la phase (D1) est associée à un métamorphisme épizonal ([22], [23], [24]). Elle correspond à une déformation plicative générant des plis isoclinaux d'axes N60° à N80°E. La schistosité de flux S_1 (schistosité du plan axial) est sub-parallèle à la stratification S_0. La seconde phase (D2) engendre des plis métriques à hectométriques à axes sub-méridiens et déversés globalement vers l'Est. Au niveau des plans axiaux se développe une schistosité de fracture avec ou sans crénulation selon le comportement rhéologique de la roche. Cette déformation hercynienne est d'âge Namuro-Wéstphalien ([4], [8]). La troisième phase (D3) est une déformation péri-plutonique liée à la

mise en place des plutons granitiques de Tichka et d'Azegour ([23], [24], [26]). Ce magmatisme hercynien est d'affinité calco-alcaline ([6], [15]) ou alcaline ([27]).

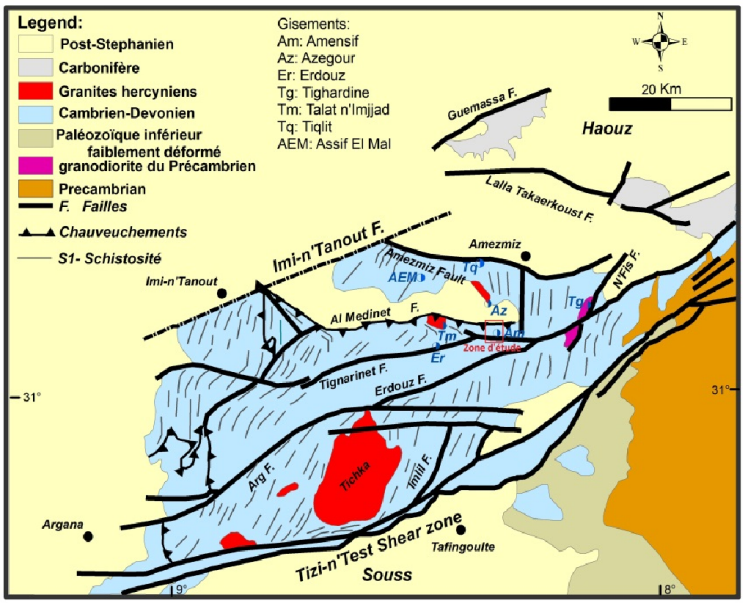

Fig. 1. Carte structurale du Haut Atlas occidental et localisation des principaux gisements du district minier d'Amizmiz (d'après [8])

Pendant l'orogenèse hercynienne, La zone d'étude est comprise dans un grand couloir de cisaillement de direction ENE-WSW limité par deux principaux décrochements dextres. Au nord, la faille d'Imi n'Tanout constitue la limite septentrionale du bloc paléozoïque du Haut Atlas. Tandis qu'au Sud le décrochement de Tizi-N-Test sépare le Haut Atlas de l'Anti-Atlas (Fig.1). Dans ce couloir, le modèle structural est assez complexe. Les grands cisaillements dextres représentent les principales caractéristiques de la chaîne hercynienne marocaine ([9], [13], [17], [20], [21], [28]).

La zone d'étude est affectée par un faisceau de failles et cisaillements de direction NE-SW à ENE-WSW formant un système conjugué avec les failles WNW-ESE à E-W.

3 MATERIELS ET METHODES

L'étude de ce gisement commence par l'établissement d'une carte géologique à 1000ème qui a permis de cartographier les différents faciès lithologiques, les structures tectoniques, les structures minéralisées et de décrire les différents types d'altération hydrothermale. Douze sondages carottés ont été étudié pour la description en aval des faciès lithologiques et des structures minéralisées. Ces travaux de terrain ont été effectués en collaboration avec la compagnie minière de Guemassa. Les observations pétrographiques des minéraux métalliques et du cortège d'alteration sont basées sur l'observation de 20 sections polies et 25 lames minces effectuées aux microscopes métallographique et optique au Laboratoire DLGR de l'Université Cadi Ayyad, Marrakech.

La prospection géophysique a été desservie par la méthode magnétique qui constitue la principale méthode d'exploration utilisée dans le Haut Atlas occidental pour la recherche des minéralisations sulfurées. La couverture magnétique au sol au niveau du gisement a été réalisée suivant un réseau de profils WSW-ESE espacés aux 100 mètres avec un point de mesure tous les 50 mètres.

L'étude des minéraux d'alteration hydrothermale est effectuée par le microscope optique et complétée par une diffraction des rayons X. Les analyses ont été effectuées par le diffractomètre aux rayons X, type *Philips*, au centre de recherche et d'exploration « Reminex » de Marrakech.

Trente-huit analyses géochimiques ciblées (Fe, Cu, Pb, Zn, As, Ag et Au) ont été réalisées en utilisant la Spectrométrie d'Emission Atomique source Plasma à Couplage Inductif (ICP AES) type *Ultima 2c* au centre de recherche et d'exploration « Reminex » de Marrakech.

4 RESULTATS

4.1 OBSERVATIONS DU TERRAIN

Les nombreuses observations de terrain et l'examen des sondages effectués dans la zone d'Amensif révèlent une séquence lithostratigraphique qui s'organise en une succession de deux grandes unités lithologiques distinctes. La compilation des données de cartographie et les données extraites des sondages carottés ont permis d'établir un log synthétique de la zone d'étude (Fig. 3).

- L'unité basale, caractérisée par des dépôts carbonatés marqués par des barres dolomitiques massives séparées par des laves essentiellement trachytiques et des produits pyroclastiques (grauwackes). Une intense activité hydrothermale a affectée ces carbonates en les transformant en carbonates hydrothermales avec localement développement des minéraux de skarns. Ces dolomies constituèrent le niveau porteur de la minéralisation à intérêt économique. Par analogie de faciès, cet ensemble est attribué au Cambrien inférieur ([1], [8], [20], [26], [30], [31]).
- L'unité sommitale est constituée de dépôts silteux-gréseux correspondant à un épisode de sédimentation détritique fine qui a caractérisé le Cambrien Moyen du Haut Atlas occidental. Ces faciès sont intercalés de quelques niveaux grauwackeux. L'ensemble a été schistosé et métamorphisé sous le climat épizonal [20].
- Ces formations sont intrudées par un essaim de filons rhyolitiques de direction N-S (Fig. 2).

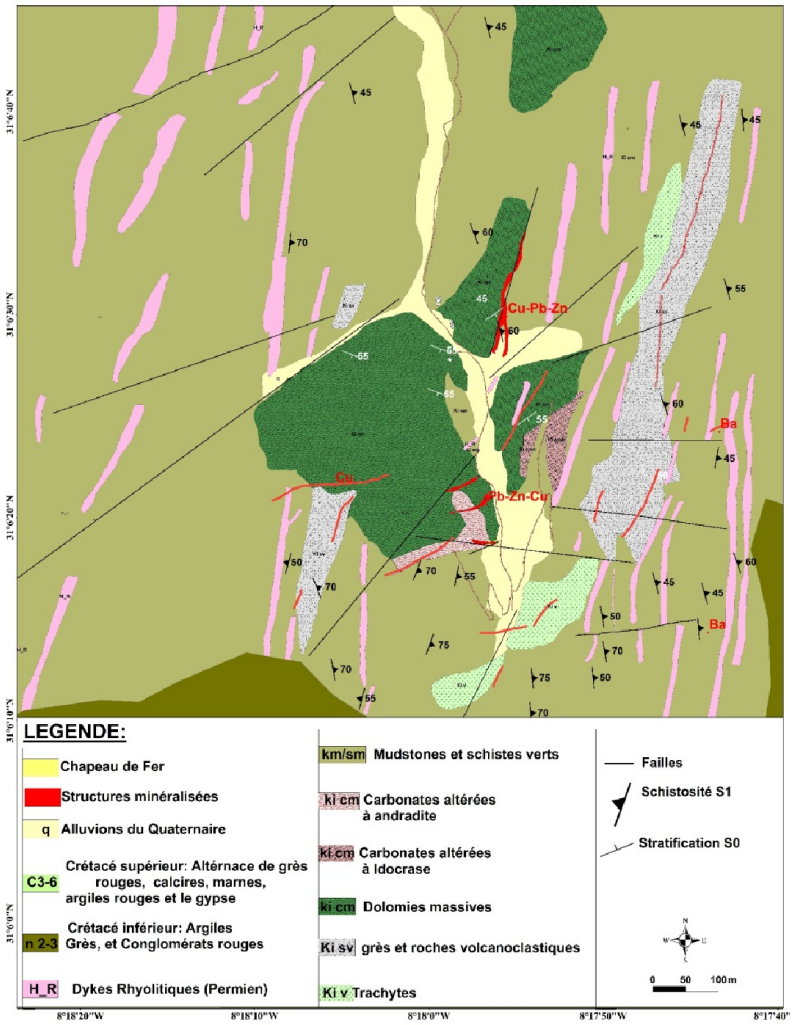

Fig.2. Carte géologique de la zone d'étude (d'après [20])

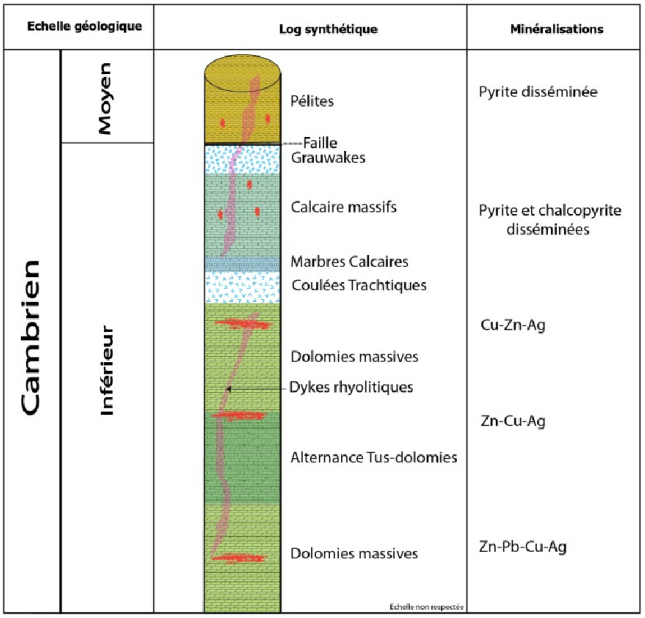

***Fig.3. Log lithostratigraphique synthétique d'Amensif** [20]*

L'étude structural du gisement a permis de mettre en evidence que les formations cambriennes d'Amensif sont affectées par un réseau de failles qui s'organisent selon deux grandes familles : NNE-SSW à NE-SW et NW-SE (Fig. 2) ([19], [20]). Ces failles sont liées au fonctionnement du système conjugué formé par deux grands accidents d'Erdouz (ENE-WSW) et celui d'Al Medinet (NW-SE) ([17]). Ce système conjugué sera le moteur qui contrôle la circulation de fluides hydrothermaux émanant de l'activité magmatique du granite d'Azegour.

A l'affleurement, les éléments géométriques, morphologiques, minéralogiques, et texturaux permettent de définir deux types de minéralisations polymétalliques : (i) une minéralisation cuprifère de type filonien; et (i) une minéralisation polymétallique à Zn-Pb-Cu-Ag-Au de type « *carbonate replacement deposit* ».

4.2 OBSERVATIONS PETROGRAPHIQUES

Les observations pétrographiques des lames minces confectionnées à partir de plusieurs échantillons collectés de surface et des sondages carottés ont permis d'identifier les faciès suivant :

- *Les dolomies*

Les dolomies saines sont composées de dolomite, calcite et d'une fraction gréseuse. La texture dolomitique originelle est bien préservée (Fig. 5C). Dans les zones minéralisées, les dolomies ont subi une alteration hydrothermale manifestée essentiellement par une forte silicification et marmorisation permettant de transformer les dolomies en marbres dolomitiques. Localement, les dolomies ont subi une skarnification permettant de produire des minéraux de skarn de haute température (grenat et idocrase) (Fig. 5E).

- *Les grauwackes*

Au microscope, le quartz et les feldspaths constituent la phase dominante des grauwackes (Fig. 5A) Le quartz se présente sous en micrograins de taille variable, de forme arrondie ou anguleuse isolé ou en agrégats à une faible extinction roulante. Les feldspaths sont souvent altérés en séricite. Les biotites sont présentes en quantités faibles, souvent altérées en chlorite et forment des lits orientés sombres (phyllites). La calcite est également présente mais son aspect est tardif. La roche est affectée par une déformation cisaillante permettant la formation de lits clairs où baignent les minéraux clairs de quartz et feldspaths et des lits sombres caractérisés par la présence des minéraux de biotite et de chlorite.

- *Les trachytes*

Les trachytes présentent une texture microlitique porphyrique à plagioclase, feldspath, quartz et biotite. Les plagioclases sont partiellement ou totalement séricitisés tandis qu'une chloritisation affecte les biotites. Localement, Les trachytes ont été affectés par des cisaillements qui ont transformé la roche initiale en une roche mylonitique (Fig. 5 B).

- *Les micaschistes*

Les micaschistes sont formés essentiellement de quartz, biotite et muscovite. La roche présente une foliation s'exprimant par une alternance de lits plus au moins sombres riches en micas et des lits clairs à quartz. La déformation de ces micaschistes se fait sous le métamorphisme de faible degré type schiste-vert.

- *Les porphyres rhyolitiques*

La composition minéralogique de ces porphyres rhyolitiques est composée de quartz (rhyolitique) présentant des golfes de corrosion, de feldspath potassique, de plagioclase, de biotite et des opaques. La séricite se développe au détriment des plagioclases et la chlorite remplace les biotites. La roche présente une texture microlitique porphyrique (Figs. 2, 5A).

4.3 DONNEES MAGNETIQUES

Les données magnétiques aéroportées d'Amensif sont présentées sous forme d'une carte de contours qui montre que ce secteur est caractérisé par un relief magnétique très agité et de formes peu elliptiques (Fig. 4). Ces formes elliptiques sont souvent étirées suivant des directions des failles et des structures minéralisées. Cette carte d'anomalie magnétique a été superposée à celle de la géologie du secteur d'Amensif. Cette superposition a rendu compte que les structures minéralisées explorées représentent des zones à fortes anomalies magnétiques caractérisées par la présence des minéraux à haut signal magnétique. Malgré la quasi-absence de la pyrrhotine (minéral à fort signal magnétique), la zone d'étude se caractérise par une forte réponse magnétique justifiée par la présence des sulfures tels que la pyrite, l'arsénopyrite, la galène et la chalcopyrite. Les valeurs du champ magnétique total observées à l'échelle de cette zone dépassent les trente Nano Tesla. Les amplitudes varient entre 10 et 400 nT.

La combinaison des données géologiques et les anomalies magnétiques ont permis d'orienter les travaux d'exploration des structures minéralisées en aval (Figs. 3 et 4). La présence d'une forte anomalie au sud d'Amensif est due probablement à la présence d'un volcanisme bien développé durant le Cambrien inférieur caractérisé par des produits pyroclastiques et des laves andésitiques et trachytiques. Ces produits volcaniques sont caractérisés par la présence des minéraux ferromagnésiens qui peuvent avoir une réponse magnétique très élevée.

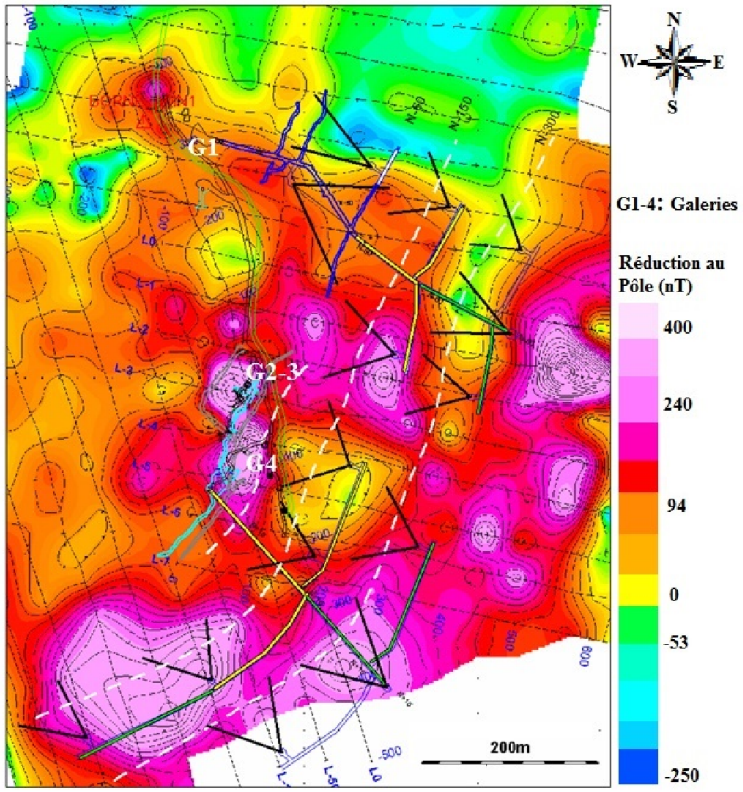

Fig. 4. Superposition des travaux prévisionnels d'exploration sur la carte de chargeabilité réalisée dans le secteur d'Amensif

4.4 GEOMETRIE DES STRUCTURES

Quatre types de minerai ont été distingués selon l'ordre d'importance décroissante : minerai massif, minerai fissural, minerai disséminé, minerai type stockwerk, et minerai très peu rubané. Ces minéralisations sont liées à une intense altération hydrothermale.

Les observations de terrain ainsi l'analyse détaillée des sondages carottés ont permis de révéler des variations importantes aussi bien de la géométrie des structures minéralisées, les relations minerai-gangue, les textures, les paragenèses métalliques et la typologie du minerai.

La minéralisation se présente sous forme de lentilles, des micro-veines (Fig. 5D), des imprégnations, de remplacement de carbonates (Fig. 5F) et en petits amas.

Les éléments morphologiques, minéralogiques, texturaux et géochimiques ont permis de distinguer deux types de minéralisations polymétalliques organisées selon l'abondance de la substance économique la plus dominante.

i) Structure cuprifère (Structure nord) (Fig. 2): cette structure de direction majeure NNE-SSW, est constituée essentiellement de minerai de cuivre. Le minerai est composé par ordre de prédominance décroissant de la chalcopyrite, la galène, la sphalérite, la pyrite, l'arsénopyrite et accessoirement la tetraedrite. La structure cuprifère jalonne la faille N20° à pendage de 45°E. La géométrie lenticulaire de la structure, la morphologie du minerai et les relations texturales entre les minéraux plaident en faveur d'un remplissage filonien da la caisse quartzeuse.

ii) Structures polymétalliques (Structure sud et structure ouest) : ces structures subéquatoriales sont constituées de minerai de plomb, cuivre, zinc et fer. Ces minéralisations sont associées à une forte activité hydrothermale responsable de la transformation des carbonates en marbres dolomitiques, dolomies hydrothermales et carbonates métamorphiques à minéraux de skarns (andradite, idocrase, épidote, trémolite) (Fig.5E). Ces structures sont de direction NE-SW à EW (Figs. 2 & 6), de puissance variables qui peuvent atteindre 2 m et sont en général marquées en surface par un chapeau de fer ou par des trainées noirâtres liées à la minéralisation plombo-zincifère.

Un chapeau de fer a été observé dans la zone. La minéralisation sulfurée a subi une forte oxydation en surface (zone d'oxydation) (Fig. 5B & 5F) permettant de développer une paragenèse secondaire marquée par la limonite, la malachite, l'azurite et la covellite.

Fig. 5. (A) Photographie montrant les dykes rhyolitiques roses et des tranchées d'exploration. (B) Photographie montrant l'importance du chapeau de fer. (C) Vue panoramique du massif carbonaté du gisement. (D) Photographie d'une veine de quartz (Qz) à chalcopyrite (Cpy). (E) Photographie montrant une zonalité d'altération hydrothermale. (F) Photographie montrant une veine à galène (Gn) dans la galerie 3.

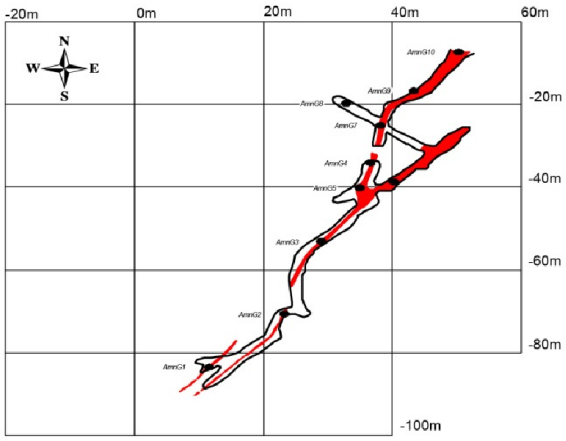

Fig. 6. Levé gîtologique des galeries 2 et 3 d'Amensif

4.5 DONNEES MINERALOGIQUES

Dans ce qui suit, nous présentons l'inventaire des observations métallographiques des espèces présentes dans la zone :

La Chalcopyrite (*$CuFeS_2$*) est le minéral abondant à Amensif (Fig. 7). Elle se présente sous forme de grandes plages de taille millimétrique à centimétrique (Fig. 5D). Elle est contrôlée par un système de fracturation permettant de former des textures en microstockwerk ou de remplissage en colmatant les microfissures de la pyrite (Fig. 7E).

La sphalérite (*ZnS*) présente de belles plages et de cristaux extrêmement variables. Les plages de la sphalérite contiennent des inclusions parfois orientées de la chalcopyrite rappelant la texture de la chalcopyrite disease (Fig. 7A) ([31],

[32]). La sphalérite est souvent associée à la chalcopyrite, galène et pyrite. Des textures de remplacement entre ces minéraux ont été observées (Fig. 7C).

La pyrite (FeS_2) se présente en deux générations (Figs 7 E et F). La première génération est dominante et caractérisée par des agrégats de grandes tailles allotriomorphes associés parfois à l'arsénopyrite au niveau des épontes des rubans. La pyrite est corrodée parfois par d'autres minéraux. La seconde génération est formée par des cristaux de petites tailles. L'association pyrite-arsénopyrite montre des caractères synchrones avec une légère antériorité de la pyrite. La pyrite est associée également à la sphalérite, chalcopyrite et galène. L'observation microscopique montre une bréchification hydraulique de la première génération (Fig. 7E). Dans d'autres observations, la pyrite est remplacée par la chalcopyrite.

L'arsénopyrite (*FeAsS*) se présente elle aussi en deux formes : en agrégats de grandes tailles et en petits cristaux automorphes montrant des formes losangiques ou carrées (Fig. 7B). Les relations texturales entre l'arsénopyrite et la pyrite montrent le caractère synchrone de leur dépôt.

La galène (*PbS*) accompagne la chalcopyrite et la sphalérite et se présente en cristaux automorphes à xénomorphes (Figs. 7C et F).

Le cuivre gris se présente sous forme de cristaux xénomorphes (Fig. 7B) associés à la chalcopyrite, galène et pyrite. Le cuivre gris (Tennantite-tetraedrite) représente le minéral porteur de l'argent.

L'or n'est pas observé microscopiquement. Il a été Détecté uniquement par les analyses géochimiques.

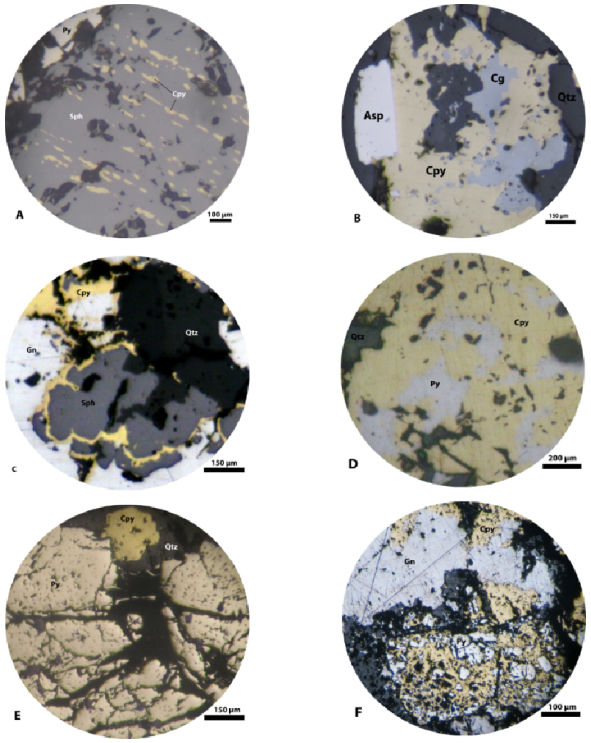

Fig. 7. Microphotographies montrant les relations micro-texturales entre les minéraux métalliques [20]. (A) sphalérite (Sph) à inclusion orientés de chalcopyrite (Cpy) (chalcopyrite disease). (B) Association de chalcopyrite (cpy), arsénopyrite (Asp) et cuivre gris (Cg). (C) Texture de remplacement entre sphalerite, galène (Gn) et chalcopyrite. (D) Remplacement de pyrite (Py) par chalcopyrite. (E &F) Bréchification hydraulique de la pyrite et remplissage des fissures par chalcopyrite et galène.

4.6 ALTERATION HYDROTHERMALE

L'encaissant de ces minéralisations est constitué de dolomies et de marbres dolomitiques. Ces formations ont subi une intense altération hydrothermale et localement pyrométasomatique. Ces altérations se manifestent par une silicification, skarnification, chloritisation, et dolomitisation. Le remplacement des minéraux carbonatés par les minéraux d'altération hydrothermale est un mode d'altération remarquable dans ce site ([19]).

La silicification est le type d'altération le plus répandu. Elle consiste en une imprégnation par la silice d'une partie des roches calcaires (Fig. 5E). Ces roches silicifiées sont riches en minéralisations massives en Cu-Pb-Zn-Fe, avec des rubanement plus minces de chalcopyrite et d'arsénopyrite. On peut ainsi conclure que ces minéralisations peuvent être résultantes d'un liquide siliceux qui a silicifié l'encaissant carbonaté tout en l'imprégnant de minéralisation et en y déposant des minéralisations massives.

La skarnification est localement manifestée par la transformation pyrométasomatique des carbonates en silicates calciques. Ces roches skarnifiées sont caractérisées par la présence de minéraux de skarns à savoir l'andratite (Fig. 8C), l'idocrase (Fig. 8D), l'épidote et la trémolite (Fig. 8F). Ces minéraux ont été identifiés et appuyés par la diffractométrie des rayons X.

La chloritisation (Fig.8E) se développe aussi bien dans les carbonates que dans les métapélites. La chloritisation s'accompagne d'une minéralisation à pyrite et chalcopyrite.

La séricitisation se développe au détriment des plagioclases dans trachytes (Fig. 8 A et B) et des rhyolites. La séricite est un minéral hydrothermal très abondant dans les faciès magmatiques et très peu dans les carbonates. La séricite est souvent associée au chlorite. La séricitisation est associée en règle générale à la cristallisation du quartz, de la pyrite, et de la chalcopyrite.

La dolomitisation se manifeste par l'apparition de la dolomite, de la calcite et très peu de l'ankérite.

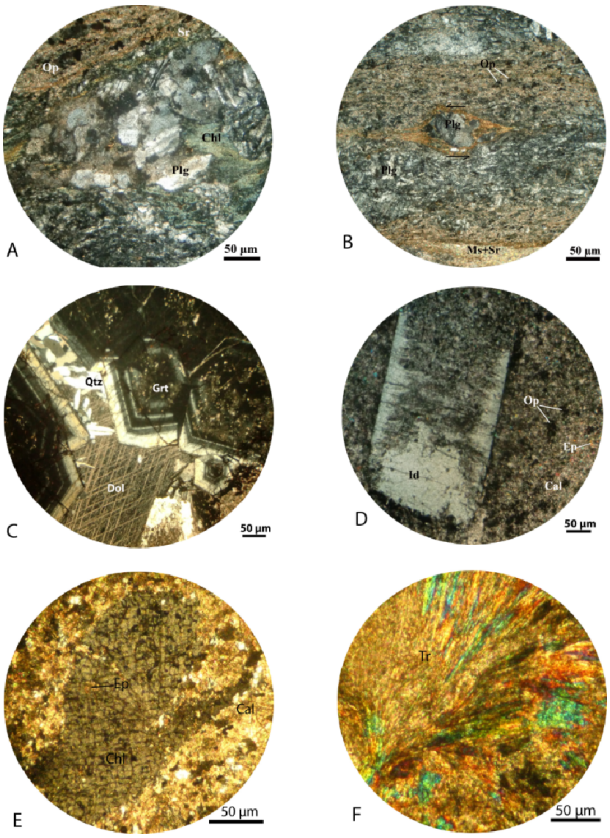

Fig. 8. Microphotographies des minéraux d'altération hydrothermale. (A &B) Photos d'un trachyte altéré et cisaillé. (C) Microphotographie d'un grenat (Grt) type andradite. (D) minéral d'idocrase (Id) dans un calcaire métamorphique. (E) Mineral de chlorite. (F) Mineral fibroradié d'une trémolite

4.7 RESULTATS GEOCHIMIQUES

Le gisement d'Amensif montrent souvent des teneurs élevées (Pb + Zn=25%) avec des teneurs élevées en cuivre et des teneurs encourageantes en or et en argent. Les analyses géochimiques des éléments Fe, Cu, Pb, Zn, As, Ag et Au des échantillons récoltés des sondages carottés et de la surface montrent un enrichissement en métaux de base. Les teneurs sont de l'ordre de 2 à 3% Cu, 11% Pb, 16% Zn, 4% As, 400 ppm Ag et 4ppm Au (Tableau. 1).

Le total des ressources délimitées au niveau de la structure sud d'Amensif (Fig. 2) s'élève à 568 110 Ttv à 3,79%Zn ; 0,69% Pb ; 1,02%Cu avec 98,30 ppm Ag et 0,48 ppm Au. Les premiers essais de traitement à l'Usine de traitement du site de Hajjar (Compagnie minière de Guemassa) seront de l'ordre de 569 814 Ttv à 3,21%Zn ; 0,58% Pb ; 0,86%Cu avec 83,30 ppm Ag et 0,41 ppm Au en fin de Juin 2012, en appliquant une dilution de 18% et une récupération de 85% (Tableau. 2).

D'autres structures furent objet de travaux d'exploration par tranchées, sondages carottés et traçage par galeries. Ce qui permettra d'augmenter les ressources dans ce site dans le futur.

Tableau 1. Résultats des analyses géochimiques des éléments ciblés

Samples	Fe (%)	Cu (%)	Pb (%)	Zn (%)	As (ppm)	Ag (ppm)	Au (ppm)
AMS 1	2,13	0,0102	0,0076	0,0727	1162	1	0,05
AMS 2	3,55	0,0264	0,0109	0,15	1218	3	0,05
AMS 3	5,18	0,0188	0,0153	0,11	2724	2	0,05
AMS 4	5,58	0,0111	0,0147	0,13	757	3	0,05
AMS 5	23,91	0,2	0,0756	10,72	3050	21	0,05
AMS 6	15,14	0,083	0,0705	6,96	5256	15	0,11
AMS 7	5,31	0,0325	0,0197	0,93	1313	8	0,15
AMS 8	3,18	0,0161	0,0077	0,33	30	3	0,05
AMS 9	3,98	0,0152	0,0076	0,45	30	3	0,05
AMS 10	12,59	0,23	0,0393	0,96	12403	24	0,93
AMS 11	0,8414	1,66	3,81	0,9	8900	443	2,32
AMS 12	7,68	0,78	11,25	13,91	2000	251	0,47
AMS 13	1,92	0,18	0,15	0,89	30	13	0,11
AMS 14	8,23	0,83	1,17	3,44	9700	104	0,83
AMS 15	12,76	0,92	0,61	1,25	8300	76	0,44
AMS 16	17,94	2,36	2,43	5,75	19500	189	1,27
AMS 17	14,24	2,01	0,94	4,55	11700	153	16
AMS 18	12,38	1,11	0,24	1,16	16800	103	3,06
AMS 19	5,08	2,28	0,11	0,46	1900	146	0,18
AMS 20	4,77	0,35	0,0901	0,41	2545	36	0,06
AMS 21	4,95	2,68	0,0589	4,67	782	99	0,06
AMS 22	4,37	0,24	0,0736	0,8	1120	17	0,05
AMS 23	2,91	0,0228	0,0262	0,18	120	3	0,05
AMS 24	2,74	0,11	0,0299	0,17	59	10	0,05
AMS 25	5,48	0,54	0,11	7,64	400	73	0,07
AMS 26	4,11	0,12	0,018	0,6	0,003	1	0,11
AMS 27	2,02	0,31	0,0263	0,49	0,0404	16	<0,05
AMS 28	2,92	0,68	0,13	12,51	0,04	73	<0,05
AMS 29	2,29	0,11	0,0263	0,22	0,003	13	0,31
AMS 30	2,66	0,46	0,15	3,57	0,11	42	0,05
AMS 31	2,72	0,006	0,003	0,078	0,0204	2	0,09
AMS 32	3,45	0,0016	0,0116	0,0203	0,1936	1	0,18
AMS 33	1,13	0,0036	0,0316	0,0938	0,003	3	0,05
AMS 34	1,93	0,0036	0,0101	0,0404	0,003	3	0,05
AMS 35	1,86	0,0032	0,0046	0,0376	0,003	1	0,05
AMS 36	1,91	0,0088	0,0139	0,31	0,003	1	0,05
AMS 37	1,03	0,32	0 0999	1,21	0,003	16	0,05
AMS 38	1,43	0,12	0,0277	6,71	0,003	2	0,05

Tableau 2. Calcul des ressources géologique ([31])

Ressources	Tonnage (t)	Fe (%)	Cu (%)	Pb (%)	Zn (%)	Ag (ppm)	Au (ppm)
Res_2012	568 110,72	6,65	1,02	0,69	3,79	98,36	0,48

Les fortes teneurs détectées dans le site d'Amensif sont comparables avec celles qui caractérisent les gisements type « Carbonate Replacement Deposits (CRD) » dans le monde ([34], [35], [36], [37], [38]). La majorité des gisements type CRD contiennent des teneurs élevées en Pb, Zn, Cu, Ag, Au, As, Mo, Bi et Sb.

5 DISCUSSION

5.1 SEQUENCE PARAGENETIQUE

En se basant sur les relations microtexturales entre les phases minérales, nous avons distingués entre trois stades paragénitiques (Fig. 9) :

- **Stade I:** ce stade se caractérise par le dépôt synchrone de la pyrite I, l'arsénopyrite I et le quartz (Fig. 7E). Localement, la pyrite présente parfois un caractère antérieur par rapport à l'arsénopyrite. Elle montre rarement, des inclusions microscopique de la magnétite. L'arsénopyrite se présente sous forme de cristaux automorphes contemporaine de la cristallisation du quartz. Elle renferme quelques rares inclusions de la pyrrhotite. Ce stade se termine par une intense bréchification hydraulique séparant les stades paragénétiques I et II.
- **Stade II :** Les sulfures de ce stade sont présents en grosso-modo en plages équigranulaires jointives et non déformées. Ce stade est subdivisé en 3 étapes ; la première est caractérisée par un fort remplacement de la paragenèse antérieure du stade (I) par une paragenèse fortement Cupro-ferrifère composée de la pyrite (II), l'arsénopyrite (II) et de la chalcopyrite (I). La seconde étape est cupro-zincifère marquée par la formation de la sphalérite à chalcopyrite disease (Fig. 7A), et enfin la troisième étape plombo-cuprifère est caractérisée par la cristallisation de la galène, de la chalcopyrite (II) et du cuivre gris en grandes plages. Cette paragenèse sulfurée montre de belles textures de remplacent aussi bien dans la gangue et /ou entre les sulfures.
- **Stade supergène :** La séquence paragénétique est complétée par une paragenèse d'alteration supérgène. Cette paragenèse se compose de la magnétite, la goethite, Azurite, malachite et de la covellite.

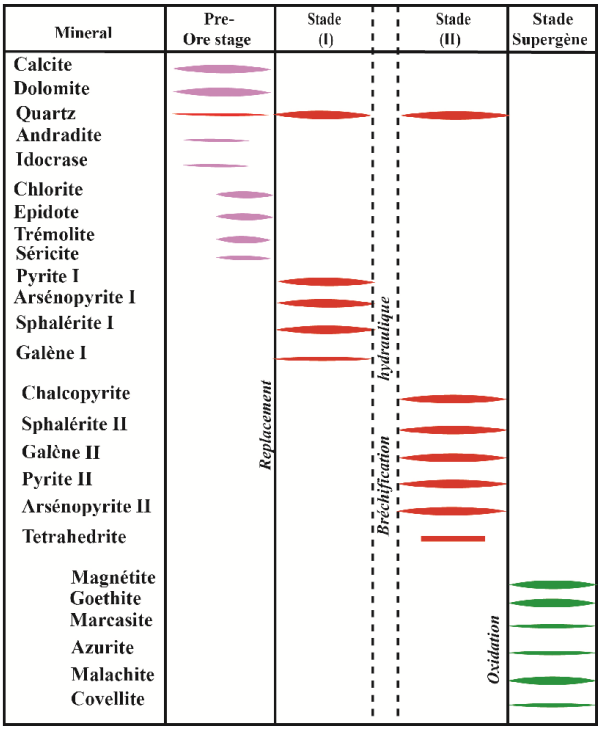

Fig. 9. Séquence paragénétique d'Amensif [20]

5.2 INTERPRETATION TYPOLOGIQUE

En se basant sur les arguments lithologiques, structuraux, gîtologiques et minéralogiques, nous attribuons la minéralisation à Cu, Zn, Pb, Ag et Au d'Amensif au type « Carbonate Replacement Deposits) ([20], [32], [33], [34][36], [37], [38], [39],[40], [41], [42],[43], [44], [45], [46], [47], [48]).

Les arguments litho-structuraux, minéralogiques, et texturaux en faveur de cette classification sont marqués par la présence d'un fort contraste rhéologique des roches hôtes de la minéralisation. Les dolomies massives à fort comportement rhéologique représentent l'encaissant idéal de la dite minéralisation. Alors que les schistes à faible comportement rhéologique ne répondent pas aux conditions suggérées pour l'hébergement de la minéralisation en question. Ces formations sont affectées par une forte activité tectonique (failles et cisaillements) favorisant l'ouverture des fractures, fentes et veines. Ces fractures serviront de chemin et canaux de drainage des fluides minéralisateurs qui seront piégés dans les formations carbonatées. La minéralogie et les relations texturales entre les minéraux métalliques de la structure nord caractérisent le type filonien.

Les formations carbonatées ont subi deux types de transformations ou de replacements : les altérations hydrothermales et localement les transformations pyrométasomatiques. Le phénomène de la transformation pyrométasomatique ou simplement la skarnification se traduit par le remplacement des roches mères carbonatées par des roches métasomatiques (marbre dolomitique, calcaire métamorphique, grenatite). La minéralogie de ces roches transformées est caractérisée par l'apparition locale des minéraux indicateurs de skarns à savoir l'andradite, l'idocrase, la trémolite et l'épidote. Le second phénomène est caractérisé par le développement d'une forte altération hydrothermale accompagnée d'une mise en place d'une minéralisation à Fe-Cu-Pb-Zn. Les minéraux caractéristiques de ces altérations sont la chlorite, la séricite, la calcite, l'épidote et les oxydes de fer.

Le lien intime entre les minéralisations et les altérations démontre un lien génétique entre la formation de minéraux d'altération et la mise en place de sulfures. Les sulfures sont directement associés aux zones d'altération hydrothermale.

La paragenèse minéralogique est constituée de chalcopyrite, pyrite, arsénopyrite, sphalerite, galène et cuivre gris. Des relations texturales entre ces minéraux permettent de caractériser les textures existantes (rubanée, massive, disséminée, en microstockwerk, remplacement, chalcopyrite disease). La présence de ces textures plaide en faveur d'un remplacement de carbonates. La présence des minéraux de skarn (andratite et idocrase) et la sphalérite à chalcopyrite disease peuvent expliquer la présence du fluide hydrothermal caractérisé par une assez forte température (350-400°C) et une solution hydrothermal à forte fugacité du soufre ([32], [49], [50], [51], [52], [53]).

6 CONCLUSION

Les approches sédimentologiques, structurales, minéralogiques et géochimiques montrent que ce gisement représente un cas particulier dans la métallogénie régionale du Haut Atlas occidental. Les formations carbonatées du Cambrien inférieur constituent le siège d'un ensemble de transformations d'ordre thermiques et chimiques. Ces transformations témoignent de la néoformation des minéraux typiques des transformations pyrométasomatiques et métamorphiques (trémolite, andradite, épidote et idocrase) et de la recristallisation de ces carbonates. Le flux des fluides hydrothermaux est facilité par le fonctionnement des failles hercyniennes. Ces failles exercent un contrôle important sur l'ouverture des veines et fractures suivant le comportement rhéologique de la roche encaissante. Ces veines et fractures représentent des conduits propices pour le drainage et la circulation des fluides minéralisateurs.

La nature des altérations hydrothermales, les données minéralogiques et les analyses géochimiques (fortes teneurs en métaux de base) présentent d'importantes similarités avec les gisements polymétalliques de type « Carbonate Replacement Deposits ».

Dans les perspectives futures, la proximité de l'intrusion granitique d'Azegour est un facteur intéressant à prendre en compte dans l'hypothèse d'un contrôle direct ou indirect du magmatisme Permien dans ce type de minéralisation. L'inventaire des autres indices minéralisés encaissés dans les carbonates du Cambrien inférieur dans le district d'Amizmiz (Tnirt, Anamerou et Tameksaout) plaide en faveur du contrôle lithologique probable dans ce type de minéralisation qu'il faudra tenir en considération.

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An Assessment of Biometry Application in Sudan a Case Study of Agricultural Research Corporation (ARC)

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ABSTRACT: Biometrics plays an active role in the research methods for scientists and research interns during planning, development and implementation of research projects. A number of measures have been put in place to improve the research capacity among the scientist in various sectors of agricultural research among other related disciplines. The present statistics shows that the field of biometry in a number of research institutions especially in Africa is still wanting. Therefore, the objective of this study was to addresses the role of biometry in developing capacity of research methods for agricultural research scientists. The study was carried in Agricultural Research Corporation (ARC), Wad Medani, Sudan. Where sample size of 50 scientists was selected using simple random sampling procedures. The major variables tested were methods used in data analysis, research experience, refresher courses, institutional capacity and quality of published papers among others through administering semi-structured questionnaire. The data was analyzed using descriptive statistics, non-parametric methods and regression modeling. The results showed that there was a significant difference ($p<0.01$) on agreement of the methods used in data analyses where over 90% strongly valued application of various statistical methods as compared to about 8% who did not value the said methods. In addition, there was a significant correlation ($p<0.01$, $R^2=41.7\%$) between the number of scientific papers and years of research where the result indicated that for every ten years of research there was about four peer reviewed journal papers. Overall, 100% of researchers indicated biometrics has an active role in developing agricultural scientific research and its most ideal solution for improving performance and building capacity through provision of training/refresher courses. In conclusion, the creation of a sustainable capacity building program in Biometrics will help researcher to produce science of high quality through use of effective statistical design, interpretation and presentation of results.

KEYWORDS: Agricultural research, Biometrics, Scientific Research.

1 INTRODUCTION

Agricultural research help farmer to produce a quantity and diversity of product within contractive of acceptable, profitability and risk, this title is however, too broad in one sense and too narrow in another [7]. The agricultural research focus in developing countries is changing and is no longer based just on the old commodity and disciplinary boundaries [8]. Agricultural research has played a key role in the development of statistical methods; statistics in fact provides scientific tool for representative data collocation, appropriate analysis and summarization of data inferential procedures for drawing conclusion in the face of uncertainty [2]. However in agricultural research, statistics find some of very interesting application which often led to development of newer statistical technique or at least refinement of exciting one [1]. Agricultural statistics has three-core object area namely sampling survey, experiment design and biometrical tools [18]. Agricultural research comprises several branches of science, and permits the formulations methods and perfection of techniques which, once they have been checked and confirmed under optimal conditions, are made available to farmers through extension services [13]. The agricultural research focus in changing, not just in sub Saharan African but also through, the world and now includes agro-ecosystem research, integrated agricultural system to problem solving natural resources management perspectives

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,participation of farmers and an increasing emphasis on providing information about alternative options rather than optimal packages [6]. Biometrics skills in developing countries are in adequate to support proprieties of agricultural research with the consequences quality researches [11].

2 WHAT IS BIOMETRICS?

Biometrics in anther core area under agricultural statistics, even though biometrics as such, is a wider term, it often used for genetics statistics involving studies of plant and animal for assessing genetic potential in section trial for genetic material improvement such trial are often conducted to develop new better performing varieties or animals with respect to chosen trials under different environments are not same [9]. Biometrics plays a significant role in all forms of scientific investigation contribute effectively on planning, statistical design, data management, data analysis, presentation results, reporting among other related research [20]. Biometrics plays a significant role in, planning experiments, conducting experiments and decision-making process of agricultural research [17]. Applied biometrics is very importance in the development of agricultural research strategies, because the nature of agricultural research is changing; the agricultural investigations are based on the application of biometrics which is helpful in testing hypotheses using observed data for effective practice in resolving the different problems that arise in the many branches of agricultural research [12]. Because of the variability inherent in biological and agricultural data, knowledge of biometrics is necessary for their understanding and interpretation different agricultural research methods such as plant breeding, soils, plant diseases, seeds, etc., statistical genetics (micro-arrays, genome data, analysis of genetic data etc, ecological modeling (forestry, fisheries and wildlife and other ecosystems, Functional and data analysis (time series, spatial analysis and data methods in GIS mapping, etc [5]. Appropriate use of biometrics allows an independent, non-pedagogic methodology for the student to arrive at his own conclusions concerning the biophysical component of the decision-making process [4].

3 ROLE OF BIOMETRICIAN IN AGRICULTURAL RESEARCH

In the most of institution of biometrician's report, may achieve three mission functions: (1) assessment, to identify problems related to the agricultural researches and determine their extent; (2) tools for developing, to prioritize the identified problems, modeling hypothesis and/or estimate and predict the effect of changes and (3) in assurance, to make certain necessary services to reach the desired goal-as determined by statistics measures-and to monitor how well the regulators and other sectors of the society are complying with agricultural research [19]. Biometrics plays a key role in each of these functions. In assessment, the value of biometrics lies in deciding what information to gather to identify agricultural researches problems, in finding patterns in collecting, summarizing and presenting of data in an effort to best agricultural strategies [14]. Biometricians are adept at developing the necessary mathematical tools to measure the problems, and predict the effects of agricultural changes will be addressing the studying relationships among variables, a long -Term Statistical Development Programs and Institutional framework for biometrics [16].

4 BIOMETRICS RESEARCH

Biometrics can enhance research and development, and encourage collaboration between the agricultural scientist and statisticians the research activities of Biometrics are still undergoing development, with the current focus on statistical modeling [10]. The research programs are listed below; describing the research directions and the common underlying methods such as Statistical Genetics: QTL analysis, Mixed models, generalized Linear Models , spatial and Temporal Modeling, genetic Resources Conservation, genotype by Environment Interaction, Optimal Experimental Designs [15]. Therefore, agricultural development also required formulation implementation and monitoring of Biometrics research program.

5 STATEMENT OF THE PROBLEM

The problem has little to do with knowledge of statistics in the strict sense , but rather with Appling common sense in trying to solve development and environmental problem through applied biometric based on hard evidence and there are some of absence of a biometrician as research collaborative way in different field of research and there is still on same challenges in statistical consultancy a case of ARC. Also there are weakness of teaching statistics course in most of Sudanese's universities with full missing in teaching of biometrics in Sudan We note that, some of the papers presented by Agricultural Research corporation (ARC) wad Medani , Sudan or theses submitted by graduate students in national universities for example a Gazira university, often demonstrate serious weaknesses in data analysis and interpretation. Continued reliance

by university instructors or by Researches Institutes (RI) upon outdated and "classical" teaching methods contributes to this problem. Weaknesses in statistical principles, knowledge in use of statistical software, and data exploration technique often leads to incompletely analyzed data and incorrectly interpreted findings.

A biometrics tool has become increasingly important and urgent in the light of the adoption of the Millennium Development Goals (MDG) and the managing for development results approach. Biometrics approach is new strategic approach will contribute to the production and dissemination of timely, reliable, and relevant statistics on a regular and sustainable basis. However, the statistical developments in agricultural research will most likely need to be pursued with vigor as the development of sustainable and durable biometrics capacity building.

The biometrician frequently quotes scientific articles assessing the roles of experimentations, exercise, the environment, and for maintaining and improving statistics. Furthermore, there is a need for investigations to continue, in order to establish biometrics capacity building in agricultural research on a global scale. To achieve this, many more sustainable researches need to be carefully studied and the problems in an environment of capacity agricultural research. So the capacity building acquire us better understanding of the nature agricultural problem and needs of a Biometrics services, or to give training courses.

6 PURPOSE OF THE STUDY

The purpose of this study is to assess the Biometry applications in agricultural research as well as addresses the role of biometry in developing capacity of research methods for agricultural research scientists and to enhance the quality and credibility of biological research at ARC through the research program and responsibilities of conducting research in experimental designs, sampling procedures, statistical genetics, computer software's and data processing along with providing advisory services on experimental design/layout for field/labs.

7 RESEARCH QUESTIONS

The research question of an assessment of Biometry applications in agricultural research encompasses the country's scientific research and biometrics capacity building. The building of biometrics capacity does not begin and end in cantered statistical, a number of Fundamental research questions are addressed:

- Biometrics can be effectively applied to agriculture.
- Biometrics in agriculture has an active role in scientific research?
- What is training required for the priority given national need such as workshop or training course or conference in the field of biometrics?
- Statistical analysis tools and statistical packages are requested to meet a conclusion.
- The Importance of biometric capacity building, to create institute of statistical research for biological studies in Sudan.

A series of detailed (interview-based) surveys were implemented in order to generate the data required to measure the number of published papers and numbers of experiences associated with the age determinants of the output of scientific research within ARC, Wad Medani, Sudan. The study used multiple choice and scale type questions in order to identify and assess researchers' education level, performance of research, a accessibility of information and capacity building of their scientific research, etc. Most of the questions in the study were research method.

8 RESEARCH METHOD

8.1 QUESTIONNAIRE DESIGN

A series of detailed (interview-based) surveys were implemented in order to generate the data required to measure the quantitative and qualitative variables associated with the determinants of the role of biometrics capacity building, experiences, and number of papers publication within statistical subject in life work and training course. The study used multiple choice and scale type questions in order to identify and assess role of biometrics and statistical capacity to build to scientific research and overlap the relationship between research and agricultural institution, training courses, workshop, encouragement and understanding of scientific research methods beside of importance of statistical methods for agricultural research. Examples of the questions asked within the questionnaire include. The study used multiple choice and scale type questions in order to identify and assess researchers' education level, performance of research, a accessibility of information

and capacity building of their scientific research, etc. Most of the questions in the study were in relation to the statistical tools, biometrics application and trainings, as access to the impact of biometrics capacity building in the agricultural scientific research. The structure of questionnaire content about 26 questions distributed for a different researches in different scientific program. Examples of the questions asked within the questionnaire include:

- How many scientific papers did you published,?
- How many practical experiences do you have?
- Is a statistical science and its applications in the agriculture have an active role in scientific research?
- Statistics is one of the scientific research methodologies
- For the research to be considered as scientific, the researcher must follow the scientific research methodologies?
- Statistics is the most ideal solution for improving performance and building capacity in scientific research?
- Do you think that statistics plays a visible role in contributing to scientific research?
- How many statistics courses did you take at the undergraduate level?
- How many training courses in statistics did you take while being employed?
- Do you agree that biometrics-training course will improve scientific research?
- Have you participated in a workshop, training course or conference in the field of statistical science?
- What is the role-played by universities and research institutions in the integration of biometrics in scientific research?
- Does your agency encourage the training in statistical analysis?
- Do you think there is a need to establish an institute of statistics research in biological studies in Sudan?
- Do you think this institute will contribute to development of agriculture and natural recourses science?
- What are most problems do you faced in the field of statistical analysis?
- How do you analyze your scientific experiment?
- How do you get advice in biometrics?
- Which statistical analysis packages do you commonly used?

8.2 DATA COLLECTION AND ANALYSIS

The data were collected used survey questionnaire day by day and interviewed researchers; the final version of the questionnaire was then produced accordingly in Arabic and then translated into English language. The data were analyzed using non-parametric statistical methods in order to test a significance difference for all questions among their option. Results of the surveys were transcribed and analysis using Statistical Package for the Social Sciences (SPSS). This statistical software provided data analysis by frequencies, means, minimum, maximum, control chart for confidence interval and linear regression modeling considerations of trend analysis using Minitab software.

9 RESULTS AND DISCUSSION

Table 1. Descriptive statistics of scientific number of papers published, experiences numbers and age

Descriptive statistics	Number of scientific papers published	Practical experiences	Age
Minimum	1.00	3.00	34.00
Maximum	27.00	35.00	62.00
Mean	5.85	17.68	45.29
Std. Deviation	5.91	8.89	7.44

Table 1 shows desiccative statistics such as minimum, maximum, mean and standard deviation (SD. The results indicated that researcher under age 34 he had published one scientific paper, otherwise the researchers who has at least three years' experience work as scientific researcher under maximum age 17-years experiences, he able to published approximately at least 6 scientific paper. Researchers with maximum age were 62 and 35 year experience has 27 paper published. In general average of paper published is 6 and 18-year experiences with age 45. This means that every three years the researcher must be published at least one scientific paper.

Table 2. The percentages of statements studies concerning of statistical method to the scientific research

Statements	SAG	AG	DAG	H	NO	Sig
Is a statistical science and its applications in the agriculture have an active role in scientific research?	96.0	4.0	-----	----	------	0.007
Statistics is one of the scientific research methodologies	36.0	34.0	8.0	14.0	8.0	0.001
For the research to be considered as scientific, the researcher must follow the scientific research methodologies?	92.0	8.0	-----	----	------	0.002
Biometrics is the most ideal solution for improving performance and building capacity in scientific research?	50.0	44.0	2.0	2.0	2.0	0.001
Do you think that statistics plays a visible role in contributing to scientific research?	46.0	48.0	4.0	2.0	------	0.001
Do you think there is a need to establish an institute of statistics research in biological studies in Sudan?	64.0	26.0	4.0	2.0	4.0	0.001

Where the SAG= Strongly agree, AG= Agree, DAG= Disagree, H= Hesitant, NO= don't know and Sig= significant

Table 2 shows were statistical significant differences for all statements and their option choice. Most of responders strongly agree that, the statistical science and its applications in the agricultural sciences had an active role in scientific research by 96% while 4% agree only. As for statistics is one of the scientific research methodologies was 36%, 34%, 8%, 14% and 8% of option choice (strongly agree and agree only disagree, hesitant and don't know, respectively. However we suggesting that about 30 % 0f the researchers was not understand the statistical methods and 70% of them have knowledge of statistical methods and its relation. 92% of researchers strong agree that, the research to be considered as scientific, the researcher must follow the scientific research methodologies while 8% agree only. The results showed that 50% and 44% strong agree and agree respectively, the biometrics is the most ideal solution for improving performance and building capacity in scientific research while 2% for all other answer of (disagree, hesitant and I don't know). Generally we estimated that about 94% agree and 6 disagree. 46% and 48% of the researchers strong agree and agree respectively, that the statistics / biometrics plays a visible role in contributing to scientific research while 4% and 2% of disagree and hesitant. We estimated about 94% represented that, the biometrics has a clear contribution in scientific research. 64% and 26% of researchers of strong agree and agree respectively, the need of establishment an institute of statistics research in biological studies in Sudan, this indicted that is there an importance of creation such as institute of statistical research of biological studies to reflect contribution in scientific research particularly in agricultural research while 4%, 2% and 4% disagree, hesitant and don't know respectively. Generally we estimated that about 90% of researchers agree establish this institution while 10% disagree.

Table 3. Indicates the statement of training course and statistical subject

Statements	Yes	No	Sig
Have you taken statistics courses at the undergraduate level?	98.0	2.0	0.000
Have you taken training courses in statistics while being employed?	42.0	58.0	0.258
Do you agree that biometrics training course will improve scientific research	100.0	----	0.001
Have you participated in a workshop, training course or conference in the field of statistical science?	8.0	92.0	0.002
Does your agency encourage the training in statistical analysis?	58.0	42.0	0.396

Table 3 shows that there were a statistical significant difference among the yes and no for statements of 1, 3, 4 and 5 respectively. 98% of researchers had taken statistical courses at the undergraduate level while 2% did not take any subject in statistics. There were no statistical significant differences for training course of statistics taken while the researchers being employed at ARC in 42% and 58% respectively, while 100% of researchers agree that, the biometrics-training course will improve scientific research. 92 % 0f the researchers have not participated in a workshop, training course or conference in the

field of statistical science, while 2% have participated. The result showed that 58%, there was an encourage for training in statistical analysis by agency while 42% said was not an encouragement. In general the training courses in biometrics face the need of agricultural capacity building and build strong statistician/ biometrician through the research and development.

Table 4. Showed the number and training course of biometrical needs and its activation in scientific research

How many training courses in statistics did you take while being employed				
N(%)	No	One	Twice	Third
	58	22	16	4
Period of Biometrics training courses needs				
N(%)	Every year	Every two years	Every three years	
	46	38	16	
What is the role played by universities and research institutions in the integration of biometrics in scientific research?				
N(%)	High	Little	Hesitant	Nothing
	30	36	10	24

Table 4 shows that 58 % of the researchers did not take any training course during research working while 22%, 16 % and 4% were trained for one, twice and third respectively in statistics/biometrics. As for Period of Biometrics training courses need, the results showed that, 46 % of the researchers needs the biometrics training courses to be held every year, while 38% and 16% needed to be held every two years and three years respectively, depend on the average of 100% approximately is 33%, which near to be (38%) and according to the cumulative percent 84 %. So the Biometrics training courses must be taken very two years. The result showed that the interactive role by universities and research institutions in the integration of biometrics in scientific research presented by 30% , 36%, 10% and 24, of high, hesitant and nothing respectively. Generally according to the cumulative 66 %, the extent of the interaction of research institutions and universities in role of biometrics in scientific research was very little.

Table 5. Indicates the statement of statistical subject and its problem and software

1-Statistics subject was taken at the undergraduate level	**N(%)**
Introduction to Statistics	40 (34)
Experimental design and analysis	46(39)
Biostatistics	14(12)
Operation research	1(0.90)
Statistical packages application	17(14)
2-What is most problems do you face in the field of statistical analysis?	**N(%)**
No problem	11(18%)
The concept of Applied Statistics	4(7%)
Statistical packages	25(42%)
Data processing and get the results	9(15%)
Statistical analysis	2(3%)
Interpretation of results	9(15%)
3.Which statistical analysis packages do you commonly used?	**N(%)**
Statistical System Analysis (SAS)	13(16%)
Genstat	16(20%)
Statistical Packages For Social Science (SPSS)	6(8%)
IRRISTAT	13(16%)
Mstatc	29(36%)
Others	3(3.75)

Through the results of study. Were found that, the distributed of searchers were 64%, 36% of male and female respectively and there no significant different at 5% and the educational level were 10%, 34% and 56% of Bachelor, Master

and Doctoral degree respectively. In general the highest percentages of statistics subject were taken at undergraduate level was 34% of introduction to statistics and 39%, 12%, 0.9%, and 14% of experiment design and analysis, Biostatistics, operation research and statistical packages application respectively, at 0.05 level of statistical significant. 25 % of the problems was faced in the field of statistical packages while 9 % in data processing and get the results and its interpretation and 11% there was not faced any problem some. 36 % of researchers commonly used Mstatc statistical analysis packages while 20%, 16%, 16%,13% and 8% were used of Genstat, SAS, IRRISTAT and SPSS respectively.

10 CONCLUSIONS

This paper described briefly the content of biometric capacity building of agricultural scientific research is designed for different study groups. 92% it has emphasized the importance of the use of biometrics research, which could be applied in agricultural work and were emphasized that, 100% of researchers strongly agree the biometrics will improve scientific research. 56% showed, there were weaknesses of training in biometrics for agricultural scientists and graduate students. This paper relates the work experiences of the researchers and publications, the results indicated that, every 10-year, the researcher must publish at least four scientific paper. And most problems were focused in statistical packages, statistical analysis, data management and interpretation of results. Mstatc statistical software was commonly used. Generally 90% of researchers agree that, for establishment an institute of statistics research in biological studies in Sudan. This paper showed importance of to study role of Biometrics capacity building for developing an innovative agricultural research system in Sudan. Depend on question; what is the extent of the interaction of scientific institutions and universities in the activation of statistics in scientific research? This study invited biometrician and the agriculture scientists (AS) must be collaborative to real headway. Because, Biometrician can tell (AS), which parameters affect selection success and in response agronomist can specify exactly, what is most important for achieving their goals. 96% of researchers confirmed that, the role of the biometrics capacity building providing the statistical expertise, ensure the hypotheses being tested in a study and statistical methods are presented completely an improvements of integrated scientific research and capacity building for cater to everybody's needs and assisting agricultural researchers to build and strengthen their statistical capacities to enable them produce reliable, timely consistent and accurate economic and appropriate statistical tools to analyze experimental data. The training courses for the researchers working in ARC adapted to the need and possibilities of target group at improving the capacity of researchers and quality of research should put more stress on critical thinking skills.

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Effets du non labour et de la gestion des résidus sur la conservation de l'eau et la qualité d'un sol calcimagnésique dans les zones semi-arides Marocaines

[Influence of residus management in a no-till system on water conservation and soil quality under Moroccan semi-arid conditions]

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ABSTRACT: In Morocco, water scarcity is a major factor limiting agricultural production. Water shortage is accentuated by soil quality depletion exaggerated by intensive cropping and tillage systems that cause a decline in soil fertility, structure and organic mater. No-tillage system (NT) has been proposed as a viable alternative to conventional tillage (CT) to improve the soil quality and ensure water conservation. The aim of the present study was to evaluate tillage effects on soil moisture, soil organic matter (SOM) and soil aggregate stability in a Calcixeroll soil under three tillage treatments: conventional tillage system (CT), NT system with crop residues removed (NT0), and NT with 50% of crop residues returned to the soil surface (NT 50). Our results showed that residue cover combined with no-tillage (NT 50) has significantly increased the levels of SOM at the top 100 mm soil layer compared to CT and NT0. The results also indicate that soil water content in the three studied layers (0-50, 50-100 and 100-300 mm) was higher for NT. The performance of soil aggregates was better with regard to the different stresses caused by the mechanical tests. This usually leads toward soil consolidation and increasing the soil resistance to wind and water erosion. We conclude that the increased yield associated with no-tillage system can be explained by both better water conservation and soil quality improvement.

KEYWORDS: No-Tillage, soil quality, crop residue, soil moisture, soil organic matter, aggregate stability.

RESUME: Au Maroc, La disponibilité des ressources en eau devient un défi majeur et menace sérieusement les systèmes de production céréalière des zones semi arides. Cette situation s'aggrave à la fois par l'état dégradé des sols et par l'utilisation des pratiques culturales inadaptées (travail du sol intensif, surpâturage, exportation de résidus…). Pour limiter ces phénomènes et raisonner avec le concept d'une agriculture durable, l'Agriculture de Conservation à base de semis direct a prouvé son efficacité pour arrêter la baisse de la fertilité des sols et de compenser les effets négatifs futurs des changements climatiques. Cet article traite l'effet de trois pratiques culturales (le labour conventionnel (LC), le semis direct sans résidus de culture (SD0) et avec 50% de résidus (SD50)) sur les propriétés d'un sol calcimagnésique notamment l'humidité, la matière organique (MO) et la stabilité structurale. Les résultats ont montré que ces indicateurs de la qualité du sol ont révélé des différences sur les trois modes de travail de sol: le SD couplé aux résidus a eu un impact positif sur les horizons étudiés (0-50, 50-100 et 100-150 mm), marqué par un taux élevé d'humidité et une meilleure teneur en MO surtout pour les deux premiers horizons. Ceci a pour conséquence direct l'amélioration de l'état structural du sol qui se traduit par une résistance des agrégats de surface face aux différents mécanismes de désagrégation, ce qui offre une possibilité de réduire l'érosion

éolienne et hydrique. En conclusion, l'augmentation des rendements sous système du SD peut s'expliquer à la fois par une meilleure conservation de l'eau et l'amélioration de la qualité des sols.

MOTS-CLEFS: Semis direct, qualité du sol, résidus de culture, stabilité structurale, matière organique, humidité.

1 INTRODUCTION

Caractérisé par une pluviométrie contrastée et irrégulière, marquée par des années de sécheresse plus longues, le Maroc est soumis à un fort stress hydrique [18]-[12]. L'agriculture, l'un des secteurs importants pour le pays en termes de croissance économique (environ 20% du Produit Intérieur Brut [13]) reste à la merci des aléas climatiques. Cette situation s'amplifie à la fois par la fragilité des sols agricoles dont 90% se situent dans les zones semi-arides et arides [30] et directement ou indirectement par des modes agricoles inadéquats [23]-[28]. En effet, l'utilisation abusive et inappropriée de matériels de travail du sol dans les exploitations agricoles, le surpâturage et l'exportation des résidus de récolte et des chaumes ont généré des conditions favorables à la baisse du taux de la matière organique des sols, à la dégradation de leur état structural [5] et par conséquent au déclin de leur fertilité [20]-[27]. En d'autres termes, l'agriculture traditionnelle basée sur le labour intense et le travail du sol a montré son inadaptation aux nouvelles données climatiques et économiques et son incapacité de répondre aux principales questions relatives à la conservation des sols et de l'eau [29].

Pour remédier à cette situation inquiétante, le semis direct, pilier de l'agriculture de conservation est proposé comme une démarche agronomique crédible qui vise à améliorer la qualité des ressources naturelles, et à fournir une production agricole abondante et plus stable [2], [11]-[31]. En effet, l'agriculture de conservation, basée sur trois principes: la non perturbation des sols, la conservation des résidus de culture en surface, la diversification des cultures en association et/ou dans la rotation, constitue une solution cohérente face aux problèmes relatifs à l'agriculture Marocaine [21]. Bien que, les recherches effectuées dans les milieux semi-arides marocains ont montré que cette approche culturale augmente la rentabilité de production des sols d'une année à l'autre, elle reste peu adoptée au Maroc (moins de 4000 hectares [3]. La performance de la production sous semis direct est due essentiellement à l'évolution de l'état hydrique du sol à travers le maintien des résidus à la surface du sol [22]-[26] et à la restauration de son état structural [7], [9]-[10]. C'est dans ce contexte que s'inscrit le présent travail. Il s'insère dans une étude plus large développée par le Centre Régional de la Recherche Agronomique de Settat visant à l'évaluation des effets de différents systèmes de travail du sol et de la gestion des cultures sur les paramètres de fertilité des sols, particulièrement l'humidité, la matière organique et la stabilité structurale. Ainsi, les objectifs assignés à notre travail sont: (i) étudier l'effet de trois techniques culturales (travail conventionnel, semis direct sans ou avec 50 % des résidus de récolte sur la conservation de l'eau dans le sol; (ii) déterminer l'impact de la gestion des résidus sous SD sur l'accumulation de la MO et (iii) évaluer la résistance des agrégats du sol face aux différents tests simulant l'action de l'érosion hydrique et éolienne.

2 MATERIELS ET METHODES

2.1 LE SITE D'ETUDE

Le terrain expérimental est situé à la station de Sidi El Aydi du Centre Régional de la Recherche Agronomique de Settat, (latitude 33° 00'N, Longitude 09°22W), au sud de Casablanca (environ 45 Km). Le sol est un calcimagnésique à caractère vertique moyennement profond avec des taux d'argile de 51%, de limon de 28% et de sable de 21%. Les teneurs en MO varient entre 2 et 2,4% pour les 60 centimètres supérieurs. Le pH est alcalin (de 8,2 à 8, 4) et des valeurs de la densité apparente qui oscillent entre 1,19 et 1,44. Le climat est semi-aride à hiver froid caractérisé par une moyenne des précipitations annuelles à long terme de 358 mm [25]. L'essai mis en place en 1987 est un dispositif en split plot (bloc aléatoire incomplet) avec trois répétitions. La rotation est pratiquée en grande parcelle (20 m de long et de 12m de large), avec trois niveaux : blé-blé (BB), jachère-blé (JB), jachère-blé-orge (JBO). Chaque grande parcelle, est subdivisée en quatre parcelles élémentaires (3 m de large et 20 m de long), dont une est labourée au pulvérisateur à disques et trois sont semées directement.

2.2 TRAVAIL DU SOL ET GESTION DES RESIDUS

Les techniques de travail comparées sont: le labour avec un travail du sol au pulvérisateur à disque (10 à 15 cm de profondeur) et le semis direct qui consiste en une ouverture de 2 à 3 cm du sol pour placer la semence à 5 cm de profondeur,

réalisé par un semoir spécial semis direct. La jachère est entretenue mécaniquement dans les parcelles labourées, par contre elle est entretenue par désherbage chimique en condition de non labour.

Pour étudier l'effet de la gestion des résidus de récolte sur les propriétés du sol sous semis direct, les trois sous parcelles ont été soumises à trois niveaux de résidus: à la récolte et dans la première sous parcelle, l'ensemble des résidus a été enlevé (SD0), dans l'autre sous parcelle, la totalité des résidus de récolte enlevée a été retournée et laissée en surface (SD100) alors que dans la troisième sous parcelle, uniquement la moitié des résidus récoltés a été maintenue en surface du sol (SD50). Dans le présent article seulement deux niveaux de résidus (SD0 et SD50) ont été étudiés.

2.3 SEMIS ET FERTILISATION

Au cours des rotations céréalières, le blé (variété Achtar ou Titila) et le fourrage (mélange de vesce et d'avoine) sont semés à l'aide du semoir direct à double disques semeurs, caractérisé par un simple disque ouvreur et des zones tisseuses. Ce semoir permet des espacements de 25 cm entre les lignes. Les dates et les doses de semis sont : Blé: début Novembre de chaque année à 120 Kg ha^{-1}, Fourrage: début Novembre de chaque année à 100 Kg ha^{-1}.

Les apports de fertilisants sont appliqués chaque année et dont les quantités sont déterminés sur la base des recommandations des laboratoires des analyses du sol du Centre Régional de la Recherche Agronomique de Settat. Au moment du semis, les différentes cultures reçoivent un apport de 75 Kg ha^{-1} de Nitrate d'ammonium et 100 Kg ha^{-1} de phosphate super triple. 50 Kg ha^{-1} d'urée sont apportés au blé au début du tallage.

2.4 CONTROLE DES MAUVAISES HERBES ET TRAITEMENT PHYTOSANITAIRE

En condition de non travail du sol, les stratégies de désherbage chimique sont assurées par l'application de glyphosate à une dose de 3 à 4 l ha^{-1} pour contrôler les mauvaises herbes avant le semis et en condition de jachère. Le chloro-sulfuron à 10g ha^{-1} est appliqué avant le semis pour le blé, le fourrage et la jachère. Dans les parcelles soumises au labour conventionnel, le contrôle mécanique des adventices est réalisé au pulvérisateur à disques avant le semis du blé et d'orge et au mois de mars pour la jachère travaillée. Le Carbofuran (insecticide) est employé à l'ordre de 25 Kg ha^{-1} au semis, dans le but de lutter contre la cécidomyie (mouche de Hess). Pour lutter contre les maladies foliaires des céréales, un traitement fongique préventif à base de Propiconazole est appliqué à une dose de 0,5 lha^{-1}.

2.5 LES METHODES D'ANALYSES

2.5.1 L'HUMIDITE

Le taux d'humidité d'un sol détermine les caractéristiques de diffusion ou de stockage de l'eau dans ce sol. Il est évalué selon la méthode gravimétrique décrite par Gardner [33]. La procédure consiste à sécher (passer dans une étuve à 105 °C pendant 48 heures) l'échantillon du sol et connaître ensuite par pesée finale (ramenée à la pesée initiale) le poids d'eau contenu par l'échantillon. Ces mesures d'humidité ont été réalisées au semis et dans les jachères.

$$\theta g = (P_{hum} - P_{sec})/P_{sec}$$

Avec : θg : humidité gravimétrique (g/g), P_{hum} : le poids humide (g) et P_{sec} : poids du sol sec obtenu après séchage (g)

2.5.2 LA STABILITÉ STRUCTURALE

Pour les trois horizons échantillonnés (0-50, 50-100 et 100-150 mm) issus des trois traitements (LC, SD0 et SD50), la stabilité structurale à sec a été déterminée par la méthode de tamisage à sec décrite par Youker et McGuiness [19]. Une prise de 150 g de chaque échantillon, séchée à l'air libre, est mise dans une colonne de tamis de mailles 10, 8, 6, 5, 4, 3, 2, 1, 0.5 et < 0.5 mm, animée d'un mouvement à 1440 vibrations/min. Le refus de chaque tamis est pesé (w_i). L'indice de stabilité à sec est défini par le diamètre moyen pondéral (DMP, mm) calculé à partir de la formule suivante :

$$DMP = \Sigma X_i * W_p$$

Avec: Xi: diamètre moyen de deux classes de tamis successifs et W_p : masse des agrégats correspondant à chaque classe W_i) / 150.

Concernant la stabilité structurale à l'eau, seulement les échantillons de surface (0-50 mm) ont été prélevés dans les trois traitements afin d'étudier la stabilité des agrégats selon la méthode proposée par Le Bissonnais [34]. Cette méthode

permet d'évaluer la sensibilité des sols à la battance et à l'érosion hydrique à partir de trois mécanismes de désagrégation qui se différent par les conditions d'interaction eau/sol. Les échantillons ont été séchés à l'air libre, puis tamisés à sec dans le but de récupérer la fraction 3-5 mm qui a été ensuite séchée à l'étuve à 40°C pendant 48 heures. Ces agrégats ont ensuite subi l'action de trois tests hydriques:

- **Test d'humectation rapide par immersion dans l'eau (HR)**

Ce traitement consiste à immerger les agrégats dans l'eau distillée. Ceci permet de tester le comportement des matériaux secs soumis à des humectations brutales du type pluie intense. Il s'agit d'un mécanisme d'éclatement, désagrégation par compression de l'air lors de l'humectation. Le protocole expérimental suivi pour réaliser ce test consiste à mettre en contact environ 5 g d'agrégats avec 50 ml d'eau distillée dans un bécher pendant 10 minutes, cette opération est suivie d'un tamisage à 50 µm dans l'éthanol pour fixer le premier état de désagrégation.

- **Test d'humectation lente par capillarité (HL)**

Ce traitement consiste à humidifier lentement les agrégats de manière à éviter le phénomène d'éclatement. Ceci permet de tester le comportement de matériaux secs à des pluies modérées. Il est moins destructif que l'humectation rapide et permet donc de discriminer des sols peu stables. 5 g d'agrégats sont disposés sur un papier "filtre" posé sur une table à succion. Après 60 minutes d'humectation des agrégats par capillarité, ces derniers sont transférés sur le tamis de 50 µm immergé dans l'éthanol.

- **Test de désagrégation mécanique par agitation après réhumectation (DM)**

Ce traitement permet de tester la cohésion des agrégats à l'état humide outre que l'éclatement; environ 5 g d'agrégats ont été immergés dans l'éthanol pendant 30 minutes, puis transférés dans un erlenmeyer contenant l'eau distillée, l'ensemble a été soumis à 10 retournements sur un agitateur rotatif. Apres 30 minutes de repos, les agrégats résultants sont transférés sur un tamis de 50 µm immergé dans l'éthanol.

Les agrégats issus de ces trois tests subissent ensuite une procédure identique qui se fait en deux étapes. La première étape consiste à appliquer cinq fois un mouvement hélicoïdal au tamis de 50 µm immergé dans l'éthanol sur lequel on a disposé l'échantillon désagrégé, afin d'effectuer une première séparation granulométrique. La fraction > 50 µm a été transférée dans une coupelle en verre pour être séchée à 40°C pendant 48 heures. Après séchage, cette fraction (> 50 µm) est passée sur une colonne de six tamis de maille décroissante (2000, 1000, 500, 200, 100 et 50 µm). Après 20 basculements latéraux de cette colonne, Les agrégats restant sur chacun des tamis sont pesés et la fraction < 50 µm est obtenue par déduction par rapport au poids initial. Le résultat s'exprime sous forme de diamètres moyens pondéraux (DMP, mm) selon la formule ci-après:

DMP= ∑ **(% de la fraction par rapport au poids total × diamètre moyen de la fraction)**.

2.5.3 LA MATIERE ORGANIQUE

La matière organique du sol, grâce à ses propriétés chimiques, joue un rôle primordial dans le fonctionnement des agrosystèmes et constitue une composante importante de la fertilité des sols [8]. Le taux de la MO a été évalué sur les trois horizons (0-50, 50-100 et 100-150 mm) selon la méthode de Walkey & Black [4], pour 1g de sol broyé et tamisé à 0,2 mm. Les résultats de la MO du sol ont été exprimés en pourcentage.

2.6 ANALYSES STATISTIQUES

La procédure GLM (modèle linéaire général) du logiciel SAS version 2009, a été utilisée pour les analyses statistiques des différents paramètres du sol et pour chaque profondeur. Les analyses statistiques consistent en une analyse de la variance pour évaluer l'effet du labour et des résidus sur les paramètres de la qualité du sol. Les différentes mesures effectuées ont fait l'objet de comparaisons multiples des moyennes selon le test de Duncan au seuil de 5%.

3 RESULTAT ET DISCUSSION

3.1 L'HUMIDITE DU SOL

La conservation de l'eau comme son utilisation efficiente sont les éléments clé de l'agriculture pluviale. Le choix d'une technique de travail du sol repose essentiellement sur son aptitude à permettre au sol de stocker l'eau et la rendre disponible aux racines particulièrement dans les climats à faible pluviométrie [35].

La disponibilité de l'eau dans les 15 premiers centimètres du sol reflète la distribution des précipitations au cours de la période de mesure. Cependant, l'intensité de cette disponibilité est fonction de la profondeur échantillonnée et le travail du sol. Pour l'horizon de surface (0-50 mm), l'humidité a enregistré les valeurs : 0,10, 0,13 et 0,16 g/g, alors que, pour les autres profondeurs (50-100 et 100-150 mm), les valeurs oscillent entre 0,12 et 0,17 g/g (Fig. 1).

Le sol cultivé en SD garde plus d'humidité que le LC surtout en présence des résidus SD50. Les parcelles non labourées présentent une humidité qui augmente de 13% en surface jusqu'au 17% en profondeur, ce qui montre que cette technique culturale permet une meilleure économie de l'eau en zone à faible pluviométrie. L'amélioration de la capacité de stockage d'eau sous SD est due à la présence des résidus en surface, ce qui permet d'atténuer les phénomènes d'évaporation [16] et de maintenir l'humidité résiduelle de la saison des pluies dans les horizons de surface [29]. Alors qu'avec le LC, les résidus sont enfouis et la surface exposée du sol est nettement plus grande, ce qui entraîne une plus grande évaporation d'eau de l'horizon supérieur [1].

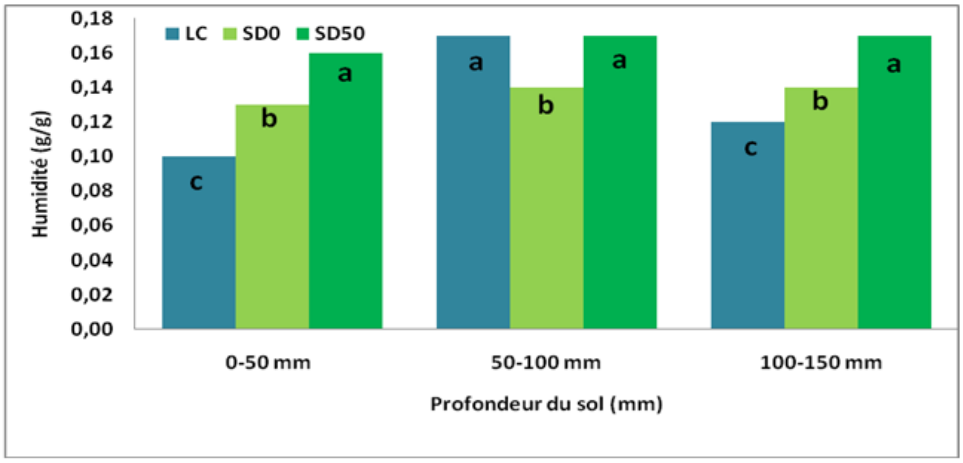

Fig. 1. Effet des trois pratiques culturales (LC, SD0 et SD50) sur l'humidité en g/g. Les traitements ayant la même lettre ne sont pas significativement différents selon le test de Duncan (P<0,05).

3.2 LA MATIERE ORGNANIQUE

La matière organique (MO) joue un rôle important dans le fonctionnement global du sol au travers de ses composantes physiques, biologiques et chimiques, qui ont des conséquences majeures pour la fertilité des sols. La céréaliculture Marocaine est généralement conduite avec le labour et l'exportation de la biomasse sans aucun apport d'amendement organique, ce qui entraîne une diminution de la matière organique dans le sol et une répercussion sur l'agrégation, la stabilité de la structure et sur la sensibilité à l'érosion [30].

L'effet du travail du sol sur le taux de la MO est significatif au niveau des deux premières couches (0,50 et 50-100 mm). En comparaison avec le LC et le SD0, le SD50 favorise l'accumulation de la MO dans l'horizon de surface sans appauvrissement en cet élément en profondeur (Fig. 2). Alors que dans la couche profonde, les trois pratiques culturales ne semblent pas induire d'importantes modifications sur la séquestration de la MO. Ces résultats rejoignent ceux de Mrabet et al [27] et Moussadek et al [22]. Ces derniers auteurs ont trouvé qu'au bout de 7 ans seulement, la teneure en MO a augmenté de 69% dans un vertisol jusqu'à 70 mm de profondeur sous SD avec résidus par rapport au LC.

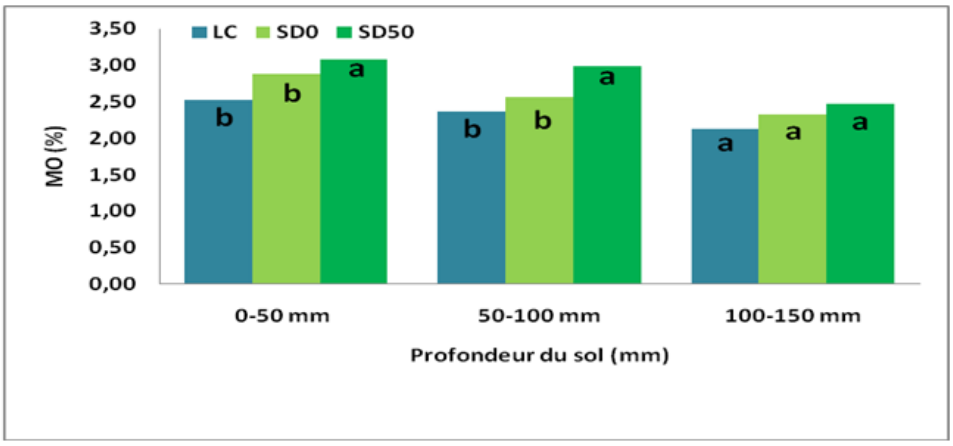

Fig. 2. Effet des trois pratiques culturales (LC, SD0 et SD50) sur la teneur en MO en %. Les traitements ayant la même lettre ne sont pas significativement différents selon le test de Duncan (P<0,05).

3.3 LA STABILITÉ STRUCTURALE

La stabilité structurale, classiquement utilisée comme indicateur de la qualité du sol est influencée par les pratiques culturales [14]. La plupart des méthodes de mesure de la stabilité structurale testent la stabilité des agrégats de sol vis-à-vis d'un stress. Avec le tamisage à sec la seule contrainte appliquée aux agrégats est celle du tamisage, alors que dans le tamisage humide, les échantillons sont exposés à l'extinction. Par conséquent, le diamètre moyen pondéral (DMP) des agrégats mesuré après tamisage à sec est généralement plus grand par rapport à celui obtenu après tamisage humide [36].

3.3.1 LA STABILITÉ A SEC

Dans les deux premières couches (0-50 et 50-100 mm), le SD couplé à une couverture de résidus de récolte (SD50) favorise la stabilité à sec, avec un effet significatif par rapport aux autres techniques culturales (SD0 et LC) (Fig. 3). La particularité du SD d'assurer au sol une structure stable est étroitement liée à la présence des résidus en surface, ce qui permet de limiter le desséchement de la couche arable et protéger par suite les particules fines du sol contre le vent [17]. En profondeur (100-150 mm), les parcelles labourées et non labourées sont de même niveau d'agrégation. Cet intérêt à utiliser le SD pour améliorer l'agrégation des sols a été souligné par Lahlou et Mrabet [32] et Saber et Mrabet [15]. Ces auteurs ont trouvé une importante amélioration de l'agrégation d'un sol argileux, mesuré en termes de pourcentage d'agrégats secs.

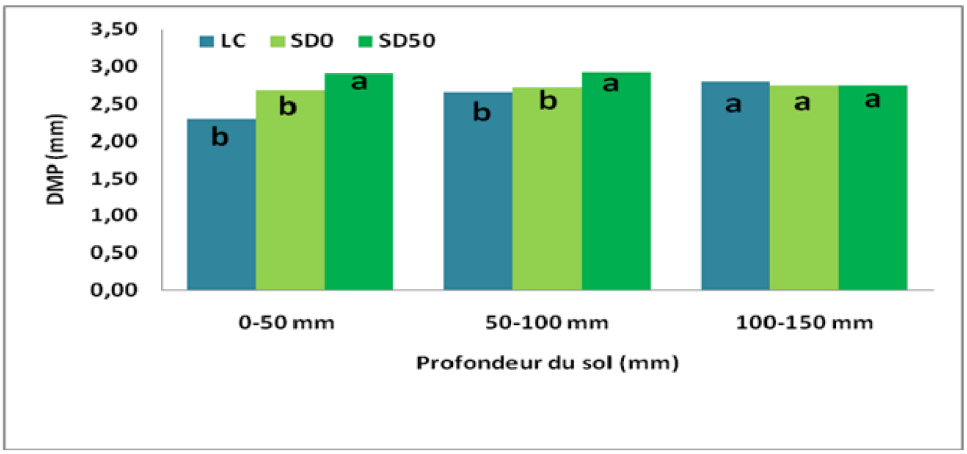

Fig. 3. Effet des trois pratiques culturales (LC, SD0 et SD50) sur le DMP en mm. Les traitements ayant la même lettre ne sont pas significativement différents selon le test de Duncan (P<0,05).

3.3.2 LA STABILITÉ A L'EAU

Il ressort des différents résultats que les agrégats de surface issus des trois techniques culturales résistent mal lorsqu'ils sont soumis à une humectation rapide (éclatement). Les valeurs de DMP (0.37 à 0,41mm) présentées par ce test destructeur sont les petits comparativement aux autres tests (Fig. 4). Les résultats de ce test indiquent qu'il faut plus de temps dans les conditions semi-arides du Maroc pour que le sol sous SD accumule suffisamment de MO afin qu'il puisse résister au phénomène de l'éclatement [9]-[22].

Pour le test d'humectation lente qui simule l'effet des pluies modérées, les agrégats en SD (avec ou sans résidus) ont un comportement stable (DMP > 1,3 mm) que ceux issus des parcelles labourées (DMP=1,27 mm). Ceci montre que la manipulation du sol avec les outils du travail du sol est plus dégradante, lors d'une humectation lente, qu'une simple élimination du labour sans maintien des résidus SD0.

Le test de la désagrégation mécanique fait ressortir que la stabilité des agrégats est supérieure en SD50 qu'en SD0 et LC, il s'est avéré que le maintien des résidus à la surface du sol sous SD améliore la résistance du sol contre l'impact des gouttes de pluie et réduit considérablement leur fragmentation [6].

En référence aux normes établies par Le Bissonnais [34], le sol, avec des valeurs de DMP < 0,4 mm, est considéré très instable quand il est soumis à une humectation rapide avec risque important et permanent du ruissellement et d'érosion quelque soit la technique culturale adoptée. Pour le test d'humectation lente, le sol sous SD est considéré stable avec risque limité d'érosion (DMP > 1,30 mm). Par contre les sols labourés ont une structure instable voir très instable vis-à-vis des différents tests hydriques avec risque fréquent du ruissellement et d'érosion. Ces résultats rejoignent ceux obtenus par Belmekki et al. [10] qui ont rapporté que le SD améliore la résistance des agrégats du sol face à la désagrégation causée par l'énergie cinétique des gouttes d'eau et par le gonflement-retrait des argiles lors de l'humectation lente.

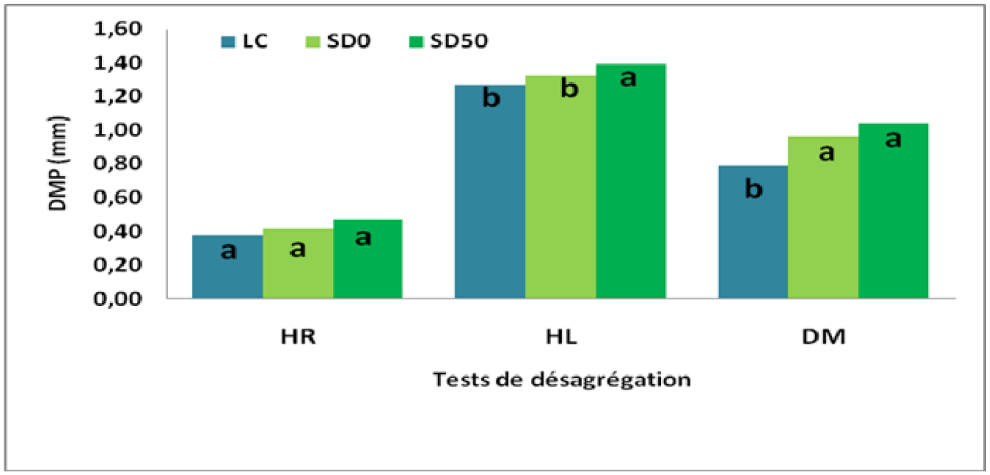

Fig. 4. Effet des trois pratiques culturales (LC, SD0 et SD50) sur le DMP des agrégats de surface (0-50 mm) en mm soumis à trois tests de désagrégation (humectation rapide (HL), humectation lente (HL) et désagrégation mécanique (DM)). Les traitements ayant la même lettre ne sont pas significativement différents selon le test de Duncan (P<0,05).

4 CONCLUSION

Les résultats obtenus sur les parcelles expérimentales montrent que le labour de conservation appliqué en continu sur plusieurs années, constitue un système potentiel d'amélioration de la qualité des sols et un outil d'adaptation au changement climatique à travers une meilleure utilisation des ressources en eau en terme de quantité, notamment avec le retour à la surface du sol de 50 % de résidus de culture(SD50) et une accumulation remarquable de la MO dans les cinq centimètres supérieurs du sol sans appauvrissement des autres profondeurs.

Les conséquences du stockage de la MO sous SD50 ont affecté positivement l'état structural du sol qui se traduit par une résistance des agrégats de surface face aux différents tests de désagrégation, ce qui permet de réduire fortement l'érosion éolienne et hydrique. Par contre la manipulation du sol avec les outils du travail du sol (LC) est plus dégradante qu'une simple élimination du labour sans maintien des résidus SD0.

Malgré ces avantages (agronomiques, économiques et environnementaux), l'adoption de l'agriculture de conservation par les agriculteurs marocains est confrontée à plusieurs obstacles (compétition entre culture et élevage pour la consommation de résidus, équipements chers, manque de connaissance sur l'AC…), ce qui impose aux décideurs à mettre en œuvre une stratégie agricole judicieuse capable d'accélérer la pénétration de ces pratiques à travers des changements majeurs à la fois des itinéraires techniques et de la gestion de l'exploitation agricole.

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La classe moyenne marocaine: Evolution et présentation

[The Moroccan middle class: Evolution and Presentation]

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ABSTRACT: The notion of inequality usually refers to the social inequalities so the reflection mostly stops by only one point judged as the criterion of the stratification: the purchasing power. That could both: allow a social ascension if it is improved or in the most obscurantist expectation aggravate the social exclusion if it is reduced. According to the history, the social stratification concerned all civilized societies, with the predominance of extremities: the upper and the poorest classes, it is only through changes of manners and savings that a new social caste lying between the two could be generated. Moroccan society has experienced this same pattern. This article reviews the first birth of the Moroccan middle class, its evolution, and then its characteristics in the current context.

KEYWORDS: Middle class, Auto-identification, Economic approach, Socio-professional profile, Indebtedness

RESUME : Quand on parle d'inégalités, on fait généralement référence aux inégalités sociales. A ce stade la réflexion se fixe sur deux extrêmes soit l'amélioration dudit pouvoir d'achat et de là la marche vers une ascension sociale soit sa dégradation et qui à son tour renvoie à l'exclusion sociale et ce dans les anticipations les plus obscurantistes. En revenant à l'histoire, on relève que la stratification sociale a depuis longtemps concerné toutes les sociétés civilisées, avec la prédominance des extrémités : la classe aisée et la classe pauvre, ce n'est que grâce aux évolutions des mœurs et des économies que l'émergence d'une nouvelle caste sociale se situant entre les deux a été engendrée. La société marocaine a vécu ce même schéma. Ce présent travail narre en premier lieu la naissance de la classe moyenne marocaine et son évolution, puis s'active pour la présenter et dégager ses spécificités dans le contexte actuel.

MOTS-CLEFS: Classe moyenne, Auto-identification, Approche économique, Profil socioprofessionnel, Endettement

1 INTRODUCTION

La théorie des sciences sociales relative aux classes sociales prend son premier élan dans l'étude de Pareto déclinée de sa notion de la sociologie fonctionnaliste. En effet, avant de parler de stratification, il est dans la logique opportune de voir la notion de société et de groupe.

Bien que Pareto ne bénéficie pas d'un grand plébiscite dans le champ sociologique, il a bien été l'auteur d'une œuvre basique pour la compréhension des faits sociaux. Dans ce sillage, Pareto met en relief l'individu entant que membre d'une société compte tenu de ses racines, ses fondements, et les conséquences de celles-ci sur l'état de la société, cette dernière est ainsi conçue tel qu'un système composé par les rapports et les interrelations des individus qui la composent ce qui implique que l'état même de cette société reste tributaire de l'ensemble des divers caractères de ses individus.

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Puis vient le concept de classe, qui à son tour prend une place indéniable au sein de son étude, où il est admis que les couches ou classes sociales sont la distribution inégale des résidus[1] [1] entre les individus dans un système social qui détermine la position de ces individus les uns par rapport aux autres en fonction des classes ou des castes qui résultent de cette distribution.

Les classes sont fondées sur la prédominance du caractère instinctuel similaire chez l'ensemble d'individu ou sur un degré comparable de puissance ou d'intensité du même instinct, ce qui renvoie à l'hétérogénéité et l'inégalité des membres de la société, ce qui revient à dire que : « *Les notions de groupe, de classe ou de caste correspondent à un agrégat d'individus, porteurs de caractères à peu près semblables, que l'on range arbitrairement dans la même catégorie mais que l'on pourrait tout aussi bien regrouper autrement, selon d'autres aspects de leur configuration psychologique* [2]»[2].

Pareto distingue deux genres de classes et ce, selon la sphère à laquelle ils appartiennent :

- Dans la sphère politique : les gouverneurs et les gouvernés
- Dans la sphère économique : les rentiers et les spéculateurs.

L'élite selon lui est décrite telle que : « *Supposons qu'en toutes les branches de l'activité humaine, on attribue à chaque individu un indice qui indique ses capacités, à peu près de la manière dont on donne des points aux examens. Formons une classe de ceux qui ont les indices les plus élevés dans la branche où ils déploient leur activité, et donnons à cette classe le nom d'élite... Nous avons donc deux couches dans la population : 1°la couche inférieure, la classe étrangère à l'élite... ; 2° la couche supérieure, l'élite qui se divise en deux : a) l'élite gouvernementale ; b) l'élite non gouvernementale.* »[3][3], Soit : L'élite gouvernementale gouverne en haut de l'échelle sociale, pendant que l'autre lui est soumise.

La distinction relative à l'appartenance à la sphère économique, repose sur la spécificité de chaque individu à avoir des instincts[4] [4] propres qui lui indiquent un comportement économique bien précis à suivre.

À savoir, c'est le comment sur quoi repose l'aptitude de chacun ; rentier et spéculateur à gagner son revenu, qui permet de tracer la ligne de rupture entre ces deux genres. Le spéculateur « *une catégorie que nous appellerons (S) les personnes dont le revenu est essentiellement variable et dépend de leur habileté à trouver des sources de gains*[5] »[5], tandis que le rentier « *des personnes dont le revenu est fixe ou presque fixe et dépend peu par conséquent des combinaisons ingénieuses que l'on peut imaginer* [6]».[6] La distinction est ainsi faite entre seulement deux castes sociales.

Dans cette même lignée, Schumpeter a donné sa vision des classes à partir des notions du besoin social et de fonction. Dans l'exemple d'une société capitaliste, la classe supérieure selon la pensée Schumpetérienne est celle ayant des aptitudes industrielles intelligentes, leurs permettant l'accès aux postes de domination suivant le schéma de sélection auquel réussi cette catégorie, en admettant la possibilité d'existence d'un phénomène de migration d'une 'famille' de classe inférieure à une classe supérieure, dans la mesure où les ou l'individu faisant partie d'elle a pour acquis les dons et l'intelligence lui permettant cette ascension sociale. Cette vision ainsi, met beaucoup le point sur les instincts « techniques » et d'habilité de l'individu parties intégrantes de la famille qui compose la caste sociale.

Pour Weber, la donne est tout autre, dans son œuvre d'économie « Économie et sociétés », bien que la pensée sociologique n'y a occupé que peu de place, sa vision a influencé moult théoriciens fonctionnalistes aussi bien américains qu'européens (Mills, Parsons, Touraine..etc). Comme fondement, Weber considère que le fait social résulte de l'action de l'individu qui dépend des sens et orientations propres à ce dernier, ce qui rejoint la notion de résidus chez Pareto et d'aptitude de Schumpeter. Or, pour Weber la création des classes sociales est une conséquence de l'existence chez les

[1] La notion de résidu est vaguement définie par Pareto : renvoie à un ensemble de faits psychiques construits pour rendre compte de la manière dont les instincts des hommes, leurs sentiments et leurs besoins profonds déterminent leurs actions

[2] Une édition électronique réalisée du livre de Nicole Laurin-Frenette, Classes sociales et pouvoir. Les théories fonctionnalistes. Montréal, les Presses de l'Université de Montréal, 1978, 360 pages, page 43.

[3] Vilfredo Pareto, Traité de sociologie générale, p. 1295.

[4] La notion d'instinct chez Pareto est expliquée comme étant états de conscience variés dérivant des désirs innés qui motivent et orientent l'action vers la satisfaction d'un ressenti

[5] Vilfredo Pareto, Traité de sociologie générale, p. 1430.

[6] Vilfredo Pareto, Traité de sociologie générale, p. 1431.

individus d'attitudes, d'orientations et de motivations différentes et inégales, alors que pour Pareto, cela résulterait de la distribution inégale des résidus et de la distribution inégale des aptitudes pour Schumpeter.

La stratification sociale selon Weber est due tout d'abord à une distribution de pouvoir dans la communauté politique, suite à laquelle résulteraient trois catégories étroitement liées entre elles, et détenant chacune un pouvoir spécifique, ce qui trace leur divergence :

- La hiérarchie économique, qui se fonde sur le pouvoir économique et qui trie les individus en « classes » sociales ;
- La hiérarchie sociale ou l'échelle de « statut », et qui se base sur le pouvoir social, la condition ou l'honneur et constitue les individus en « groupes de statut » ou « ordres » (*Ständische Lage*) ;
- Et la hiérarchie politique qui correspond aux ayant « droit » du pouvoir politique ou de l'influence et constituée de groupes auxquels sera donné le nom de « partis ».

De ces trois dimensions de l'inégalité sociale, Weber place la stratification sociale dans la sphère économique, où il juge sa création comme étant un résultat habituel de la relation même des inter-actionnaires au sein du marché, et en découle une sédimentation sociale.

Il relève qu'en parallèle du marché des biens et services, il y a le marché de l'emploi. À ce titre, la première hiérarchie s'identifie aux différences relatives à la propriété des biens productifs, c'est-à-dire ce qu'elle détient ou plus encore entant que « classe de possession ».

Suivie d'une seconde strate, la classe possédante « non privilégiée » : a) les esclaves b) les déclassés (prolétariats de l'Antiquité) c) les pauvres et les débiteurs[7][7].

Et une classe moyenne tire son revenu de la propriété ou de compétences acquises : entrepreneurs, prolétaires, paysans, artisans, fonctionnaires.

Et dans notre étude c'est cette dernière qui nous interesse. On vient de réaliser que parmis les rares théoriciens de l'ancienne ère, seul Weber a distingué l'existence d'une classe du juste milieu dans son travail relatif à la sphère économique. Il l'identifie comme étant l'ensemble d'individus, ni provilégiés ni possédés, gagnant leur revenu d'une acquisition , d'un bien ou des compétences. Même si la définition de cette classe est plutôt simpliste alors que de nos jours l'existence d'une classe moyenne est jugée importante, et est comptée comme étant une marque de développement dans les sociétés développées, il n'existe pas une définition précise et claire qui permet la distinction automatique et générale de cette caste.

En effet, aussi bien du point de vie technique que théorique, il est indéniable que les structures sociales sont loin d'être identiques. Cette divergeance implique l'existence de plusieurs critères à prendre en compte pour établir sa définition, critères qui sont aussi bien différents par leurs genres que par les données mêmes dont ils regorgent.

L'objectif de ce travail est d'apporter un éclaircissement sur la stratification sociale au niveau du Royaume du Maroc en se basant exclusivement sur cette classe moyenne. La première étape est la présentation résumée les méthodologies sur lequelles se sont basées les Etats Unis d'Amérique en premier lieu et la France en second lieu pour identifier leur ou leurs classe(s) du juste milieu, suivi de la présentation détaillée de la classe moyenne marocaine, qui a été basée sur l'étude préparée par le Haut Commissariat au Plan en 2008, suite à la plébiscitation de SA Majesté le Roi Mohammad VI, dans son discours de la même année (le plébiscité royal n'en était pas à son premier pas, vu que feu SM Hassan II vers le début des années quatre vingt dix avait vivement incité à l'augmentation du traitement salarial en vue de l'agrandissement de la classe moyenne et le rétrécissement des disparités sociales).

Cette démarche a eu pour objet l'amélioration du pouvoir d'achat de cette catégorie et de son agrandissement en volume, vu qu'une importante existence rime toujours avec développement social et économique d'un pays.

Cependant, la prise en compte des méthodologies de pays étrangers a pour objet de faire acte de comparaison avec les méthodes appliquées par le HCP. Le choix porté sur ces deux pays est dû à l'histoire américaine chargée par une effervescence sociale liée à ses faits politiques et économiques historiques qu'on aura l'occasion d'étayer, et à la proximité

[7] Nicole Laurin-Frenette, Classes sociales et pouvoir : les théories fonctionnalistes, Les Presses de l'Université de Montréal, 1978, édition électronique réalisée, 360 pages, page 43.

économique et géographique française, dont l'histoire nationale sociale en est bien imprégnée et qui sera aussi à son tour ressortie durant la partie consacrée à la classe moyenne marocaine.

2 LES CLASSES SOCIALES AU MAROC DES ANNEES DE L'INDEPENDANCE

L'évolution de la structure sociale du Royaume a été très liée aux conséquences de son évolution politique. Mais une classification sociale au vrai sens du terme est plus adéquate au Maroc urbain où les disparités y ont fait émergence plus ou plutôt exclusivement. Cette présentation historique est basée sur cette constatation.

Dans son article « Les classes sociales urbaines au Maroc », publié dans la « Revue de l'Occident musulman et de la Méditerranée », N°8, 1970. pp. 223-238 en 1970, le Pr. Adam André[8][8] a comparé la société marocaine de la fin des années 60 et début des années 70, à la société occidentale du 19ème siècle au début de la révolution industrielle. Cette comparaison trouve son origine dans l'existence de deux points en commun :

- Une abondance de main d'œuvre qui est exclusivement composée de paysans récemment transplantés en milieu urbain
- Un taux élevé d'analphabétisme

Mais comme les circonstances historiques, culturelles et sociétales ne sont pas identiques, cette comparaison se heurte à des différences, des différences qui contrairement à l'Europe du 19ème siècle n'aboutiront pas à une implosion progressiste (*révolution industrielle*).

En effet, la révolution industrielle qui a bouleversé l'histoire européenne tant en mœurs qu'en techniques, n'a jamais pu avoir lieu au Maroc où l'industrie au sens stricto-sensu n'a été en fait qu'apportée par les européens soit lors du protectorat soit lors de la colonisation, ainsi que la main d'œuvre qualifiée qui devait mettre en marche la machine infernale.

Le Maroc indépendant et de l'après guerre seconde guerre mondiale, était bloqué entre deux rives. Le modernisme apporté par les pieds noirs et dont s'était imprégnée la caste autochtone et le traditionalisme qui a demeuré ancré grâce notamment à la prédominance d'une instruction monolingue et théorique archaïque.

Cet enseignement à deux faces, a en toute évidence donné lieu à un ensemble de dualismes aussi bien sur les plans social, que culturel et économique.

La production locale marocaine se limitait à la production artisanale traditionnelle et l'artisanat d'entretien et de réparation. Le commerce dans son image la plus commune - il est à noter que l'acte d'Algésiras[9] [9] avait joué un grand rôle dans le développement des échanges- qui a mis en exergue l'économie locale et l'a placée dans le devant de la scène internationale.

Le commerce traditionnel a coexisté tout de même avec le commerce moderne surtout lors des années quarante/cinquante, et tout spécialement après l'indépendance où beaucoup de commerçants étrangers sont retournés chez eux, et dont les fonds ont été repris le plus souvent par les autochtones. Ce négoce, n'a tout de même pas évincé du champ économique la classe mercantile locale qui tenait très bien sa place surtout dans certains secteurs tels que le textile, et les produits alimentaires (sucre/thé).

2.1 STRUCTURE SOCIALE URBAINE MAROCAINE D'HIER

Ce qui faut prendre en compte dans cette petite analyse de la stratification sociale du Maroc des années cinquante et soixante, est que l'article sur lequel s'est appuyée cette recherche a analysé spécifiquement la société marocaine urbaine d'entant, jugeant que c'était celle où apparaissait une stratification sociale passible d'être étudiée.

[8] Pr. Adam André à la faculté des lettres et des sciences humaines d'Aix-en-Provence en 1970

[9] Acte d'Algesiras : résultat d'une réunion le 7 Avril 1906, suite à une confrontation diplomatique entre la France et l'Allemagne, le Maroc est placé sous le protectorat de douze puissances européennes dont la France, l'Allemagne, l'Italie, l'Espagne et le Royaume uni. Suite auquel, avec le désistement des autres pays en faveur de la France, le traité du protectorat a été signé le 30 Mars 1912.

- ***La bourgeoisie marocaine***

Le royaume a longtemps eu une classe bourgeoise commerçante, et cela remonte à sa plus vieille histoire.

Durant le protectorat et la colonisation (les années quarante), la bourgeoisie nationale avec ses revenus pouvait bénéficier du même niveau de vie de la bourgeoisie européenne, elle en avait même adopté ses habitudes de consommation (habillement, habitation, loisir, moyen de transport, culture…). Cette première génération (par rapport à celle qui viendra après l'indépendance, leurs enfants en l'occurrence), n'était pas « très instruite » mais avait tout de même une bonne connaissance des techniques modernes de crédit, et une conscience que l'avenir était dans l'enseignement moderne bilingue chose qui s'est traduite par l'envoi de leurs enfants à l'étranger pour étudier, ces derniers formeront la futur élite nationaliste marocaine.

Mais la conscience et la prévoyance de cette riche caste avait ses limites. En effet, en adoptant le style de consommation de son paire européen, elle a oublié d'en prendre sa vision et sa force productive.

Ceci va jouer en grande défaveur du pays après l'indépendance. Le bourgeois marocain est un investisseur risquophobe, et n'investit que dans la spéculation à court terme qu'est la pure fonction de marchand, et a repris les commerces laissés par les colons et continué son activité, mais sans jamais penser à faire du lourd investissement.

Et c'est cette classe qui pouvait prendre le relais du colon après l'indépendance et prendre les rennes pour donner lieu à une « révolution industrielle » comme il a été le cas en Europe du 19ème siècle. D'autant plus que ceci était en concordance avec la pensée de l'état marocain qui prônait le libéralisme et l'appuie de l'investissement privé.

Devant cette déficience, l'Etat s'était retrouvé agir contrairement à sa propre idéologie en intervenant chaque jour dans l'économie et assumer tout seul ses lourds investissements en industries.

- ***La classe ouvrière divisée par deux clivages***

En dessous de cette classe supérieure, il y a une classe ouvrière. Cette dernière comme il a été précisé ci-haut était en grande majorité composée de paysans illettrés.

Le prolétaire marocain était dans le bas de l'échelle sociale, d'un coté et contrairement à la bourgeoisie locale qui arborait une vie similaire à sa pareille européenne, lui, avait un niveau inférieur à celui de son paire français, allemand ou américain.

D'un autre coté, l'ouvrier marocain bénéficie tout de même contrairement aux ouvriers européens du 19ème siècle des révolutions et résolutions déjà discutées, disputées et adoptées par le monde moderne, ce qui fait que l'émergence de cette classe est venue au monde marocain mais dans une ère où son cadrage était déjà prêt, et biensûr il n'en fallait que le modeler à la pâte nationale. On comprend par ici que tous les sujets épineux liés à cette classe tels que : les luttes ouvrières vieilles de 150 ans, conquêtes du syndicalisme, législation du travail, les salaires minimum fixés par les lois, et les journées de travail fixées à 8h/jour, le travail réglementé des femmes et enfants, l'inspection du travail et les primes d'ancienneté, tout cela a été « résolus ».

La venue tardive de cette classe a échappé au despotisme qui lui a été imposé auparavant, et a bénéficié des avancées de la loi du travail dans le monde moderne partant des décrets de l'Allardes de 1791[10][10], en passant par la genèse du droit de travail durant la deuxième moitié du 19ème siècle à la première guerre mondiale et même après. Elle n'aura enfin de compte que la version finale et améliorée du cadre de travail dans lequel elle devrait exercer, sans autant de militance telle qui a été le cas de l'ouvrier européen.

L'émergence d'un commerce moderne relayé par le colon, n'a pas fait disparaître l'artisanat de production locale. Ce secteur concernaient en 1960, 85000 personnes (selon le rapport Martinel datant de cette même époque), dont 77% avaient un revenu moyen inférieur à 400 francs par jour et qui pouvait descendre jusqu'à 38 francs par jour.

Sauf que par leurs techniques traditionnelles, niveau de vie, culture, et attachement aux usages passés, les ouvriers de l'artisanat traditionnel étaient condamnés à rester au sein de la bulle de la société coutumière, et de là à rester loin du salaire minimum légal.

[10] Les décrets d'Allarde des 2 et 17 mars posent le principe de la liberté du travail selon lequel "chaque homme est libre de travailler là où il le désire, et chaque employeur libre d'embaucher qui lui plaît grâce à la conclusion d'un contrat dont le contenu est librement déterminé par les intéressés." Ils suppriment les corporations. http://www.vie-publique.fr/politiques-publiques/regulation-relations-travail/chronologie/

En parallèle de cet artisanat traditionnel, un artisanat de réparation et d'entretien coexistait, qui contrairement au précédent donnait vit à une classe ouvrière avec un niveau de vie supérieur à celui de la précédente vu que le revenu moyen était supérieur ou égal au salaire minimum légal en vigueur en 1960.

Contrairement aux ouvriers de l'artisanat traditionnelle, ces ouvriers de l'artisanat avaient un minimum d'instruction, il y en avait même ceux qui avaient fait des écoles professionnelles, et tous ont eu une expérience des techniques modernes. Le mode de vie de cette caste s'approche de celui de l'ouvrier européen, par son ouverture aux idées nouvelles et son attention et écoute des messages des partis progressistes de l'époque.

- ***La classe moyenne***

Entre ces deux extrêmes, existait même si peu nombreuse, une classe sociale du juste milieu. Selon le même rapport datant de 1960, elle était composée de fonctionnaires moyens, enseignants, employés, techniciens, commerçants modernes moyens, et quelques ouvriers qualifiés tels que ceux définis dans le dernier paragraphe ici-haut.

Cette classe moyenne se caractérisait par un modernisme résolu dans leur comportement psychosociologique et dans leurs habitudes de vie. Elle doit cette situation aux diplômes surtout ceux de l'enseignement secondaire d'instruction bilingue.

La relative rareté des diplômes à cette époque, a donné à cette classe une importance et une influence dans la société civile.

2.2 STRATIFICATION SOCIALE ET INSTRUCTION/EMPLOI

L'enseignement des années cinquante se percutait contre deux cantons : l'instruction traditionnelle et l'instruction moderne, avec la présence d'un fort taux d'analphabétisme.

Dû à son passé culturel et poids dans la virtuosité scientifique de jadis, la Madrasa archaïque a gardé une place importante dans un Maroc nouveau de par son indépendance. Une instruction qui paraissait plus accessible aux tranches sociales modestes. Celle-ci, présentait une scolarisation monolingue (en arabe) purement théorique, sans aucune formation technique, sa plus grande faille. En effet, cette limite aurait eu gain de cause de ses érudits qui au même titre que les illettrés sont restés bloqués dans le clivage de l'économie traditionnelle, sans pouvoir mettre la main sur un emploi moderne qui nécessiterait des connaissances techniques, et une maitrise bilingue.

La modernité importée des colons, et même avant par les missionnaires, s'était petit à petit faite sa place dans le Maroc.

La seconde guerre mondiale révolue, l'indépendance acquise, le pays s'est retrouvé en présence d'un autre type d'enseignement : l'école moderne, qui s'est développée petit à petit durant toute cette période d'avant et après guerre.

Ce développement tient son origine dans la portée même de ce type d'instruction durant une époque où tout était d'une importance structurelle pour la levée et marche du pays surtout après son indépendance. En effet, l'école moderne dispensait ses cours en français et en arabe, bilingue, elle était ouverte sur la culture de l'autre et aux nouvelles idées. Elle a permis en l'occurrence à frayer le chemin à ses diplômés vers la classe moyenne, classe qui était du moins rare à cette époque.

Les visionnaires qui ont eu l'opportunité d'aller au-delà de l'enseignement secondaire –notamment, les descendants de la bourgeoisie bénéficiant d'études à l'étranger-, ont eu quant à eux, la porte grande ouverte sur l'accès à la classe « dirigeante ». Etant un nombre restreint, cette catégorie a eu l'opportunité de servir dans la haute administration et dans les offices publics, mais ceci a été aussi encouragé par deux autres points essentiels :

- L'inexistence d'interlocuteurs de leur niveau dans le secteur privé sauf s'il s'agit d'interlocuteurs étrangers
- Absence d'un régime représentatif laissant libre champ à la technocratie

Le Maroc indépendant avait grand besoin de cadres qualifiés pour servir le pays et le relever. Sauf, que comme ce nombre d'élus était bien restreint et que la classe moyenne aussi n'était pas très présente, c'était la prédominance de l'analphabétisme et la main d'œuvre disqualifiée qui régnait.

Ceci et dans la logique des choses impliquait un fort taux de chômage.

Dans le Grand Casablanca de 1958 par exemple, on comptait un citadin en âge de travailler sur cinq sans emploi. En 1961, la ville s'est vu allouer ses secours à ses chômeurs et miséreux dont le nombre s'était élevé à 165 000 personnes dont 43 000 chefs de familles. Et la situation ne s'en était guère apaisée lors des émeutes de Mars en 1965, provoquées par la vague de licenciements et fermeture d'usines, où le taux de chômage avait pris son envol.

Biensûr depuis cette étape transitoire, le Maroc a pu trouver une stabilité et sérénité surtout après la fin des années quatre vingt suite à l'adoption du plan d'ajustement structurel. Le développement économique continu a eu et a toujours une grande répercussion sur l'évolution de la société nationale. L'analyse qui va suivre est basée sur les enquêtes du HCP s'étalant de 1985 jusqu'à 2007, relatives au revenu et niveau de vie, pour en dégager les spécificités de la classe moyenne marocaine.

3 LA CLASSE MOYENNE MAROCAINE AUJOURD'HUI

Dans la pratique internationale, la distinction de la classe moyenne parmi les autres classes sociales a donné lieu à différentes méthodes et estimations statistiques, qui dépendent de manière très étroite de la structure propre de la hiérarchie sociale et des critères choisis aussi multiples qu'ils soient -tels que l'âge, profession, structure du ménage…etc- mais s'accordent tout de même sur presque le même principe de calcul.

Avant d'étayer les résultats de l'étude du HCP, il est opportun de rappeler la définition concoctée par le commissariat relative à cette classe.

La classe moyenne selon le HCP est constituée des populations dont les dépenses de consommation ou le niveau de revenu se situent dans la fourchette centrale de la distribution sociale de ces indicateurs.

S'étant essayé à appliquer les formules de délimitation de la classe moyenne des pays et organismes étrangers sur les données nationales, par la formule de l'OCDE, on trouve que la classe moyenne se situe entre 75% et 150% du revenu médian par habitant, alors que pour la méthode française extensive, la classe moyenne se trouve entre le second et $9^{ème}$ déciles du revenu par personne.

Par ailleurs, avec le calcul élaboré par la banque mondiale, la classe moyenne marocaine devrait avoir un pouvoir d'achat compris entre 2$ et 13$ par jour qui correspondrait respectivement à 9.76dh et 63.44DH.

En termes de parts dans la population totale et toujours selon ces estimateurs étrangers, la classe moyenne marocaine représenterait 41.8% de la population totale selon l'OCDE, contre 84.1% estimée par la banque mondiale, et 80% selon la méthode extensive de l'INSEE français.

La divergence des résultats ne fait que prouver que ces méthodes étant élaborées à partir de données non spécifiques au Maroc, ne peuvent en aucun cas y être appliquées, et c'est dans cette perspective que le HCP, a élaboré ses propres seuils à partir desquels la classe moyenne marocaine puisse être distinguée des autres catégories sociales. Pour ce faire, il s'est basé sur sont enquête sur les revenus et niveau de vie de 2007, en prenant en compte un échantillon de 7200 ménages, dont 4320 du monde urbain et 2880 du monde rural.

3.1 MÉTHODOLOGIE DE DÉFINITION

La distinction de la classe moyenne parmi les autres classes sociales repose comme on l'a montré plus haut sur deux méthodes.

D'un coté le critère « *auto-identification sociale des chefs de familles* », aussi subjectif de par sa non prise en compte de la stratification objective de la société globale, même si il présente néanmoins l'avantage de la représentativité du vécu de l'individu et de son statut social, la méthode subjective ne prend pas en considération la conceptualisation de sa société dans ses infimes détails, et est jugée insuffisante par la plupart des instances statistiques internationales (exemple : INSEE, USA…etc).

D'un autre coté, on retrouve le critère « le Revenu et le Niveau de vie » qui est le plus considéré, car comme il a été énoncé, en plus de son objectivité il présente un large panel d'avantages dont la particularité de relier la réalité personnelle de l'individu à la réalité de sa société et donc peut donner une image correcte de sa place par rapport aux autres au sein de cette société. Cette méthode se base essentiellement sur[11] [11]:

[11] Enquête du HCP de 2007 relative aux revenus et niveaux de vie datant de 2007 sur les classes moyennes

- Le partage statistique de la richesse nationale entre les différentes catégories sociales
- L'identification des segments et caractéristiques socio-économiques et leurs évolutions

La prise en compte de ces deux points essentiels a permis- suivant l'objectif premier de cette étude -, l'établissement d'une stratégie opérationnelle visant l'augmentation de cette catégorie sociale en plus de la consolidation de leur position économique.

Cependant, le HCP s'est essayé aux deux formules, afin d'en tirer le maximum d'informations susceptibles d'être prises en compte dans l'identification factuelle de la classe moyenne marocaine.

3.1.1 L'AUTO-IDENTIFICATION DES MÉNAGES

Avec la méthode subjectif, il a été trouvé qu'un peu plus de la moitié des ménages marocains (55.8% soit 17.2 millions d'habitants) s'auto-identifient entant que classe moyenne, et que dans les 20% des plus riches on retrouve 75% qui s'y auto-identifient et de même pour les 20% des plus pauvres, 37% parmi eux qui admettent y appartenir aussi.

Ce taux cache par contre une toute autre réalité puisque 39.4% de cette dernière catégorie appartient en réalité aux classes pauvre et relativement pauvre, tandis que 3.2% sont de la catégorie controversée : riche et relativement riche.

Se basant toujours sur le critère subjectif, l'étude révèle aussi que tant que le lieu est modeste et avec une moindre disparité sociale apparente, l'auto-déclaration d'appartenance à la classe moyenne est plus importante, ceci est appuyé par un chiffre : 79% des habitants de ces lieux s'autoproclament de classe moyenne. Le biais engendré par cette approche est accentué encore plus avec le fait que l'évaluation des tendances passées en est totalement exclue, ce qui détache complètement le résultat de la réalité surtout qu'une bonne partie aussi bien des riches que des pauvres pense se trouver dans le juste milieu social. La méthode n'a aucune référence passée pour juger de l'évolution de la tendance actuelle, mais une fois de plus elle montre que l'individu égocentrique part toujours de ses propres ressentis pour identifier sa place sociale : le pauvre se sous-estime et se croit plus pauvre qu'il l'est tandis que le riche, gêné par sa richesse refuse de montrer son appartenance à la haute sphère sociale car il en veut plus.

3.2 L'APPROCHE ÉCONOMIQUE DES CLASSES ÉCONOMIQUES

L'approche économique admise par le HCP consiste à situer les classes moyennes dans la fourchette centrale de distribution sociale des revenus ou des dépenses de consommation.

Statistiquement, quand on parle de « centrale » on pense généralement à « la moyenne », sauf que cette mesure a été jugée inappropriée par le HCP vu que les valeurs extrêmes ainsi que les inégalités existantes entre la distribution de revenus et les dépenses en consommation qu'elle met en relief biaisent les limites de cette catégorie, ce qui laisse à opter pour la médiane qui présente un choix plus pertinent, puisqu'elle permet la correction de l'influence des valeurs extrêmes fixant les bornes des fourchettes des classes moyennes et répartie ces dernières en deux groupes de même observations (xi), et s'aligne ainsi sur la méthode des deux pays étudiés plus haut.

Par la « médiane », le HCP est arrivé à délimiter la fourchette à partir de laquelle on peut identifier la classe moyenne au Maroc telle que :

- La borne inférieure correspond à 0.75 fois la médiane des revenus ou des dépenses de consommation (ceci exclut les pauvres, les vulnérables et les très vulnérables se trouvant au-delà du seuil de vulnérabilité[12][12]), tel que :

0,75× Taille × Revenu médian par personne et par mois (663,1 DH)

Et, pour le calcul à partir des dépenses par ménage par mois :

0,75 × Taille× Dépense médiane par personne et par mois (674,6 DH)

[12] Seuil de vulnérabilité au Maroc, le HCP l'attribue selon le nombre des membres d'un ménage, voire : http://www.hcp.ma/Taux-de-vulnerabilite-selon-la-taille-de-menage_a654.html

- La borne supérieure a été exprès fixée à 2.5 fois la médiane supérieure, tel que :

2,5 × Taille × Revenu médian par personne et par mois (663,1 DH)

Et, pour le calcul à partir des dépenses par ménage par mois :

2,5 × Taille× Dépense médiane par personne et par mois (674,6 DH)

Cela suivant une option extensive, dont le choix se justifie par l'existence d'une distribution inégalitaire des revenus comme il a été spécifié ci-haut. En effet, l'étude du HCP[13] [13] recèle que :

- 38% des revenus et 33% des dépenses de consommation sont aux 10% les plus aisés de la population
- 27% vivent en dessous du seuil de vulnérabilité avec une part dans l'ensemble des revenus qui s'établit à 11% et une participation dans les dépenses de consommation qui ne dépasse pas les 10% du total des dépenses en consommation.

Contrairement à l'option restrictive, dont résulte une réalité maquillée de la classification sociale de la population qui estime une classe aisée à 37.7% de la population, l'option objective permet de réduire au profit des classes moyennes, la catégorie des ménages aisés ce qui reflète au mieux la réalité de la distribution sociale des revenus au Maroc.

3.3 PRÉSENTATION DE LA CLASSE MOYENNE MAROCAINE

Selon la méthode objective expansive de délimitation des intervalles extrêmes des classes moyennes, 53% de la population totale fait partie de la classe moyenne, soit 16.3 millions de personnes où 59% sont du milieu urbain contre 45% du milieu rural. Ceci relève du fait que l'urbanisation participe au développement de la classe moyenne, puisqu'une corrélation de 67% existe entre ces deux éléments.

3.3.1 PROFIL DE LA CLASSE MOYENNE MAROCAINE EN TERMES D'HETEROGENEITE

Les chiffres auxquels a abouti l'étude, démontrent que les classes moyennes ont profité aux côtés de la classe modeste de la hausse du taux brut de scolarisation depuis le milieu des années quatre vingt à 2008, à hauteur de 15.2%.

L'évolution de ce taux a impliqué la prédominance des chefs de familles scolarisés dans les ménages de classe moyenne. Ainsi, on relève que les chefs de familles ayant effectué un cycle fondamental ont un revenu moyen de 4.990 DH, celui des chefs de familles avec un niveau secondaire de 6.975 DH, de 13.033 DH pour les chefs de familles de classe moyenne ayant fait des études supérieures, contre seulement 4.356 DH, pour les chefs de ménage non scolarisés.[14] [14]

A coté du niveau scolaire, l'étude a identifié aussi d'autres spécificités de cette classe, telles que ses aspects hétérogènes seront spécifiés ici-bas et ce, à partir de plusieurs critères partant du revenu moyen par ménage par mois jusqu'au taux de chômage la touchant.

En termes de revenu moyen par ménage et par mois, on relève que :

Etant donné que le revenu moyen désigne le montant autour duquel l'ensemble des revenus ne s'écartent que faiblement, pour notre cas on remarque que :

- 28% de la classe moyenne fait partie de la catégorie supérieure, dont le revenu est supérieure à la moyenne nationale qui elle, est établi à 5308 DH

[13] Intervention de M. Ahmed LAHLIMI ALAMI, Haut-Commissaire au Plan, Rabat, 19 Mai 2009, lien : http://www.hcp.ma/Intervention-de-M-Ahmed-LAHLIMI-ALAMI-Haut-Commissaire-au-Plan-Rabat-19-Mai-2009_a830.html

[14] http://www.infomaroc.net/economie/23527-le-revenu-mensuel-moyen-par-menage-marocain-seleve-a-pres-de-5300-dirhams-hcp.html

- 42% de la classe moyenne fait partie de la catégorie intermédiaire dont le revenu est compris entre la médiane du revenu national qui est égale à 3500 DH, et la moyenne du revenu national (5308 DH).
- 30% de la classe moyenne appartient à la catégorie inférieure qui correspond aux revenus inférieurs à la médiane nationale soit les moins de 3500 DH par mois et par ménage.

En termes de structure socioprofessionnelle :

La structure professionnelle désigne l'appartenance à un corps de métier précis, ici l'étude s'est référée à six catégories :

Tableau 1. Les sources socioprofessionnelles de la composition classe moyenne

Catégorie socioprofessionnelle	Part dans la classe moyenne totale	Part dans la classe moyenne modeste totale	Part dans la classe moyenne aisée totale
Employés, artisans, ouvriers qualifiés des métiers de l'artisanat	63%	26.1%	10.9%
Rentiers, retraités et inactifs	58.6%	26.7%	14.7%
Cadres moyens, commerçants, intermédiaires financiers	56.3%	12.6%	31%
Ouvriers agricoles et non agricoles	48.6%	48.4%	3%
Exploitants agricoles	40.2%	53.2%	6.6%
Cadres supérieurs et professions libérales	19.5%	4%	76.5%

Source : Elaboré à partir des données statistiques de l'enquête du HCP de 2007 relative aux revenus et niveaux de vie datant de 2007 sur les classes moyennes

Le tableau affirme que les niveaux de formation et de qualification participent largement à la création de la classe moyenne. Aussi, le gap existant entre le niveau de revenu et la condition de vie participe à l'hétérogénéité socioprofessionnelle de la classe moyenne. Toutefois, le HCP a stratifié la classe moyenne en grandes catégories de métiers et on a recensé la représentativité selon la catégorie de la classe moyenne. (Voir tableau ci-dessous)

Tableau 2. Structure socioprofessionnelle de la classe moyenne

	Part dans la classe moyenne totale	Part dans la catégorie inférieure	Part dans la catégorie intermédiaire	Part dans la catégorie supérieure
Employés, conducteurs d'installation, artisans, ouvriers qualifiés des métiers de l'artisanat	29.4%	-	42%	28%
Rentiers, retraités, et inactifs	26%	27%	-	32%
Exploitants agricoles	16.2%	35%	-	21%
Ouvriers	16.1%	38%	-	18%
Commerçants, cadres moyens, intermédiaires financiers	11.5%	23%	77%	
Cadres supérieures, professions libérales	0.8%	-	-	75%

Source : Elaboré à partir des données statistiques de l'enquête du HCP de 2007 relative aux revenus et niveaux de vie datant de 2007 sur les classes moyennes

On remarque que les catégories « employés, conducteurs d'installation, artisans, et ouvriers qualifiés des métiers de l'artisanat » et « rentiers, retraités et inactifs » prédominent la classe moyenne, alors que « les cadres supérieurs et les

professions libérales » n'en représentent même pas les 1% mais qui, tout de même présentent 75% de la catégorie supérieure de la classe moyenne. D'un coté encore, la classe moyenne intermédiaire est dominée par la catégorie « Commerçants, cadres moyens, intermédiaires financiers » alors que la première catégorie qui est la plus représentative de la classe moyenne totale n'y est présente qu'à hauteur de 42%.

Alors que de l'autre coté, la catégorie ouvrière est la plus présente dans la catégorie inférieure de la classe moyenne à hauteur de 38% contre seulement 27%et 23% pour respectivement les catégories « Rentiers, retraités, et inactifs » et « Commerçants, cadres moyens, intermédiaires financiers ».

En termes d'activités

L'élargissement des classes moyennes est positivement corrélé à la tertiarisation de l'économie, sauf que l'étude relève que 48% d'actifs occupés de la classe moyenne travaillent majoritairement dans le secteur secondaire (61%), en coexistence avec 43.7% de personnes inactives composées de : femmes au foyer, étudiants, retraités et rentiers, personnes âgées et infirmes ….et autres, et 8.2% de chômeurs.

Par rapport aux autres catégories sociales, la classe moyenne est plus touchée par le chômage, puisque 14.6% des concernés en font partie- surtout les diplômés qui en représentent 31.7% -, que les classes modestes et aisées qui respectivement, en sont touchées respectivement à 10.9% et 10.4%.

Le fléau prédomine surtout dans le milieu modeste urbain (à 24%) et à peine existant dans le milieu rural aisé (à 2.8%). Avec une petite diminution en 2007 par rapport à 2001, passant de 14,8% à 14,1%. La baisse du taux de chômage a bénéficié durant cette période à l'ensemble des actifs compte tenu de leurs niveaux de scolarisation:

- Le taux de chômage des « sans niveau scolaire », est passé de 8,1% à 7,4%,
- De 27,5% à 23,5% pour les diplômés de niveau moyen,
- Et pour les diplômés de niveau supérieur, de 37,0% à 31,9%.

3.3.2 PROFIL ECONOMIQUE DES CLASSES MOYENNES

Le poids économique de la classe moyenne dans la population est mesurable à partir de ses revenus et ses postes de dépenses. Ainsi, pour ce qui est du revenu, l'étude du HCP relève que la classe moyenne dispose par ménage et par mois un revenu moyen composé du salaire, des transferts, des entreprises individuelles agricoles et non agricoles et des rentes, tels que:

Tableau 3. La composition du revenu de la classe moyenne

Sources du revenu	La part dans le revenu	Milieu urbain	Milieu rural
Salariat	44.5%	52.7%	27.7%
Entreprises individuelles agricoles et non agricoles	30.3%	19.3%	53.2%
Transferts	13.3%	13.8%	12.2%
Rentes	9.4%	11.4%	5.2%

Source : Elaboré à partir des données statistiques de l'enquête du HCP de 2007 relative aux revenus et niveaux de vie datant de 2007 sur les classes moyennes

On remarque qu'en milieu urbain le salaire représente la source première de revenu (52.7%), alors qu'en milieu rural, il s'agit plutôt des entreprises individuelles agricoles et non agricoles qui en constituent la part principale.

Dans une moindre mesure, les rentes ne contribuent qu'à hauteur de 9.4% dans le revenu total surtout au milieu rural où elle n'en représente que 5%.

Pour ce qui est des dépenses, on relève que la classe moyenne consomme les deux tiers de son revenu en alimentation et habitat, et moins que cela en transports et communication où est conduit 9% du revenu. Il est à noter que ce dernier poste de dépense est plus important chez la classe moyenne aisée où il consomme jusqu'à 19% de leur revenu. L'étude affirme aussi qu'entre 1985 et 2007, la structure des dépenses des classes moyennes a été marquée par:

Tableau 4. Variation du poids des dépenses dans le revenu de la classe moyenne en 2007 par rapport à 1984

Poste de dépense	Variation en % en 2007 par rapport à 1985
Transport et communication	**+ 100%**
Hygiène et soins de santé	**+ 68,8%**
Enseignement, loisir et culture	**+ 44%**
Transferts, tabac, impôts et taxes	**+ 56,3 %**
Habillement	- **54,2%**
Equipement ménager	- **31,4%**
Alimentaire	- **13,9%**

Source : Elaboré à partir des données de l'étude de 2008 du HCP

Ainsi, dépendamment de la sous-catégorie de la classe moyenne, on trouve que le revenu de la classe moyenne supérieure est plus important que l'ensemble de ses dépenses de consommation de 8%, ce qui lui laisse une marge suffisamment large pour épargner, tandis que pour la catégorie intermédiaire le revenu égale sa consommation, ses ressources donc couvre tout juste l'ensemble de ses dépenses, alors que pour la classe moyenne modeste le revenu est inférieur de 12% de ses dépenses, elle consomme plus que ce qu'elle est en mesure de se payer, cette carence a peut être comblée par un endettement, chose à vérifier.

3.3.3 L'ENDETTEMENT CHEZ LA CLASSE MOYENNE

Les données remises par le HCP, relèvent que dans sa globalité la classe moyenne a beaucoup recours au crédit, et ceci dans une fréquence plus rapide par rapport aux autres classes sociales. Les ménages endettés sont estimés à 31% de la classe moyenne totale, où :

- 26.8% appartiennent à la catégorie inférieure
- 30% appartiennent à la catégorie intermédiaire
- Et 34.8% appartiennent à la catégorie supérieure.

D'où on relève que la catégorie supérieure est celle qui est la plus endettée de la classe moyenne, mais durant l'intervalle [1999-2007] l'endettement a connu une évolution variable dépendamment de la sous-catégorie de la classe moyenne puisque la catégorie modeste s'est endettée à 25% plus qu'avant 1999, tandis que les catégories moyennes et aisées respectivement à 33.55% et 23.5%.

Cette augmentation correspond aussi à l'augmentation du poids démographique de la classe moyenne durant [2001-2007] de 3.8% et celle de leur poids économique de 1.9%.

Cette endettement se compose généralement en crédit à la consommation courante, crédit immobilier et à l'équipement et moyen de transport, telle que:

Crédit à la consommation courante à hauteur de 59%

- Catégorie inférieure 71.2%
- Catégorie intermédiaire 55.8%
- Catégorie supérieure 54.6%

Crédit immobilier à hauteur de 25.1%

- Catégorie inférieure 16%
- Catégorie intermédiaire 26.7%
- Catégorie supérieure 29.3%

Et le crédit à l'équipement ménager et moyen de transport à hauteur de 15.9%

- Catégorie inférieure 12.8%
- Catégorie intermédiaire 17.5%
- Catégorie supérieure 16.1%

Ces types d'objet de crédit renvoient automatiquement à la remarque relevée par le département américain d'économie et des statistiques dans son étude sur la classe moyenne et qui attribue à cette dernière un panel d'aspirations qu'on retrouve en grande partie ici, entre autres :

- Le besoin d'acquisition immobilière : avoir un toit, un chez soi et se délaisser du poids de la location ou autre forme d'engagement envers des tiers
- Le besoin d'équipement : étant donné le niveau d'instruction de cette masse, son aspiration à la modernité est forte et cherche à se payer un confort domestique
- Le besoin de transport : l'acquisition d'un moyen de transport est devenue une nécessité pour la liberté de se déplacer et l'indépendance vis-à-vis du transport commun. Cette liberté ouvre plusieurs champs d'exploitation d'où la plus importante est la recherche de l'emploi et travailler même loin de chez soi. Les opportunités deviennent géographiquement accessibles à cette classe.

A partir de ces données, on peut confirmer qu'en effet, même avec de différents environnements, les classes moyennes continuent à partager les mêmes besoins et objectifs.

Cependant, on remarque que quand la classe moyenne s'endette, elle a plutôt recours aux établissements non institutionnels surtout quand il s'agit du crédit à la consommation où la demande à ce type d'institution représente 70% du total des crédits, alors que pour les lourds crédits à long terme (crédits immobiliers) la classe moyenne s'orientent plutôt auprès des établissements institutionnels où 38.4% des crédits octroyés sont en leur faveur.

A cet effet, les chiffres révélés par l'étude du HCP montrent confirme fortement l'engouement de la classe moyenne vers l'acquisition immobilière, d'ailleurs :

- 68% de la classe moyenne résident dans des maisons modernes, dont 63% en sont propriétaires
- 15% habitent dans des appartements dont 68% en sont propriétaires
- 1,3% dans des villas dont 59% en sont propriétaires
- Et enfin, 8% dans des maisons traditionnelles (propriétaires : 58,2%) et 6% dans un habitat sommaire avec des taux de propriété respectifs de 58.2% et 75%

Etant donné, que c'est l'un des postes budgétaires les plus importants de la classe moyenne, le taux de propriété est important pour toutes les sous-catégories confondues. Sauf que la classe moyenne ne se rue pas sur le même type de logement. En effet, l'enquête montre qu'elle est présente dans plusieurs formes d'habitat et n'en partage pas forcément un type précis.

Enfin, il ressort de l'étude que la classe moyenne marocaine a des similarités avec les classes moyennes américaines et françaises. Elle en partage les ambitions, et est influencée et gonflée par les mêmes facteurs : le niveau d'instruction, le revenu et le niveau de vie.

De la particularité, il se trouve que les classes moyennes marocaines ont pris du temps pour se former contrairement dans les sociétés développés. La prédominance du monde rural et de l'analphabétisme ont dû attendre les faits économiques et politiques pour que surgissent une classe parmi la classe élitiste et la classe modeste. Durant sa première ère, la formation ou plutôt l'accès à la classe moyenne se faisait grâce à l'instruction du niveau secondaire.

Ce facteur s'est depuis développé et renforcé avec d'autres pour permettre sa ou leur formation, vu qu'actuellement on distingue trois sous-catégories de la classe moyenne. Le revenu et le niveau de vie en plus de l'instruction deviennent les facteurs les plus indicatifs sur cette caste.

D'après les dernières données sur lesquelles s'est appuyé le HCP pour fonder son intervention, la classe moyenne marocaine est majoritairement propriétaire de son toit, mais elle s'endette beaucoup surtout pour sa consommation courante, et ceci dans un rythme beaucoup plus rapide que celui de l'évolution de son revenu, ce qui indique son importante fréquence de consommation. Ainsi, il s'agirait plutôt et selon les chiffres d'une caste endettée, d'une instruction intermédiaire et concentrée en grande partie dans le milieu urbain.

4 CONCLUSION

La littérature économique ne donne pas une définition théorique de la classe moyenne mais néanmoins, admet la construction de couches sociales. Bien que grand nombre des théories anciennes ne parlent que des deux extrêmes : la riche et la pauvre, même le grand Karl Marx ne pas identifiée la classe moyenne entant que telle mais en tant que « petite

bourgeoisie », mais avec l'évolution des mœurs et du développement politico-économique, elle est arrivée à se frayer un chemin et se faire une place imposante dans la société moderne.

En effet, l'apparition de cette mi-classe et l'importance qu'elle a prise, l'ont rendu un gage de modernité et de développement des sociétés avancées, ceci appuyé par des théories telles que celles relatives aux classes sociales en forme de sablier[15] qui reflètent une société à très forte disparité sociale : l'existence d'extrémités domine versus une classe moyenne très faible ou casi-inexistante, et la société modèle en forme de montgolfière, où le inégalités sociales sont très faibles avec une importante classe moyenne, comme la structure sociale de la société Tunisienne qui compte selon l'étude de l'AFDB[16] [16], 89.5% de la population totale.

Selon la même étude, la classe moyenne africaine ne cesse d'augmenter en volume (350 millions d'individus soit 34% de la population totale en 2010), et plus fortement dans l'axe nordique du vieux continent. Cette expansion tient son origine dans l'évolution favorable de plusieurs indicateurs comme la baisse du taux de vulnérabilité, l'amélioration de la gouvernance, la croissance économique…etc. Ce gonflement accompagne une tendance mondiale, et dans une frénésie continue puisque selon une étude éditée par l'OCDE[17] [17], la classe moyenne mondiale passera de 1.8 milliards de personnes en 2009, à 3.2 milliards en 2020, et à 4.9 milliards en 2030. Cette augmentation sera engendrée par l'Asie dont la classe moyenne représentera 66% de la classe moyenne mondiale contre seulement 28% en 2009.

Les exemples pris en considération dans ce travail, présentent ces mêmes tendances, et partagent comme on l'a noté des similarités. Quelle que soit son origine, la classe moyenne n'a pas une connaissance précise sur sa place dans l'échelle sociale dans l'environnement auquel elle appartient, elle a toujours les mêmes préoccupations : avoir une maison, une voiture, scolariser ses enfants, …sa vie se résume à planifier et épargner pour répondre à ces besoins.

Cependant, les divergences sont plutôt liées à divers paramètres. Tout d'abord, excepté les Etats Unis d'Amérique, aussi bien la France que le Maroc parlent des classes moyennes.

Ce « s » du pluriel vient de la définition même donnée à la classe du juste milieu, comme on vient de le voir, tandis qu'en parle d'une unique tranche moyenne dans la société américaine, on distingue dans les deux autres pays, entre une classe moyenne inférieure, c'est le moyen pauvre, la classe moyenne intermédiaire ou le moyen « moyen » et finalement la classe moyenne supérieure qui, autrement dit le moyen riche.

Cette sous-stratification admet que chacune des sous-catégories a ses propres seuils d'identification, de seuil de vulnérabilité et tendances qui, même communes vont différer par leur degré de la classe moyenne inférieure, à l'intermédiaire et supérieure.

S'en suit, la nature de l'échantillon et de sa taille. Les USA ont reposé leur étude sur un échantillon qui a pris en compte les formes d'engagement familial les plus répandues dans son territoire, avec un intérêt porté sur les deux types de familles les plus communes à leur société. Le travail donne un aperçu très complet sur la nature de l'échantillon et les spécificités sociales, ce qui rend la lecture plus fluide et le renvoi d'idées rapide.

L'étude du CREDOC, s'est beaucoup penchée sur divers enquêtes et études de l'INSEE et d'elle-même, où chacune est relevée d'un ou plusieurs échantillons à la fois, donc il n y a pas un échantillon spécifique à l'étude qui a fait l'objet de tout son questionnement, et ne nous donne pas ainsi une idée sur la structure familiale qui a compté le plus pour cette recherche.

Toujours dans la même inquiétude, l'étude du HCP s'est basée sur un échantillon dont la taille n'est pas vraiment représentative de la population effective (7200 ménages pour *32 272 974* habitants). En plus de cela, dans sa prise en compte du profil socioprofessionnel on ne voit pas les fonctions issues du secteur informel ou une référence à son étude à ce sujet, sachant que selon cette même source[18][18], il s'agirait de 2,216 millions emplois en 2007, contre 1,902 millions en1999, soit une création nette de 314 169 emplois au cours de la période, qui représente tout de même 14.3% du PIB national.

[15] Alain Lipietz, politicien et économiste français, dans sa représentation de la stratification sociale en France

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Enfin, ce modeste travail permet tout de même d'avoir une vision globale sur la classe moyenne nationale, comparée à d'autres classes moyennes, et à partir des carences relevées dans les sources sur lesquelles on s'est appuyées nous dirigeront vers les points à prendre en compte dans l'étape à venir qu'est l'enquête spécifique à cette catégorie pour en dégager les composantes et origines du risque crédit.

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Projection of cassava production due to introduced cassava processing technologies: Goal Programming Approach

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ABSTRACT: This study was proposed to project future production of cassava due to introduced cassava processing technologies in Mikongeni (Kibaha district) and Tongwe village (Muheza district) in Tanzania. Primary data were generated from 120 consumers who were randomly selected with the use of questionnaire, focus group discussion and experimentation. The study projected the future trend of production for cassava using goal programming approach and indicated that about 128 571.4 tonnes (an increase of 60.7% per year) can be produced per annum in the two districts, if farmers use the said technology in full scale. The study recommended that the farmers have to be informed on the growing demand of the mechanically processed cassava products, thus the need to meet this demand.

KEYWORDS: cassava, goal programming, processing technologies, demand, projection.

1 INTRODUCTION

BACKGROUND INFORMATION

Cassava (*Manihotesculenta* Crantz) is the starchy root crop that is grown almost entirely within the tropics. Although it is one of the most important crops in the tropical countries, it is little known elsewhere in some parts within the tropics, and considered to be a low grade substance crop (Cock, 2001).

Cassava ranks second in the list of staple food crops in developing countries after maize (Nweke, 2003). In sub-Saharan Africa, cassava is grown chiefly as human food, but it is also an important animal feed and has several industrial uses. Being one of cheapest source of food energy, cassava gives a carbohydrate production per hectare which is about 40% higher than rice and 25% more than maize. Thus cassava plays a major role in meeting developing countries' rising demand for consumption of both food and animal feed (Tonukari, 2004).

The total area harvested in the world in 2005 was about 16 million hectares, with 57% in Africa, 25% in Asia and 18% in Latin America. About 15% of the world's population of cassava is exported to Europe and Japan as chips, pellets and/or starch. The starch is used in food industries, textiles, paper industries and in beer brewing. The remaining 85% of the world production is used within the producing countries for food (58%), animal feed (28%) and industrial uses (3%) where the wastage is about 11% (CIAT, 1993).

The area of land planted with cassava is greatest in Africa, but yields are lower than other continents, where in 2005 Africa, Asia and Latin America had 12 354 000, 3 429 000 and 2 649 000 hectares of land planted with cassava whereas productions were 109 755, 56 082 and 34 094 (000 metric tonnes) respectively (Prakash, 2008).

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In Tanzania, cassava is grown in most parts of the country. However, chief growing areas are Tanga, Mwanza, Pwani and Lindi regions. In recent years, cassava is also grown in other parts of the country as a result of Government efforts to stimulate local self-sufficiency in food supply (Nang'ayo *et al*., 2007); as such, making cassava the most important root crop in the country. Despite its importance, Tanzania is estimated to produce 6.3 million tons of cassava per year.

The main inherent problems with cassava include high perishability of the edible roots within 2-3 days after harvesting, high level cyanogenic glucosides in some variation (Mlingi and Ndunguru, 2003) and low nutritional value as it is mainly composed of starch. In addition, there exists stigma in some transects of Tanzanians to regard cassava as a poor man's food, therefore reduced production and consumption of cassava and increased vulnerability of cassava farmers to poverty.

One solution to the perishability problem has been to leave the crop in the field and harvest in piecemeal only where there is need but this is uneconomical because it ties up the land unnecessarily. Another solution is to transfer the risk by selling the crop to businessman while still in the field at price set arbitrary and often very low, which gives very little income to farmers and thus a disincentive to increased cassava production. A noble solution has been to process the roots into shelf-stable product, for example flour but the methods used are still inadequate as in most area they are tedious, rudimentary and unhygienic, often leading to insufficient processing and poor quality products (Silayo *at al*., 2004).

Both the tuber and leaves of cassava contain Cyanogenic glucosides, which may lead to toxicity if cassava is not properly processed. Safe consumption of cassava depends on successful removal of cyanogens. The percentage of cyanide reduction varies from 70 to 100% depending n the kind of processing method used (Nwapa, 1986). In order to minimize the cyanogens content, cassava is processed by different traditional methods, which includes fermentation (wet and solid-state) and drying. However, in solid state fermentation and drying, there is proliferation of spoilage and pathogenic micro-organisms on cassava, some of which may produce mycotoxins (Nwapa, 1986). The resulting flour is coloured thus not appealing to the consumer.

A recent study on consumer preference on mechanical processed cassava products has revealed that there is an increasing demand for the products (Theodory, 2010). The increase in demand pulls the production and hence the future production of cassava had to be known beforehand. Studies conducted on cassava in Tanzania (Silayo *et al.,* 2004; Laswai *et al.,* 2005) have focused more on processing and processed products of cassava, but the studies did not revealed the future production of the cassava. Therefore, this paper was proposed to evaluate the future cassava production due to the introduced cassava processing technologies using goal programming approach.

2 THEORETICAL APPROACH

DEMAND FOR CASSAVA

Due to higher population growth rates and higher levels of cassava consumption the greatest growth potential for the use of cassava as a human food appears to exist in Africa. Equally, Asia has shown some signs of growth, while Latin America a slight decline. In Tanzania, the situational analysis showed that there is a big potential demand for cassava. The current supply of fresh unpeeled cassava for immediate domestic consumption is far below demand, with unsatisfied market. Peeled and dried cassava chips as raw materials for human food and processing industries are in short supply. The same is experienced for unpeeled dried chips as raw materials for livestock feeds industries. Moreover, a long term potential is the market for fresh unpeeled cassava roots for starch processing industries (if well invested in) (TAC, 2004).

Demographic changes provide both a challenge and an opportunity for increased demand for cassava as a human food. On the other hand, the increasing urban population provides an opportunity to sell more cassava if the product is of good quality and competitive price. Domestically therefore, growing urbanization offers opportunities to develop new, or unexploited markets for cassava (Ponte, 2001). Increased demand for cassava and its products caused the emergence of different cassava processing technologies in different cassava growing areas in the world.

PROJECTION FUTURE PRODUCTION OF CASSAVA INDUCED BY INTRODUCING MECHANIZED CASSAVA PROCESSING TECHNOLOGIES

Itharattana (2003) attempted to forecast cassava production in Thailand at two levels, national and regional levels. Ordinary Least Square (OLS) was used to estimate the coefficients in each equation. Cobb-Douglas type was applied in the planted area equation while time series model was used in the yield one. Applying the model for the *ex-ante* forecast, the total production was expected to be almost the same in 2002 when compared with the previous year. Weaknesses in the model still remain in terms of some specification errors. Thus, to make *ex-ante* forecast more useful, some policy variables

should be added to reflect the real situation. The situation above shows that there is need to employ goal programming approach for solving the multi-objective function.

The approach has been used in river flow forecasting which constitutes one of the most important applications in hydrology. Several methods have been developed for this purpose and one of the most famous techniques is the auto regressive moving average (ARMA) model. The goal was used to minimize the error for a specific season of the year as well as for the complete series of years. Goal programming (GP) was used to estimate the ARMA model parameters. Shaloo Bridge station on the Karun River with 68 years of observed stream flow data was selected to evaluate the performance of the proposed (GP) approach. The results when compared with the usual method of maximum likelihood estimation were favourable with respect to the new proposed algorithm (GP approach) (Mohammadi *et al.,* 2006).

Most of fishery related literature have used lexicographic goal programming (LGP) model for the fishery planning problem and the solution under the decision-maker's priority structure is considered as the optimal solution (Sharma *et al*., 2006). However, in different complex decision-making situations, the desired solution may not be acceptable under the imposed priority structure; that is, a better solution is always expected for which a number of priority structures may be considered (Sharma *et al*., 2003).

A major strength of goal programming is its simplicity and ease of use. This account for the large number of goal programming applications in many and diverse fields (Jones and Tamiz, 2002). As weighted or non pre-emptive goal programmes can be solved by widely available linear programming computer packages, finding a solution tool is not difficult in most cases. Lexicographic goal programmes can be solved as a series of linear programming models (Ignizio and Cavalier, 1994).

Goal programming can hence handle relatively large numbers of variables, constraints and objectives. A debated weakness is the ability of goal programming to produce solutions that are not *Pareto* efficient. This violates a fundamental concept of decision theory that, there is no rational decision maker will knowingly choose a solution that is not *Pareto* efficient. However, techniques are available (Tamiz*et al*., 1999) to detect when this occurs and project the solution onto the *Pareto* efficient solution in an appropriate manner. The setting of appropriate weights in the goal programming model is another area that has caused debate, with some authors (Gass, 1987) suggesting the use of the Analytic Hierarchy Process (AHP) or interactive methods (Ciptomulyono, 2008) for this purpose.

3 METHODOLOGY

LOCATION OF THE STUDY AREA

The research was conducted at Tongwe village in Muheza District (Tanga region) and at Mikongeni village in Kibaha district (Pwani region). These have been chosen because cassava is widely cultivated by many farmers and cassava processing technologies (both traditional and mechanical) are used. Moreover, the study areas are in close proximity to urban markets such as Tanga and Dar es Salaam where there is potential growing demand for cassava and its respective products.

RESEARCH DESIGN

A cross sectional research design was used where data were collected at a single point in time. The reason for choosing this design is simply because it is flexible, economical and easy to manipulate data and information (Bailey, 1994).

SAMPLING PROCEDURE AND SAMPLE SIZE

Purposeful sampling was used to select two villages where there is an on-going PANTIL cassava project whereby Mikongeni village (Kibaha district) and Tongwe (Muheza district. Then proportionate stratified sampling based on their income (i.e. those with low income versus those with high income) was employed. Thereafter, random sampling was employed to get a sample of 30 respondents from each stratum. Ultimately sample of 120 respondents were used for this study. A sample size of 30 respondents is deemed large enough. The Central Limit Theorem (CLT) states that the average from a random sample for any population, with finite variance, has an asymptotic standard normal distribution. Most estimators encountered in statistics and econometrics can be written as functions of sample averages. Therefore, the t-statistic was used as inference test of the model, based on the law of large numbers and the Central Limit theorem (CLT).

DATA COLLECTION

Structured questionnaires with both closed and open-ended questions, group discussions and observation were used as methods for collecting primary data. Data were collected through interview of the sampled households and key informants who were the village chairmen and agricultural field officers to each village. The key variables asked were the farmers (household) characteristics, household sources of income, cassava production, processing (traditional, wet and dry and mechanical) and consumption.

The experimentations were used to collect information on efficiency (in terms of operational, time, fuel consumption) of the mechanical processing technology from the study area. The experiments were conducted by taking 5 kg of chunks/pieces of pealed cassava into each machine (manual cassava chipper, engine powered cassava chipper and cassava grater). The time used to process the cassava by each machine was recorded by using stopwatch as a pilot, and then the experiments were repeated four times, whereas deep stick was used to measure the fuel level.

DATA ANALYSIS

Goal programming is a branch of multi-objective optimization, which in turn is a branch of multi-criteria decision analysis (MCDA), also known as multiple-criteria decision making (MCDM). It can be thought of as an extension or generalization of linear programming to handle multiple, normally conflicting objective measures (Pournamdarin, 2008). Each of these measures is given a goal or target value to be achieved. Unwanted deviations from this set of target values are then minimized in an achievement function. This can be a vector or a weighted sum dependent on the goal programming variant used as satisfaction of the target which deemed to satisfy the decision makers (Andrew *et al*., 2008). This approach was used to project the future production of cassava resulting in a change of cassava processing technology and consumption behavior by using LP-WYE software; it was formulated as follows;

Objective function:

Max $Z(Q)$

Subject to $C_r(Q) - g_r = u_r^+ - u_r^-$, *r =1 to k*

Non-negativity

$$u_r^+, u_r^- \geq 0, \text{ r =1 to k} \quad \text{.....(1)}$$

Where;

$Z(Q)$ = The production function for cassava maximization (Objective function)

G_r = The goal or target value

u_r^+ = The positive deviation from the goal or target value set

u_r^- =The negative deviation from the goal or target value set

Q = Is a summation of Q_1 and Q_2 which are bitter and sweet varieties respectively

$C_r(Q)$ = The constraints of the objective function were as follows:

The consumption is given the first priority level i.e.

$$C_o(Q) - G_{CO} = U_{CO}^+ - U_{CO}^- \quad \text{.....(2)}$$

The variety is given the second priority level i.e.

$$V(Q) - G_V = U_V^+ - U_V^- \quad \text{.....(3)}$$

The access to market is given the third priority level i.e.

$$M(Q) - G_m = U_m^+ - U_m^- \quad \text{.....(4)}$$

The cost of processing is given the fourth priority level i.e.

$$C_c(Q) - G_c = U_c^+ - U_c^- \quad \text{.....(5)}$$

The price of the processed products is given the fifth priority level i.e.

$$P_p(Q) - G_p = U_p^+ - U_p^- \quad \text{.....(6)}$$

Where:

$C_o(Q)$ = Consumption function, G_{co}= Goal set for consumption, V(Q)= Variety function, G_v= Goal set for variety production, M(Q) = The quantity of Cassava accessed to the market, G_m = Goal set for quantity to be accessible to the market, $C_c(Q)$ = Cost processing function, G_c = Goal set for processing cost, $P_p(Q)$ = The price function of the processed product, G_p = Goal set for the price for the processed products, U^+s, U^-s are the non-negativity deviation from the goal setting.

4 RESULTS AND DISCUSSION

SOCIAL-ECONOMIC CHARACTERISTICS OF THE RESPONDENTS

Characteristics of respondents interviewed have important social and economic implications towards factors influencing cassava production and consumption. For example, family characteristics such as age usually influence the quantity of the agricultural output. Therefore, this section describes the characteristics of sampled respondents, focusing on age, gender, household size and education level.

AGE OF THE RESPONDENTS

The distribution of farmers according to age is presented in Table 1. Results show that majority of the respondents (67.5%) were above 36 years of age and people with active age (17 to 55 years) constituted 80.8% of total respondents. Meanwhile, respondents aged above 55 years were 19.2%. Basing on the information above, it is clear that in the study area the working force is available and able to work in agriculture as their main economic activity but large percentage (48.3%) of the sampled cassava farmers are falling in the age of 35 to 55 years (Table 1).

GENDER OF THE RESPONDENTS

Result in Table 1 show that, about 63% of the respondents were male and the remaining 37% were female. Skewed results were expected since men are the household heads to whom the interview was directed. As far as cassava production is concern as observed by TADENA (2004), access and use of land for cassava production is not gender biased. Either of the sexes can get involved in cassava production. There is no bias when it comes to providing access to farmland for women. Likewise, there are no important cultural beliefs and practices that are likely to affect the development of cassava (Table 1). The results also show that 32% and 38% of the men and women respectively within sampled households were using mechanized cassava processing technology.

Table 1: Social-economic characteristics (n=120)

Variable	Categories	Frequency	Percentage
Age	17-35	39	32.5
	36-55	58	48.3
	>55	23	19.2
Gender	Male	75	62.5
	Female	45	37.5
Household size	1-3	28	23.3
	4-6	71	59.2
	>6	21	17.5
Education level	No formal education	22	18.3
	Standard four (iv)	3	2.5
	Primary education	74	61.7
	Secondary education	21	17.5

HOUSEHOLD SIZE OF THE RESPONDENTS

Results in Table 1 shows that about 23.3% of the households have 1-3 members and 59% of the household sizes have members ranging between 4 and 6 and only 17.5% of the sampled households were above 6 household's members.

Therefore, majority of the households (76.7%) have 4 members and above, which signifies that there is enough work force due to the fact that majority of population in the study area fall in the age of 17-55 years.

EDUCATION OF THE RESPONDENTS

Education is one of the factors that influence cassava production. A farmer with formal education is likely to be innovative or adoptive to new technologies than a farmer with no formal education whereas other factors remain constant. The study revealed a moderate rate of literacy in the study area. Results on level of education showed that respondents in the study area have attained formal education. The majority of sampled household heads in the study area (61.7%) and (17.5%) had attained primary education and secondary education respectively. These findings support the observation by the assessment of agricultural marketing information needs study (URT, 2004), which found that there is a large number of farmers with primary education and above. This shows that, the introduced cassava processing technology could be easily adopted in the study area because most of the farmers have formal education although the adoption depends with the efficiency of the technology and its profitability to the farmers.

PROJECTION OF FUTURE PRODUCTION OF CASSAVA RESULTING FROM MECHANIZED CASSAVA PROCESSING

The projection for the future production in cassava of the two districts (Muheza and Kibaha) was done by using goal programming approach. Muheza district is superior to Kibaha district in cassava production, but the total production of the two districts was taken as the bench mark for future projection for cassava production. According to the respective District Agricultural and Livestock Development Officers (DALDO), the production of Muheza and Kibaha districts were estimated at 75 000 and 5 000 tonnes, respectively which make a total of 80 000 tonnes.

The study categorised production into two categories, that is sweet and bitter varieties of cassava, and results of production found to be with a proportionality of 5:3 respectively. According to this proportionality, the sweet varieties had production of about 50 000 tonnes and about 30 000 tonnes for the production of bitter varieties. This shows that, sweet varieties are more produced than bitter varieties due to their immediate consumption.

FORMATION OF COEFFICIENT MATRIX FOR CONSTRAINTS

Any maximization function must involve constraints; the constraints used to maximize production of cassava in this study were consumption of cassava, varieties for cassava production, access to the market for cassava products, costs of cassava processing and prices for processed cassava. Therefore the coefficient matrix formed was as follows: the consumption of bitter and sweet varieties ratio was 1 500:2 000 tonnes and the goal or targeted value for this was set at 30 000 tonnes per year per village with the positive and negative deviations of 500 tonnes.

The second constraint was variety, in good management (agronomic) bitter variety can produce up to 8 tonnes per acre and 7 tonnes for sweet variety, which in combination they can produce 15 tonnes, therefore the goal or targeted value set for that one was 18 tonnes with a positive deviation and negative deviation of 3 tonnes. The important concept to bear in mind here is that, bitter varieties produce more yield than sweet varieties.

The third constraint was access to the market. Table 2 shows that the constraint has 400:500 ratio of bitter and sweet variety accessed to market respectively, with a goal or targeted value of 20 000 tonnes from a bench mark of 15 000 tonnes. Also the positive and negative deviations were 5 000 tonnes.

The fourth constraint was cost of processing. The observation made shows that there was no difference in cost of processing of neither bitter varieties nor sweet varieties and thereafter it was estimated to cost 150 TZS per kilogram which implies 150 000 TZS per tonne as processing cost. The positive and negative deviations were 50 000 TZS (Table 2).

Table 2: Coefficient matrix for optimization of cassava production

Constraints	Bitter variety in tonnes (Q_1)	Sweet variety in tonnes (Q_2)	Positive deviation from targeted value(U^+)	Negative deviation from targeted value (U^-)	Total
Consumption (t)	1 500	2 000	500	500	30 000
Variety productivity (t/acre)	8	7	3	3	18
Access to market (t)	400	500	5 000	5 000	20 000
Cost of processing (TZS/kg)	150	150	50 000	50 000	150 000
Price per tonne (TZS)	500	500	100 000	100 000	700 000
Total for each variety	30 000	50 000	-	-	-

The last constraint was the price of the processed products. The cassava flour processed from bitter varieties is more preferred, than the sweet cassava flour. This caused the price of bitter cassava flour to be higher than sweet cassava flour price. The bitter cassava flour was TZS 500 per kilogram whereas TZS 500 was the price for sweet cassava flour. Therefore, taking the maximum price per tonne, a cost of about TZS 500 000 with a positive and negative deviations of TZS 100 000. This information is summarized in the Table 2 above.

VALUES OF THE PROGRAM

The coefficients matrix formed ready for maximization process was estimated using linear programming software. Results indicates that the pivot value was 7.00 and the optimum solution found after first iterations and the maximum value for cassava production was 128 571.4 tonnes, which is the projection for future production of cassava for the two districts.

Results revealed that the disposal or slack variables were consumption, access to the market, processing costs and price of the processed products. Since the maximization of cassava production realistically did not use the entire quantity of each constraint available, provisions must be made for the non-use constraints in the final plan. These variables allow the non-use or changes to be made.

Furthermore, the objective of the study was to maximize production subject to those constraints mentioned above, with a goal or targeted value to be achieved. Therefore, the final (optimal) plan was to produce sweet varieties 2.57 times the previous production, setting aside the bitter varieties. This is due to reasons that, many farmers do not feel like to produce bitter varieties because the varieties take long time to mature in the field and tedious work in processing.

5 CONCLUSION AND RECOMMENDATION

The introduction of mechanized processing technology has resulted into the change in cassava consumption behaviour, hence increase in demand of the product. This has further stimulated production of cassava in the study areas. Based on goal programming approach the projection of the future production of cassava will be 128 571.4 from 80 000 (current production) tonnes per year. This is an increase of 60.7% per year.

Basing on the above conclusion it is highly recommended that the farmers have to be informed on the growing demand of the mechanically processed cassava products, thus the need to meet this demand. The processors, businessmen, government and others stakeholders of the cassava sub sector have to be highly coordinated with the farmers and provide the farmers with all agronomic, economic and technical supports so as to sustain the production of cassava and meet the growing demand of the products.

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The fracturing role in the conditioning of karst groundwater circulations in the calcareous Dorsal (Northern Rif, Morocco)

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ABSTRACT: Natural fracturing includes all the mechanical discontinuities affecting the rock matrix. These natural fractures usually constitute preferential drains or permeability barriers which partially control the movement of fluids during production. The fracturing map of the Calcareous Dorsale in the Northern Rif was established using remote sensing (photo-interpretation) and GIS techniques, as well as field measurements of fractures randomly distributed in six microtectonic stations.

Firstly, using the above mentioned approaches the main sets of fractures are detected. The dominant direction of fractures corresponds to the NE-SW direction which also coincides with the dominant orientation of the hydrographic network. Thus, the results from these two methodological approaches permit the development of a hypothetical scenario of karst groundwater circulations between the different units of the study area and other nearby units.

KEYWORDS: Fracturing, photo-interpretation, orthorectification, water flow, Calcareous Dorsal, Rif

1 INTRODUCTION

The fracturing studies are conducted by a variety of simple or complex methods. Although the study area presents a very difficult access due to the much accentuated relief and the high density of vegetation (forest area very important), two methodological approaches were used to analyze the fracturing process. These are, firstly, the cartography based on photo-interpretation (aerial photography) and secondly, the field microtectonic analysis.

The study is carried out on fracturing carbonate formations of the limestone ridge which, together with Ghomaride and Sebtide nappes, form the Rifian internal domain. The Sebtides consist of varied metamorphic nappes, including a granulitic-mantle ultramafic unit, which are underlain (Sebta massif) and overlain (Beni Bousra massif) by gneiss and schist of upper-crustal affinities. The Ghomarides nappes form the uppermost nappes in the Rifain Alpine belt. Paleozoic rocks constitute the prominent part of these nappes, together with Triassic and younger cover sediments. The Calcareous Dorsale is a complex tectonic domain, but its Mesozoic-Paleogene paleogeographic evolution is well constrained by many paleontological and sedimentological data. The Calcareous Dorsale stratigraphy corresponds to three contrasting sequences, which encompass the Triassic-Miocene time interval. The oldest, late Triassic-Liassic sequence forms the competent part of the nappes, and on the other hand, allowed the authors to classify the varied nappes into "Internal Dorsale" and "External Dorsale" although, in some cases, this traditional classification does not correspond to the actual position of the nappes. The intermediate, Liassic-Paleocene sequence records the evolution of a Tethyan paleomargin, and finally the youngest, Eocene-Miocene sequence records that of the Alpine orogeny [1].

Indeed, the polyphased tectonic have controlled the genesis and the evolution of the fissured networks as well as the karstification in carbonate domain. The Calcareous Dorsale object of this study provides a good example of karst massif with a high water potential. However, the boundary between the internal zones and the external zones of the Rifian domain are

affected by strike-slip faults, including the Jebha-Chrafate fault which makes one of the major transcurrent faults of the Rif Cordillera. This is a sinistral strike-slip fault of which the main left lateral displacement is at least 50 km ([2], [3], [4]).

The aim of this study is to establish the role of fracturation in determining the flow conditions of groundwater and surface water, together with the relation between karstic aquifers. It is shown that tectonic and karsts are related [5].

On a regional scale, the fracturing was analyzed using aerial photography to bring out a thematic fracturing map of large scale. Moreover, more than 500 lineaments were located. However, at outcrop scale, the fracturing was analyzed in six microtectonic stations randomly selected due to the inaccessibility of some area, together with the important forest density.

1.1 GEOLOGICAL SETTING

The study area forms part of the Septentrional Internal Rif. It corresponds to the segment of the external Calcareous Dorsale located precisely between the Oued Laou valley in the north, and the major fault of Jebha-charafate in the south (Fig. 1). It consists of three stacked tectonic units: Jbel Tissouka unit, Jbel Lakraa unit, and the Jbel Bouslimane unit, where some peaks exceed 2000 meters in high (2122 m in Jbel Tissouka and 2159 m in Jbel Lakraa).

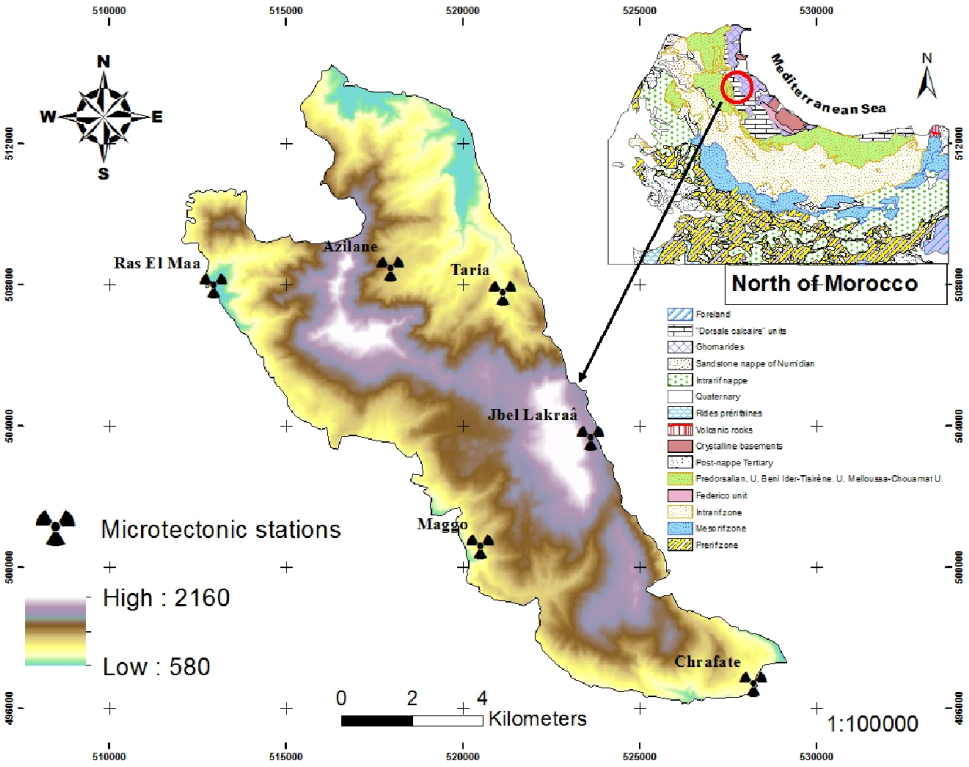

Fig.1. General Localization of the study area and DTM (Digital Terrain Model)

These units are stacked in nappes with tectonic contacts dipping westward (Nold et al., 1981). They are separated from the massif of Jbel Tazout by the directed NW-SE fault of Jbel Lakraa. The stratigrafic successions of the Calcareous Dorsal are described from bottom to top as [6] (Fig. 2):

- Up to 900 m in thick of Carnian to Norian stromatolitic dolstones with intercalations of marly limestone.
- 80 to 300 m of limestone and dolomite alternation (Rhetian),
- Massive limestone and/or dolomite, their attribution to the Hettangian age is not strictly deducted;
- Flint limestone with marls and bituminous facies and intraformational breccias (from Sinemurian to Pliensbachian);
- The radiolarites and breccias of Dogger-Malm age;
- The conglomeratic and brecciated formations of Tertiary.

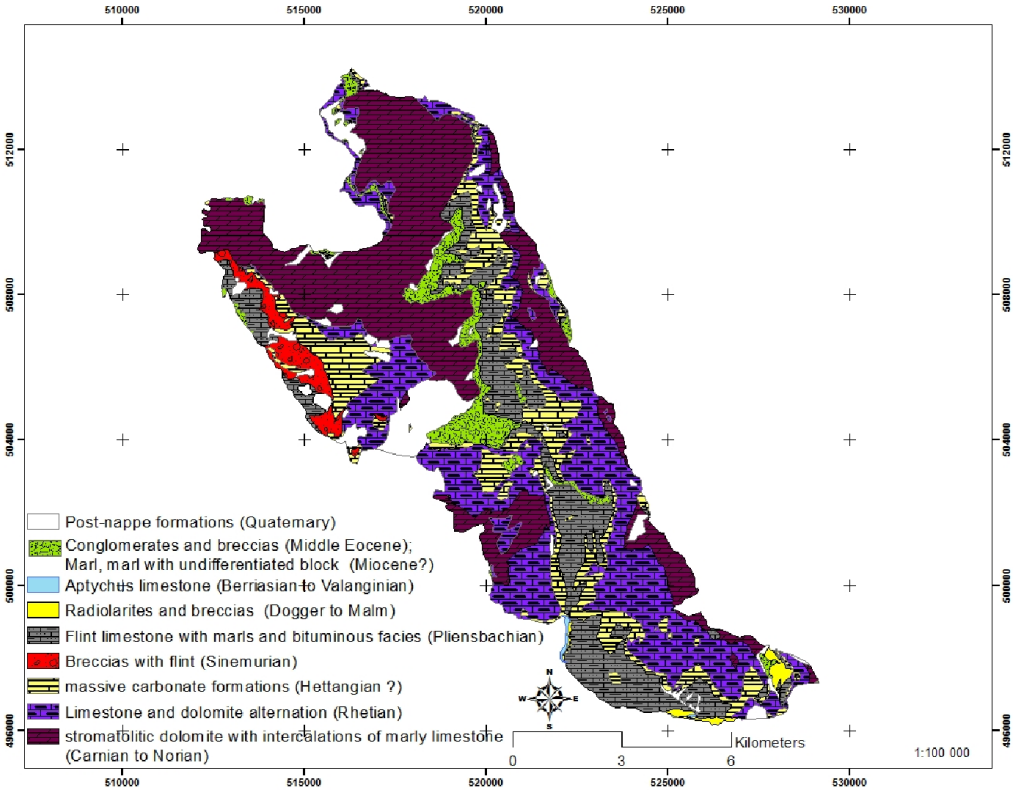

Fig.2. Schematic Simplified geological map of the study area

1.2 HYDROGEOLOGICAL SETTING

The study area is crossed by many superficial streams. In addition, several springs gush at the foot of the limestone ridge, while others are dispersed geographically in the different formations. The most important springs are: Ras El Maa Spring located at west of the Jbel Tissouka unit whose it rises in the flint limestone; Ahramen and Aayaden Springs welling in massive carbonate formations of Hettangian age; and Chrafate Spring which is part of the Bouslimane unit and that gushes in the flint limestone of Pliensbachian age.

For the whole area, these sources are the main water resources for both drinking water and irrigation. Aquifers are karstic, this can be proved by the presence of morphologically karst forms such as lapies, sinkholes, dry valleys, canyons and caves.

2 METHODS

The methodology used in this paper consists of establishing a fracturing map essentially based on the analysis of aerial photographs, combined to a microtectonic field study of fractures. Six stations were chosen to measure fracture orientation.

The data include 22 aerial photographs at 1/20000 acquired in 1986, across five transverse bands covering the study area, and topographical and geological maps of Bab Taza and Chefchaouen (scale 1/50000). In addition, we used a 90-meters resolution DTM (Digital Terrain Model) from the SRTM database (Schuttel Radar Thematic Mapper) and a 30-meters resolution DTM created from digitizing contour lines of topographical maps. From a planimetric point of view, the orthorectified images show the field reality since they show the details in their real geographical coordinates (X and Y). The 22 aerial photographs were digitized, georeferenced and geometrically corrected using image processing software.

The process of geometric correction is also known as “orthorectification”. During this process, data is corrected according to the user's ground reference system. Since the resulting output images are geometrically correct, they can then be used as maps. The technique of orthorectification implies the existence of a DTM and the focal length of the camera while introducing fiducial markers which is in the calibration certificate of the flight mission. Thus, we have chosen six control points on aerial photographs and their counterparts in the maps.

The orthorectified aerial photographs were already processed by subtracting the contours, and were then assembled into a single image called orthomosaic. This latter integrated in a GIS, served as the main support on which were presented all the fractures that were identified in the stereoscopic observation. The rose diagram for the azimuth of fractures was made employing the method of "REDES DE BÚSQUEDA" elaborated by Galindo-Zaldivar and González-Lodeiro [7]. This method is based on the principle of BOTT [8], which considers the striae fault is parallel to the direction of maximum shear stress.

3 RESULTS AND DISCUSSION

3.1 PHOTO-INTERPRETATION

Firstly, we tried to map the rock fracturing without using the orthorectified images. The results did not match, however, the field observations since they present several inherent errors such as:

- The same object shows at least two different directions (Fig. 3);
- A spatial offset between the object image and its counterpart on the topographic map or aerial photograph (Fig. 3);
- Changing real direction of the fractures.

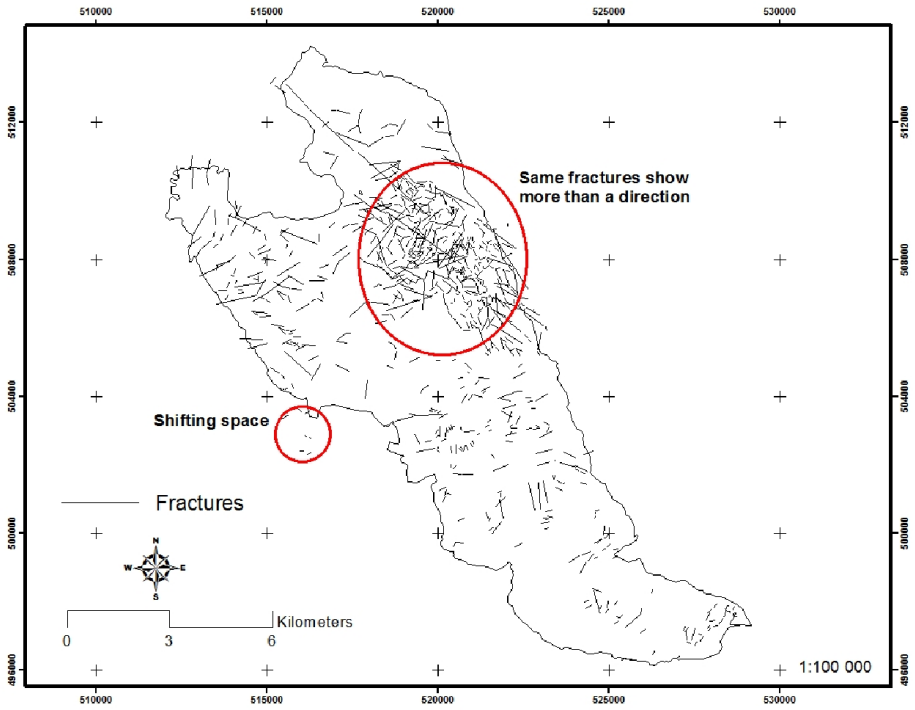

Fig. 3. The summary map of fracturing before orthorectification

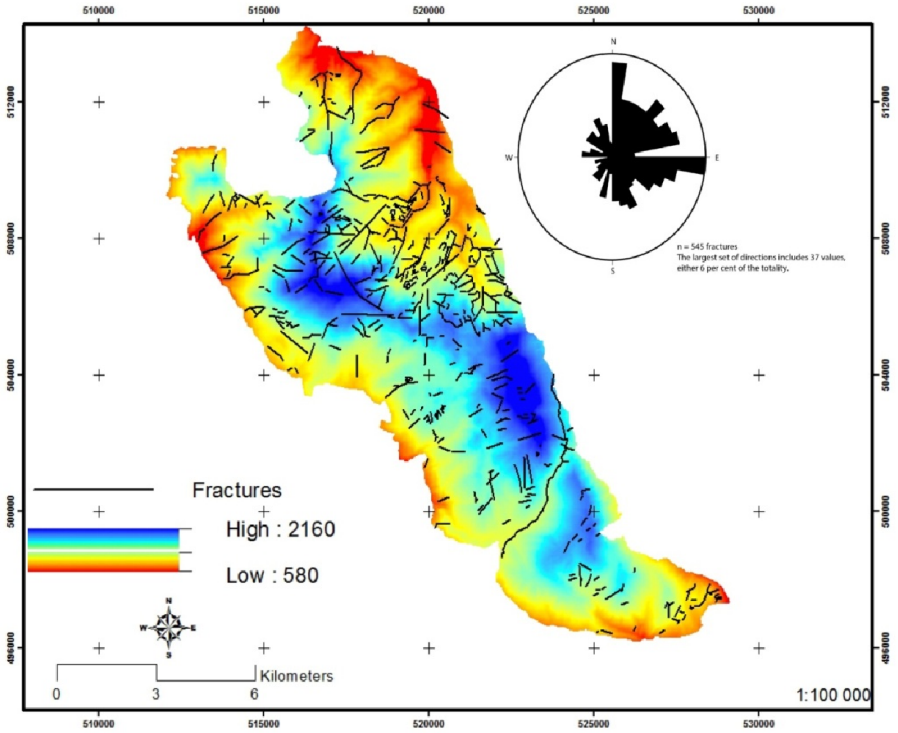

Fig. 4. The summary map of fracturing after orthorectification and its rose diagram of the azimuth data.

Fig. 4 represents a map with 543 fractures plotted on a simplified Digital Terrain Model where the altitude varies from 580 to 2160 m. The distribution of these fractures is heterogeneous. This disproportion seems likely to be caused by the extensive forest cover in the study area rather than particular tectonic shifting.

The rose diagram of fractures in Fig. 4 shows 10 fracture patterns, which can be categorized into four classes according to their direction: NE-SW, NW-SE, N-S, and E-W.

- Fracture set oriented NE-SW: this is the main direction of the fractures in the study area. It brings together 112 measurements (20% of all measured fractures). This set of direction (N40-N50) is approximately parallel to the Jebha-Chrafate Major Fault, and seems to be related to the transversal network faults and joints associated with a N60-N80 direction of this major fault. The Jebha-Chrafate fault is a sinistral strike-slip fault that played a key role in structuring the Rif belt during the Neogene ([9], [10], [11], [12]). On the other hand, the rose diagram of hydrographic network (Fig. 5) shows that the N40-N50 oriented fractures represent the predominant direction, probably due to the existence of a relationship between the development of the hydrographic network and setting up of the Jebha-Chrafate fault.
- Fracture set oriented NW-SE: these fractures are precisely oriented N130-N140. According to reference [6], they are parallel to the Jbel Lakraa Fault, which had a normal movement at some point of its geological history revealed by the presence of fault striae with a high rake indicating significant vertical component of the fault setting. The Jbel Lakraa fault had left locally secondary normal faults associated with the main fault setting steeply dipping N120-N168 with a dip of 50º-80º (synthetic) and normal faulting N135-N150 with a dip of 25º-60º (antithetic) affecting the Triassic dolstones of the Jbel Lakraa unit [13].
- Fracture set oriented N-S: the fractures with this direction may be related to a recent extension step associated with the uplift of the Rif Cordillera [4].
- Fracture set oriented E-W: it is consistent with the shortening direction of the Eurasian and African plates, without any influence of the movement being detected at the west of the Alboran domain [4].

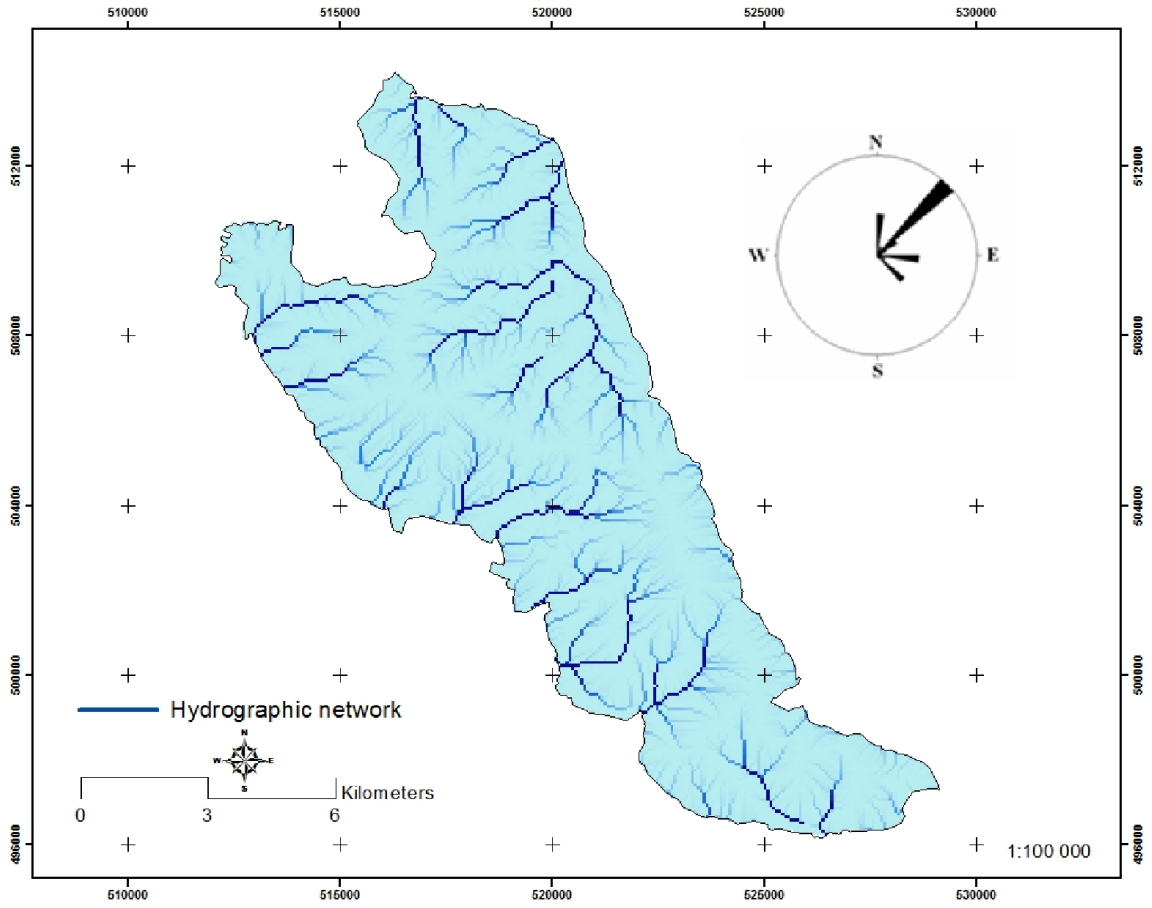

Fig. 5. Map and rose diagram of hydrographic network

3.2 MICROTECTONIC ANALYSIS

The distribution of microtectonic stations shown in Fig. 6 is not made homogeneously. This is due to the inaccessibility of some areas, and the presence of a very high forest density with forest covers more than 70 per cent of the study area and that makes it difficult to choose a favorable site for such study.

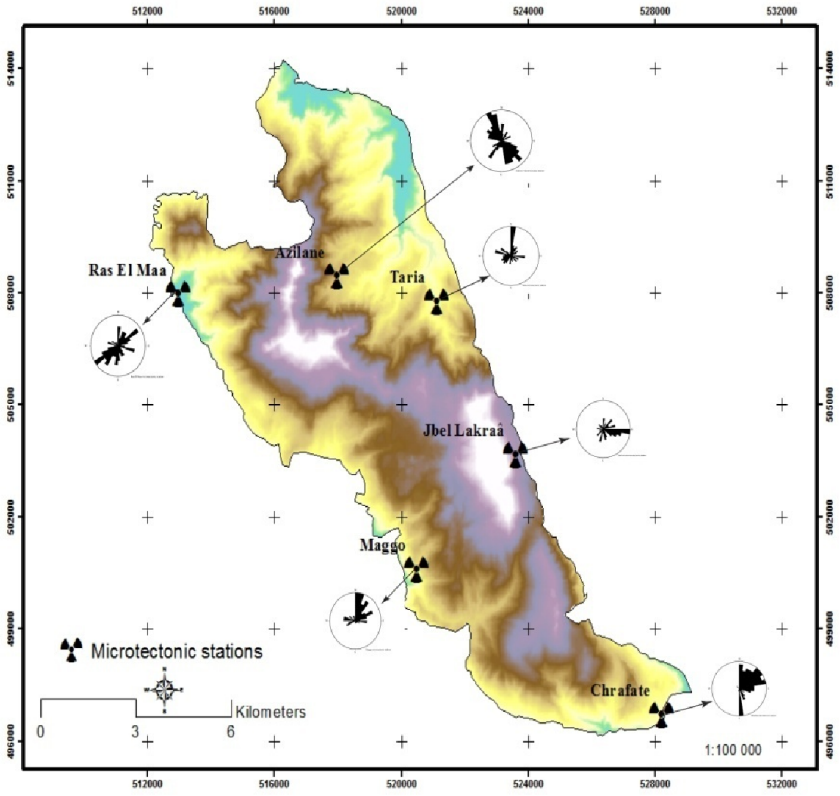

Fig. 6. Map of the microtectonic stations positioning

► **Ras El Maa microtectonic station**

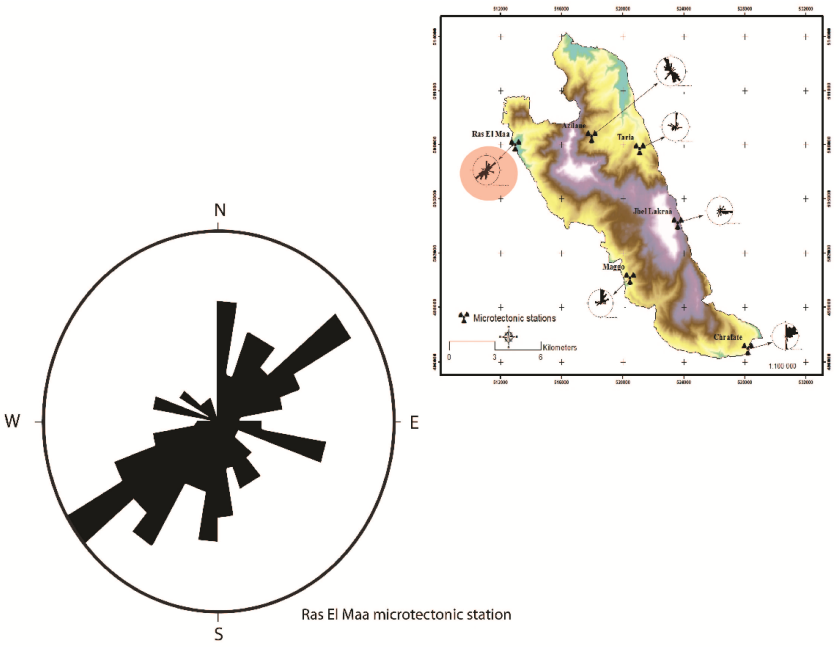

Fig. 7. Rose diagram of Ras El Maa micrtectonic station

Field surveys at Ras El Maa station microtectonic show that the set of direction NE-SW is clearly predominant (Fig. 7). This could be explained by the Jbel Tissouka Unit supply by groundwater directly from the Jbel Tazoute unit; therefore the groundwater flow direction is guided by a NE-SW fracture network. The N-S fractures direction appears less important than the NE-SW dominate direction, it could be responsible for a supply of Jbel Lakraa unit by groundwater of Jbel Tissouka unit, which it may cause a partial flow northward.

► **Maggo microtectonic station**

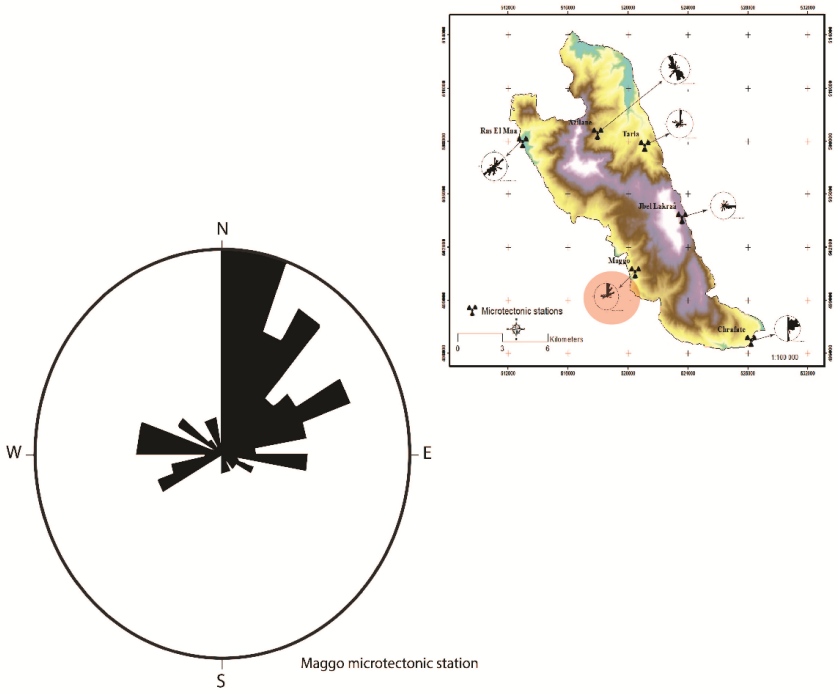

Fig. 8. Rose diagram of Maggo micrtectonic station

Field surveys at Maggo microtectonic station shows a dominance in N-S direction and then of NE-SW direction. Finally the E-W fractures remain the least significant ones (Fig. 8). Moreover, the sustainability and very marked karst objects of Ahramen and Aayaden springs demonstrate the existence of a purely karst groundwater flow.

Pursuant to the diagram rose of directions, it can be concluded that there is an N-S groundwater flow direction from Jbel Tissouka unit. This suggests that the groundwater reserve of Jbel Tissouka unit is supplied from a groundwater of Jbel Lakraa unit.

Another groundwater flow in direction NE-SW seems to be related to the presence of a large number of caves and sinkholes in north-east of Maggo village (Jbel Lakraa massif). These can directly contribute to the recharge of the karst groundwater above all that infiltration is concentrated and faces no impermeable barrier. The karstification was responsible for this flow direction.

To the east of the village, the existence of lapiaz and some sinkholes may suggest a partial groundwater flow in an E-W direction.

► **Chrafate microtectonic station**

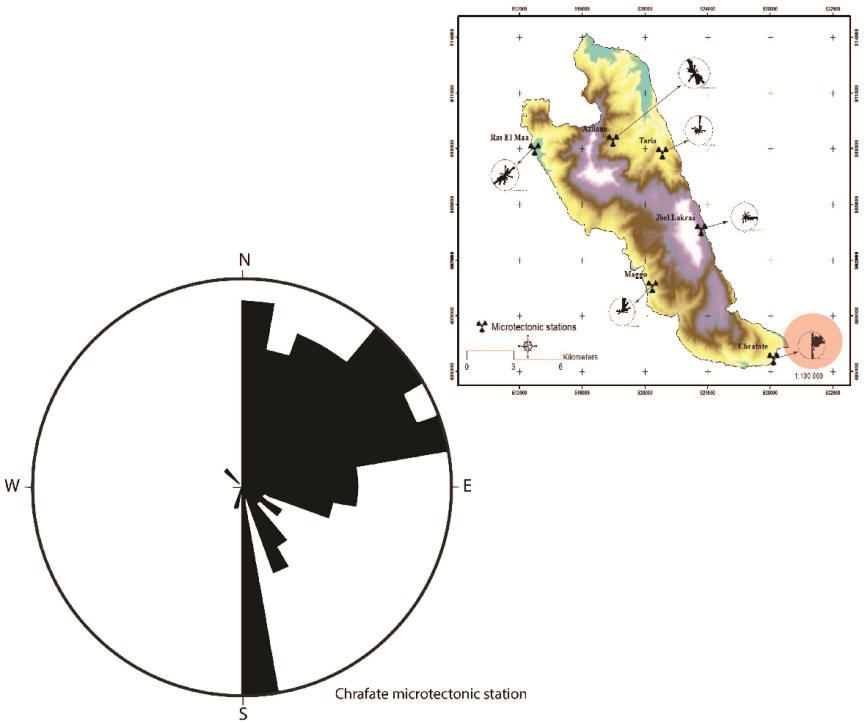

Fig. 9. Rose diagram of Chrafate micrtectonic station

The Chrafate spring is a Vauclusian spring formed by the culmination of a subvertical conduit that can be the ascending branch of a reverse siphon and penetrable only by underground diving. A fluorescence staining experience being made into the Taghobaït sinkhole located a few kilometers of the spring. It had demonstrated its participation in supplying the vauclusian springs of Chrafate [14].

The diagram rose of directions shows the predominance of fractures in a NE-SW direction, followed by N-S direction (Fig. 9). Indeed, the NE-SW fractures seem to be responsible for groundwater flow that circulates from northeast to southwest.

Moreover, the N-S fractures can cause groundwater flows which circulate from carbonate formations in the north to the impermeable substratum of Predorsalian unit in the south.

► **Jbel Lakraâ microtectonic station**

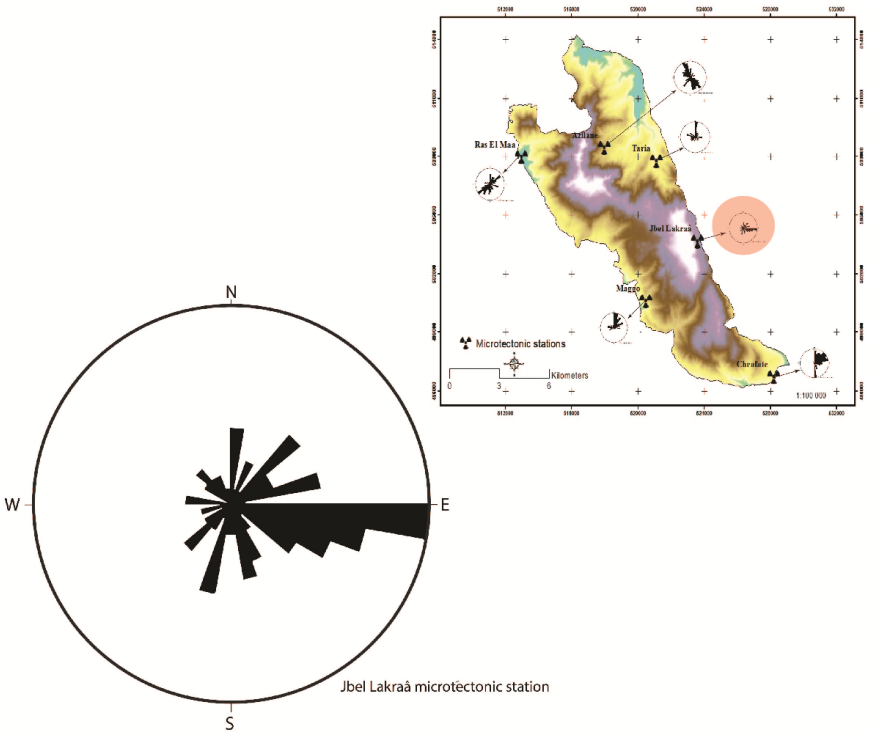

Fig. 10: Rose diagram of Jbel Lakraâ micrtectonic station

The Jbel Lakraa microtectonic station was choosen in the alternating calcareous-dolomitic formation considered to be of Rhetian age, near a forest warden's house. This massif is characterized by the absence or scarcity of karst springs. However, there are several sinkholes. The predominant fractures are E-W oriented (Fig. 10), and this fracturing is responsible for communication between the Jbel Lakraa and the Jbel Talassemtane units. According to reference [15], the unit of Jbel Lakraa contributes to water supplying of the other units. He conducted a hydrochemical study to achieve this result based on the chemical facies of Ain Danou spring (X = 520000, Y = 509600, Z = 900) that gush in the Farda riverbed and which is comparable to the Onsar el Khwa and Haouta Dra facies (X = 525700, Y = 504850, Z = 1260) gushing in Jbel Talassemtane unit and to the Onsar Azarhar spring (X = 524750, Y = 515600, Z = 980) emerging from Jbel Tazoute unit. The sustainability of the Farda River is ensured through this water output.

► **Azilane microtectonic station**

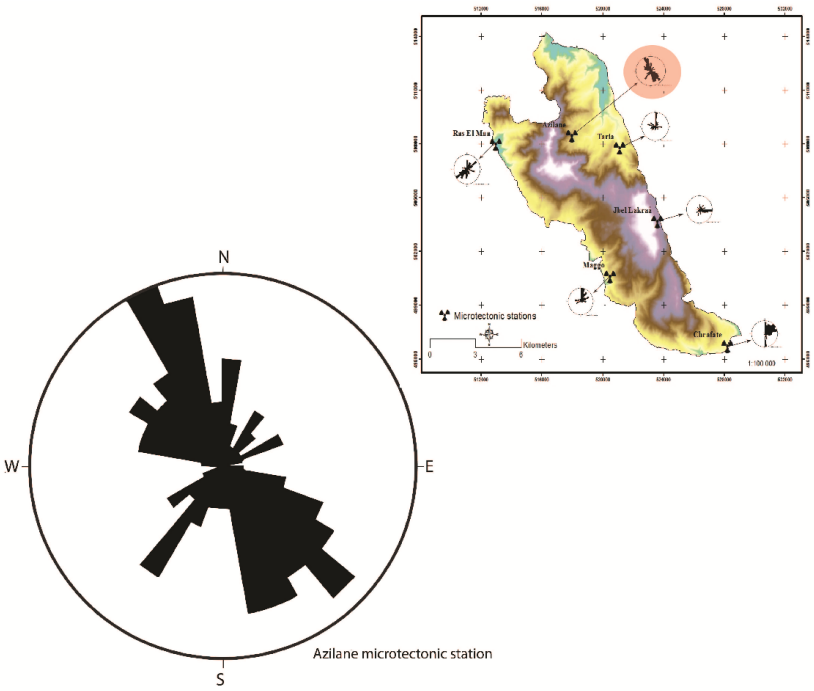

Fig. 11. Rose diagram of Azilane micrtectonic station

This microtectonic station is selected in stromatolitic dolomite with marl-limestone formations (Norian to Carnian) located western of the Azilane village. It has a very limited number of springs (3 or 4) which are relatively a low flow, but of great importance to their inhabitants. Field surveys have shown a predominance of fractures trending NNW-SSE (Fig. 11), which can lead to groundwater flow in the same direction. This direction joined what was said previously about the Jbel Lakraa unit supply by underground flow of the Jbel Tissouka unit following the direction N-S.

► **Taria microtectonic station**

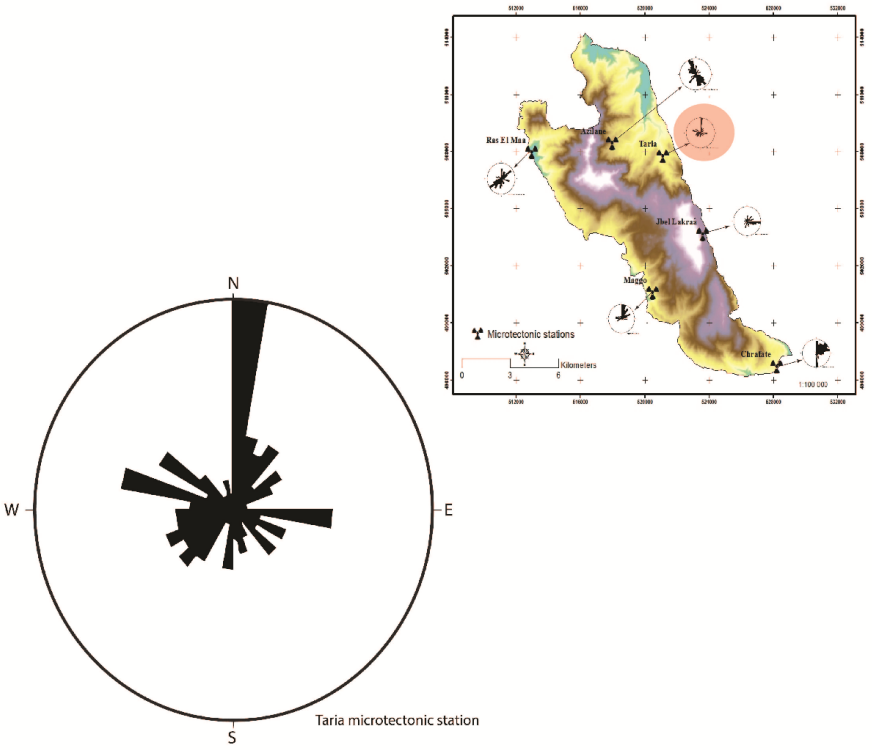

Fig. 12: Rose diagram of Taria micrtectonic station

Measures were carried out in the limestone and dolomite alternation of Rhetian age in the west of Taria village. The rose diagram of directions shows that the N-S oriented fractures are the most predominant (Fig. 12). This reassures the water recharge in Jbel Lakraâ unit from the north (Jbel Tissouka unit).

In summary, we distinguish three main directions (Fig. 13), which may explain the interconnections between the various aquifers in the study area, and a relationship with neighboring units particularly the Jbel Tazoute and Jbel Talassemtane units.

The NE-SW direction probably reflects the existence of a connection between the Jbel Tissouka and the Jbel Tazoute units. This relationship provides groundwater recharge for both units. This is marked by the sustainability of Ras El Maa spring.

The N-S fractures are responsible for the relationship between the the Jbel Tissouka and Jbel Lakraa units.

Finally, the E-W oriented fractures are responsible for water transmission between the Jbel Lakraa and Jbel Talassemtane units. The lack of water springs in the Jbel Lakraa unit suggests that groundwater flow is towards the east (Talassemtane unit). On the other hand, the sustainability of the Farda River reflects that the unit recharge of Jbel lakraâ was made by underground flow from the Jbel Talassemtane unit.

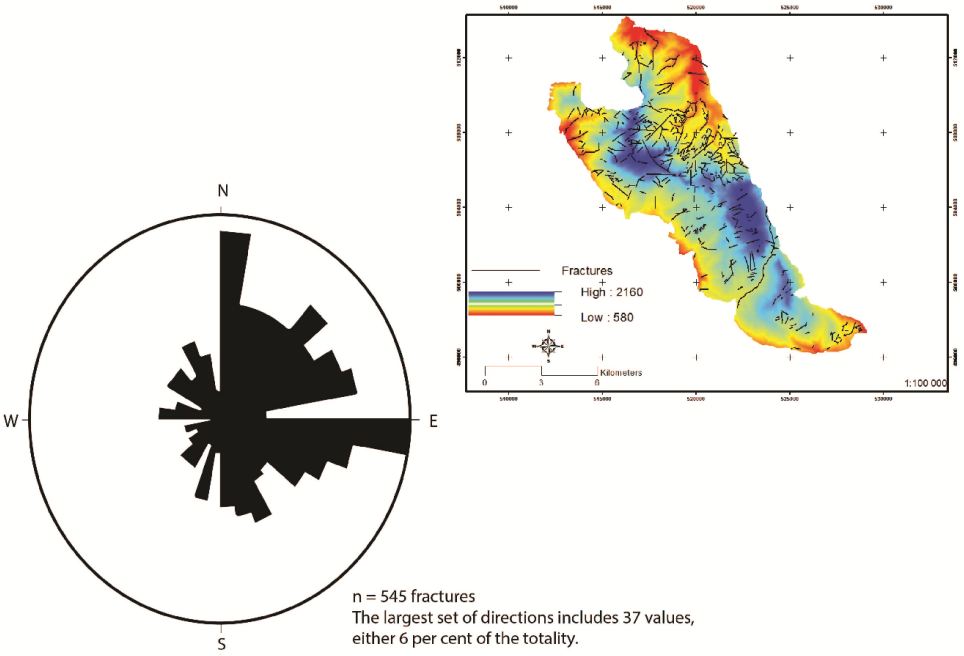

Fig. 13. Rose diagram directions of study area

4 CONCLUSION

The results of fractures analysis in the carbonate massifs in the Calcareous Dorsal in the Rif belt show the relationship of groundwater recharge in the same study area or with neighboring units. Four main directions of fractures were identified: NE-SW, NW-SE, N-S and E-W. The NE-SW oriented fractures are the most predominant and coincide with the fractures analysis of the hydrographic network, suggesting that the fracturing guides the surface streams.

With respect to the water supply, there has probably been an underground flow from Jbel Tazoute unit (NE-SW) toward Jbel Tissouka one, an interconnection between the groundwater of Jbel Lakraa and Jbel Talassemtane units (E-W) and a supply toward the south of the Jbel Lakraa unit by the groundwater flow of Jbel Tissouka unit (N-S).

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Contribution of official development assistance to improve health: Empirical validation from a panel of five countries in the South Shore of the Mediterranean

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ABSTRACT: We try in this article to see how can help bring health outcomes, particularly on improving life expectancy. The purpose of this paper is to study the contribution of GDP rate of literacy, health expenditure and aid allocated to health on improving life expectancy for 5 countries of the southern shore Mediterranean using econometric techniques given in panel unit root test, cointegration test, and causality test during the period 1992-2010. We note that the variable aid allocated to health contributes positively to the improvement of life expectancy.

KEYWORDS: allocated to health; gross domestic product; human capital; economic efficiency; life expectancy; cointegration test; unit root test; panel data.

1 INTRODUCTION

The emphasis today in health economics is crucial because of the awareness of the international community of the strong relationship between economic development and health. Indeed, of the eight Millennium Development Goals (MDGs), three focus on improvements in health by 2015: to reduce infant mortality, reduce maternal mortality and slow the spread of HIV/AIDS, malaria and tuberculosis.

The International assistance could consist of a proposed means of achieving these objectives, and thus, to reduce child mortality. The international community has pledged to double the share it pays to help developing countries, part of the aid with the aim of improving their health systems. This increases in the amounts necessary for the development of these countries. But to what extent public aid affects development on health?

At the macroeconomic level, many empirical studies have investigated the impact of the International aid on economic growth. But few studies have investigated its impact on the health of beneficiaries.

The FDA[1] is led by the Development Assistance Committee (DAC), which deals with issues relating to cooperation with countries in developing the Organization for Economic Cooperation and Development.

The economic literature offers several definitions of FDA, including that of the OECD DAC, characterizing it as “gifts (not involving a legal obligation for the recipient), and loans (however, the resulting refund of the amount transferred), preferential budgeted and transferred from rich countries to developing countries”.

It is in this context that the AFD proposes to define DDA as a public tool whose ultimate goal is to advance economic development mainly the least developed countries (LDCs) through increased funding some considered crucial sectors such as

[1] *French Development Agency*

education, health , infrastructure, but also in some cases, civil wars (through weapons), and thus achieve a higher standard of living. In other words, it is a financial transfer from one country considered "developed" to another State then called “underdeveloped” theory to promote its long-term development.

International aid varies from one period to another. After a rise in the 80s, we see a recovery. It had been a significant drop in real terms in the 1990s, partly due to the decline in strategic motivation after the end of the Cold War. Since 2000 there has been a resumption of FDA to rise, reaching over $ 120 billion in 2005 before declining to $ 110 billion in 2007.

International aid devoted to health has been a steady and significant increase since the early 1990s. Thus, according to the Institute of Health Metrics and Evaluation (IHME), international aid flows, public and non-public, allocated to health, have quadrupled since 1990, and amounted in 2007 to more than $ 20 billion. Of these, a large proportion comes from civil society through non-governmental organizations and private foundations. According to data from the IHME (2009), in 2007, about one-third of foreign aid to health came from U.S. private sector. We note that in recent years, civil society has increasingly shown to improve the health of populations by lack of resources. For this reason, the public wants more justice in the world, at least in terms of health.

Global health partnerships such as GAVI and GFATM are also very popular, and, as of 2007, 13% of international flows allocated to health. Most aid flows to health is still public source. According to IHME in 2007, more than a third of health assistance comes from bilateral development agencies, the rest from the United Nations (15%), the World Bank (5%) of European Commission (2%) and the Regional Development Banks (2%). Finally, according to IHME, more than 60 % of aid flows to the health of financial flows. The other match of in-kind assistance: donations of medicines and goods or technical assistance services, management and research.

2 REVIEW OF THE LITERATURE ON THE MACROECONOMIC EFFECTIVENESS OF HEALTH AID

One of the most recent topics is to discuss the effectiveness of aid allocated to health on health. However, very few works have been published. Two studies published HAVE 2T2 those of Bokhari et al. (2007) and Wolf (2007), but they are imperfect and questionable. The first focuses more specifically on the effectiveness of public health spending on the health of individuals, while taking account of the aid allocated to health, to monitor the effect of health projects from outside. A cross-sectional data for 127 countries in 2000, the effect of the aid is estimated to be insignificant, regardless of the selected health indicator (infant and child mortality, maternal and or life expectancy). However, this estimate is not perfect due to non treatment of potential endogeneity of aid.

A second study published the Wolf (2007), is more interested in profits sectoral support, both on health, water and sanitation, and education. A cross-sectional data from 110 countries for 2002, economist shows that aid allocated to health significantly reduces child mortality (but not mortality). However, the estimated model does not control for the level of income of the population or to the level of education, which are nevertheless recognized variables. The effect of aid and assessed is probably part. Consequently the result is biased, since ignores the endogeneity problem here help.

Mishra and Newhouse (2007) conducted a much more thorough study on the effects of aid allocated to health on health. From a panel of 118 countries between 1973 and 2004, the authors find that aid allocated to health has a positive and significant effect on the reduction of infant mortality, but its effect is rather small: doubling the health aid per capita is associated with a 2% reduction in infant mortality. Economists correct the endogeneity problem through the GMM estimator.

Gyimah et al. (2008) also use GMM estimates on a panel of 90 countries with 3-year averages over the period 1990-2004, and find a negative but significant effect of aid allocated to health on mortality infant. Finally, Gubert and Somps (2008), using data for 98 countries from 1987 to 2004, show that aid allocated to health is effective in reducing child mortality and it affects more in the poorest countries. This latest study uses instrumental variables, which effectively corrects the endogeneity of aid.

In general and as other research, these studies have limitations, and require improvements. Note first that while the quality of aid data they use is not good is questionable. Indeed, sectoral aid data are reliable only from 1995.

The study should focus on a recent period (i.e. from 1995) and therefore cannot in 1973. Then sectoral aid allocated to water supply, sanitation, family planning, but also must have a direct effect on health. Indeed, if the quality of the health care system is important to ensure good health for the population (whether to cure or prevent) the quality of the water, sanitary environment is very important and prevents diseases. Finally, flows provided by foundations such as the Bill and Melinda Gates and the many NGOs are not put into consideration when their participation is increasingly important.

This paper represents an attempt to test whether the ODA contributes to improving health or not, for a given sample in panel 5 countries on the southern shore of the Mediterranean over the period 1992-2010.

3 MODELS

In this section we will look at a public aid indicator development ADP and know the effect of this variable on improving health. So our model regresses as follows: a variable that is explained by the following variables:

❖ **Dependent variable**

- *Life expectancy at birth (**EV**):* The number of years a newborn infant would live if normal mortality at birth should be the same throughout his life.

❖ **Explicative variables**

- *Gross Domestic Product per capita (**GDP**):* is an economic indicator used to measure production in a given country. It is defined as the total value of the production of wealth (value of goods and services created - value of goods and services destroyed or transformed during the production process) in a given country during a given year resident economic agents within the national territory. It is also the measure of income from production in a given country.

- *Enrollment (**TA**):* what is the ratio of total enrollment (regardless of age) in the population age group that officially corresponds to the level of education considered. Enrollment is considered in the primary, secondary and higher education.

- *Health expenditure per capita (current U.S. $) **(DS)**:* total health expenditure is the sum of expenditures on public and private health as a ratio of the entire population. It covers the provision of health services (preventive and curative), family planning activities, activities related to nutrition and emergency health assistance reserved but excludes the provision of water services and hygiene.

- *The aid allocated to health "broad sense" **(ADP)**:* is defined as assistance to affected areas of health, water and sanitation and population (according to the type of CAD). It is assumed that the activities improving access to clean water, sanitation or quality family planning permit, as well as aid allocated to the health sector, to directly and significantly improve health in poor countries.

Table 1: Descriptive statistics

Variables	Statistics			
EV	Mean	Median	Min	Max
	69,947	70,000	62,000	76,000
	Sd.Div	C.V.	Skewness	Kurtosis
	2,922	0,0417	-0,549	0,0062
GDP	Mean	Median	Min	Max
	2814,29	1825,00	626,000	14802,0
	Sd.Div	C.V.	Skewness	Kurtosis
	2444,46	0,868589	2,29986	6,41483
DS	Mean	Median	Min	Max
	228,442	207,000	66,0000	525,000
	Sd.Div	C.V.	Skewness	Kurtosis
	116,091	0,508185	0,923332	0,243860
ADP	Mean	Median	Min	Max
	7,11149e+008	3,52570e+008	2,87000e+006	6,06520e+009
	Sd.Div	C.V.	Skewness	Kurtosis
	1,01793e+009	1,43139	3,06630	11,4300
TA	Mean	Median	Min	Max
	73,9789	81,0000	42,0000	86,0000
	Sd.Div	C.V.	Skewness	Kurtosis
	13,7524	0,185895	-1,30311	0,0551570

4 ECONOMETRIC SPECIFICATIONS

We constructed a regression specification of infant and child mortality rates. We introduce the indicator aid allocated to health. We try to use the following template:

$$\boldsymbol{LogEV_{it}} = \boldsymbol{logGDP_{it}} + \boldsymbol{Logs_{it}} + \boldsymbol{logDS_{it}} + \boldsymbol{logADS_{it}} + \boldsymbol{\varepsilon_{it}} \quad \textbf{(1)}$$

Where,

- SIJ: infant and child survival in for thousands. It is obtained from the infant mortality rate (SIJ = 1 - MIJ).
- GDP: GDP per capita expressed in international dollars, i.e. parity purchasing power.
- S: The rate of adult literacy.
- DS: Public health expenditure per capita in constant dollars, i.e. parity purchasing power.
- ADS: Wide health aid per capita. Amount of aid disbursements in the areas of health.

4.1 RESULTS OF ESTIMATION

In this part we estimate the model represented in equation (1) using different methods. We offer classical estimators in the context of panel data models such as fixed or random effects.

Table 2: Health impact of aid on on the health state of health fixed effects

Variables	*Coefficient*	*Std.div*	*t-Student*	*p. critique*	
Const	3.501634	0.1570506	22.30	0.000	***
LPIB	0.0124324	0.0063069	1.97	0.052	**
LTA	0.0964399	0.0368734	2.62	0.011	**
LDS	0.0667877	0.0052377	12.75	0.000	***
LADS	0.0061005	0.0024659	2.47	0.015	**

* Indicates significance at 10% risk

** significance at 5% risk

*** Significance at 1% risk

Table 3: Impact of aid on the health state of health random effects

Variables	*Coefficient*	*Std.div*	*t-Student*	*p.critical*	
Const	4.011377	0.0720305	55.69	0.000	***
LPIB	-0.0021201	0.0057224	-0.37	0.711	
LTA	-0.0466142	0.0097034	-4.80	0.000	**
LDS	0.0866006	0.005775	15.00	0.000	***
LADS	-0.0004077	0.0015424	-0.26	0.792	

* Indicates significance at 10% risk

** significance at 5% risk

*** Significance at 1% risk

4.2 TEST OF HAUSMAN

Null hypothesis: GCM estimators are unbiased.

Asymptotic test statistic: Chi-square (7) = 190.258 with p. critical = (0.0000)

We must now choose the test we will choose the all based on the Hausman test that compares between the fixed effects and random effects with 7 degrees of freedom. It is to test the null hypothesis of independence between errors and explanatory variables in order to see which test you will choose.

And since Prob> X^2 (4) = (0.0024) <5%, we should reject the null hypothesis. I.e. the errors dependes explanatory variables. And therefore we will choose the test fixed effect is to say that all countries have the same individual effect.

4.3 TEST OF STATIONARITY

Before testing the significance of each variable in health and its impact on economic growth, it is very important to test the stationarity ie if it varies around its mean over time. Thus, it will do two stationarity tests namely Levin-Lin-Chu test (LLC) and Im-Pesaran-Shin (IPS).

The standard approach to test for the existence or not of a unit root is the regression Augmented Duckey-Fuller (ADF):

$$\Delta \boldsymbol{y_{it}} = \boldsymbol{\delta_i} + \boldsymbol{\alpha_i t} + \boldsymbol{\beta_{it}} + \boldsymbol{y_{it-1}} + \sum_{j=1}^{p_i} \boldsymbol{\rho_{ij}} \Delta \boldsymbol{y_{it-j}} + \boldsymbol{\varepsilon_{it}}$$

i= 1,…, N

t= 1,…, T

Where, $\Delta y_{it} = y_{it} - y_{it-1}$

t : Linear trend

p : number of delay

a- Test of Levin-Lin-Chu (LLC) :

Among the unit root tests that we apply in this study included testing Levin et al (2002) which is an extension of Levin and Lin (1993) and test (IPS) Im et al (1997 and 2003) .

The structure of the LLC test assumes that each individual unit in the panel shares the same coefficient AR (1), but takes into account the individual effects, time effects and the possibility of a trend over time.

$$\Delta y_{it} = \delta_i + \theta_t + \alpha_{it} + \beta_i y_{it-1} + \sum_{j=1}^{p_i} \rho_{ij} \Delta y_{it-j} + \varepsilon_{it}$$

The null hypothesis H_0 : β_i=0 for all (i).

The delays of the dependent variable are presented to reflect the correlation in the periodic errors.

The statistics of this LLC test is given by:

$$t_{\beta}^{*} = t_{\beta=0} - N\tilde{T}\,\hat{S}_{NT}\,\hat{\sigma}_{\varepsilon}^{-2} RSE\,(\widehat{\beta})\alpha_{\bar{t}} \;/\; \sigma_{\bar{T}}$$

Where $t_{\beta=0}$ is the statistical associated $\hat{\beta}_i$ under the null hypothesis $\beta_i = 0$.

$$\tilde{T} = (T - \bar{p} - 1) \text{ et } \quad \bar{p} = N^{-1} \sum_{i=1}^{N} P_i$$

$\widehat{s_{NT}^2}$ is the standard variance of y_{it}

$\widehat{\sigma_{NT}^2}$ is the variance of the residual

RSE ($\hat{\beta}$) is the standard residue estimating $\hat{\beta}_i$

Under the null hypothesis that ($\beta i = 0$), the test panel t_β* is distributed as normal.

b- Test of Im-Pesaran-Shin (IPS):

Another test of Im et al (1997 and 2003) called test (IPS) was performed to further confirm the results found in the test (LLC). This test represents an extension and generalization of the test (LLC). This model is represented by the following equation:

$$\Delta y_{it} = \delta_i + \theta_t + \alpha_{it} + \beta_i y_{it-1} + \sum_{j=1}^{p_i} \rho_{ij} \Delta y_{it-j} + \varepsilon_{it}$$

The null hypothesis H_0 : β_i=0 for all i is tested against the alternative hypothesis H_1 : β_i< 0 for i test that takes into account the heterogeneity des β_i without losing sight of the objectives of Pesaran and Smith (1995) on use of panel estimators pooled. So the test IPS proposes the use of statistical t-bar:

$$Z_i = N^{\frac{1}{2}}(\bar{t}\ NT - E(\bar{t}\ \mathbf{NT}))/(\mathbf{var}\ (\bar{t}\ \mathbf{NT}))^{\frac{1}{2}}$$

Where,

$$\bar{t}\ NT(\rho_i) = \frac{1}{N} \sum_{i=1}^{N} t_{iT}\ (\rho_i)$$

And t_{iT} (p_i) is the t-statistic to test individual β_i =0 for all (i).

While E ($\overline{T_{NT}}$) and var($\overline{T_{NT}}$) are obtained by stochastic simulation.

Under the null hypothesis of non-stationarity H_0, the $Z_{\overline{T}}$-statistic converges to a normal distribution $Z_T \rightarrow$ N (0,1).

Table 4: Test of unit root in panel

Variables	IPS		Levin lin		Stationarity
	Coef	p- value	Coef	p- value	
LEV	2.1563	0.9845	-2.2201	0.3356	Stationary in first differences
ΔLEV	-1.571	0,043	-3.7829	0.0632	
LPIB	- 1.144	0.126	-1.388	0.085*	Stationary level
ΔLPIB	-1.484	0.068	-1.728	0.041**	
LS	-1.763	0,0225	-1.842	0,0327**	Stationary level
LDS	-1.3382	0,067	-2.726	0,003**	Stationary level
LADS	0.237	0,594	-4.3470	0.0377	Stationary in first differences
ΔLADS	-1.366	0.042	-1.578	0.050**	
* Indicates significance at 10% risk ** significance at 5% risk *** Significance at 1% risk					

4.4 TEST OF COINTEGRATION IN PANEL

Given the results of the test panel unit root, we proceed to test for panel cointegration, we find that, overall, all variables are integrated order.1 . Cointegration fear is defined as a systematic co- movement in the long term between two or more economic variables (Yoo 2006). Testing Granger (1981) and Johansen (1988) are based on time series and do not include panel data. Several tests are developed in the framework of panels: The cointegration panel data proposed by Pedroni (1995, 1997, 1999, 2004), Kao (1999) and Bai and Ng (2001) tests are similar residual tests the proposed by Engle and Granger (1987) in the context of time series tests.

In addition, Pedroni (1995, 1997) gave various cointegration tests in two steps to apprehend the null hypothesis of absence of intra-individual cointegration for both homogeneous and heterogeneous panels in the presence of a single regressor in cointegrating relationships , Pedroni (1999, 2004). It offers an extension to the case where cointegration relationships include more than two variables and develops seven (7) tests based on the estimated residuals of the model in the long term. Pedroni tests take into account the heterogeneous by using parameters which are different among individuals. Thus, under the alternative hypothesis, there is a cointegration relationship for each individual, and the parameters of the cointegrating relationship are not necessarily the same for each individual panel (Hurlin and Mignon 2007). In addition, Kao (1999) also proposed testing the null hypothesis of no cointegration: type test Dickey -Fuller test type and Augmented Dickey-Fuller.

The tests of Pedroni based on the estimation of the long-term relationship of heterogeneity model coefficients following slope:

$$\boldsymbol{y_{it} = \alpha_i + \delta_{it} + \beta_{1i} x_{1,it} + \beta_{2i} x_{2,it} + \cdots \beta_{mi} x_{m,it} + e_{it}}$$

Where i = 1, ..., N denotes the individual, t = 1, ..., T (time), and m = 1 ..... M index (slope coefficients)

From this model Pedroni has developed seven (07) test statistics, four are based on the Within dimension (intra) and three on the Between dimension (inter). Both types of tests based on the null hypothesis of no cointegration (H0: ρi = 1 whatever i). The parameter ρi is the autoregressive coefficient estimated residuals under the alternative hypothesis as

$$\hat{e}_{i,t} = \boldsymbol{\rho_i}\ \hat{e}_{i,t} + \boldsymbol{\mu_{i,t}}$$

The distinction between the two categories of tests lies in the specification of the alternative hypothesis (H_1):

- For tests based on intra dimension, the alternative hypothesis is written:

$$\rho_i = \rho < 1 \text{ whatever i}$$

- For-based international dimension tests, the alternative hypothesis is written:

$$\rho_i < 1 \text{ whatever i}$$

It is thus seen that the test based on the international dimension is more general in that it allows the presence of heterogeneity among individuals under the alternative hypothesis.

Table 5: Results of different tests based on the size of the interior (panel cointegration statistics) and one (group mean panel cointegration statistics)

Alternative hypothesis: AR coefs. Common (inner dimension)		
	Statistic	Prob
Panel v-Statistic	0.174	0.120
Panel rho-Statistic	-0.254	0.399
Panel PP-Statistic	-5.275	0.000
Panel ADF-Statistic	-4.656	0.000
Alternative hypothesis: AR coefs. Individualle (one-dimension)		
Group rho-Statistic	0.756	0.775
Group PP-Statistic	-9.291	0.000
Group ADF-Statistic	-5.096	0.000

This table summarizes the results of seven (07) statistics of Pedroni cointegration. They were calculated using Eviews 7 has an appropriate program to address the data cointegration heterogeneous panels. The cointegration variables depend on the value of the statistical probability associated with each. Thus the seven statistics have four probability values below 5%. It is mainly (Panel pp-Statistic) and (Group ADF-Statistic), which proves that there is a cointegration relationship between the variables in the model.

4.5 TEST DE CAUSALITÉ DE GRANGER EN PANEL :

Following the results of the cointegration test, we estimate the VECM in panel to test the causality of Engel and Granger (1987). We adopt the two-step procedure by first estimating the long-term model to obtain residuals.

$$\ln EV_{it} = \alpha_{it} + \delta_t + \gamma_{1i} s_{it} + \gamma_{2i} ADS_{it} + \varepsilon_{it}$$

Delayed value of these residues is introduced as a term of VECM error correction, the dynamic correction model is estimated following error:

$$\Delta \ln EV_{it} = \alpha_{iy} + \sum_{K=1}^{q} \theta_{11ik} \Delta \ln EV_{it-k} + \sum_{K=1}^{q} \theta_{12ik} \Delta \ln S_{it-k} + \sum_{K=1}^{q} \theta_{13ik} \Delta \ln ADS_{it-k} + \Lambda_{1i} \varepsilon_{it-1} + \mu_{it}$$

$$\Delta \ln s_{it} = \alpha_{is} + \sum_{K=1}^{q} \theta_{21ik} \Delta \ln s_{it-k} + \sum_{K=1}^{q} \theta_{22ik} \Delta \ln EV_{it-k} + \sum_{K=1}^{q} \theta_{23ik} \Delta \ln ADS_{it-k} + \Lambda_{2i} \varepsilon_{it-1} + \mu_{it}$$

$$\Delta \ln ADS_{it} = \alpha_{iSE} + \sum_{K=1}^{q} \theta_{31ik} \Delta \ln ADS_{it-k} + \sum_{K=1}^{q} \theta_{32ik} \Delta \ln EV_{it-k} + \sum_{K=1}^{q} \theta_{33ik} \Delta \ln S_{it-k} + \Lambda_{3i} \varepsilon_{it-1} + \mu_{it}$$

With Δ the first difference operator, and q is the number of delays peuventt be determined by the two-step procedure suggested by Abdalla and Murinde (1997), the optimal number of delay is one that maximizes the value of R^2, and u is the error term.

Table 6: The test of causality between health and variable growth economy in PRSM over the period 1992-2010

Null Hypothesis:	Obs	F-Statistic	Prob.
LPIB does not Granger Cause LEV	85	2.93116	0.0591
LEV does not Granger Cause LPIB		1.55376	0.2178
LDS does not Granger Cause LEV	85	4.43543	0.0149
LEV does not Granger Cause LDS		2.00497	0.1414
LTA does not Granger Cause LEV	85	1.38455	0.2564
LEV does not Granger Cause LTA		0.46298	0.6311
LOG_ADS does not Granger Cause LEV	85	2.38568	0.0190
LEV does not Granger Cause LOG_ADP		3.04671	0.0531
LDS does not Granger Cause LPIB	85	2.94956	0.0581
LPIB does not Granger Cause LDS		0.70474	0.4973
LTA does not Granger Cause LPIB	85	0.30975	0.7345
LPIB does not Granger Cause LTA		0.00922	0.9908
LOG_ADP does not Granger Cause LPIB	85	0.51333	0.6005
LPIB does not Granger Cause LOG_ADP		3.12172	0.0495
LTA does not Granger Cause LDS	85	0.09509	0.9094
LDS does not Granger Cause LTA		2.22269	0.1150
LOG_ADP does not Granger Cause LDS	85	0.70333	0.4980
LDS does not Granger Cause LOG_ADP		2.88816	0.0615
LOG_ADP does not Granger Cause LTA	85	0.37568	0.6880
LTA does not Granger Cause LOG_ADP		0.43645	0.6479

From the results presented in this table Granger, there:

- A bidirectional causality between aids allocated to health and life expectancy.
- A causal relationship between GDP growth and life expectancy.
- A causal relationship between health and expenditure of aid allocated to health.

Table 7: Test of exogeneity

Variables	**LEV**	**LPIB**	**LDS**	**LADS**
Restoring Forces	-0.084	-0.125657	-0.011973	-0.012819
T- statistic	[-3.819]	[-3.85214]	[-1.9999]	[-2.32407]
P value	0.020	0.0002	0.0485	0.0223

All explanatory variables are strongly exogenous forces as reminders are negative and significant. Thus, according to the results of the VECM estimation, we find that the force is negatively significant in relation to the logarithm of the relative life expectancy in the relationship relative to the logarithm of gross domestic product in the relationship on the logarithm of enrollment and the logarithm relation aid allocated to health. It is said that the deviation from the target converges towards equilibrium. Thus, these variables are strongly exogenous and lead to the long-term equilibrium which confirms the technique Pedroni concerning the existence of a relationship explanatory long-term evolution of life expectancy by gross domestic product, enrollment and aid allocated to health. The long-term relationship can be written as follows:

$$\mathbf{L\,EV_{it} = 0{,}10TS_{it} + 0{,}11\,LPIB_{it} + 0{,}029\,LADS_{it} + \mu_{it}}$$

Similarly, and by focusing on our main problem, we find the equation of a long-term positive and significant correlation between aid allocated to health and improved life expectancy. There is a 10% improvement of aid allocated to health contributes to an increase of 0.29% of the life expectancy. This result suggests accordance with that found by Bloom et al. (2001) and Weil (2004). These authors found that the improvement of the health of the individual helps to increase the rate of economic growth. Similarly, income and education are also two important factors of human capital accumulation. The results show the existence of a long-term relationship between adult literacy and health improvement so that a 10 % literacy rate contributes to an improvement of 1 % of hope life. Similarly an increase in GDP of 10% is associated with an increase in life expectancy of 1.1 %.

5 CONCLUSION

The purpose of this article is to evaluate the effectiveness of aid to improve health. The first part of this paper describes the evolution of health indicators in countries of the southern Mediterranean. In the second part we reviewed the contribution of aid allocated to health to improve life expectancy and found that external financing can improve the health of populations. In the context of this article, preliminary estimates have been made to test the effectiveness of foreign aid on health. Those conducted on health are consistent with the theoretical results.

In the countries of the southern Mediterranean, all the variables are stationary in first differences. Based on the test results panel unit root, we proceed to test for cointegration. We use the test pedroni, the results show that the variables are cointegrated of order 1. It is thus seen that there is a long-term relationship between the variable aid allocated to health and improved life expectancy.

The test causality Engel and Granger (1987) application of VECM in panel aims. The results found mention that there is bidirectional causality between external assistance and health improvement. Similarly, the estimate of long-term pattern in the countries of the southern Mediterranean shows that the 10% increase in aid allocated to health results in increased life expectancy of 0.3 %.

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La diplomatie économique et l'insertion internationale de l'économie marocaine

[Economic diplomacy and international integration of the Moroccan economy]

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ABSTRACT: Economic diplomacy is increasingly associated to the overall development strategy, particularly in developing countries which are still having echoes tied to integrating a global economy characterized by a fierce competition. Considered as a developing country, Morocco is building its economic diplomacy to reduce the structural deficit in its trade balance and support Moroccan investors in their pursuit of foreign markets. The purpose of this article is: to understand the Moroccan economic diplomacy, to study its contribution by recalling all its limitations and constraints, to assess the performance of the Moroccan economic diplomacy, to better understand the issues and to spot light on the practice of Moroccan economic diplomacy and its role in improving integration of the Kingdom into the global economy.

KEYWORDS: Economic diplomacy, strategic intelligence, trade policy, international integration, Moroccan economy, promotion.

RESUME: La diplomatie économique est de plus en plus associée à la stratégie globale du développement, notamment dans les pays en voie de développement, qui continuent à faire face à de multiples difficultés pour s'intégrer dans l'économie mondiale dans une conjoncture marquée par une concurrence acharnée. A l'instar de ces pays, le Maroc mise sur sa diplomatie économique pour réduire le déficit structurel de sa balance commerciale, attirer les investissements étrangers et accompagner les investisseurs marocains dans leur quête des marchés étrangers. L'objet de notre article est de mieux comprendre la diplomatie économique marocaine tout en mettant l'accent sur les actions stratégiques de la diplomatie économique tant directes qu'indirectes. Nous étudions également l'apport de la diplomatie économique marocaine. Enfin, nous étudions les réalisations macroéconomiques du pays dans l'objectif d'évaluer les performances de la diplomatie économique marocaine et afin de mieux cerner les enjeux et d'apporter un éclairage sur la pratique de la diplomatie économique marocaine et son rôle pour une meilleure insertion du pays dans l'économie internationale.

MOTS-CLEFS: Diplomatie économique, intelligence stratégique, diplomatie des contrats, économie marocaine, insertion internationale, promotion.

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1 INTRODUCTION

L'économie mondiale est de plus en plus hiérarchisée. Les fruits de la mondialisation ont été répartis de manière inégale, ce qui a conduit à une hétérogénéisation croissante du monde en voie de développement. Si les pays émergents ont su tirer profit de la mondialisation et ont pu *bénéficier d'une croissance forte*, les pays en voie de développement semblent être restés en marge et *continuent à faire face à plusieurs problèmes structurels et conjoncturels. Ces derniers cherchent à prescrire* une stratégie de développement fondée sur l'insertion rapide à l'économie mondiale en cherchant à drainer le maximum d'IDE, promouvoir les entreprises nationales et attirer l'aide publique à travers la mise en place, dans ces économies, de mesures permettant de remédier aux défaillances bloquant leur intégration à l'économie mondiale.

Du point de vue théorique, une insertion plus active aux différents circuits de l'économie mondiale est censée engendrer de nombreux effets positifs. C'est un moyen d'améliorer l'allocation des ressources en les concentrant vers les activités où le pays possède un avantage comparatif, mais aussi d'accroître l'efficacité grâce à l'intensification de la concurrence, et enfin de favoriser le transfert technologique.

Ainsi, la plupart des pays du sud se sont convertis à l'idéologie libérale, dominante en matière de développement, de leur propre gré ou en contrepartie de l'aide du FMI et de la Banque Mondiale pour le remboursement de leurs dettes extérieures. Toutefois, le consensus tend à se faire autour de l'impossibilité de concevoir une issue durable à la crise sans passer par des transformations majeures, capables d'adapter les économies en développement aux nouvelles conditions financières mais aussi commerciales et technologiques qui se font jour dans l'économie mondiale.

Ce nouveau contexte, porteur de grandes opportunités et de nouveaux défis, a placé la diplomatie économique au cœur de la politique étrangère. En effet, la diplomatie économique, perçue en tant que mécanisme incontournable de développement économique, occupe de plus en plus une place primordiale dans la mesure où elle a toujours été liée au contexte d'intégration compétitive dans l'économie mondiale. Dans ce sens, la diplomatie économique des pays en voie de développement est de plus en plus sollicitée au niveau de la stratégie globale de développement.

L'étude de la diplomatie économique prend de plus en plus d'intérêt dans la mesure où une diplomatie économique efficace permet de faire évoluer le pays vers une situation caractérisée par des échanges satisfaisants avec le reste du monde en vue de son intégration dans l'économie mondiale.

La capacité de ladite diplomatie à promouvoir les exportations du pays, attirer les investissements étrangers et accompagner les entreprises nationales dans des politiques offensives de conquête de marchés extérieurs, lui a permis d'occuper une importance remarquable en tant que facteur incontournable de développement économique.

Dans ce cadre, l'étude de la diplomatie économique marocaine en tant que facteur d'insertion dans l'économie internationale est d'autant plus actuelle et opportune. Plus précisément, les axes de cet article s'articulent autour d'une question centrale : Quel est le rôle de la diplomatie économique marocaine pour une meilleure insertion de l'économie marocaine dans l'économie internationale ?

2 ESSAI DE DÉFINITION

La notion de diplomatie économique suscite un intérêt particulier dans la mesure où elle se situe à l'intersection de préoccupations majeures des pays : politique de développement, intelligence économique, compétitivité de l'entreprise, délocalisation des firmes, géo-économie et internationalisation des champions nationaux. Aussi, c'est une notion difficile à cerner : d'une part, parce qu'elle a des acceptions différentes selon les acteurs et selon les pays et les gouvernements et, d'autre part, parce qu'elle se définit "non par ses instruments, mais par les problèmes économiques qui lui donnent son contenu[1]". En effet, plusieurs définitions ont été proposées par plusieurs chercheurs.

Dans ce cadre, le sujet peut être traité selon deux approches. La première reste dans une logique de subordination de l'économique au politique[2]. Dans cette perspective, les marchés ont leur logique, mais ils ne participent pas à la définition du

[1] *Laurence Badel, Introduction, "Diplomaties en renouvellement", Les Cahiers Irice, n°3, 2009, note 39.*
[2] *CHAVAGNEUX. C., « La diplomatie économique : plus seulement une affaire d'États », Pouvoirs, 88, janvier 1999, p. 34*

système international qui reste maîtrisé politiquement par les États. La seconde approche repose sur l'autonomisation du champ économique et la montée en puissance des acteurs privés.

Le terme diplomatie désigne la politique étrangère d'un Etat. Elle est considérée comme étant "l'ensemble des règles, us et protocoles internationaux qui organisent les relations entre les Etats et les organisations internationales, les procédures d'application des règles du droit international, la conciliation entre les différents intérêts des Etats, l'art de négocier et de prendre la parole lors des réunions et des congrès internationaux et la conclusion d'accords et de conventions[3]".

Appliquée au domaine économique, une telle définition peut conduire à voir dans la diplomatie économique l'ensemble des moyens par lesquels le gouvernement parvient à promouvoir l'intérêt économique national. Pour Marie-Christine Kessler, la diplomatie économique se définit par "la mise en œuvre, par une autorité publique, d'une politique à finalité commerciale et financière, destinée à assurer la prospérité économique du pays à travers les intérêts de ses entreprises, de ses groupes socioprofessionnels, de ses citoyens"[4]. À cette analyse centrée sur la mobilisation économique de l'État et de ses administrations se rattache la réflexion de Guy Carron de la Carrière qui définit la diplomatie économique en tant que "la recherche d'objectifs économiques par des moyens diplomatiques, qu'ils s'appuient ou non sur des instruments économiques pour y parvenir"[5].

Néanmoins, la définition classique de la diplomatie économique ne rend pas compte de l'ensemble des évolutions qui ont accompagné la mondialisation économique, et en particulier de la montée en puissance d'acteurs comme les firmes, les établissements financiers ou les organisations économiques internationales, mais aussi les ONG6. Aussi, elle ne permet guère de prendre en considération le rôle grandissant des marchés dans le fonctionnement majeur de l'économie mondiale. Ainsi, elle présuppose l'existence d'un intérêt économique national que la mondialisation rend de plus en plus difficile à cerner. Enfin, les relations entre Etats et sociétés deviennent chaque jour plus complexes et ambiguës. Elles nécessitent une approche nouvelle. La diplomatie économique prend une importance majeure dans cette nouvelle donne. Cette définition, reflète une vision d'un système international dans lequel les Etats sont les acteurs principaux. Elle subordonne l'économique au politique.

Les limites de la définition classique de la diplomatie économique, l'émergence de nouveaux enjeux et l'évolution des objectifs de la diplomatie économique qui englobe non seulement les relations interétatiques mais aussi les relations qui se tissent entre les États et les autres acteurs de l'économie mondialisée[7] sont autant de raisons pour la recherche d'une nouvelle définition qui prend en considération l'ensemble de ces changements. C'est ainsi que nous proposons de donner au terme « diplomatie économique » une acception plus large qui permet d'englober non seulement les relations interétatiques mais aussi les relations qui se tissent entre les Etats et les autres acteurs de l'économie mondialisée[8].

La diplomatie économique résulte d'une interaction entre enjeux économiques et objectifs politiques, d'une association entre l'Etat et le secteur privé et d'un dosage entre les décisions internes et les engagements internationaux. Dans ce sens, Bergeijk et Moons considèrent que la diplomatie économique consiste en "un ensemble d'activités visant les méthodes et procédés de la prise internationale de décision et relatives aux activités économiques transfrontières dans le monde réel. Elle a comme champs d'action le commerce, l'investissement, les marchés internationaux, les migrations, l'aide, la sécurité économique et les institutions qui façonnent l'environnement international, et comme instruments les relations, la négociation, l'influence"[9]. Lee considère la diplomatie économique comme "l'ensemble des efforts déployés par un réseau

[3] *Samouhi Fawk Al Ada, Glossaire de la diplomatie et des affaires étrangères, Anglais-arabe-français, publications du Liban, Beyrouth, 1979, p. 127.*

[4] *Marie Christine Kessler, La politique étrangère de la France. Acteurs et processus, Presses de Sciences Po, 1999, chap. 7*

[5] *Guy Carron de la Carrière, La diplomatie économique. Le diplomate et le marché. Economica, 1998.*

[6] *Bertrand Badie, L'impuissance de la puissance, Paris, Fayard, 2004.*

[7] *N. Bayne, S. Woolcock, The New Economic Diplomacy. Decision-Making and Negotiation in International Economic Relations, 2e éd., Londres, Ashgate, 2007.*

[8] *Cette approche s'inspire notamment des travaux d'auteurs comme Susan Strange. Voir notamment The Retreat of the State. The Diffusion of Power in the World Economy, Cambridge, Cambridge University Press, 1996.*

[9] *Cité par REVEL, Claude. Diplomatie économique multilatérale et influence. Géoéconomie, 2010, no 1, p. 59-67.*

d'acteurs publics et privés afin de gérer les relations commerciales à travers les divers canaux et processus diplomatiques. Le terme relations commerciales fait référence aux échanges commerciaux ainsi qu'à l'investissement direct étranger"10.

Dans ce sens, la définition qui répond le mieux aux besoins de notre recherche peut être formulée comme suit : la diplomatie économique est considérée comme **étant "l'ensemble des mécanismes et pratiques adoptés par des acteurs, publics ou privés dans le but de réaliser les objectifs économiques d'un État par le recours à des moyens politiques, ou de réaliser les objectifs politiques par le recours à des moyens économiques[11]**". Cette définition a été reprise par la chambre de commerce française dans son dernier rapport sur l'apport de la diplomatie économique[12]. Dans ce qui suit, nous allons retenir cette définition pour la désignation du concept de la diplomatie économique.

3 REVUE DE LITTÉRATURE

Pourquoi pratique-t-on la diplomatie économique ? La réponse n'est pas évidente. En effet, il est important de préciser dans le cadre de l'analyse théorique de la diplomatie économique qu'il n'y a pas une théorie spécifique qui peut fournir des réponses sur la façon dont les États, dans des circonstances données, vont conduire leurs politiques[13].

S'il existe un riche corpus théorique en analyse de la politique étrangère avec toute une littérature qui vise à expliquer quels sont les facteurs qui influencent les choix des différentes stratégies, les études théoriques visant à expliquer la diplomatie économique ne sont pas assez abondantes. Comme discuté par Kostecki et Naray[14], le corps de la littérature sur le sujet est encore limité. La littérature "n'identifie pas, n'explique pas et ne comprend pas la plus grande influence d'intérêts privés en diplomatie[15]" et dessine à peine une image complète de tous ses aspects.

D'un point de vue théorique, la diplomatie économique va à l'encontre du libre-échange et de la libéralisation des échanges économiques. Contrairement à la doctrine libérale recommandée, le nationalisme économique est toujours une réalité au XXIe siècle[16]. Les Etats interviennent de plus en plus aux côtés de leurs entreprises nationales pour les aider à conquérir des marchés stratégiques[17].

Si les théories réalistes[18] considèrent la diplomatie économique comme étant un outil pour un État lui permettant de renforcer sa puissance face aux autres Etats. Le néoréalisme se distingue par la prise en compte des interdépendances, la nécessité de renforcer les logiques temporaires d'alliances afin de bâtir des systèmes de sécurité. Ainsi, les États chercheraient à maintenir un équilibre permanent des forces afin de juguler le développement de la puissance d'autres États considérés comme concurrents[19].

La théorie ricardienne des avantages comparatifs, qui constitue la justification du commerce international, et in fine celle de la mondialisation, trouve aussi son pendant dans le domaine de la diplomatie économique[20]. En effet, une certaine forme de spécialisation est observée dans ce domaine, selon des modi operandi qui permettent de maximiser l'avantage compétitif national, tout en reflétant la culture politico-administrative du pays, grand ou petit, émergent ou émergé, et sa capacité effective à intégrer les facteurs clés de succès qui fondent une insertion optimale dans la chaîne de production mondiale.

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[10] Cité par MERCIER, Alexandre. Commercial Diplomacy in Advanced Industrial States, Canada, the UK, and the US. Netherlands Institute of International Relations' Clingendael', 2007.

[11] A. Dafir, « La diplomatie économique marocaine en Afrique subsaharienne : réalités et enjeux », Géoéconomie 2013 - cairn.info.

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[16] http://www.infoguerre.fr/interviews/la-diplomatie-commerciale-quelques-elements-de-reflexion/ consulté le 15/02/2010

[17] Pomes, E. Conquérir les marchés: le rôle des états. L'harmattan, 2004.

[18] L'école réaliste classique puise sa tradition chez Thucydide, Machiavel et Hobbes.

[19] Lucas, D, Le temps de l'hypercompétition, Géoéconomie 3/2009 (n° 50), p. 139-149.

[20] Kateb, A. La diplomatie économique des nouvelles puissances. Géoéconomie, 2010, no 1, p. 87-96.

Au concept d'avantages comparatifs vient se substituer celui de compétitivité des nations. Vivement critiqué par les économistes libéraux pour sa non-pertinence[21], le concept a néanmoins été intégré par les États, à commencer par les Etats-Unis et l'Union européenne, et les indices de sa mesure[22], sont devenus aujourd'hui des références incontournables. Dans sa définition la plus générale, le concept vise à mesurer la capacité d'une nation à faire face à la concurrence internationale et sa capacité à créer les conditions susceptibles de générer de la croissance dans un monde ouvert à la concurrence internationale[23]. Entre ainsi en jeu, en amont, tout ce qui est susceptible d'influencer les choix des investisseurs et d'attirer favorablement l'investissement international, et en aval, tout ce qui est susceptible de favoriser la compétitivité des entreprises « nationales » sur les marchés internationaux. Partant de là, plus qu'un régulateur de l'activité économique, l'État apparaît comme un promoteur, et ce, dans le triple sens du terme, c'est-à-dire à la fois comme vendeur d'un produit, l'espace économique national, comme acheteur d'un facteur de développement, l'investissement international, et comme assembleur des énergies, celles de la nation[24].

Cependant, ces théories font des simplifications importantes en ce qui concerne des Etats comme des acteurs unitaires avec les préférences politiques clairement définies et stables, et il est possible de tester si elles sont correctes ou non. Par ailleurs, il ne fait aucun sens de penser que les États sont des acteurs unitaires, que les négociateurs ont plein connaissance des préférences de politique nationale ou que ces préférences seront stables et non affectées par l'évolution du marché.

Ce genre de théories n'apporte pas un surplus en matière de compréhension de la nouvelle diplomatie économique qui s'intéresse à l'interaction entre les facteurs nationaux et internationaux et entre les préoccupations économiques et politiques[25].

En plus, plusieurs des approches recensées sont employées tant dans le cadre de la recherche en science économique qu'en science politique. Certaines des recensions théoriques auxquelles nous avons fait référence tentent d'ailleurs de faire le pont entre les deux disciplines. En fait, la diplomatie économique est un domaine d'étude complexe qui se situe à l'interstice de la politique nationale et de la politique internationale, de l'économie et de la politique, des intérêts de la nation et des intérêts des groupes privés. Elle subit l'influence d'un nombre croissant de variables et qui requiert, pour être appréhendée, une démarche multidisciplinaire comme le montre bien la littérature spécialisée dans ce domaine.

Dans ce sens, Robert Putnam a proposé une solution permettant de concilier deux niveaux à la fois : les Two-Level Games (jeux à deux niveaux)[26]. Selon lui, le responsable de la prise de décision est placé entre deux échiquiers, l'un composé de tous les constituants de la scène politique interne, l'autre de toutes les données de la négociation internationale. Chaque fois que la situation évolue sur le second échiquier, il doit aller négocier sur le premier, puis revenir poursuivre la négociation avec une donne légèrement modifiée sur le second, et ainsi de suite. Le postulat est qu'aucune négociation internationale ne peut aboutir à un résultat tangible s'il n'y a pas dans le pays une coalition suffisante pour accepter la décision et permettre son application[27].

Guy Carron de la Carrière développe une nouvelle approche et propose des pistes de développement de la théorie classique pour prendre en considération la complexité des acteurs impliqués et les différents modèles poursuivis par les Etats[28].

Dans ce sens, un inconvénient de la littérature est que les instruments de la diplomatie économique ont été étudiés d'une manière isolée. Il est tout à fait possible que les instruments sont liés dans la pratique. Par exemple, les agences publiques de promotion des exportations se servent souvent du réseau des ambassades et des consulats à l'étranger pour des informations sur un marché particulier. Par conséquent, les deux types de corps peuvent tirer bénéfice des synergies

[21] *Par l'économiste Krugman notamment.*
[22] *Le Global Competitiveness Report ou le World Competitiveness Report par exemple.*
[23] *Deblock, C. Du mercantilisme au compétitivisme: le retour du refoulé. Cahier de recherche 02-0, Research group on continental integration, September 2002, pp. 9–15.*
[24] *Michalet CA, La séduction des Nations ou Comment attirer les investissements, Paris, Economica, 1999.*
[25] *Bayne, N and Woolcock, S. The New Economic Diplomacy. Decision-Making and Negotiation in International Economic Relations. Bayne. Hampshire, Ashgate Publishing, 2003.*
[26] *Putnam, R, Diplomacy and Domestic Politics : The Logic of Two-Level Games, International Organization, n° 42, été 1988, p. 427-460.*
[27] *Smouts, MC. Que reste-t-il de la politique étrangère?. Pouvoirs, 1999, p. 5-16.*
[28] *Carron de la Carrière, G. La diplomatie économique. Le diplomate et le marché. Economica, 1998.*

considérables. C'est également une possibilité que les activités des instruments évincent parce qu'elles sont employées simultanément tandis que le but de cette intervention pourrait également être atteint avec seulement un seul instrument[29].

Cependant, une approche d'unification est inacceptable, puisque la diplomatie économique est concernée par l'interaction des facteurs internationaux et domestiques et soucis économiques/politiques, qui sont souvent tout à fait divers[30].

Aussi, la littérature dans ce champ analytique est, dans une grande proportion, américaine et elle se consacre assez souvent à l'étude de la diplomatie économique des États-Unis. Les approches théoriques ainsi développées sont généralement conceptualisées pour expliquer la politique américaine[31].

4 ACTIONS DE LA DIPLOMATIE ÉCONOMIQUE MAROCAINE

La diplomatie économique constitue l'un des leviers les plus puissants de la performance des entreprises et de la compétitivité de l'Etat et présente donc un grand intérêt pour la compréhension de la dynamique du développement international, tant pour les Etats que pour les entreprises. Son analyse dans le cadre d'un pays donné apparait déterminante pour juger de son importance au niveau institutionnel.

Dans cette perspective, le Maroc a entamé un large processus de libéralisation de son économie depuis l'adoption du PAS en vue de réaliser à la fois sa croissance et la mise à niveau de son économie, dans l'objectif de rétablir les équilibres aussi bien économiques que financiers, intérieurs qu'extérieurs.

Pour ce faire, le Maroc s'est doté, ces dernières années, d'une politique économique particulière sur un certain nombre d'axes : le premier est de conforter le cadre macro-économique et le second est d'insérer l'économie marocaine dans son environnement mondial et régional. Il s'agit du renforcement du cadre macro-économique et de la définition des plans d'actions nationaux. De grands chantiers de développement et des stratégies sectorielles qui cherchent à donner une visibilité claire aux opérateurs marocains et étrangers ont été lancés (Projet de Tanger Med, Vision 2010 pour le tourisme, Plan Azur, Emergence, Plan Maroc Vert, Plan Halieutis, Vision 2015 pour l'artisanat, Maroc Numéric pour les TIC, Maroc Export Plus et la stratégie énergétique du Maroc…).

Ainsi, le Maroc mise de plus en plus sur sa diplomatie économique pour réussir le pari de l'insertion de son économie dans l'économie internationale. Occupant une place désormais stratégique et membre de plusieurs organisations internationales, le pays multiplie la conclusion des accords de libre échange et adopte une stratégie active, visant à diversifier ses partenaires, promouvoir l'attrait des investissements extérieurs et défendre ses intérêts économiques.

En effet, la stratégie de la diplomatie économique marocaine est considérée comme étant un équilibre d'intérêts et de pressions. L'objectif de soutenir le développement économique du pays doit trouver un équilibre entre les différents aspects qui y sont associés: attirer des investissements étrangers, soutenir les activités d'investissements marocains à travers le monde, promouvoir les exportations marocaines, maintenir une relation stable avec les grandes puissances en adoptant une diplomatie des contrats, contribuer à la stabilité régionale et assumer les responsabilités qui découlent du poids croissant du Maroc sur la scène régionale.

Cependant, le Maroc s'attarde à tirer bénéfice des différentes stratégies développées. L'économie marocaine est de plus en plus touchée par une crise de liquidité sans précédent. Le solde extérieur se dégrade et la balance commerciale du pays est systématiquement déficitaire avec l'ensemble de ses partenaires. Les sources de rentrées de devises dans le pays comme les exportations, les IDE, les recettes du tourisme ou les transferts MRE s'étant dégradées, ne comblent plus les dépenses. S'ajoute à cette situation critique, la flambée des prix des matières premières importées par le Maroc et des accords de libre-échange déséquilibrés qui profitent plus à ses partenaires commerciaux qu'au tissu productif du pays.

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[29] Van Veenstra, M, Yakop, M, Et Bergeijk, P. Economic Diplomacy, the Level of Development and Trade. Netherlands Institute of International Relations' Clingendael', 2010.

[30] Reuvers, S et RUËL, H. Research on Commercial Diplomacy: A Review and Implications. Advanced Series in Management, 2012, vol. 9, p. 1-27.

[31] Bayne N et Woolcock S, « What is Economic Diplomacy ? », in Nicholas BAYNE et Stephen WOOLCOCK. The New Economic Diplomacy, pp. 3-20. 2013.

Dans ce sens, une diplomatie économique au service du développement de la nation et capable de relever les défis de la mondialisation à travers une stratégie axée sur la promotion des investissements et des exportations permet de tirer avantages des délocalisations, de l'économie du savoir, du commerce et des finances.

L'ensemble de ces éléments ont poussé le Maroc à miser sur sa diplomatie économique pour booster sa croissance économique et équilibrer sa balance commerciale. D'ailleurs, la renégociation des accords de libre échange, la défense des produits nationaux et des entreprises nationaux face au protectionnisme, la promotion les exportations et l'attraction des investissements étrangers, la signature des contrats internationaux pour les entreprises marocaines, la recherche d'opportunités pour les industries nationales ainsi que la mise à la disposition des opérateurs économiques des informations stratégiques pour les rendre plus compétitives sont les enjeux de la nouvelle diplomatie économique marocaine[32].

5 RÉALISATIONS EN MATIÈRE D'INSERTION

La diplomatie économique marocaine a permis une plus grande ouverture du Maroc dans l'économie mondiale, une présence internationale des entreprises marocaines sur le continent africain et une diversification des débouchés pour les exportations. Fort de sa stabilité politique et de sa bonne image auprès des investisseurs, le Maroc s'érige en une destination de premier choix des investisseurs[33] avec la meilleure politique de promotion des investissements en Afrique. Il est le deuxième investisseur africain sur le continent et le premier en Afrique de l'Ouest.

L'effet global de la diplomatie économique résulte de la combinaison de différentes actions et la mobilisation de différents acteurs et moyens. Les liens entre les différentes actions de la diplomatie économique et la performance des exportations peuvent donc être très vastes et sont souvent indirects. En fait, il se pourrait que les rôles indirects moins visibles soient plus productifs que les services explicites orientés client destinés aux exportateurs, si ceux-ci se substituent à un soutien qu'offrirait de toute façon le secteur privé, plutôt que d'apporter une aide complémentaire.

Ainsi, l'étude de l'efficacité de la diplomatie économique représente une certaine complexité vu les différents objectifs assignés à ladite diplomatie par les décideurs marocains. Dans ce sens, les réalisations d'ordre politique et géostratégique sont difficiles à cerner.

De surcroit, la réussite de la diplomatie économique marocaine est liée à d'autres facteurs d'ordre micro et macroéconomique. En effet, l'évaluation de l'action de la diplomatie économique marocaine et l'efficacité de différentes actions de promotion n'est pas aisée dans la mesure où l'association entre action et résultat ne peut se faire que d'une manière générale. Une opération d'exportation n'est pas toujours due à des efforts de promotion, et un investissement n'est pas toujours dû à une négociation privé-public. L'étude de la corrélation entre les moyens budgétaires et humains et les résultats réalisés s'avère indispensable pour mieux mesurer l'impact et l'apport de la diplomatie économique marocaine.

Dans cet essai d'évaluation de la diplomatie économique marocaine, nous nous pencherons à analyser les différentes relations commerciales que noue le Maroc avec ses divers partenaires et l'évolution des transactions économiques réalisées dans ce cadre.

5.1 AU NIVEAU DE LA PROMOTION DES EXPORTATIONS :

constituant l'élément central de la stratégie de la diplomatie économique marocaine, la politique d'intégration du Maroc à l'économie mondiale a permis au pays d'enregistrer un certain dynamisme des exportations au cours des dernières années. En 2012, les exportations de marchandises se sont élevées à 183 milliards de dirhams avec une croissance de 5,5% par rapport à l'année 2011. Néanmoins, les résultats n'ont pas été au niveau des attentes. Le Maroc n'a pas connu, comparativement à d'autres pays concurrents, une amélioration de sa part de marché au niveau mondial. En effet, l'évolution de cet indicateur montre, d'une manière générale, une stabilité autour de 0,11% au cours de la période 2000-2012. Il a atteint son niveau le plus élevé en 2008 (0,121%) en lien, notamment, avec la croissance importante des

[32] Parmi les recommandations de la 6ème Table Ronde qui s'est déroulée les 22 et 23 décembre 2009 au siège du Ministère des Affaires Etrangères et de la Coopération, sous le thème «Promotion et Diplomatie Economique en vue d'une sortie de crise».

[33] La revue spécialisé du Financial Times, FDi Intelligence, vient de publier en août 2013, son rapport sur l'attractivité des pays du monde en terme d'investissements directs à l'étranger (IDE), intitulé « African countries of the future 2013/2014". Le Maroc est en 2éme position après l'Afrique du Sud.

exportations de phosphates et dérivés au cours de cette année. Toutefois, ce taux a enregistré une baisse en 2012 pour s'établir à 0,112[34].

En effet, la structure actuelle des exportations pose un certain nombre de problèmes. Les exportations de produits manufacturiers sont concentrées sur des produits à faible valeur ajoutée. De plus, une grande partie de ces exportations proviennent de la sous-traitance, une activité vulnérable et de valeur ajoutée très limitée. Toutefois, ladite structure présente quelques points positifs. Il existe un certain nombre de nouveaux produits à l'exportation en croissance rapide même si leur part dans les exportations de biens reste modeste. Ces produits prometteurs et particulièrement ceux à fort contenu technologique nécessitent pour leur développement des actions vigoureuses en matière d'investissement physique et humain, de maîtrise technologique, de recherche et de développement et d'amélioration de la gestion au niveau de l'entreprise et de commercialisation.

L'importance du facteur technologique dans la détermination du succès à l'exportation souligne l'opportunité de l'intervention de l'État pour soutenir les efforts des industries qui ne sont pas encore dotées des moyens leur permettant de faire face à la concurrence. Dans ce sens, le rôle primordial de la diplomatie économique est de négocier les possibilités du transfert technologique lors de la discussion des grands contrats.

5.2 AU NIVEAU DE L'ATTRACTION DES IDE :

Représentant 6% des IDE destinés à l'Afrique en 2011 et 33% des IDE vers l'Afrique du nord, le Maroc a fait mieux que certains pays comme la Tunisie et l'Egypte, dont les flux d'IDE ont baissé au cours de cette année. Le Maroc se classe ainsi comme 1ère destination en Afrique du Nord et 2ème en Afrique après l'Afrique du Sud.

Les recettes d'IDE au Maroc diminuées des dépenses ont enregistré, selon la CNUCED[35], une hausse de 10,4% en 2012, atteignant 2,8 milliards de dollars contre 2,6 milliards de dollars en 2011, ramenant ainsi la contribution des flux d'IDE à la FBCF[36] à 9,1% et le stock d'IDE à 49,1% du PIB, contre 8,1% et 44,4% respectivement en 2011. En recettes, les entrées d'IDE au Maroc ont atteint 31 milliards de dirhams en 1021, soit l'équivalent de 3,7 milliards de dollars, en hausse de 23% par rapport à 2011[37].

La politique d'attraction des investissements directs étrangers est devenue le nouvel impératif de la politique industrielle au niveau mondial. Désormais, il ne s'agit plus seulement d'être compétitif en termes d'exportations, il faut aussi être attractif pour faire venir les filiales des firmes étrangères. Les pays hôtes multiplient les politiques incitatives d'investissements, afin de bénéficier le plus possible des externalités technologiques positives "*spillovers*" générées par les IDE. A ce propos, l'investissement direct étranger (IDE) constitue l'une des principales voies de transfert technologique vers les pays en développement[38].

5.3 AU NIVEAU DES IDE SORTANTS :

Le Maroc est devenu depuis quelques années une source croissante de flux d'investissements directs à l'étranger (IDE), générant des flux de près de 23 milliards de dirhams entre 2007 et 2012, suite à de nombreux projets émanant d'entreprises marocaines particulièrement dans les secteurs des banques et des télécommunications. La densité des efforts fournis par la diplomatie marocaine a permis de faire de l'Afrique une zone d'accueil importante pour les investissements marocains, ce qui fait du Maroc le deuxième investisseur africain sur le continent, après l'Afrique du Sud, et le premier en Afrique de l'Ouest[39]. En axant ses efforts sur la promotion des intérêts économiques et commerciaux, la diplomatie marocaine vise à devenir le meilleur allié des « champions nationaux » dans la quête des marchés africains. A ce niveau, il est indispensable de

[34] *DEPF, Performance commerciale du Maroc sur le marché de l''Afrique Subsaharienne. Avril 2012.*
[35] *CNUCED, Rapport sur l'investissement dans le monde 2012. Vers une nouvelle génération de politiques de l'Investissement. New York et Genève 2012.*
[36] *Formation Brute de Capital Fixe.*
[37] *MEF, Projet de loi de finances pour l'année budgétaire 2014. Rapport économique et financer ; 2013.*
[38] *Toufik, S. Existe-t-il des spillovers provenant de l'investissement direct étranger au sein de l'industrie manufacturière marocaine ? Colloque AED, 7 et 8 Septembre 2006 – Paris.*
[39] *Chambre française de Commerce et d'Industrie du Maroc. « Maroc-Afrique. La nouvelle frontière », in Conjoncture n° 889, Casablanca, janvier 2008, p. 21-22.*

différencier les entreprises publiques plus faciles à s'orienter dans le sens des intérêts géopolitiques du pays et les entreprises privées orientées plutôt à des intérêts purement commerciaux et financiers. L'efficacité de la diplomatie économique réside dans la capacité des acteurs publics à coordonner leurs actions avec les décisions des acteurs privés qui échappent, en tout ou en partie, aux logiques de contrôle et d'influence étatiques[40]. La vision marocaine est de permettre aux firmes marocaines de devenir les véritables ambassadeurs du Maroc en Afrique. C'est un *puissant outil d'influence* à l'échelle internationale qui permet au Maroc de consolider son autorité à l'extérieur des frontières. Cependant, ces investissements ne se traduisent pas encore par une augmentation des échanges avec l'Afrique subsaharienne. C'est-à-dire que les investisseurs marocains n'ont pas une vision globale intégrant leurs actions d'internationalisation dans le cadre d'une décomposition régionale des processus productifs.

6 CONCLUSION

A travers cette analyse, nous estimons que le pari de réussir l'insertion de l'économie marocaine dans l'économie mondiale exige que l'évaluation de la diplomatie économique soit réalisée sur la base de nouveaux critères, notamment sa capacité à mettre en évidence les atouts du pays.

L'évaluation des principaux indicateurs de compétitivité du Maroc montre que, malgré les efforts des différents acteurs et en dépit de certaines réussites ponctuelles ou sectorielles, le pays n'arrive pas encore à atteindre le niveau adéquat pour affronter la concurrence mondiale et ce, en raison de la persistance de plusieurs handicaps structurels.

Si la diplomatie économique n'arrive pas à réaliser les objectifs fixés, il serait légitime alors de poser la question quant aux raisons derrière cet échec. A notre sens, les points suivants représentent autant de réponses possibles :

- Les enjeux économiques ne sont pas le seul objectif de la diplomatie économique. Des considérations géopolitiques peuvent rentrer en jeu pour expliquer le choix de certains pays ou certaines régions du monde comme partenaires.
- Les limites citées précédemment concernant la pratique de la diplomatie économique marocaine. L'évaluation de la pratique actuelle de la diplomatie économique fait apparaître l'ampleur des réformes qu'il convient de réaliser au regard des expériences des pays émergents.
- La réussite de la diplomatie économique est relative à d'autres points dont notamment le développement de l'offre exportable et l'amélioration de la valeur ajoutée nationale des exportations marocaines.

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Étude comparative entre le système goutte à goutte de surface et le système enterré pour l'irrigation d'une culture de pomme de terre

[Comparative study between surface and subsurface drip irrigation systems: Case of potato crop]

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ABSTRACT: Subsurface irrigation system is one of promising techniques for better valorization of water irrigation particularly in arid and semi-arid regions. This irrigation system is characterized by low, frequent and localized water supplies within the root zone. Researchers conducted in relation to subsurface irrigation are unanimous about its several benefits, which explain its rapid expansion across the world. However, its implementation in Tunisia is still very limited. In order to identify the performance of subsurface irrigation system (SDI) under arid conditions of southern Tunisia, a comparative experimental study (between this system and the drip irrigation system (DI)) was conducted within the experimental station of the Institute of Arid Regions-Chenchou (Gabes), in a potato plot. The experimental protocol consisted of eight treatments:
a)- Two treatments with the DI system : T1 (q = 4 l/h) and T2 (q = 2 l/h).
b)- Six treatments with the SDI system: emitters of different flow rates (4 l/h and 2 l/h) and laterals buried at three depths (10 cm, 15 cm and 20 cm) .
Results show that water content within the root zone was always higher under SDI system and that its fluctuation is especially more restricted than that recorded under DI system. This could explain high irrigation efficiency values recorded with SDI treatments where laterals buried at 15 cm depth's have generated the highest water productivity. However, for laterals buried at 20 cm depth's and with emitters delivering 4 l/h, deep water percolation is more evident. Nevertheless, these results obtained during a single season, are still preliminary and could not be so reliable in order to give suitable recommendations on the appropriateness of this irrigation technique, but support to carry on these trials under other conditions (other soil types, different crops and other climates) of Tunisia.

KEYWORDS: Drip irrigation, Subsurface irrigation, Water efficiency.

RESUME: Le système d'irrigation localisée enterrée (ou Sub-irrigation) est une des techniques prometteuses pour une meilleure valorisation de l'eau d'irrigation particulièrement dans les régions arides et semi-arides. Ce système est caractérisé par des apports d'eau faibles, fréquents et localisés au niveau de la zone racinaire. Les travaux de recherche menés dans ce sens sont unanimes quant aux avantages multiples de ce système d'irrigation, ce qui explique son extension rapide à travers le monde. Toutefois, sa mise en application en Tunisie est encore très limitée. Dans le but de dégager les performances du système d'irrigation localisée enterrée (SDI) dans les conditions arides du sud tunisien, une étude expérimentale comparative

(entre ce système et la technique d'irrigation goutte à goutte de surface (DI)) a été réalisée à la station expérimentale de l'Institut des Régions Arides à Chenchou (Gabès), dans une parcelle de pomme de terre d'arrière-saison.
Le protocole expérimental comprenait huit traitements:
a)-Deux traitements avec le système DI : T1 (q = 4 l/h) et T2 (q = 2 l/h).
b)-Six traitements avec le système SDI : Des goutteurs de débits différents (4 l/h et 2 l/h) et pour trois profondeurs d'emplacement des rampes (10 cm, 15 cm et 20 cm).
Les résultats montrent que la teneur en eau dans la zone racinaire était toujours plus élevée sous le système SDI et surtout fluctue dans un intervalle plus restreint que celui enregistré sous le système DI. Ce qui pourrait expliquer entre autres les valeurs élevées de l'efficience de l'eau d'irrigation enregistrée avec les traitements SDI où les rampes enterrées à 15 cm ont engendré les meilleures productivités de l'eau. Mais, pour les rampes enterrées à 20 cm avec des goutteurs de 4 l/h, les risques de pertes par percolation sont plus évidents.
Toutefois, ces résultats obtenus à la suite d'une seule campagne agricole sont encore préliminaires et ne pourraient pas être si fiables pour pouvoir décerner des recommandations quant à l'opportunité de cette technique d'irrigation, mais incitent à poursuivre ces essais dans d'autres conditions (autres types de sol, différentes cultures et autres climats) de la Tunisie.

MOTS-CLEFS: Irrigation goutte à goutte, Irrigation localisée enterrée, Efficience de l'eau.

1 INTRODUCTION

L'agriculture irriguée en Tunisie est le secteur le plus consommateur d'eau. Le volume alloué à ce secteur représente plus de 80% du potentiel total mobilisé dont les ressources sont d'ailleurs très limitées [7]. Les régions du sud sont particulièrement les plus touchées par la rareté des ressources en eau dont la plupart sont fossiles donc non renouvelables et où l'exploitation est de nature à intensifier la baisse piézométrique et à en accentuer la salinisation [8]. Dans de telles circonstances, l'extension des techniques d'économie d'eau pour la sauvegarde du patrimoine irrigué est plutôt une nécessité. Le système d'irrigation localisée enterrée (SDI) est une des techniques prometteuses pour une meilleure valorisation de l'eau en irrigation. Les résultats de la majorité des travaux de recherche sont unanimes quant aux avantages multiples de cette technique: localisation des apports d'eau, réduction substantielle des pertes par évaporation et par percolation profonde, limite des risques de salinisation par évapo-concentration, amélioration des rendements des cultures.

Camp [1] a montré que, pour plus de 30 cultures, le système (SDI) permet d'obtenir des rendements supérieurs ou du moins égaux à ceux obtenus avec l'irrigation localisée de surface (DI). Selon Lamm et al. [6], avec un système SDI bien conçu, on peut diminuer les apports en eau d'une culture de maïs d'environ 25%, tout en conservant le même niveau du rendement. A la suite d'une étude expérimentale comparative entre les systèmes SDI et DI, Neelam et al. [10] ont montré que le rendement d'une culture de pomme de terre était meilleur sous SDI pour les trois ans d'essai. Une économie en eau d'environ 10%, a été enregistrée avec une culture de maïs irrigué par le système SDI enterré à 30 cm [13]. De même, Douh et al. [2] ont enregistré, outre une économie d'eau d'environ 11,4%, une amélioration de 22,8% du rendement du maïs irrigué en faveur du SDI comparé à DI. A la suite d'une étude expérimentale similaire, Sakellariou et al. [12] ont aussi reporté une économie d'eau de 16,6% et une amélioration du rendement de 22,2% d'une culture de canne à sucre en faveur du système SDI. Par ce travail, on projette évaluer l'opportunité du système SDI dans les conditions du sud tunisien à travers une étude expérimentale comparative avec le système DI pour l'irrigation d'une culture de pomme de terre d'arrière-saison.

2 MATÉRIEL ET MÉTHODES

2.1 SITE

L'expérimentation a été réalisée à la station expérimentale de l'Institut des Régions Arides à Chenchou (Gabès) dont les coordonnées géographiques : latitude = 33,88° Nord; longitude =9,79° Est. Elle est à une altitude de 59 m où la température moyenne varie entre 5,4°C et 35,2°C. La pluviométrie moyenne annuelle y est de 162 mm alors que l'ETP est de 1430 mm [11]. Ce grand écart entre les précipitations et la demande en eau des cultures fait de l'irrigation une nécessité plutôt qu'un choix pour la sauvegarde des activités agricoles. Les essais ont été conduits (du 25 /09/2012 au 05/01/2013) sur une culture de pomme de terre d'arrière-saison, variété Spunta, plantée à une densité de plantation de 0,80m x 0,40m. Pour la caractérisation physique du sol, des échantillons dans quatre couches (0-20, 20-40, 40-60 et 60-80 cm), à raison de quatre échantillons par couche, ont été prélevés. Ces prélèvements ont été répétés dans quatre profils répartis au hasard dans la parcelle dans le but de mettre en exergue la plus ou moins variabilité spatiale de certaines propriétés du sol. Les analyses ont porté sur les caractéristiques qui importent surtout pour le pilotage des irrigations et le suivi du stock d'eau dans le sol, à

savoir : texture, densité apparente Da et les teneurs en eau respectivement à la capacité au champ Θc, au point de flétrissement Θf et à la saturation Θs.

2.2 DISPOSITIF EXPÉRIMENTAL

La parcelle d'essais d'une superficie de 0,72 ha, a été subdivisée en huit blocs où deux traitements ont été conduits :

- Irrigation goutte à goutte de surface (DI)
- Irrigation localisée souterraine (SDI)

Huit sous-traitements ont été distingués :

- Deux pour le système DI où deux débits différents : 2,0 et 4,0 l/h (les plus communément utilisés) ont été appliqués
- Six pour le système SDI où deux débits différents (2,0 et 4,0 l/h) et trois profondeurs d'enterrement des rampes ont été appliqués (Tableau 1). Les profondeurs d'enfouissement des rampes SDI ont été fixées tenant compte des résultats de Neelam et al. [10] obtenus avec une culture de pomme de terre.

Chaque bloc, de 9 lignes de culture (de longueur 86 m, et écartement 0,80 m), a été subdivisé en trois sous-blocs où ont eu lieu les répétitions des prélèvements et des mesures. La station de tête est commune pour les deux systèmes et comporte un filtre à gravier, un filtre à disque, un injecteur d'engrais, un compteur et trois manomètres de pression (Fig. 1).

Tableau 1. Description des traitements

Traitements	Technique d'irrigation	Débit	Profondeur d'enterrement des rampes
T1	DI	q = 4 l/h	Surface
T2	DI	q = 2 l/h	Surface
T3	SDI	q = 4 l/h	10cm
T4	SDI	q = 2 l/h	10cm
T5	SDI	q = 2 l/h	20 cm
T6	SDI	q = 2 l/h	15 cm
T7	SDI	q = 4 l/h	15 cm
T8	SDI	q = 4 l/h	20 cm

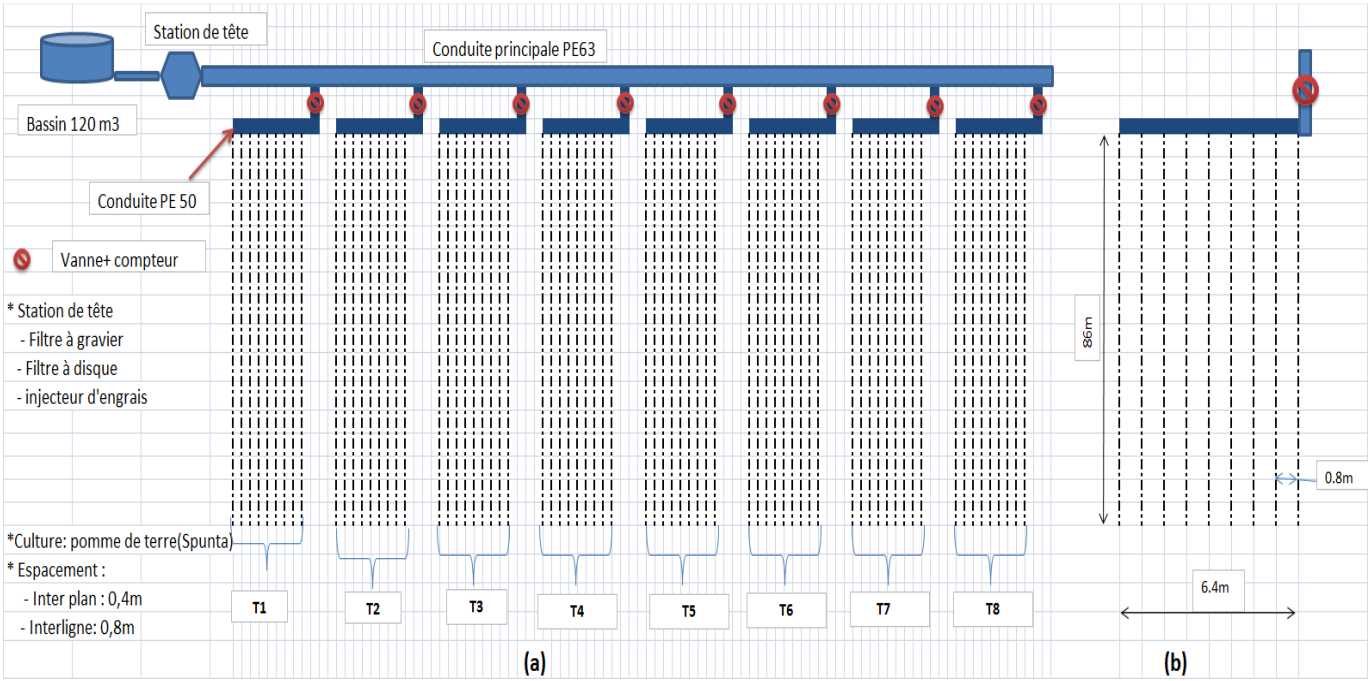

Fig.1. Schéma du dispositif expérimental: pour toute la parcelle (a) et au niveau du bloc (b).

2.3 MÉTHODES

Les critères de comparaison retenus étaient :

2.3.1 EVOLUTION DES RÉSERVES EN EAU DANS LE PROFIL RACINAIRE

Les réserves utiles en eau dans le sol constituent le stock à partir duquel s'alimentent les plantes. Le volume de sol contribuant à ces réserves, correspond à celui prospecté par les racines (60 cm pour la pomme de terre au stade adulte [3]). A tout instant (t) ce stock est donné par:

$$S(t) = \iiint \quad \Theta(x,y,z,t)\, dxdydz \qquad (1)$$

Etant donné la difficulté de déterminer l'expression analytique décrivant l'évolution spatio-temporelle de la teneur en eau dans le sol Θ(t,x,y,z), l'équation (1) est souvent résolue par approximation des opérateurs différentiels par des différences finies:

$$S(t) = \sum_j \sum_k \sum_l \Theta(t)\Delta x_i \Delta y_j \Delta z_k \qquad (2)$$

Cette approximation est d'autant précise que les pas d'espace $\Delta x_i, \Delta y_j, \Delta z_k$ sont réduits. A cette fin, le domaine racinaire a été subdivisé virtuellement en volumes élémentaires V_e aux centres desquels la valeur de Θ(t) a été déterminée à l'aide d'un TDR (Time Domain Reflectometry). A tout moment la valeur de Θ, en tout point de ces volumes élémentaire V_e, était supposée uniforme égale à celle mesurée au centre de chacun de ces volumes. V_e = Δx.Δy.Δz. Où Δx = 20 cm, Δy= 16 cm et Δz = 20 cm (Fig. 2). Dans chaque sous bloc, ces mesures ont été réalisées avant et après irrigation en trois sites (au début, au milieu et à la fin de la ligne médiane) où 3 tubes d'accès ont été installés. Seule la moyenne des trois lectures a été considérée. A tout moment, le stock d'eau est par suite déterminé par:

$$S(t) = \sum_{i=1}^{3} \sum_{j=1}^{3} \sum_{k=1}^{4} \Theta(t)\Delta x_i \Delta y_j \Delta z_k \ (3)$$

Etant donné la haute densité des goutteurs (distants de 40cm) sur la rampe, le domaine humecté est en fait la somme des bandes où l'humidité varie peu le long de chacune de ces bandes. L'évolution du stock par bande est par suite ramené à :

$$S(t) = Lr. \sum_{j=1}^{3} \sum_{k=1}^{4} \Theta(t)\Delta y_j \Delta z_k (4)$$

Lr=Longueur de la rampe.

Ce qui permet de suivre l'évolution du stock dans chaque bloc et par suite en déduire l'efficience d'irrigation à chaque apport.

2.3.2 EFFICIENCE DE L'IRRIGATION

Pour chaque traitement et à chaque apport, l'efficience d'irrigation est déterminée par:

$$E_c = \frac{S_f - S_i}{V_a}$$

Où, S_i et S_f stocks en eau dans le profil enraciné déterminés respectivement avant et après chaque irrigation.

V_a = volume appliqué mesuré par compteur placé en tête du block (Fig. 2).

La fréquence et le volume des apports ont été déterminés par calcul des besoins en eau de la culture ETc moyennant des ajustements en fonction du stock enregistré au début de chaque irrigation.

$$ET_c = K_c.ET_o$$

Où,

ET_c = évapotranspiration de la culture (mm/j).

K_c = Coefficient cultural (adimensionnel) dont les valeurs sont définies pour les différents stades de la pomme de terre [3].

ET_o = évapotranspiration de référence (mm/j) déterminée par la méthode de Penman-Monteith (F.A.O, 1998). Les données climatiques nécessaires sont prélevées de la station météorologique de la Société Zina Fresh (à 500 m du site d'essai).

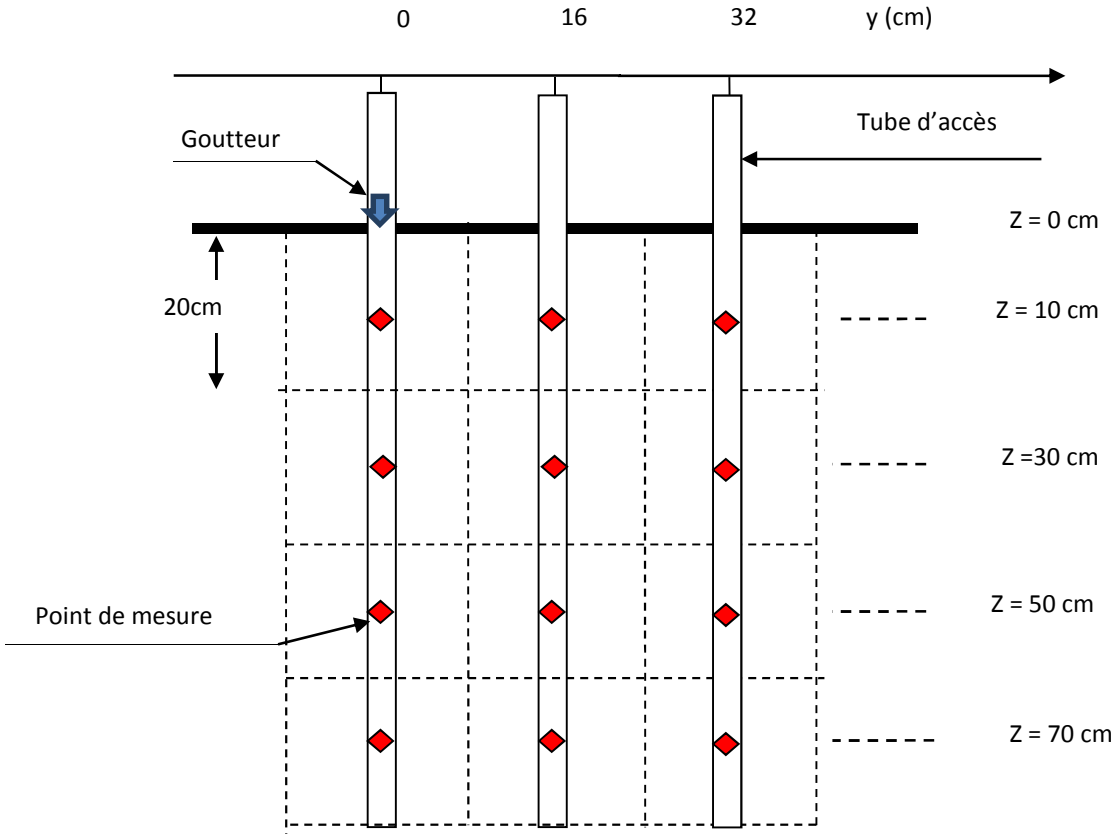

Fig.2. Représentation des points de mesure (avec les mailles de calcul correspondantes) dans le profil du sol au niveau de chaque site.

2.3.3 RENDEMENT

Trois paramètres ont été retenus pour évaluer le rendement obtenu avec chaque traitement:

- Longueur et diamètre moyens des tiges
- Le nombre moyen de tubercules
- Le poids moyen par tubercule où cinq calibres ont été distingués [15]: C1 < 50 g, 50 g ≤ C2< 100 g , 100 g ≤ C3< 200 g, 200 g ≤ C4< 300g et C5 ≥ 300 g. Ce classement a été adopté surtout pour mettre en evidence la part du produit commercialisable (C2 + C3 + C4 + C5) de la production totale obtenue [14], [15].

A cette fin, cinq plantes ont été choisies, au hasard dans chacune des lignes (la médiane et les deux avant extrêmes) dans chaque sous-bloc (soit au total 45 plantes par bloc), où les paramètres ci-dessus ont été déterminés. Par souci de fiabilité des résultats, seule la moyenne des cinq prélèvements a été à chaque fois considérée. Par suite, une analyse statistique des données a été réalisée par le modèle statistique SPSS et le test Student-Newman-Keuls au seuil de signification 5% .

3 RESULTATS ET DISCUSSIONS

3.1 CARACTÉRISATION DU SOL

Les valeurs moyennes des caractéristiques physiques du sol, sont récapitulées dans le Tableau 2 qui montre que la texture est limoneuse fine à très fine en profondeur, où les proportions d'argile et de limon sont relativement équilibrées. Alors que la proportion de sable diminue d'une façon prononcée jusqu'à 60 cm. La faible fluctuation de la densité apparente (de l'ordre de 3,4 % par rapport à la moyenne) et des humidités caractéristiques (surtout Θ_c et Θ_s) confirme cette texture équilibrée sur toute la profondeur prospectée. Ce qui reflète aussi une capacité de rétention moyenne (de l'ordre de 100 mm/m).

Tableau 2. Caractéristiques physiques du sol

Couches	Sable (%)	Limon (%)	Argile (%)	D_a (g/cm^3)	Θ_c	Θ_f	Θ_s
0-20 cm	22	73	5	1,56	19,3	10,5	38,5
20-40cm	19	77	4	1,62	21,4	10,1	36,3
40-60cm	11	85	4	1,62	18,7	8,8	37,4
60-80cm	17	80	3	1,53	17,2	7,4	42,2

3.2 EVOLUTION DE L'HUMIDITÉ DANS LE PROFIL DES RACINES

La figure 3 reproduit l'évolution de la teneur moyenne en eau dans le profil racinaire sous les différents traitements au cours de la saison d'irrigation.

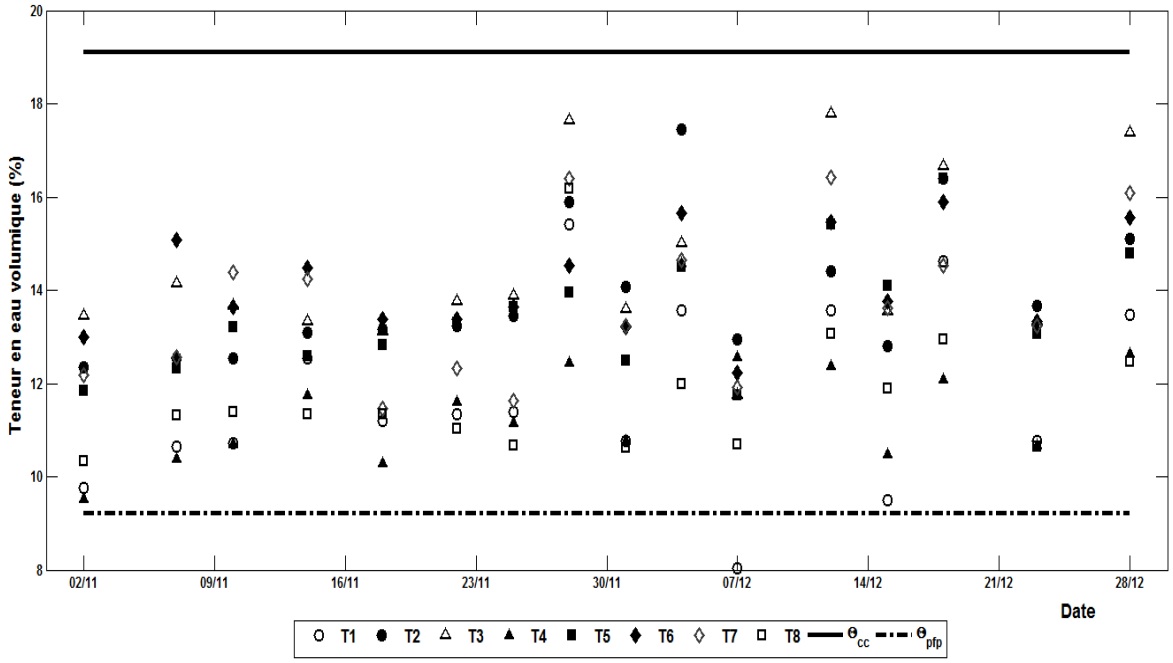

Fig.3. Variation de la teneur moyenne en eau dans les couches enracinées sous les différents traitements au cours de la saison d'irrigation.

Pour tous les traitements, la teneur en eau (Θ) dans les couches enracinées était maintenue dans un intervalle tolérable par la culture (comprise entre les valeurs critiques Θ_c et Θ_f).Toutefois, sa fluctuation était en général plus restreinte et maintenue dans une gamme plus élevée sous les traitements SDI tout au long du cycle. En fait, elle variait dans les intervalles : [13,2% ; 17,7%], [11,8% ; 16,4%], [12,4% ; 15,9%] et [11,5% ; 16,3%], respectivement pour les traitements T3, T5, T6 et T7, sauf pour les traitements T4 et T8 où Θ était aussi maintenue dans un intervalle restreint mais à un niveau d'humidité relativement plus faible respectivement [10,4% ; 12,8%] et [10,5% ; 13,2%]. Ceci pourrait être expliqué par les pertes plus perceptibles par évaporation à la surface pour T4 (où les rampes étaient enterrées à faible profondeur 10 cm) et celles par percolation au-delà des couches enracinées pour T8 puisque les rampes étaient plus profondes (enterrées à 20 cm) et assurant un débit fort (4 l/h). Alors que sous les traitements DI, les valeurs de Θ enregistrées étaient comprises dans les intervalles [09,8% ; 15,4%] et [12,3% ; 17,5%] respectivement pour T1 et T2. Soit des marges de fluctuation moyenne respectivement de $\Delta\Theta \approx 3{,}75\%$ et $\Delta\Theta \approx 5{,}40\%$ sous les traitements SDI et DI. Certes, cet avantage est à l'origine de l'amélioration du rendement des cultures irriguées par le système SDI. Ces résultats confirment l'approche de Hammami et al. [4] qui stipule que le système SDI offre l'opportunité de maintenir l'humidité dans la zone des racines dans une marge très restreinte fonction de la nature du sol. Kandelous et Simunek [5] rapportent que la redistribution de l'eau dans le sol est fortement affectée par les propriétés physiques du sol, par la profondeur de la rampe, le débit et l'écartement des goutteurs.

3.3 DÉVELOPPEMENT VÉGÉTATIF

La longueur et le diamètre moyens (de 45 plantes) mesurés à la fin du cycle végétatif pour les différents traitements sont récapitulés au tableau 3.

Tableau 3. Diamètre et longueur de la tige à la fin du cycle cultural

Traitements	Longueur moyenne de la tige (cm)	Diamètre moyen de la tige (cm)
T1	58,55a	1,144 a
T2	57,58a	1,224 ab
T3	60,26a	1,216 ab
T4	60,00a	1,182 ab
T5	58,44a	1,271b
T6	60,20a	1,267b
T7	58,66a	1,227 ab
T8	60,22a	1,254b

Les comparaisons des longueurs des tiges entre traitements, moyennant le test de Student Newman Keuls (SNK), a révélé que les différences n'étaient pas significatives au seuil 5%. Donc, il n'ya pas un effet traitement sur la croissance de la tige de la pomme de terre. Par contre, pour la croissance des diamètres des tiges, les différences étaient significatives au seuil 5%. Les diamètres les plus épais (1,27 ; 1,27 et 1,25 cm) correspondaient respectivement aux traitements T5, T6 et T8.

3.4 RENDEMENTS

3.4.1 RENDEMENT PAR PLANTE

Le tableau 4 récapitule la production moyenne (de 45 plantes) par plante, enregistrée pour chaque traitement.

Tableau 4. Rendement par plante

Traitements	Nombre moyen de tubercules	Poids moyen par tubercule (kg)
T1	7,36a	0,872 a
T2	7,36a	0,943 a
T3	5,98a	0,845 a
T4	6,78a	0,864 a
T5	6,24a	0,852 a
T6	6,64a	0,926bc
T7	6,47a	0,978 c
T8	6,13a	0,879c

Moyennant le test SNK au seuil 5%, la comparaison des nombres de tubercules obtenus, a révélé des différences non significatives entre tous les traitements. Donc, il n'ya pas un effet traitement sur le nombre de tubercules récoltés par plante. Par contre, l'effet traitement était nettement significatif sur le poids moyen des tubercules. Les poids les plus élevés ont été enregistrés avec les traitements SDI, à savoir T6, T7 et T8. Donc, le système SDI permet d'augmenter le rendement de la pomme de terre à travers l'augmentation du calibre des tubercules.

3.4.2 PRODUCTIONS TOTALES ET COMMERCIALISABLES

Les productions moyennes totales obtenues avec chaque traitement sont présentées au Tableau 5. Les meilleurs rendements sont enregistrés respectivement avec les traitements T7, T2 et T6 qui se distinguent (des autres traitements) significativement au seuil de 1%. Les autres traitements engendrent pratiquement le même rendement avec un risque d'erreur de l'ordre de 4%. Puisque la récolte de pomme de terre d'arrière-saison a lieu pendant une période où les opportunités d'exportation sont fréquentes, on a cherché à distinguer la part du rendement qui pourrait être facilement liquidée en se basant sur la classification (Tableau 6) par calibre adoptée par Xiao et al.[15]**.** A l'instar du rendement total, les traitements T7, T6 et T2 offrent l'opportunité d'avoir une proportion commercialisable la plus élevée avec une distinction nette pour le traitement T7. Donc, le système SDI (enterré à 15 cm) engendre, non seulement le meilleur rendement, mais offre aussi l'opportunité de liquider au meilleur prix la majorité de la production.

Tableau 5. Rendements total et commercialisable

Traitements	Rendement (T/ha)	Rendement commercialisable (T/ha)
T1	27,25a	25,92a
T2	29,47b	27,88b
T3	26,42a	25,44a
T4	26,99a	25,78a
T5	26,63a	25,67a
T6	28,95b	27,99b
T7	30,55c	29,37c
T8	27,46b	26,43b

Tableau 6. Rendement par calibre

Traitements	Poids<50g	50g ≤Poids<100g	100g ≤Poids<200g	200g ≤Poids<300g	Poids≥300g	Poids≥50g
T1	1,92	6,48	19,15	8,57	3,12	37,32
T2	2,3	5,55	17	13,23	4,36	**40,14**
T3	1,41	3	18,49	11,53	3,62	36,64
T4	1,72	4,5	17,57	9,19	5,86	37,12
T5	1,38	4,74	17,62	8,6	6	36,96
T6	1,39	5,59	15,69	11,49	7,53	**40,3**
T7	1,67	3,24	15,06	16,53	7,46	**42,29**
T8	1,48	4,14	14,48	11,39	8,05	38,06

3.5 EFFICIENCE DE L'IRRIGATION

Hormis le traitement T1, l'efficience de l'irrigation (E_c) est dans tous les cas bonne (Tableau 7). Mais avec les traitements SDI surtout T6 et T7 se distinguent par des efficiences excellentes. Les valeurs relativement faibles enregistrées avec les traitements T5 et T8 pourraient être imputées aux éventuelles pertes par infiltration au-delà des couches prospectées puisque les rampes étaient plus profondes (enterrées à 20 cm) d'autant plus que le sol est d'une texture limono-sableuse (Tableau 8). Ces résultats corroborent les données de la Figure 3. Neelam and Rajput [9] ont obtenu le meilleur rendement (25,7 t/ha) pour une culture d'oignon avec des rampes SDI enterrées à 10 cm. Selon ces auteurs, les pertes par infiltration profonde étaient significatives pour des rampes enterrées à 20 cm et maximales avec celles enterrées à 30 cm.

Tableau 7. Efficience de l'irrigation

Traitements	T1	T2	T3	T4	T5	T6	T7	T8
Efficience (%)	62	85	84	83	77	87	90	78

Tableau 8. Productivité et marge brute de l'eau

Traitements	ETR (m^3/ha)	Rendement (T/ha)	Marge brute (DT/ha)	Productivité (DT/m^3)
T1	242,82	25,92	18142	4,6
T2	205,38	**27,88**	**19513**	**5,9**
T3	209,42	25,44	17811	5,3
T4	219,89	25,78	18044	5,1
T5	210,37	25,67	17967	5,3
T6	203,67	**27,99**	**19590**	**6,0**
T7	204,34	**29,37**	**20558**	**6,2**
T8	223,17	26,43	21144	5,1

4 CONCLUSION

L'objectif de ce travail est d'évaluer les performances de l'irrigation localisée souterraine, en conditions arides du sud Tunisien. Cette évaluation a été basée sur la comparaison de l'efficience de l'eau d'irrigation enregistrée avec les systèmes SDI et DI pour l'arrosage d'une culture de pomme de terre d'arrière-saison.

Les résultats montrent que la teneur en eau dans la zone racinaire était toujours plus élevée sous le système SDI avec un intervalle de fluctuation plus faible que celui enregistré sous le système DI. Ce qui pourrait expliquer entre autres la valeur plus élevée de l'efficience de l'eau d'irrigation enregistrée avec le système SDI enterrée à 15 cm. Mais, pour les rampes enterrées à 20 cm avec des goutteurs de 4 l/h, les risques de pertes par percolation sont prépondérants.

Les meilleures efficiences de l'eau d'irrigation sont enregistrées avec les traitements T7 et T6 soit respectivement 8,74 et 8,28 Kg /m^3. Le système SDI avec des rampes enterrées à 15 cm portant des goutteurs de 2 ou 4 l/h a engendré une amélioration nette du rendement de la pomme de terre dans les conditions du sud Tunisien. Ces résultats incitent à poursuivre ces essais dans d'autres conditions (autres types de sol, différentes cultures et autres conditions climatiques) en vue d'une meilleure valorisation de nos ressources en eau si limitées.

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Degradation of Siachen Glacier in the Context of Volumetric Decrease in Siachen, Baltoro and Biafo Glaciers of Pakistan

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ABSTRACT: The glaciers of the Hindukush-Karakoram-Himalayan (HKH) region consist of a huge amount of perpetual snow and ice. These glaciers are retreating in the face of accelerating global warming. Estimation of volumetric decrease of Siachen glacier out of Shyok river basin and that of Baltoro and Biafo Glaciers out of Shiger river basin is carried out in this study using Remote sensing satellite and Topographic data.

The total geographic area of the river basins in northern areas is about 128,730 km2. Altogether, 5,218 large and small glaciers in northern areas cover a total glaciated area of about 15,040 km2. The total ice reserves in HKH region of Pakistan are about 2,738 km3. The Hunza, Shyok and Shigar basins contain the major part (about 83%) of these ice reserves.

Alpine glaciers are subjected to volumetric decrease owing to host of factors. This study presents the volumetric decrease computations during the decade of 1990-2000 of largest glaciers of northern areas of Pakistan. The results computed through study are there after compared with mathematical model of ice reserves and ice thickness which supplements their validity. Finally the correlation of volumetric decrease of these glaciers with average temperature rise of northern areas and sea level rise along coastline of Pakistan during the last decade is carried out.

The percentage volumetric decrease of Siachen, Baltoro and Biafo and glaciers during the decade, computed in this study work, subjected to manifest of global warming and anthropogenic activities indicates that three out of world's seven largest glaciers have experienced a volume loss of 11.09, 6.14% and 3.79% respectively during the decade of 1990-2000.

KEYWORDS: Siachen Glacier, Volumetric Decrease, Baltoro and Biafo Glaciers, Pakistan.

1 INTRODUCTION

The glaciers are nature's renewable storehouse of fresh water that benefits hundreds of millions of people downstream. The glaciers of the Hindukush - Karakorum - Himalaya (HKH) region, however, are retreating in the face of accelerated global warming since the second half of the 20th century and have contributed to the formation of many glacial lakes on the recent glacier terminus (Mool et al., 2001). Rapid accumulation of water in these lakes can lead to sudden breaching of the unstable moraine dams discharging huge amounts of water and debris causing loss of life, property and the destruction of valuable forest and pasture resources, farmlands, and costly mountain infrastructures downstream. Some glaciers are reported to have created long-term secondary environmental degradation physically and socio-economically, both locally and in neighboring downstream countries (Nurkadilov et al., 1986). Glaciers retreat is recognized to be a common phenomenon in the Hindukush - Himalayan countries such as Bhutan, China, India, Nepal and Pakistan.

A major part of the snow and ice mass of the Pakistan's HKH region is concentrated in the watershed of the Indus basin. This watershed can be divided into distinct river basins. The study is carried out in two river basins of HKH region of the country in two phases. In the first phase the volumetric decrease of Siachen, Baltoro and Biafo glaciers was estimated. In the second phase quantitative correlation with average temperature rise in northern areas and sea surface rise along the coast line of Pakistan during the last decade was analyzed and discussed.

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The total geographic area of northern Pakistan is about 128,730 km^2. Altogether 5,218 glaciers were identified which cover a total glaciated area of about 15,040 km^2 (about 11.7% of the total geographic area of the basins). These glaciers contribute total ice reserves of about 2,738 km^3. The Shyok, Shyok and Shigar basins contain the major part (about 83%) of these ice reserves.

Accurate and comprehensive knowledge of glaciers is of utmost importance for water resource management. A digital repository of valuable knowledge on glaciers can enhance the ability to inform policy makers on the vulnerability, risk mitigation and action/adaptation measures. Specifically for Pakistan where irrigation network of the country is heavily dependent on the snow melt in summer, this information on one hand can serve to plan the agricultural activities downstream according to the ice reserves available and the prevailing climate and on the other it can provide a basis for future climate change / global warming studies.

The northern and western parts of Pakistan are mountainous regions, where all the land is in the form of rugged terrain including mountains and hills. Generally, the northern mountainous slopes are steep and the region is vulnerable to landslide and river erosion due to great elevation differences, and fragile geological conditions. In addition, the watersheds of the region are covered by some major glaciers, which are quite susceptible to disastrous outbreak / flooding hazards. In general, snow clad line is found above 5,300 meters above sea level. The glaciers, some of which consist of a huge amount of perpetual snow and ice, are found to retreat at a faster pace than ever during the last 50 years. In Pakistan these glaciers are the sources of the headwaters of Indus River, thus are a precious natural asset for the country.

1.1 GEOMORPHOLOGY

High mountains of Pakistan comprise the western end of 2,400 km long Himalayan range and some parts in the Hindukush and Karakoram ranges stretching over the province of Khyber Pakhtunkhwa and the northern areas. Northern areas spread over 72,496 km^2 with a midst towering snow-clad peaks having heights varying from nearly 1,000 to over 8,000 meters above sea level. OUt of the 14 over 8,000 m peaks on earth, 4 occupy an amphitheater at the head of Baltoro glacier in the Karakoram Range. These are: K-2 (Mount Godwin Austen) which is 8,611 m and is world second highest peak, Gasherbrum-I (8,068 m), Broad Peak (8,047 m) and Gasherbrum II (8,035 m). There is yet another peak which is equally great, that is, Nanga Parbat (8,126 m) at the western most end of the Himalayas and is rated as world's 8^{th} highest peak. In addition to these, there are 68 peaks over 7,000 m and hundreds which are over 6,000 m high. Generally, because of their rugged topography and the rigors of the climate, the northern highlands and the Himalayas to the east have been formidable barriers to movement into Pakistan throughout history. There are though several famous passes like Khyber, Kurrum, Tochi, Gomal, Lowari and Khunjerab, which have been used historically as trade routes.

The northern Pakistan has some of the longest glaciers outside polar region like Siachen (76 km), Hispar (61 km), Biafo (62 km), Baltoro (59 km), Batura (64 km), Yenguta (35 km), Chiantar (34 km), Trich (29 km) and Atrak (28 km). The lower Himalayan valleys of Swat, Kaghan and Chitral in the Hindukush range equally share the beauty and diverse culture of the northern Pakistan. The HKH region in Pakistan house many gorgeous lakes especially like Saif-ul-Maluk, Satpara and Kachura.

The lower mountain ranges in the northeast receive high monsoon rainfall in summer and snow precipitation during winter. The forest cover is dense in this mountain region. The high northern and northwestern areas are out of monsoon reach so the climate is dry and precipitation occurs only due to cyclonic depressions moving in from the west during spring and summer. Three out of seven world's largest glaciers are present in the northern areas of Pakistan making its geographic location prime in the region.

1.2 CLIMATE

Pakistan is basically a dry country of the warm temperate zone. The climate of the area is transitional between that of central Asia and the monsoonal region of south Asia, which varies considerably with latitude, altitude, aspect and local relief. There is not only high spatial variability but temporal variability is quite high as well. Except for a small strip of sub-tropical terrain in Punjab and the wet zone on the southern slopes of the Himalayan and Karakoram mountain ranges, most of the country is arid or semi-arid steppe land.

There are two distinct rainy periods, one in summer and one in winter. The monsoon rainfall is extensive in period from July to September. The winter is dominated by the westerly fronts originating from Mediterranean region. In the north of the country, most of the precipitation is not only derived from the Indian monsoon but from depressions moving in from the west during the spring and summer as well. The winter snow, glaciers and snowfields start melting from April and continue till July when monsoon sets in.

The snowmelt run-off constitutes a substantial part of water resources of the rivers of Pakistan. The Indus River, primarily supplied by glaciers in its upper reaches, and subject to the least seasonal variation, still has a maximum flow more than fifty times its minimum. The Indus basin irrigation network in Pakistan stretches over an area of 14 M ha (Asim et al., 2002). The network has three major reservoirs (Tarbela, Mangla and Chashma), 19 barrages or headworks, 12 link canals and 43 canal commands.

Five main rivers, namely, the Indus, Jhelum, Chenab, Ravi and Sutlej flow through the country's plains. Aided by a number of smaller tributary rivers and streams, these rivers supply water to the entire Indus Basin Irrigation System (IBIS), which forms the world's largest contiguous irrigation system. Alpine glaciers contribute 50 % of the Indus water flow. The Indus River is about 2,800 km long and 62% of its catchment lies in Pakistan (Shafique and Skogerboe, 1984). Indus system receives a number of tributaries from the west: Kabul, Kurram, Tochi and the Gomal Rivers. The eastern tributaries are Jhelum, Ravi and Sutlej. The five major rivers combine at Panjnad. The swelling of Indus and its tributaries is subjected to volumetric decrease of glaciers and if coupled with heavy monsoonal rains, can cause floods during summer.

1.3 HYDROMETEOROLOGY

The hydro meteorological cycle forms a link between two great natural reservoirs, the snow and glaciers in the mountains and the groundwater contained in the aquifers in the plains of Pakistan.

1.3.1 GLACIATED RIVER BASINS OF PAKISTAN

For hydrological studies, Pakistan's northern area is divided into 10 major river basins (Figure 1.1). Clockwise from west, these basins are of Swat River, Chitral River, Gilgit River, Hunza River, Shigar River, Shyok River, Indus River, Shingo River, Astor River, and the Jhelum River. Most of the snow and ice reserves are concentrated in the mountain ranges lying in these basins. These river basins contain glaciated part of northern Pakistan, which forms headwaters of the main Indus basin.

The tributary rivers also have their origin in the Himalayas and derive their flows mainly from snowmelt and monsoon rains. Snowfall at higher altitudes (above 2,500 m) accounts for most of the river runoff. The active hydrological zone lies between 2,500 and 5,500 m, and snowfall in the mountains accounts for a large portion of the total runoff into the river (PSIHP, 1991). Within this zone, snow and glacial melt contribute towards river runoff from March to September. In the upper Indus catchments, the snow line is at an elevation of 5,500 m; above this elevation it's the process of snow accumulation that dominates rather than melting of snow even during the summer months.

Figure 1.1: Glaciated river basins of northern Pakistan, a major source of Indus river outflow in Arabian sea.

The snow and ice melt from the glacial area of the upper Indus catchment supply approximately 80% of the total flow of the Indus River in the summer season. Snowmelt accounts for more than 50% of the flow in the Jhelum River but it is much more dependent than the Indus River for variable monsoon runoff. Since the Chenab River rises at higher altitudes, snowmelt accounts for a considerable proportion of its runoff.

1.3.2 SHYOK RIVER BASIN

The Shyok River basin actually forms the sub basin of the Gilgit River but due to its considerable size and importance it is considered as a separate basin. The river drains the Karakoram Mountains comprising of large glaciated area in the north.

The Karakoram highway linking Pakistan to China passes across this basin. Part of the road runs along Shyok River and ends near Khunjerab Pass.

The tributaries joining the Shyok River are Chabursan, Khunjerab, Ghujerab, and Shunsha River. The basin comprises of major valleys and hanging glaciers on the high Karakoram Range. Karimabad, the capital of the Shyok valley, is stretched over miles and miles of terraced fields and fruit orchards. It offers a panoramic view of the Rakaposhi, Ultar and Balimo peaks.

Gulmit is shining white and deeply crevassed - just as you would expect a glacier to look. Above this glacier to the left is the jagged line of the Passu and Siachen peaks, seven of which are over 7,500 m. Passu is the setting-off point for climbing expeditions up the Siachen, Passu, Kurk and Lupgar groups of peaks, and for trekking trips up the Shimshal Valley and Siachen Glacier.

1.3.3 SHIGAR RIVER BASIN

Shigar River is a small right bank tributary of the Indus River. This river rises from the Hispar glacier at the base of the Haramosh and Kanjut Sar peaks in Shigar valley. Thereafter it flows towards the southeast and joins the Indus at Skardu. The Shigar River drains parts of Haramosh range and Masherbrum range in the northeast of the country. The river fed by melting water of large glaciers, joins the main Indus River near Skardu. In the east of the basin there is a tributary named Bro River entering into the Shigar River.

An important tributary of the Shigar River rises from the Baltoro glacier at the base of the Masherbrum peak and flows westwards to join the main channel of the Shigar in its middle course. Thus the Shigar system drains the melt-waters of two of the most important glaciers (Baltoro and Biafo) of the Karakoram Range. This river descends along a very steep gradient. Its entire catchment has been influenced by the action of glaciers. The valley is deep in its upper reaches but widens near its mouth. A small river island has formed at the junction of the main stream with the tributary draining the Baltoro glacier. The catchment area of this river is virtually devoid of a vegetative cover due to its high altitude and scarcity of rainfall moreover the human habitation is sparse.

Shigar Valley, 32 km from Skardu is watered by the Shigar River. It forms the gateway to the great mountain peaks of the Karakoram, including K-2.

1.4 OBJECTIVES

The prime objective of this study is to assess the degradation of Siachen glacier in the context of volumetric decrease in Siachen, Baltoro and Biafo glaciers of Pakistan subject to global warming incl anthropogenic activities. The secondary objectives are as following:

- Estimation of three major glaciers depletion during the decade.
- Correlation with sea surface rise along coast line of Pakistan during the decade.
- Correlation with average annual temperature rise in northern areas in a decade.

1.5 SCOPE OF THE STUDY

Indeed, attempt has been made to document the glaciers depletion of northern Pakistan in the past but with traditional survey methods. In recent times, the dynamics of land cover and particularly climatic change in the area requires a more powerful and sophisticated system such as GIS and remote sensing data which provides a general extensive synoptic coverage of large areas than the traditional survey methods. Remote sensing is helpful in providing up-to-date information and GIS assists in marking spatial distributions and its management. Spatial distribution of glaciers depletion is now possible with high spatial, spectral and temporal resolution image giving fairly accurate results. This study deals with,

- Three major glaciers of Siachen, Baltoro and Biafo in northern Pakistan.
- Only volumetric changes during the last decade are estimated.
- RS and meteorological data are used for the subject study.

2 LITERATURE REVIEW

Earth surface is unique in characteristics it possesses in the form of land cover. Intergovernmental Panel on Climate Change (IPCC) in 1988 reported that global warming is the gradual rise of the earth's near-surface temperature over

approximately the last hundred years. The best available scientific evidence based on continuous satellite monitoring and data from about 2,000 meteorological stations around the world indicates that globally averaged surface temperatures have warmed by about 0.3 to 0.6°C since the late nineteenth century. Generally, the northern hemisphere has warmed to a greater extent than the southern hemisphere, and mid to high latitudes have generally warmed more than the tropics. Alpine glaciers are subjected to heat flux thus causing them to melt.

Mare (1997) found that the edge of the summer ice moved almost 3 degrees south between the mid-1950s and early 1970s. That's a big shift almost 200 miles enough to reduce the area of the sea ice by 25 percent. Mare's (1997) finding signals an increase in planetary temperature and is an indication that polar ice would shrink if greenhouse gases do warm the planet. Such a precipitous decline in ice area "poses a challenge to model simulations of recent climate change," Mare (1997) wrote, since climatologists have assumed that such changes would be much more gradual. The shrinking of Antarctic ice sheet signals a rise in global temperature (Mare, 1997). Any change in ice distribution could affect ocean circulation. Ocean currents redistribute heat from the tropics to the poles and are a key part of the global climate system.

Titus and Vijay **(**1995) studyed that after the last ice age, the rapid melting of glaciers rapidly raised sea level. That melting tapered off about 6,000 years ago, and sea level compared to land became fairly stable. However, over the past century, sea level over much of the United States has risen by 25 to 30 centimeters relative to land. They concluded that sea level during the last century raised more than average over the last several thousand years (Titus and Vijay, 1995).

The warming of the atmosphere caused by increases in greenhouse gases is melting glaciers and causing ocean water to warm and expand thermally. Both effects increase the volume of the ocean, raising its surface level. How far has the average ocean surface moved from the center of the earth, nobody has made that measurement consistently, so we must settle for records of relative sea level rise, which tells us about sea level rise in comparison to a certain hunk of coastal real estate.

Crests of the high ranges in the Karakoram–Himalayan region are largely snow bound. The Karakoram has greater ice and snow cover (27 to 37%) than any other mountain system outside the polar region (Wissman, 1959). In Hindukush, western Karakoram and high Himalaya, ice and snow cover is relatively less extensive, and in other ranges west of Nanga Parbat only the highest peaks are snow bound. Snow line is at about 5,200 masl to 5,800 masl along the northern aspects of the high Himalaya. It is at 5,100 masl to 5,600 masl in southern Karakoram and 4,700 masl to 5,300 masl in the northern part of the Karakoram (Kick, 1964).

2.1 GLACIOLOGICAL COMPLEX

The Karakoram-Himalayan region lies in an environment that is glaciological complex with high altitude source areas (above 4,500 m) having permafrost and annual precipitation in excess of 2,000 mm (Khan, 1994).

The Karakoram alpine glaciers are amongst the steepest in the world and they extend through a wide range of climatic environments. Most of the precipitation is not derived from the Indian monsoon but from depressions moving in from the west during the spring and summer. However, occasional monsoon disturbances do succeed in extending sufficiently far north so as to enter the area. Under such circumstances the precipitation levels increases substantially.

2.1.1 GLACIER'S VELOCITY AND FLUCTUATIONS

Due to great thickness of ice, the deeper parts of the glaciers are at or close to 0 °C and they behave like temperate glaciers (Hewitt, 1998). Owing to relatively high activity indices, these glaciers have relatively high flow rates ranging from 100 to 1,000 m/yr (Goudie et al., 1984). Velocities of some of the selected glaciers of Karakoram are shown in Table 2.1. Historical record of glacier fluctuations in the Himalayas and the Karakoram indicate that in the late nineteenth century the glaciers were generally advancing followed by predominant retreat (Goudie et al., 1984).

High summer radiation and steep barren slopes control the glacier ablation patterns. It is estimated that melting accounts for 80% of the heat loss whereas only 20% is due to evaporation and convection (Goudie et al., 1984).

Table 2.1: Published estimated lengths and velocities of Siachen, Baltoro and Biafo glaciers. The length data is of year 1998 and the velocities are yearly average (Hewitt, 1998).

Glaciers	Length (km)	Velocity (m/yr)
Siachen	76	1,000
Baltoro	59	300
Biafo	62	19

There are episodes of rapid advances and catastrophic movements occasionally observed in alpine type of glaciers subject to global warming. Hewitt (1998) observed catastrophic movement of 16-km-long Chiring glacier (Indian Himalayans) between 1994 and 1996, which transferred 1-1.5 km^3 of ice from its upper two-third to its lower one-third, and into the main Panmah glacier of which it is a tributary.

2.1.2 GLACIAL SURGES AND CLIMATE CHANGE

Five confirmed and three other possible glacial surges in Karakoram have occurred in the past decade (Hewitt, 1998), possibly indicating sensitive response to climate change. The Karakoram lie within the variable influence of three major weather systems: the sub-Mediterranean regime of mainly winter, westerly storms; the summer monsoon; and the Tibetan anticyclone. Winter storms dominate glacier nourishment at present. However, nearly one third of the high-elevation snow accumulation which has been measured occurs in summer (Hewitt, 1990). Moreover the general patterns of advance and retreat in the region relate to changing vigor of the summer monsoon. The possibility of such large shifts in the atmospheric sources, regime, and seasonal occurrence of glacier nourishment, does not seem to be a factor in other regions with surging glaciers. This seems to be a further reason to give more attention to surging glaciers in a relatively neglected region as the glaciers fluctuation is subjected to terrestrial heat flux.

2.2 HYDROLOGY

The Karakoram and Himalayan mountains form the main source of snow and ice melt runoff to the Indus River System. The precipitation enhancing and shadowing effects of the main mountain ranges provide dramatic contrasts that greatly complicate the hydrological picture. Snowmelt predominates the south of the Himalayan crest. The Indus and its tributaries form the main drainage in the Karakoram-high Himalayan region. East to west, its main tributaries are Hunza, Shigar, Shyok, Astor, Gilgit, Ishkuman, Yasin, Ghizer, Yarkhun, Rich Gol, Arkari, Kunar, Panjkora, and Swat rivers.

2.2.1 RUNOFF

The Pakistan Water and Power Development Authority (WAPDA) have gauged the flow of the upper Indus since the early 1960s, at a string of flood monitoring stations upstream of Terbela. The gauging station on the Indus River at Partab Bridge just below the confluence of the Gilgit River covers the runoff of 142,700 km^2 catchment including the whole of the Karakoram mountains except for their NE slopes draining to the interior basins in western China. In 1976 WAPDA established gauging stations on the upper Indus at Kachura near Skardu south of the central Karakoram; on the Shyok River, which drains the eastern Karakoram; on the Hunza River at Dainyor Bridge near Gilgit in the western Karakoram; and on the Gilgit River just downstream of its confluence with the Hunza.

The Siachen is the first of a series of large glacier-fed tributaries of the Shyok River, which increase its annual runoff from 320 mm above the Siachen confluence of 5,000 km^2 to a mean of 910 mm during 1966-79 near Gilgit (catchment 13,200 km^2). The other gauged catchments in the Karakoram region have lesser percentages of permanent snow and ice cover and correspondingly lower annual runoff depths (Goudie et al., 1984). The monthly stream regimes throughout the Karakoram show very strong summer peaks attributing to glacier melt. Discharge decreases progressively throughout autumn and winter to a minimum in March, begins to rise with April snowmelt, but does not peak until July or August. A clear but considerably lagged diurnal cycle is interrupted by sharp recessions when snowfall or prolonged cloud cover halts glacier ablation. The general 20^{th} century movements of the Karakoram glaciers must also have affected runoff but no attempt has been made to quantify this. The river flow is affected by the creation of major natural dams as a consequence of either glacial, mudflow or landslide blocking (Goudie et al., 1984). Thereby the run off accumulation has resulted the recent flood outburst of Indus river which is a clear indication of global warming effects on glaciers volume, causing the historic catastrophe.

Salerno et al. (2008) studied variations in the surface area of glaciers in Sagarmatha National Park (Mount Everest region) for the second half of the 20th century. They found an overall decrease in glacier area by 4.9% (from 403.9 to 384.6 km^2) in four decades and they ascribed the decrease in area to a decrease in precipitation and hence a glacial retreat. They found that the glaciers oriented to the south show less decrease in area, in comparison with the glaciers oriented to other ordinal directions. The analysis in Manaslu area showed that Nepalese glaciers are retreating at the rate of 11 to 14 meters per year during the period of 1962 to 2008 (Salerno et al., 2008).

Fischer (2009) evaluated different methods of glacier volume calculations from ice-thickness data used on Austria glacier-Schaufelferner. The so calculated glacier volumes were compared with the ice-volume changes calculated from digital elevation models (DEMs) of the Austrian glacier inventories. The manually interpolated volumes based on the 1995 and 2003/06 ground penetrating radar (GPR) data yielded a volume loss of 0.021 km^3, only slightly different from volume loss of 0.020 km^3 calculated from the area / volume scaling algorithms applied to the Austrian glacier inventories data of 1997 and 2007. The calculation of volume change from surface elevation data seems to be more cost effective way of monitoring volume change, which is especially true on a timescale of decades (Fischer, 2009).

3 MATERIALS AND METHODS

The basic materials required for the compilation of volumetric estimation of glaciers are high quality topographic maps and temporal high resolution satellite data. The remote sensing data of land observation satellite Landsat-7 Thematic Mapper (TM) are used for the temporal analysis of glaciers and the identification of potentially dangerous depletion. A combination of digital satellite data and the Digital Elevation Model (DEM) of the area are used for better and more accurate results for the computation of volumetric calculations of glaciers.

Earth's ice cover is changing dramatically. Shrinking ice cover is a clear sign of global warming (Mare, 1997). Global ice melting accelerated during the 1990s, which was also the warmest decade on record. Ice is melting both at sea and on land, with shrinking mountain glaciers and thawing permafrost.

Ice is melting at a dramatic pace. Pakistan too is confronted with this problem. Three of the world's seven longest glaciers outside the Polar Regions are located in Pakistan (Figure 3.1) namely Siachen Glacier, Baltoro Glacier and Biafo Glacier which spread over an area of 72,496 km^2 and are reported to be melting fast.

This study work is restricted to Siachen glacier out of Shyok river basin and Baltoro and Biafo glaciers out of Shigar river basin of northern areas of Pakistan. The area is bounded by:-

- Shyok river basin 75^0 to 77^0 E Long and 34^0 to 35^0 N Lat
- Shigar river basin 75^0 to 77^0 E Long and 35^0 to 36^0 N Lat

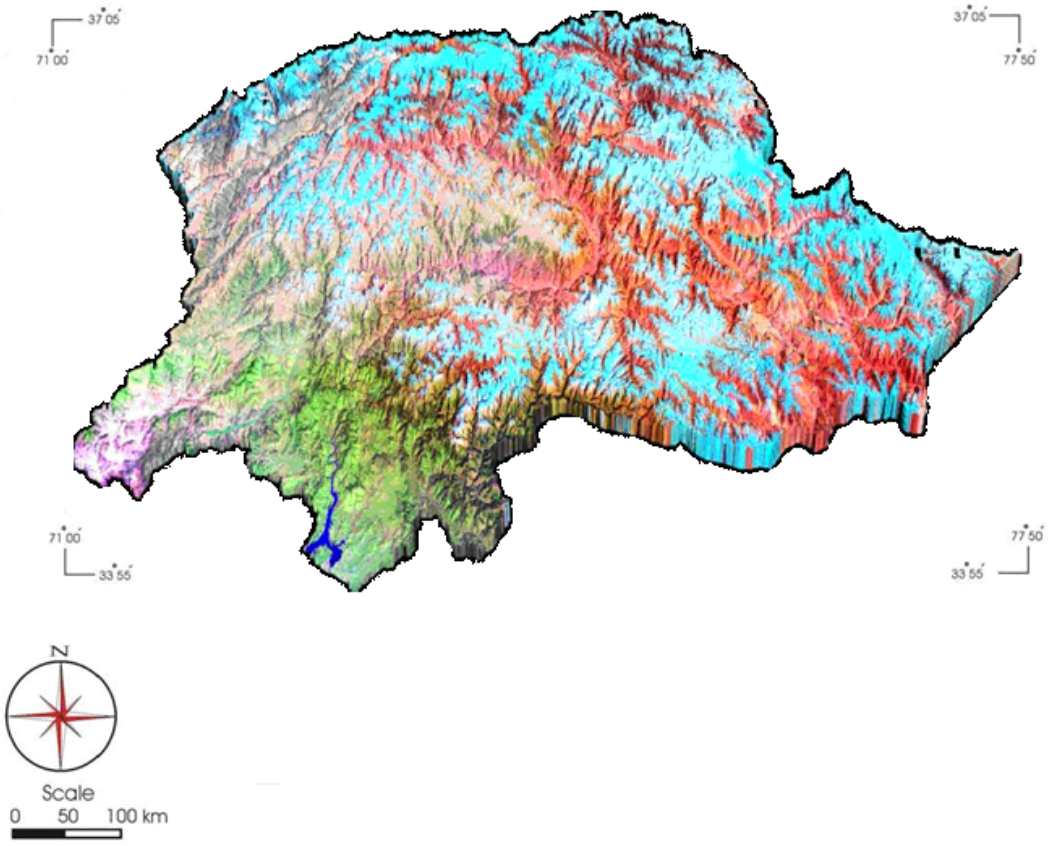

Figure 3.1: 3D views of glaciated areas of northern Pakistan generated with SRTM data of year 2000 of 90 m resolution.

3.1 DATA SETS

- Landsat-7 TM Images of Siachen, Baltoro and Biafo glaciers of northern Pakistan with a lag of 5/10 yrs in the decade of 1990-2000 obtained from SUPARCO (Appendix1).
- Digital elevation models of Baltoro, Biafo and Siachen glaciers from SRTM data of year 2000 and topographic maps of Svy of Pakistan of year 1990 (Appendix 2,3,4).
- Average annual temperature record of northern areas of Pakistan during the last decade obtained from Pakistan Meteorological department (Table 4.1 & 4.2).
- Satellite Radar Altimeter data for sea surface rise along coast line of Pakistan (Figure 4.6 & 4.7).

3.1.1 TOPOGRAPHIC MAPS

The glaciers are mostly concentrated in the north. The river basin boundary and spatial distribution of glaciers were identified from the satellite images and supplemented with the available topographic maps at scale of **1:250,000**. The topographic maps (43M, 52A and 52E) are the map series of the 1990 published by the Survey of Pakistan. These topographic maps are based on aerial photographs, field surveys at various times, and verification through large-scale topographic sheets.

3.1.2 SATELLITE IMAGE

The remote sensing data of Landsat-7 TM have been used for the spectral differentiation / delineating the boundry of the glaciers. The image data are in digital format and have a pixel size of 30m. Eleven scenes of Landsat-7 TM are required to cover the glaciated part of northern Pakistan (Figure 3.2).

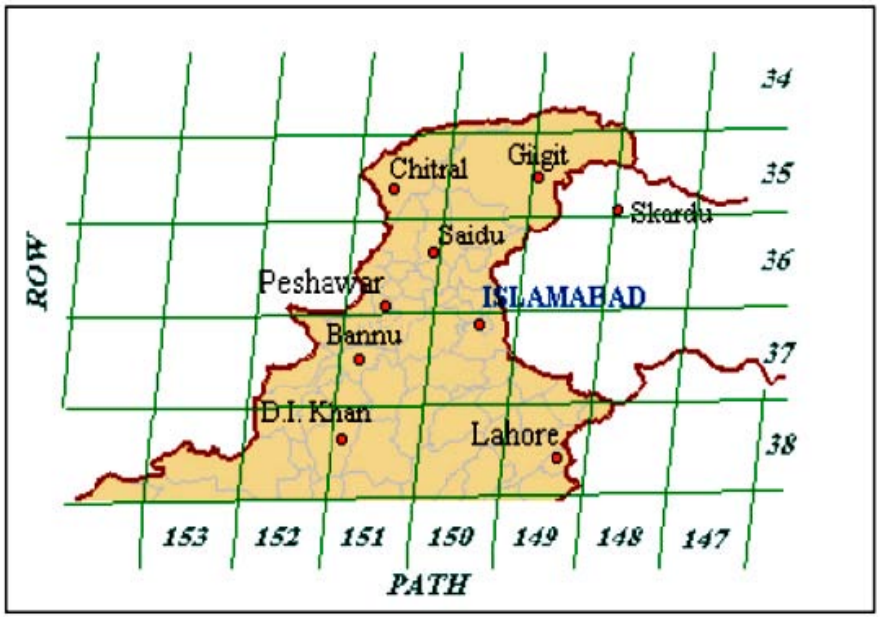

Figure 3.2: Scenes of Landsat-7 TM of northern Pakistan, datasets with lag of 5/10 years acquired from SUPARCO of 1990-2000.

For analysis of the Baltoro, Biafo and Siachen glaciers out of the two river basins Shyok and Shigar of northern areas, two scenes (147 and 148) of Landsat-7 of the period 1990 - 2000 were used.

3.1.3 SOFTWARE

- ERDAS IMAGINE
- ArcGIS
- Land serf
- Global Mapper

3.1.4 DIGITAL ELEVATION MODEL

Digital Elevation model (DEM) of study area having 30m resolution was generated from both the contours of topographic sheets of Survey of Pakistan and the SRTM data down loaded, thus obtaining the slope, aspect and elevation information.

3.2 MEAN GLACIER THICKNESS AND ICE RESERVE

All perennial snow and ice masses are observed for the study. Measurements of glacier dimensions are made with respect to carefully delineated drainage area for each 'ice stream'. Tributaries are included in main streams when they are not seperable from one another. If no flow takes place between separate parts of a continuous ice mass, they are treated as separate units.

Delineation of visible ice, firn, and snow from rock and debris surfaces for an individual glacier does affect various study measurements. Marginal and terminal moraines are also included if they contain ice. The 'inactive' ice apron, which is frequently found above the head of the glacier, is regarded as part of the glacier. Perennial snow patches of large size are also included in the calculations. Rock glaciers are included if there is presence of large ice content.

The data based on different geophysical techniques available for the measurement of glacial ice thickness in the northern parts of Pakistan are available for only selected glaciers. To supplement the study results the mathematical model of ice thickness and ice reserves is incorporated. Measurements of glacial ice thickness in the Tianshan Mountains, China, show that the glacial thickness increases with the increase of its area (LIGG/WECS/NEA, 1988). The relationship between ice thickness (H in m) and glacial area (F in km^2) was obtained there as:

$$H = -11.32 + 53.21\ F^{0.3}$$

This formula has been used to estimate the mean ice thickness of the glaciers in meters. The ice reserves are estimated in km^3 by multiplying mean ice thickness by the glacial area. The area of the glacier is divided into accumulation area and ablation area (the area below the firn line). The volume of the glaciers is calculated using Digital Elevation Models of both times datasets by keeping the minimum elevation as threshold for plane height. The length of the glacier is divided into three columns: total length, length of ablation, and the mean length. The total (maximum) length refers to the longest distance of the glacier along the centerline. The mean value of maximum lengths of glacier tributaries (or firn basins) is the mean length.

The orientation of accumulation and ablation areas is represented in eight cardinal directions (N, NE, E, SE, S, SW, W, and NW). Some of the glaciers are capping just in the form of an apron on the peak, which is inert and sloping in all directions, and is represented as 'open'. The orientations of both the areas (accumulation and ablation) are the same for most of the glaciers.

Glacier elevation can be divided into highest elevation (the highest elevation of the crown of the glacier), mean elevation (the arithmetic mean value of the highest glacier elevation and the lowest glacier elevation), and lowest elevation. The glaciers identified and mapped in the satellite images are also mapped in the available topographic map and hence in this study the elevation of the glaciers is considered for both the datasets involving the contours of topographic sheets (1990) and point data of SRTM (2000).

3.3 IMAGE PROCESSING

The Land Sat-7 (TM) images are acquired from SUPARCO, georeferenced and then the desired Area of Interest (AOI) is extracted. Moreover the topographic maps were scanned and then after georefrencing, all were digitized to get GIS layers for analysis.

- The Landsat images are processed and georeferenced.
- Volume is calculated mathematically using height information extracted through DEMs.
- Decrease in glaciers volume is determined temporally with the lag of ten years.

3.4 METHODOLOGY

The study and acquisition of literature, topographic maps and satellite images for capturing the digital data of glaciers was carried out in first phase. Thereafter from maps and SRTM data the digital elevation models were generated for analysis of volumetric decrease of Siachen, Baltoro and Biafo glaciers. Finally the correlation with average temperature rise of northern areas and with sea level rise along coast line of Pakistan for computation of results was carried out. The methodology adopted in this study is shown in a flow chart (Figure 3.3).

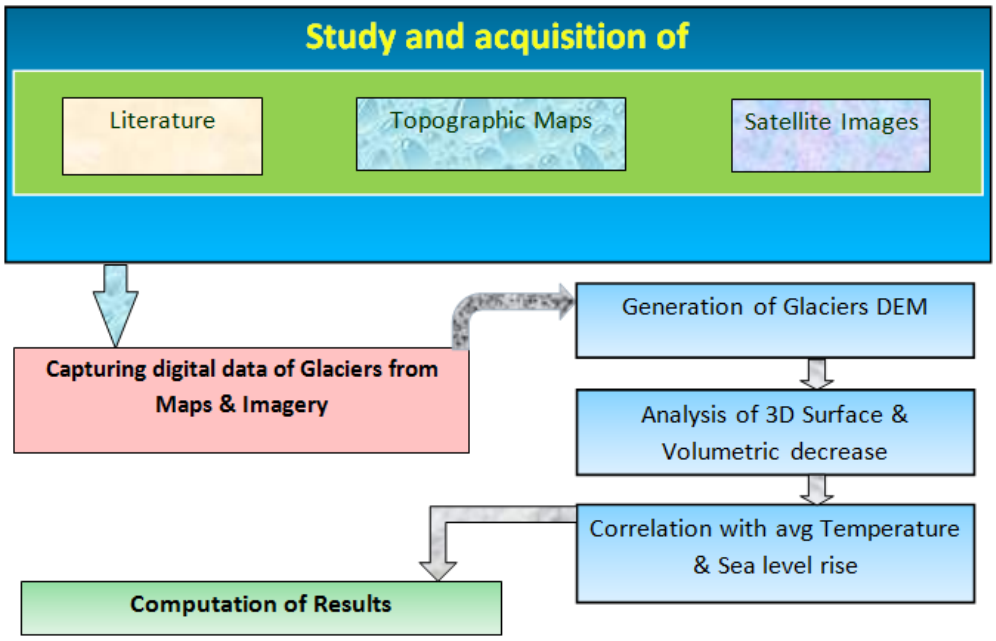

Figure 3.3: Methodological flow chart of capturing digital data of Siachen, Baltoro and Biafo glaciers for volumetric decrease estimates.

4 RESULTS AND DISCUSSION

The objectives of this study form the basis of all the analysis carried out in this chapter. The results are presented in the form of maps, charts, statistical tables and discussed appropriately. These include volumetric decrease of the three important glaciers of northern Pakistan during last decade, spatial distribution of the glaciated areas, correlation with average temperature rise in northern areas and correlation with sea surface rise along coastline of Pakistan.

The occurrence of glaciers has always been linked to climatic conditions. Climate is of fundamental importance to the inception and growth of glaciers. The form of the landscape dictates the threshold conditions for glacier occurrence and determines glacier morphology. Under certain climatic conditions for glaciation, glaciers of different shapes and sizes are formed depending on the landscape. Mountain glaciated regions are associated with climatic fronts and zones of maximum precipitation.

Alpine glaciers are generally situated at middle latitude regions of the globe. During most of the summer season, high flows in the Indus River system are due to snow and ice melt of alpine glaciers in the Himalayas. Hewitt (1990) states that evidences over the past 150 years indicate that the snow and ice cover of the upper Indus River basin undergoes large spatial as well as temporal variations.

The glacier area of northern Pakistan forms the single most concentrated source of runoff for the whole Indus basin. Since this frozen precipitation contributes more than 50% of the total flow of the Indus River System and a larger part of the future supplies upon which Pakistan can depend, knowledge of this resource seems a prime requirement for water resource and flood hazard monitoring on the Indus basin.

The glaciers in Karakoram region are high activity glaciers and have some of the steepest gradients in the world. According to their movement patterns, Karakoram and Himalayan glaciers are grouped into the following three categories:

- Glaciers with steady movement (these are also the longer ones)
- Glaciers having cyclic advances (these have short steep crevasses)
- Surging glaciers characterized by catastrophic advances

4.1 SHYOK RIVER BASIN

The Shyok River basin stretches over a latitudinal and longitudinal range of 34º 39' to 35º 42' and 75º 56' to 77º 27' respectively. This river basin is bounded with Jammu and Kashmir disputed Territory in south, China in northeast and Shigar and Indus River basins in the west. The elevation in the basin varies from more than 2,500 masl to more than 7,700 masl.

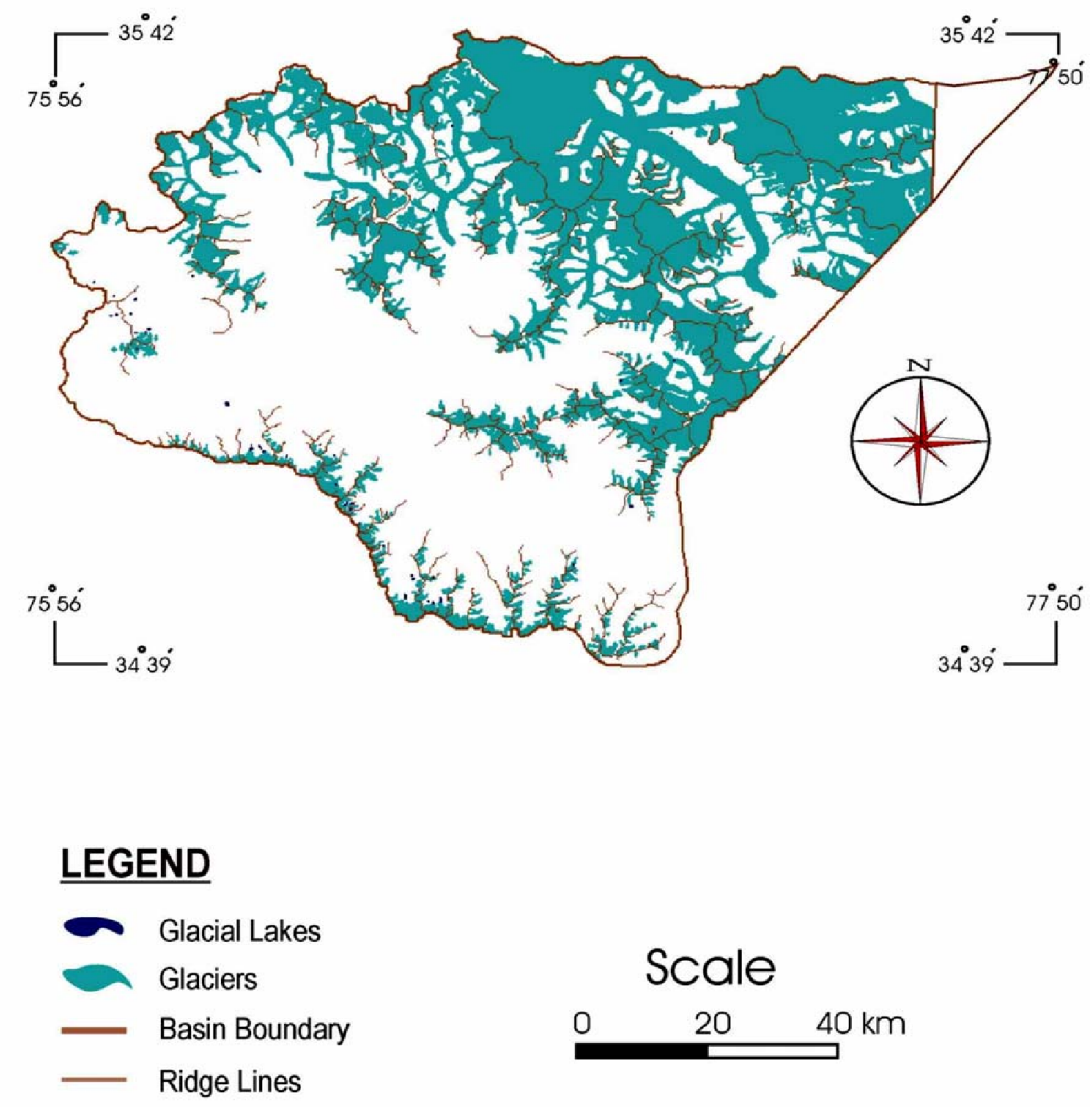

Figure 4.1: The glacier distribution in Shyok river basin showing Siachen glacier's significance in the region being the largest.

The total area of the basin is about 10,235 sq. km out of which 34.67% is under the glacier cover. There are 372 glaciers in the basin out of which 86% can be classified as mountain type glacier while only 14% are the Valley glaciers. The Siachen is the biggest valley glacier of this basin having an area of 1,112 sq. km. The Bilafond glacier is a large size Valley glacier having several supra glacial lakes.

4.1.1 SEASONAL SNOW COVERAGE OF SHYOK BASIN

The figure 4.2 shows that in the months of June, July and August are lowest that depicts high rate of melting during these months in this area. Whereas, comparison of the seasonal snow cover behavior of Shigar and Shyok basins shows that Shyok has high snow melting activities during the months of June, July and August.

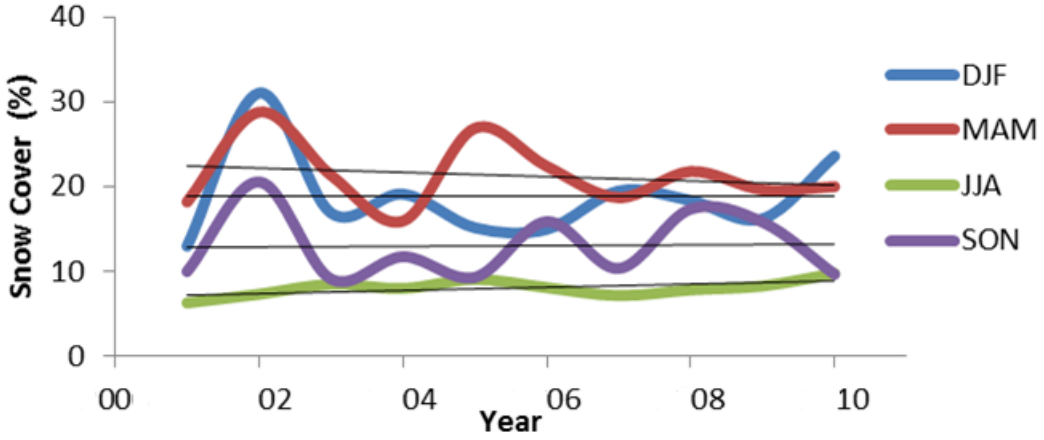

Figure 4.2: Snow Coverage of Shyok Basin in Km in a Decade

This result leads us to the conclusion that the anthropogenic activities in the region of Shyok are causing comparatively higher melting and thus more risks of glacial mass movement to occur. This may be verified by using high resolution satellite data and ancillary records.

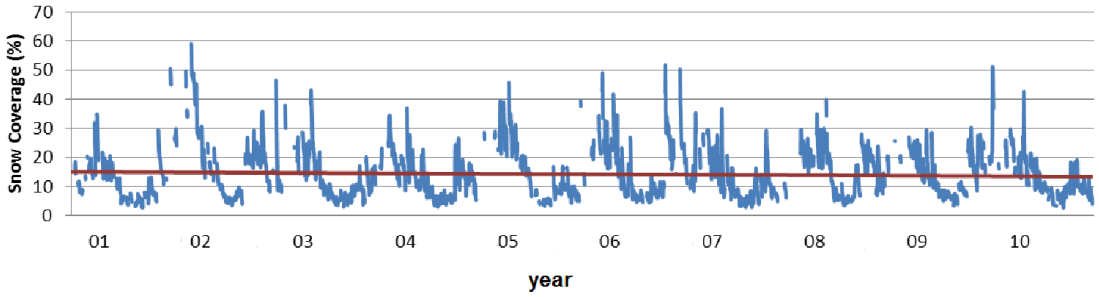

Figure 4.3: Temporal Assesment of Snow Coverage in a Decade in Shyok Basin

The snow cover trend is relatively stable in the Shigar area, whereas it is quite fluctuating in the Shyok. This fact again confirms high rate of changes over time being covered in the Shyok region which are cause melting and thus more chances of catastrophic events.

4.1.2 Aspect Wise Snow Coverage of Shyok Basin

The huge size glaciers are concentrated on NE and SE aspect of the basin. The SE and S aspects have the maximum glacier area of about 1,657 and 501 sq. km respectively owing to the fact that the larger glaciers like Siachen, Kondus, Bilafond, Ghandogoro, Masherbrum, etc. are facing to these aspects.

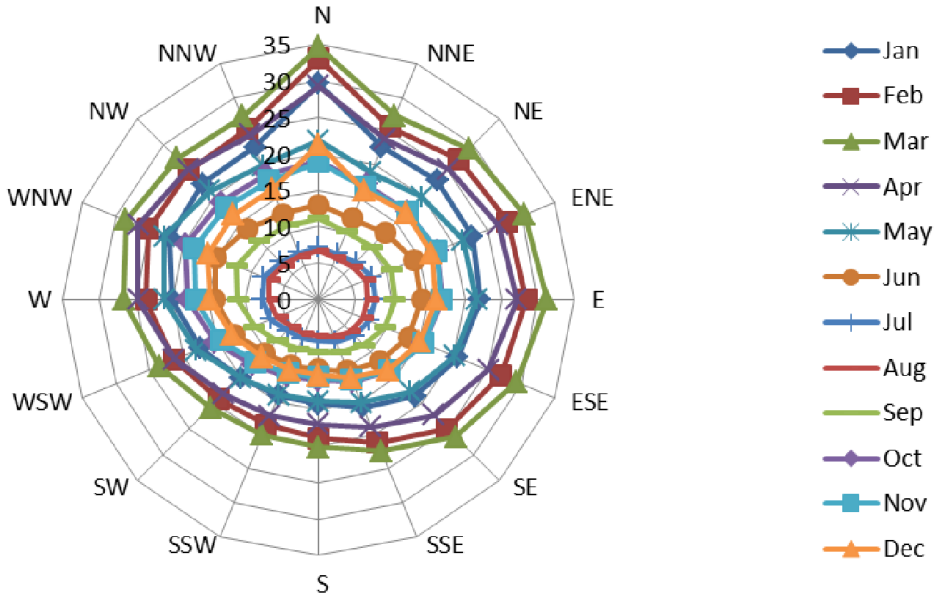

Figure 4.4: Aspect Wise Snow Coverage in Km in a Decade of Shyok Basin

The above figure shows aspects zone of N has maximum snow coverage whereas zones of W to ESE have minimum snow coverage over the year. Five different seasons and the aspect-wise snow distribution in these seasons can be seen easily from the figure. Here it is clear that the aspect zones N to NE and S to SW hold greater area of the basin than other aspect zones and the other aspect zones have maximum melting activities which may cause triggering of some catastrophic event in combination with factors such as seismic activity, high temperature and anthropogenic activity.

4.1.3 DISTRIBUTION OF GLACIERS ON DIFFERENT ASPECTS IN SHYOK BASIN

Table 4.1: Distribution of glaciers under different aspects in Shyok River basin

Aspect	Number		Area (km2)				Length (m)			Ice Reserves (km3)	
	Total	%	Smallest	Largest	Total	%	Min.	Max.	Total	Total	%
N	48	12.9	0.23	13.65	111.63	3.15	390	5348	90014	7.802	0.87
NE	70	18.82	0.17	140.15	311.35	8.78	552	15085	154196	44.975	5.04
E	57	15.32	0.08	322.78	471.04	13.28	288	30587	152962	107.603	12.07
SE	48	12.9	0.21	1112.03	1656.52	6.69	540	76641	254334	576.934	64.69
S	57	15.32	0.18	177.69	500.74	14.11	533	21362	186446	87.127	9.77
SW	30	8.06	0.28	81.63	198.98	5.61	548	18219	109754	25.507	2.86
W	9	2.42	0.36	9.43	23.63	0.67	1135	5353	22387	1.658	0.19
NW	53	14.25	0.11	84.51	273.95	7.72	265	19948	123387	40.195	4.51
Total	372				3547.84				1093480	891.801	

4.2 SIACHEN GLACIER

The Siachen is the biggest valley glacier of this basin having an area of 1,056 sq. km followed by glacier having an area of more than 323 sq. km. The total length covered by the Valley glaciers is more than 500 km. The maximum length recorded for the Siachen glacier is 76.6 km. Since the inception of anthropogenic activities the Siachen glacier is showing abnormal behaviour. The Siachen glacier is subj to 2 km retreat during the last two decades which is the max retreat in the vicinity.

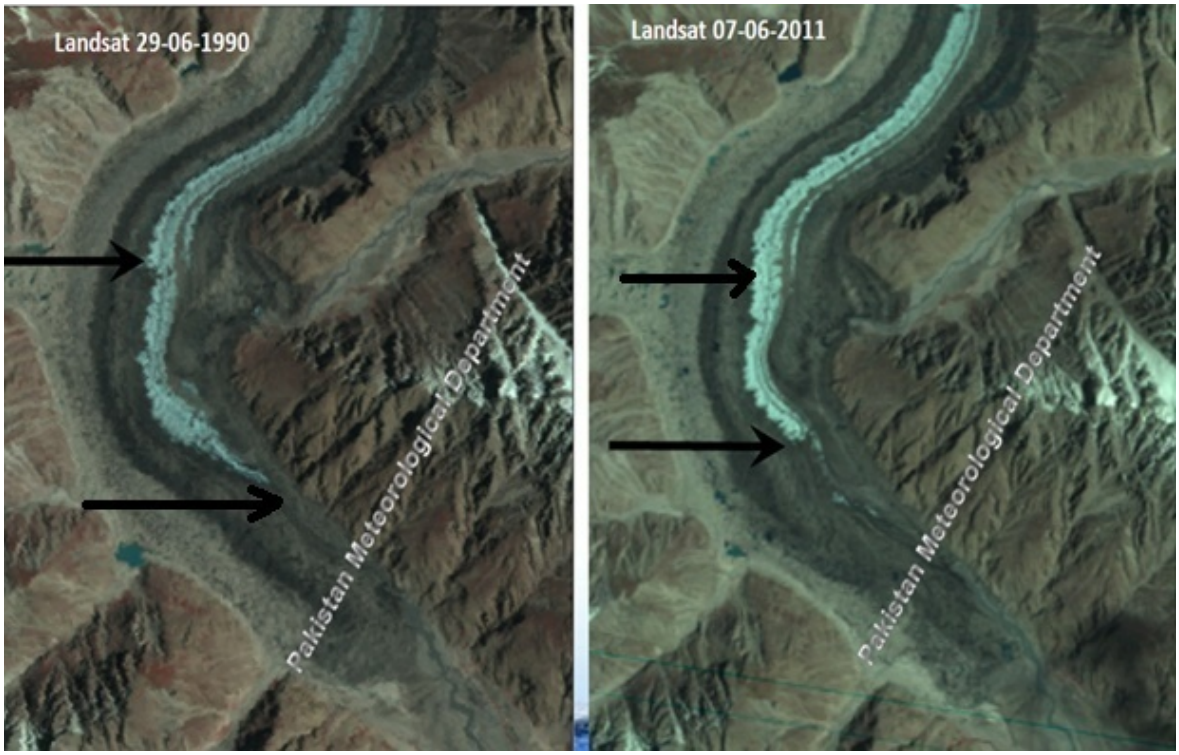

Figure 2.1: Siachen Glacier Retreat (2 km in 2 Decades)

After acquiring the image from SUPARCO, different band combinations were used for glaciers classification. Band ratio 4/5 gave the Siachen glacier's bounds (Appendix 4a). The resultant of Siachen glacier's shape file was ascertained after the identification of the bounds of the glacier (Appendix 4b). For volumetric decrease calculations the digital elevation models of both time bounds were generated (Appendix 4c). The contours of topographic map sheets of 1:25000 scale of Survey of Pakistan of 1990 were digitized for generation of DEM as one dataset (Appendix 4d). The SRTM data of 2000 was downloaded and there after the voids were removed with the help of land serf software and DEM of Baltoro glacier was generated for another dataset (Appendix 4e). Extract by mask utility was incorporated for computation of 3D surface area and volume of glacier having established the plane height (Appendix 4f).

The volumetric decrease of Siachen glacier subjected to global warming during the last decade is computed as following:

Siachen-93

- Plane height: 3300 m
- 3D area: 1056×10^6 m^2
- Volume: 1631×10^9 m^3

Siachen-98

- Plane height: 3300 m
- 3D area: 1043×10^6 m^2
- Volume: 1541×10^9 m^3

Volumetric decrease over 5 years = 90×10^9 m^3, i.e., 5.55 %

Volumetric decrease over 10 years = 11.10 %

The mathematical model of mean glacier thickness and ice reserves has a relationship:-

$$H = -11.32+53.21\ F^{0.3}$$

Where, H = Ice thickness in meters

F = Glacial area in km^2

This model gives the following results in the volumetric decrease:-

Siachen-93

- Glacial area: 1056×10^6 m^2
- Thickness: 419 m
- Ice reserve: 441 km^3

Siachen-98

- Glacial area: 1043×10^6 m^2
- Thickness: 416 m
- Ice reserve: 421 km^3

Decrease in ice reserves over 5 years = 20 km^3, i.e., 4.8 %

Decrease in ice reserves over 10 years = 9.6 %

4.3 SHIGAR RIVER BASIN

The Shigar River basin is situated in the latitude and longitude range of 35º 19' to 36º 07' N and 74º 53' to 76º 45' E respectively (Figure 4.2). The elevation range varies from about 2,500 m to more than 8,600 m.

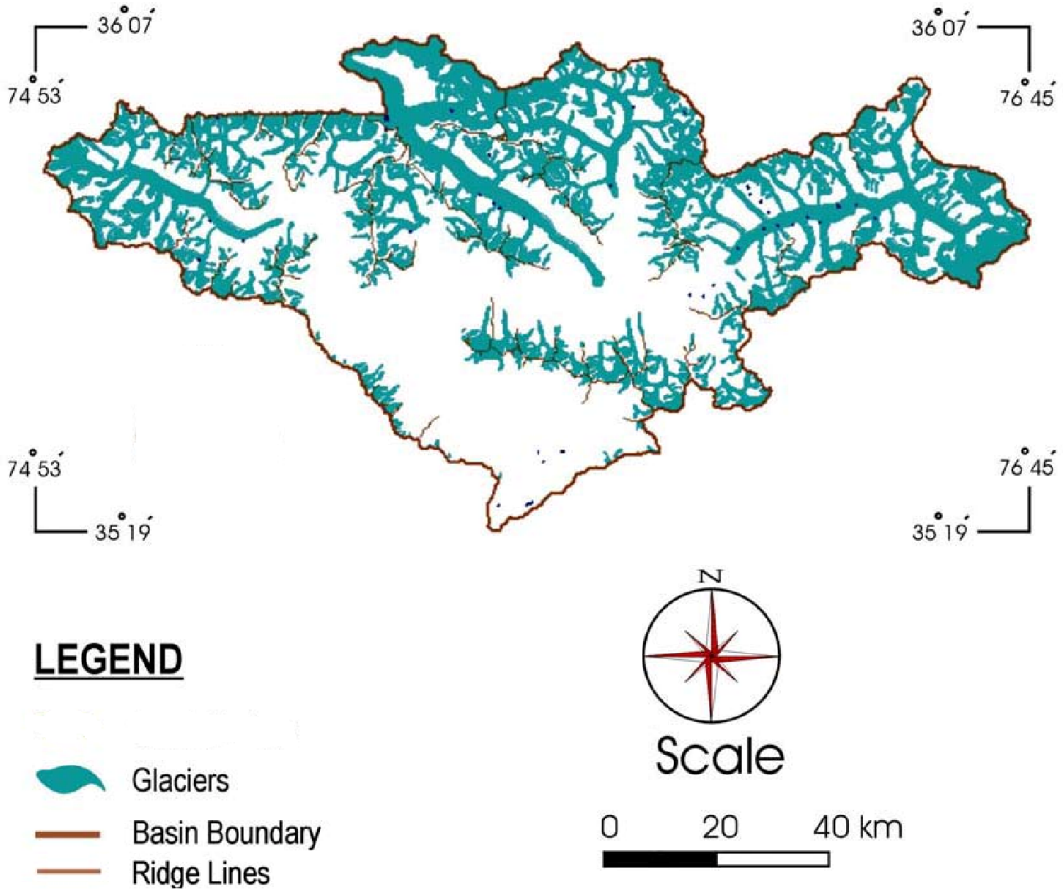

Figure 4.2: The glacier distribution in the Shigar river basin showing Baltoro and Biafo glaciers significance in the region being the largest.

The basin stretches over an area of 7,382 km^2 out of which, the glacier area is about 2,240 km^2. The distribution of different types of the glaciers is presented in Figure (4.2). The large size glaciers are mainly concentrated on the N, NE and NW aspects. The total ice reserves of this basin are 581 km^3.

4.3.1 SEASONAL SNOW COVERAGE OF SHIGAR BASIN

The figure 4.3 shows that the months of June, July and August are lowest that depicts high rate of melting during these months in this area. Whereas, comparison of the seasonal snow cover behavior of Shigar and Shyok basins shows that Shyok has high snow melting activities during the months of June, July and August.

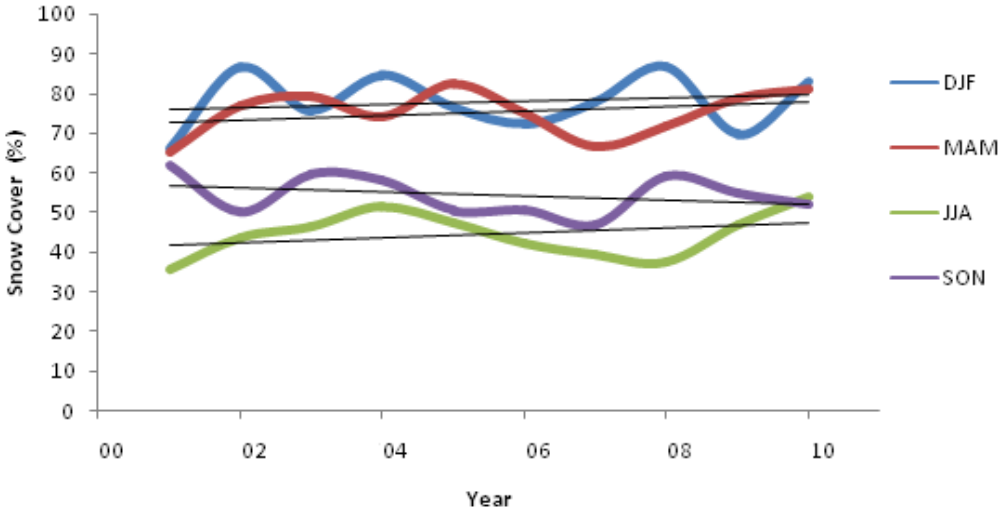

Figure 4.3: Snow Coverage of Shigar Basin in Km in a Decade

This result leads us to the conclusion that the anthropogenic activities in the region of Shyok are causing comparatively higher melting and thus more risks of Gayari like incident to occur. This may be verified by using high resolution satellite data and ancillary records.

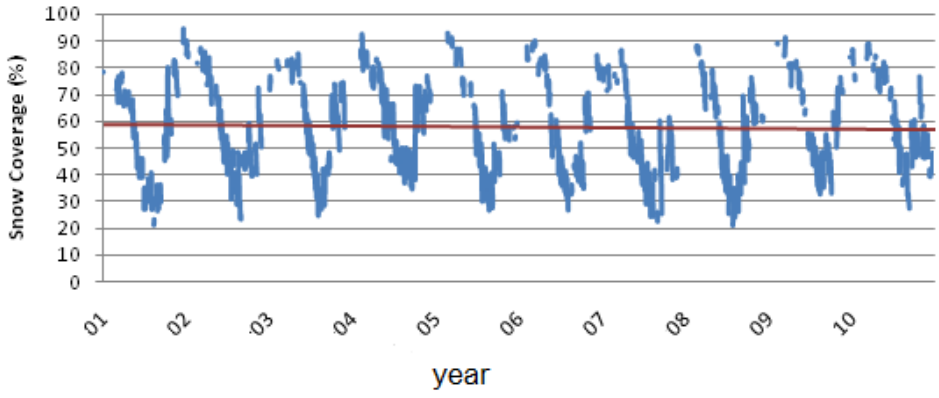

Figure 4.4: Temporal Assesment of Snow Coverage in Shigar in a Decade

The snow cover trend is relatively stable in the Shigar area, whereas it is quite fluctuating in the Shyok. This fact again confirms high rate of changes over time being covered in the Shyok region which are cause melting and thus more chances of catastrophic events.

4.3.2 ASPECT WISE SNOW COVERAGE OF SHIGAR BASIN

The huge size glaciers are concentrated on SW and SE aspect of the basin. The SE and W aspects have the maximum glacier area of about 1,111 and 693 sq. km respectively owing to the fact that the larger glaciers like Biafo and Baltoro etc. are facing to these aspects. The two out of world's seven largest glaciers lie in Shigar river basin. The Baltoro glacier with a

length of 59 km has the maximum area of 633 km^2 and the Biafo glacier has maximum length of 62.6 km covering an area of 404 km^2.

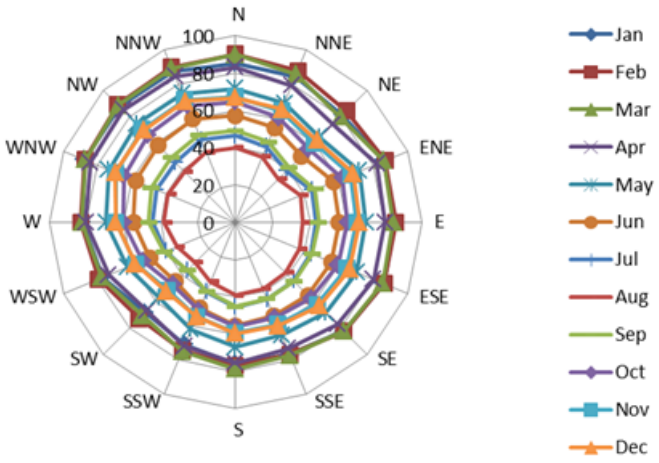

Figure 4.5: Aspect Wise Snow Coverage in Km of Shigar Basin

The figure 4.5 shows aspects zone of N has maximum snow coverage whereas zones of W to ESE have minimum snow coverage over the year. Five different seasons and the aspect-wise snow distribution in these seasons can be seen easily from the fig 4.22. Here it is clear that the aspect zones N to NE and S to SW hold greater area of the basin than other aspect zones and the other aspect zones have maximum melting activities which may cause triggering of some catastrophic event in combination with factors such as seismic activity, high temperature and anthropogenic activity.

4.3.3 DISTRIBUTION OF GLACIERS ON DIFFERENT ASPECTS IN SHIGAR RIVER BASIN

Table 4.8: Distribution of glaciers under different aspects in Shigar Basin

Aspect	Number		Area (km2)				Length (m)			Ice Reserves (km3)	
	Total	%	Smallest	Largest	Total	%	Min.	Max.	Total	Total	%
N	26	13.40	0.08	27.74	97.64	4.36	290	13123	89716	9.98	1.72
NE	38	19.59	0.09	11.19	79.97	3.57	469	8559	113071	5.81	1.00
E	27	13.92	0.06	10.47	36.70	1.64	250	6460	51590	2.42	0.42
SE	32	16.49	0.11	426.09	1111.14	49.60	344	62624	230256	304.69	52.42
S	17	8.76	0.26	53.27	124.54	5.56	724	15324	74293	16.67	2.87
SW	17	8.76	0.23	7.40	41.60	1.86	392	6675	60337	2.85	0.49
W	16	8.25	0.08	641.21	693.86	30.97	355	58970	107300	234.79	40.39
NW	21	10.82	0.13	11.97	54.63	2.44	604	8233	66950	4.07	0.70
Total	194				2240.08				793513	581.27	

The two out of world's seven largest glaciers lie in Shigar river basin. The Baltoro glacier with a length of 59 km has the maximum area of 633 km^2 and the Biafo glacier has maximum length of 62.6 km covering an area of 404 km^2.

4.4 BALTORO GLACIER

After acquiring the image from SUPARCO, different band combinations were used for glaciers classification. Finally with band ratio 4/5 and the thermal band Baltoro glacier's bounds were identified (Appendix 2a). The resultant of Baltoro glacier's shape file was ascertained after the identification of the bounds of the glacier (Appendix 2b). For volumetric decrease calculations the digital elevation models of both time bounds were generated (Appendix 2c). The contours of topographic map sheets of 1:25000 scale of Survey of Pakistan of 1990 were digitized for generation of DEM as one dataset (Appendix

2d). The SRTM data of 2000 was downloaded and there after the voids were removed with the help of land serf software and DEM of Baltoro glacier was generated for another dataset (Appendix 2e). Extract by mask utility was incorporated for computation of 3D surface area and volume of glacier having established the plane height (Appendix 2f).

The volumetric decrease of Baltoro glacier is computed having established the parameters for both the datasets, as shown below:

Baltoro-90

- Plane height: 3420 m
- 3D area: 633 X 10^6 m^2
- Volume: 1031 x 10^9 m^3

Baltoro-98

- Plane height: 3420 m
- 3D area: 609 X 10^6 m^2
- Volume: 978 x 10^9 m^3

Volumetric decrease = 53 x 10^9 m^3, i.e., 5.14 %

The mathematical model of mean glacier thickness and ice reserves has a relationship: $H = -11.32+53.21 F^{0.3}$, here H = Ice thickness in meters, F = Glacial area in km^2. This model gives the following results in the volumetric decrease:

Baltoro-90

- Glacial area: 633 x 10^6 m^2
- Thickness: 357 m
- Ice reserve: 226 km^3

Baltoro-98

- Glacial area: 609 x 10^6 m^2
- Thickness: 353 m
- Ice reserve: 214 km^3

Decrease in ice reserves = 12 km^3, i.e., 5.30 %

4.5 BIAFO GLACIER

Biafo glacier's bounds were identified (Appendix 3a) using ratio of band 4 to band 5. The resultant of Biafo glacier's shape file was ascertained after the identification of the bounds of the glacier (Appendix 3b). For volumetric decrease calculations the digital elevation models of both time bounds were generated (Appendix 3c). The contours of topographic map sheets of 1:25000 scale of Survey of Pakistan of 1990 were digitized for generation of DEM as one dataset (Appendix 3d).

The SRTM data of 2000 was downloaded and there after the voids were removed with the help of land serf software and DEM of Biafo glacier was generated for another dataset (Appendix 3e). Extract by mask utility was incorporated for computation of 3D surface area and volume of glacier having established the plane height (Appendix 3f).

The volumetric decrease of Biafo glacier is computed having established the parameters for both the datasets, and shown below:

Biafo-93

- Plane height: 3060 m
- 3D area: 404 X 10^6 m^2
- Volume: 686 x 10^9 m^3

Biafo-98

- Plane height: 3060 m
- 3D area: 398 X 10^6 m^2
- Volume: 673 x 10^9 m^3

Volumetric decrease =13 x 10^9 m^3, i.e., 1.90 %

Using the mathematical model, the ice reserves in Biafo glacier are estimated as under:

Biafo-93

- Glacial area: 404x 10^6 m^2
- Thickness: 311 m
- Ice reserve: 126 km^3

Biafo-98

- Glacial area: 398 x 10^6 m^2
- Thickness: 309 m
- Ice reserve: 123 km^3

Decrease in ice reserves = 3 km^3, i.e., 2.18 %

The volumes of ice estimated at two different times were compared to one another to estimate the volume loss (Table 4.1). The volumes calculated here are actually the volumes of the ice and the underlying rock to the depth of plane height (the height of terminus of the glacier; Figure 4.3). The thickness of this ice-plus-rock column is the difference of elevation between terminus and the point where from the glacier originates. Using these volumetric comparisons, Baltoro glacier's volumetric loss over 8 years is estimated to be 5.14 %, where as in Biafo and Siachen glaciers the volumetric loss over 5 years is estimated as 1.90 and 5.55 %, respectively. The calculated estimates of percentage decrease of ice volume over 5 years (Biafo and Siachen glaciers) and over 8 years (Baltoro glacier) were recalculated to represent volume loss over a decade (10 years). The recalculated percentage decrease of ice volumes are Baltoro 6.43%, Biafo 3.79%, and Siachen 11.09%.

SUMMARY OF VOLUME ESTIMATES

Table 4.1: Summary of volume computations of Baltoro, Biafo and Siachen glaciers during the period from 1990-1998 using areal bounds from remote sensing data and using mathematical model.

	Study Volumetric Decrease			Mathematical Model	
	Plane Height (m)	3D Area (km^2)	Volume (km^3)	Ice Thickness (m)	Ice Reserve (km^3)
Baltoro-90	3420	633	1031	357	226
Baltoro-98	3420	609	978	353	214
Biafo-93	3060	404	686	311	126
Biafo-98	3060	398	673	309	123
Siachen-93	3300	1056	1631	419	441
Siachen-98	3300	1043	1541	416	421

The difference in glaciers percentage volumetric decrease is because of the aspect, slope, geothermal gradient, density and glacier bed rock topography. The following assumptions are made in ice volume calculations (Figure 4.3):

- The plane height is the elevation of the terminus of the glacier.
- The highest elevation is where a glacier originates.
- The thickness used in volume calculations of ice and the underlying rock is the difference of elevation between the plane height and the highest elevation.
- Since the exact ice thickness above the rock across the length of the glacier can not be determined without drilling or geophysical equipment, it is assumed that a uniform layer of ice exists in the glacier from head (where glacier originates) to toe (glacier terminus).
- The density of the glacier and the rock combination is same and constant throughout the length and thickness of the glacier.
- There is no rock or glacier debris around to modify the volume calculations.
- Crevasses in the glacier are not large enough to modify the volume calculations.
- A schematic cross-sectional profile (Figure 4.3) of glaciated area is presented to show the actual volume calculated versus the existence of ice and underlying rocks.

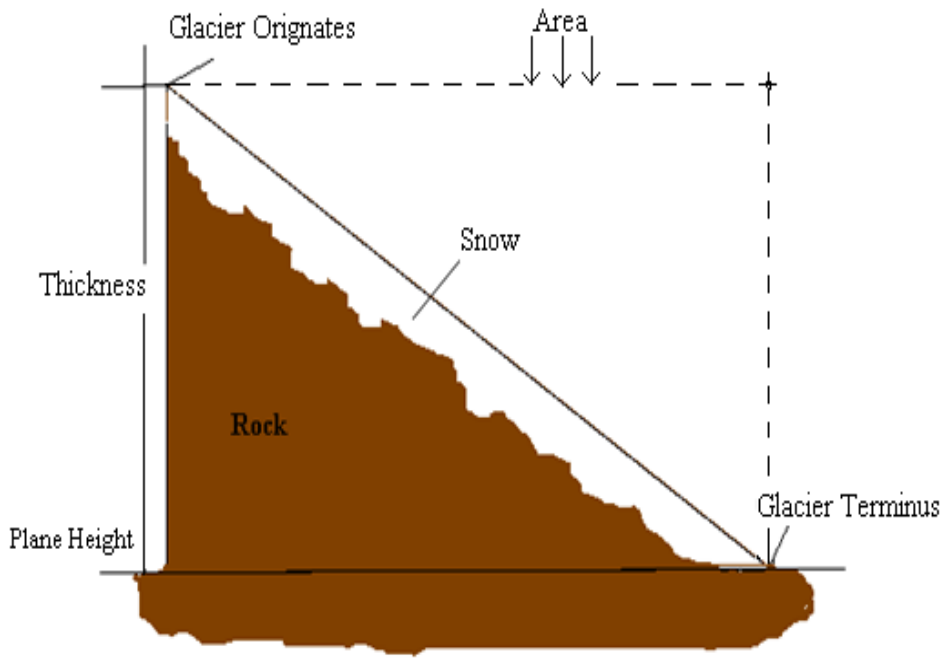

Figure 4.3: A schematic cross-sectional profile of glaciated area showing input parameters in volume calculations and comparison for volume loss over time.

4.6 GLOBAL TEMPERATURE RISE

Greenhouse gases in our atmosphere have increased since 1750 due to the consumption of fossil fuels**,** new forms of land use, and agriculture. The massive increase in greenhouse gases has lead to a rise of average temperatures by 0.74 ^{0}C since 1900. The last half of the 20th century has been the hottest period in the Northern Hemisphere (IPCC, 2007). The average temperature rise in northern areas of Pakistan in the last decade is 1.78 ^{o}C which is correlated with volumetric decrease of Siachen, Baltoro and Biafo glaciers.

To a great extent, weather patterns are predicted to change in response to global warming. Mean yearly temperature of northern areas based on five meteorological stations dataset of 1990 is 20.64 ^{o}C (Table 4.2; PMD, 1990) and that of 2000 is 22.42 ^{o}C (Table 4.3; PMD, 2000).

Table 4.2: Mean monthly temperature in 1990 in northern areas of Pakistan, dataset of selected stations provided by PMD for the correlation of average temperature rise with volumetric decrease of glaciers.

Month	Skardu	Bunji	Gilgit	Astore	Chilas
Jan-90	1.2	9.3	8.6	2.6	10.5
Feb-90	2.1	8.6	9.3	5.5	10.6
Mar-90	8.4	17.5	17.3	7.5	17.5
Apr-90	16.6	24.4	24.9	14.5	27.3
May-90	27.0	32.6	34	24.5	36.3
Jun-90	26.8	31.8	32.2	24.1	35.8
Jul-90	27.3	30.9	30.6	22.4	35.1
Aug-90	27.8	32.7	32.5	23.5	37.2
Sep-90	26.7	30.8	30.1	23.3	36.5
Oct-90	19.5	26.3	27.2	18.8	26.7
Nov-90	12.3	18.9	19	11.2	19.5
Dec-90	2.3	11.5	11.2	4.1	13.2
Yearly Average	16.5	22.94	23.07	15.16	25.52

The change of mean annual temperature from 20.64 ^{o}C in 1990 to 22.42 ^{o}C in 2000 (1.78 ^{o}C change over 10 years period) probably has caused directly or indirectly, the change in the precipitation regime and hence glacial retreat. Therefore the mean monthly temperature of Skardu, Bunji, Gilgit, Astore and Chilas is considered for this change detection, which is causing melting of alpine glaciers of northern areas.

Table 4.3: Mean monthly temperature in 2000 in northern areas of Pakistan, dataset of selected stations provided by PMD for the correlation of average temperature rise with volumetric decrease of glaciers.

Month	Skardu	Bunji	Gilgit	Astore	Chilas
Jan-00	1.8	10.9	10.6	3.6	12.7
Feb-00	3.4	12.6	13.3	2.9	14.6
Mar-00	11.9	19.1	19.3	9.5	20.5
Apr-00	20.1	25.9	26.5	17.5	28
May00	27.5	33.7	34.9	24.9	37.3
Jun-00	29.3	34.3	35.2	25.3	37.8
Jul-00	30.3	34.9	34.6	26.4	38.1
Aug-00	29.6	34.8	35.3	25.5	38.2
Sep-00	26.9	31.8	32.9	23.9	35
Oct-00	21	26.6	27.8	19.8	29.7
Nov-00	13.3	19.4	19.9	12.1	21.5
Dec-00	4.5	13.1	12.9	5.7	14.9
Yearly Average	18.3	24.75	25.26	16.43	27.36

4.7 RISING SEA SURFACE

One of the most often stated pieces of drivel from the climate science community, is that sea level rise is an indication of warming temperatures. In fact, majority of the glaciers all over the world are apparently declining, which is considered as an effect and result of temperature rise among other factors and components of climate change. IPCC (2007) reveal that sea levels have risen almost 17 centimeters during the 20th century. Probably the sea level is rising due to a collective impact of more and more water being released from glacial retreat due to global warming and of volume increase of water due to temperature rise. The sea surface rise along coast line of Pakistan is determined from satellite radar altimeter data (Figure. 4.4). Sea level rise is nearly 14mm within the last decade (IPCC, 2007).

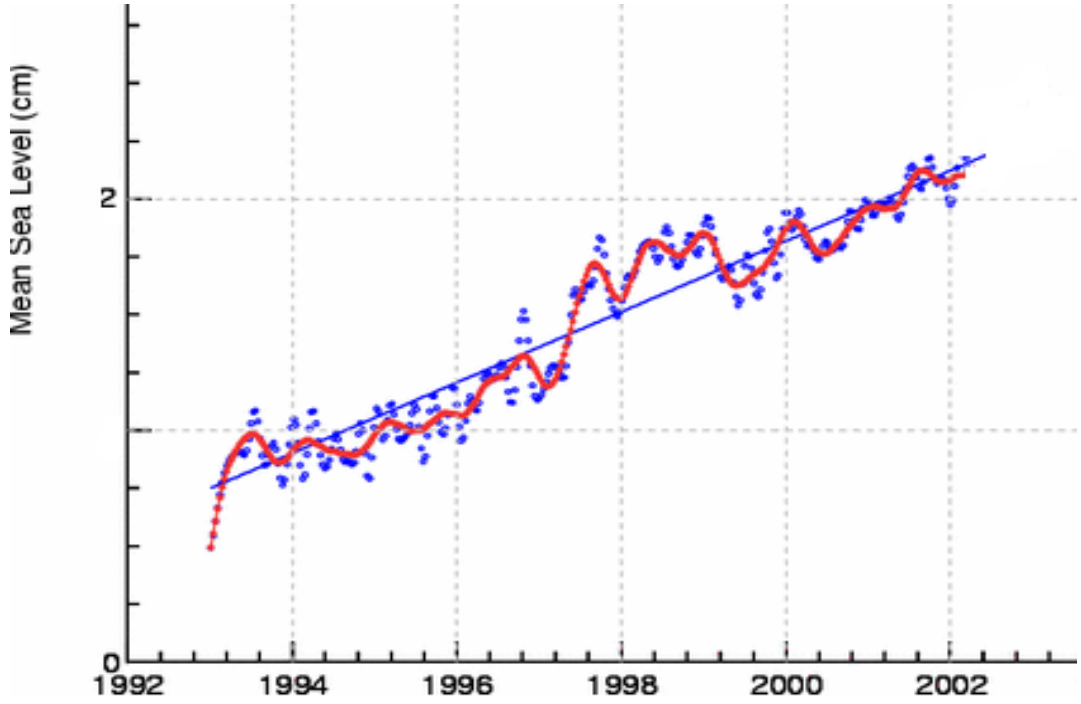

Figure 4.4: Estimated altimetry mean sea level along coastline of Pakistan (Oct 1992 – Sep 2002; IPCC, 2007).

The trend of mean sea level for Pakistan Harbor is taken from the sea level trends (Oct 1992 – Sep 2002) of the world (IPCC, 2007) shown in Figure 4.5. The increasing pattern in sea level trend has been taken as a base reference to ascertain the range of sea level rise along Pakistan coast. The estimated sea level trends show that the sea level rise along the coastline of Pakistan is within 10 to 15 mm range (Oct 1992 – Sep 2002: Figure. 4.5).

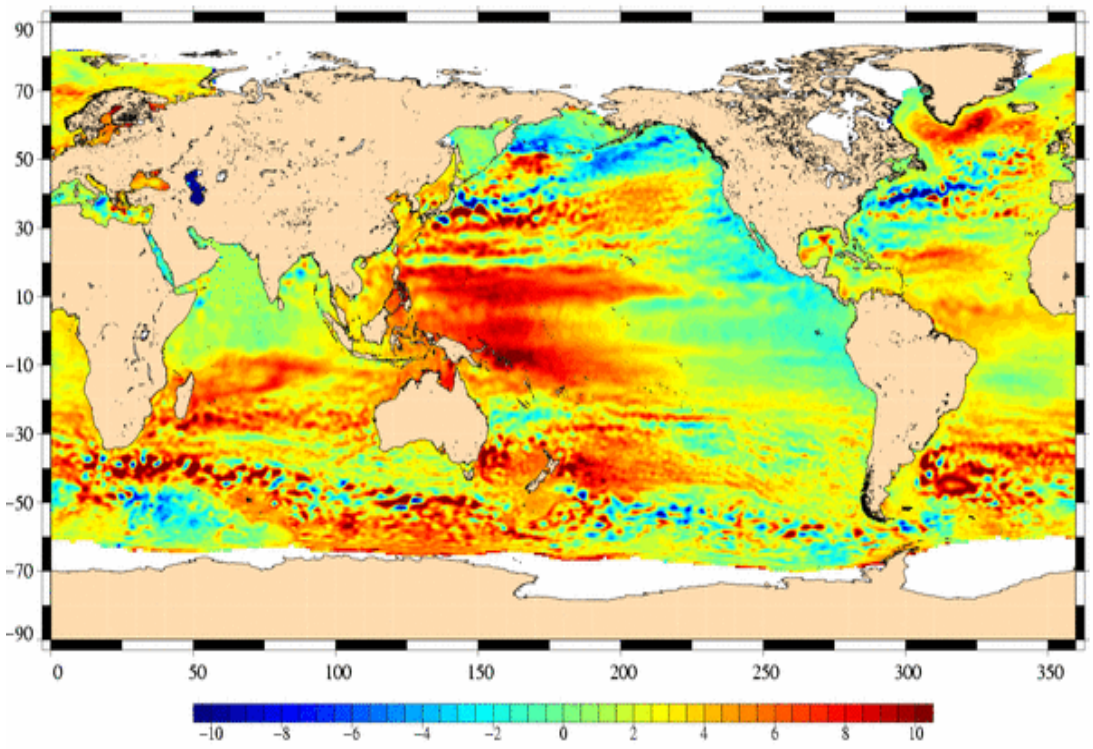

Figure 4.5: Estimated sea level trends of the world showing sea level along coastline of Pakistan within 10 to 15 mm range (Oct 1992 – Sep 2002; IPCC, 2007)

4.8 RELATIONSHIP

Glaciers are formed under conditions of sub-zero temperatures and abundant snow precipitation. Warmer temperatures and possibly reduced snow precipitation are responsible for their melting and retreating. Melting of Alpine glaciers has been particularly striking since the 1980's. Alpine glaciers had already lost more than 25% of their volume in the 50 years before the exceptionally hot and dry summer 2000 and roughly one third of their original volume since 1850 (Bundesministrium, 2003). Glaciers will experience a substantial retreat during the 21st century and the duration of snow cover is expected to decrease substantially for each °C of temperature increase at mid elevations (Bundesministrium, 2003). Glaciers will suffer a further volume reduction. Glacier retreat is expected to enhance summer flow of the alpine rivers. As they retreat, glaciers leave important masses of unstable rock material, which may contribute to debris flows.

The estimated total glacier volume loss in the alpines during the last decade corresponds to 5-10% of the remaining ice volume. As with 1.78 ^{o}C temperature rise, the average volumetric decease of Siachen, Baltoro and Biafo glaciers during the last decade is 7 % and the sea level rise along coast line of Pakistan is 14 mm, the resultant relationship applying unit rule is, "with temperature rise of 1^{o}C in northern areas of Pakistan, the volumetric decrease of alpine glaciers of Pakistan would be 4 % and sea level rise would be 8 mm along coast line of Pakistan".

5 CONCLUSION & RECOMMENDATIONS

The study of three important glaciers of northern areas of the Pakistan and their volume estimation is carried out. The study area comprised two river basins, the Shyok and Shigar. Using remote sensing data and the topographic maps available at a scale of 1:250,000 the study was completed. For volumetric decrease of glaciers, the methodology adopted is followed to achieve the subject results.

5.1 CONCLUSION

Glaciers are major sources of water, studying the volumetric decrease with temporal analysis is vital for planning, development water resource conservation, flood monitoring and mitigation activities. The major sub basins of Indus River in HKH region of Pakistan are Shyok and Shigar. Most of the snow and ice reserves are concentrated in the mountain ranges lying in these basins. These river basins contain the glaciated part in northern Pakistan, which forms the headwaters of the main Indus basin.

In this report the information given is about volumetric decrease of the three largest glaciers, Siachen, Baltoro and Biafo of HKH region of the country. In northern areas the total glaciated area is about 15,041 km^2 which is 11.7% of the total area. The volumetric decrease of these glaciers is calculated as 4 % with an increase of 1^{0}C average temperature rise during the last decade. The total ice reserve estimated in these basins is about 2,738 km^3. Altogether, more than 80% of the ice reserves are contributed collectively by Shyok (32%), Shyok (30%) and Shigar (21%) river basins. The ice reserves are subjected to manifest of global warming which is causing their decay. Overall in these basins, maximum glaciers are oriented towards north and northeast. The aspect is one of the major factors for volumetric decrease of the glaciers. Each basin behaves differently owing to the orientation of the glaciers in various ordinal directions.

There are several impacts of glaciers volumetric decrease which need monitoring and early warning systems. The most important mitigation measure for reducing the risk is to reduce the volume of water in the glacial pockets in order to reduce the peak surge discharge. Downstream in flood prone areas, measures should be taken to protect infrastructure against the destructive forces of outburst floods, as a resultant of volume decay of glaciers. Careful evaluation by detailed studies of the lake, mother glaciers, damming materials, and the surrounding conditions are essential in choosing an appropriate mitigation measure. Controlled breaching can be carried out by blasting, excavation, or even by dropping bombs from an aircraft to avoid possible peak surge discharge from glacial pockets. The volumetric decrease of these glaciers is probably due to global warming, which is a consequence of a host of factors, such as increase in greenhouse gases and decrease in ozone layer. An immediate result of melting glaciers is a rise in sea levels. Even a modest rise in sea levels could cause flooding problems for low-lying coastal areas like Karachi. Antecedent global warming factors need to be monitored and mitigated to safe guard the alpine glaciers.

5.2 RECOMMENDATIONS

The integration of visual and digital image analysis with GIS provided useful utilization for the study of glaciers. For further study and studies following propositions are made:

- Fine resolution data be acquired, to more accurately define the boundary of glaciers.
- Mathematical / empirical models be developed for ice volume calculations and for manipulations of RS data.
- Geophysical data on depth of glaciers / thickness of glaciers be collected through Pakistan Army units posted in the glaciated areas.
- The dangerous moraine dams, especially near the headwaters and settlements, needs to be monitored regularly, which are there as a consequence of volumetric decrease of these glaciers.
- In the HKH region, many rivers flow down from the high Himalayan or Tibetan Plateau to more than one country. Flash floods from landslide dam failure or glacial outburst in one country can cause havoc in the downstream areas of other countries. So inter-country flood warning systems should be established in the river valleys. A mechanism for sharing the costs and benefits of flash flooding mitigation works should be devised.

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I am highly grateful to Almighty Allah, the most beneficent, the most merciful, for giving me strength, courage and resources to complete this study.

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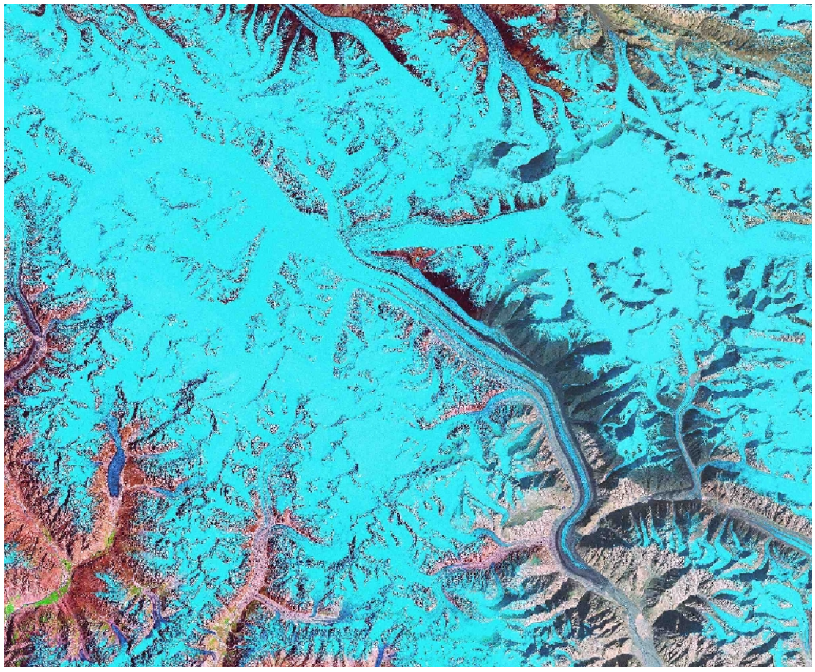
APPENDICES

APPENDIX 1(A): SCENE OF LANDSAT-7 TM OF SIACHEN GLACIER (1993)



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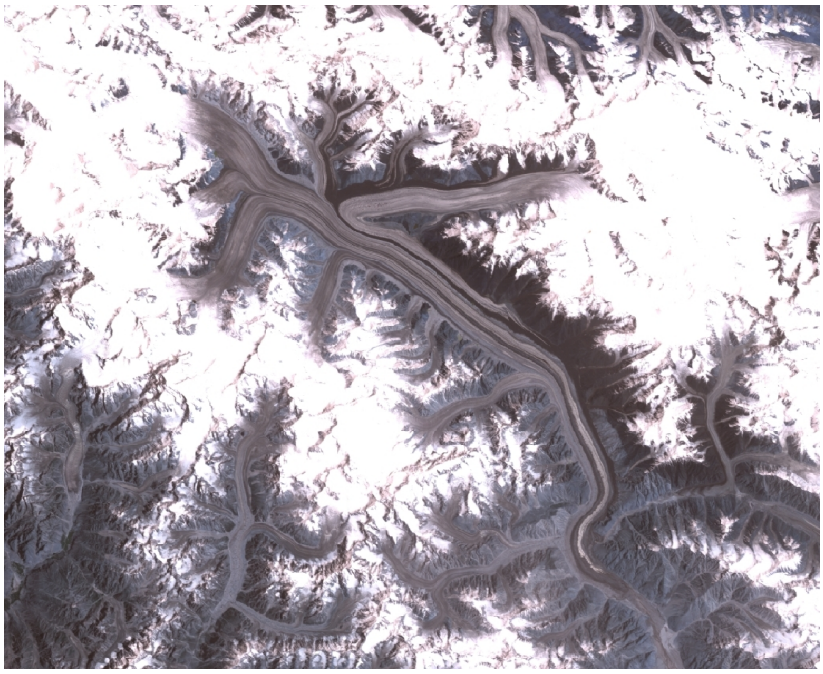

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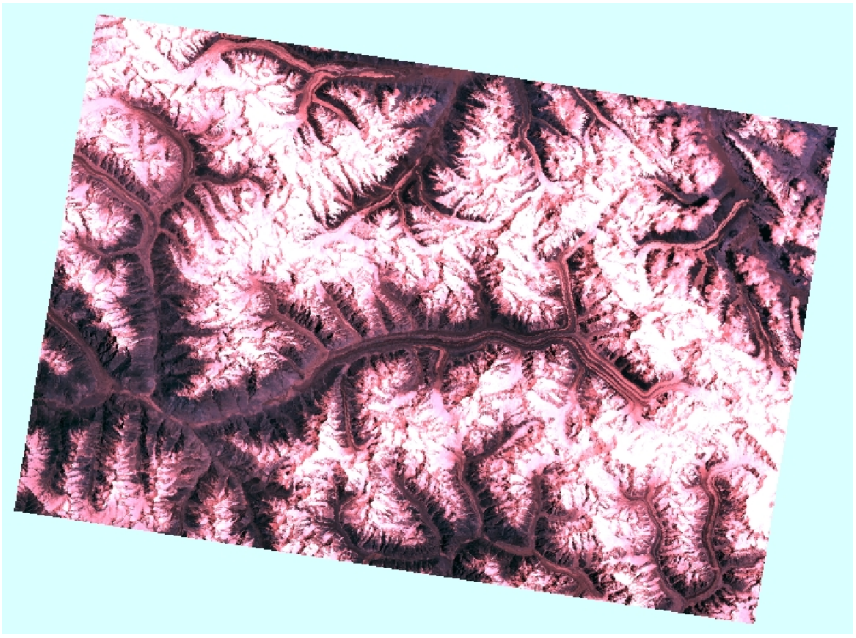

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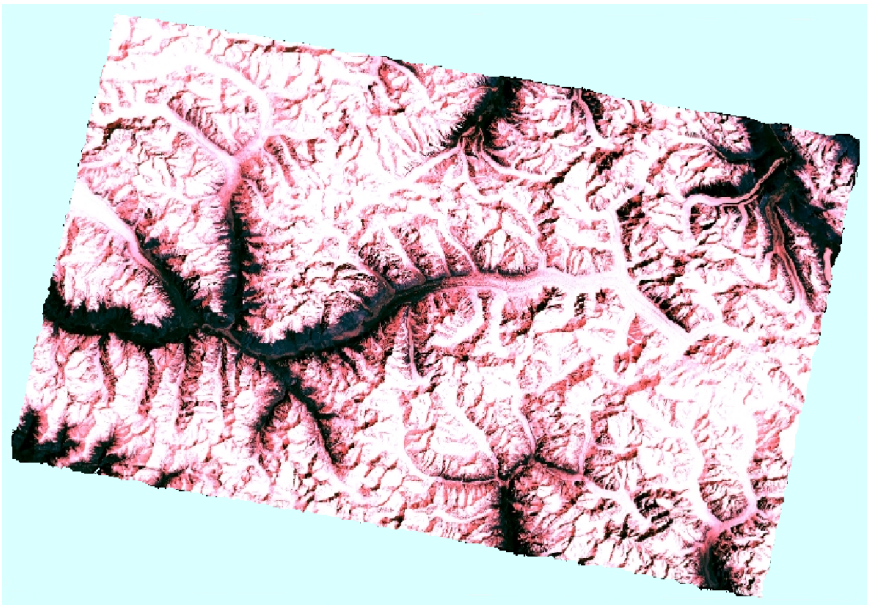

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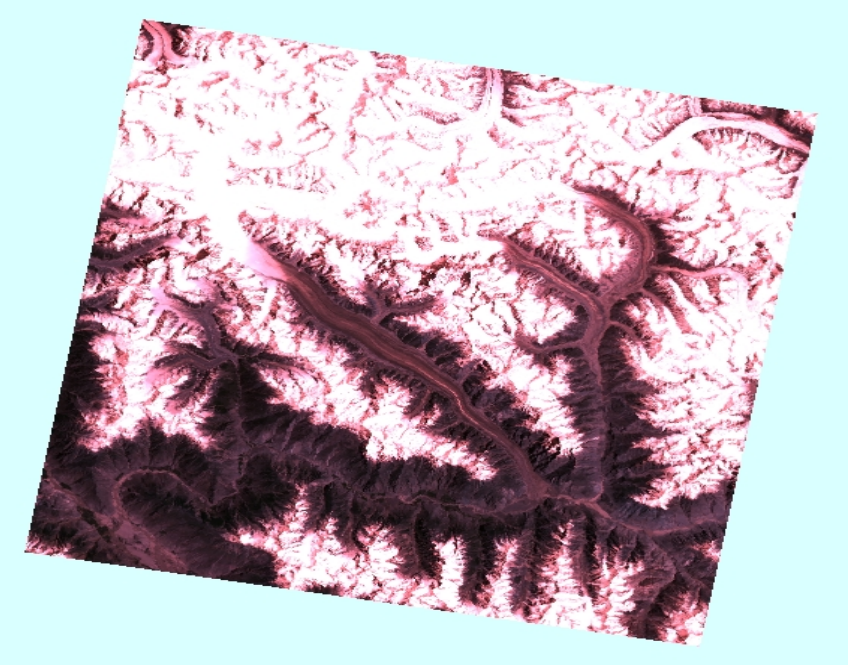

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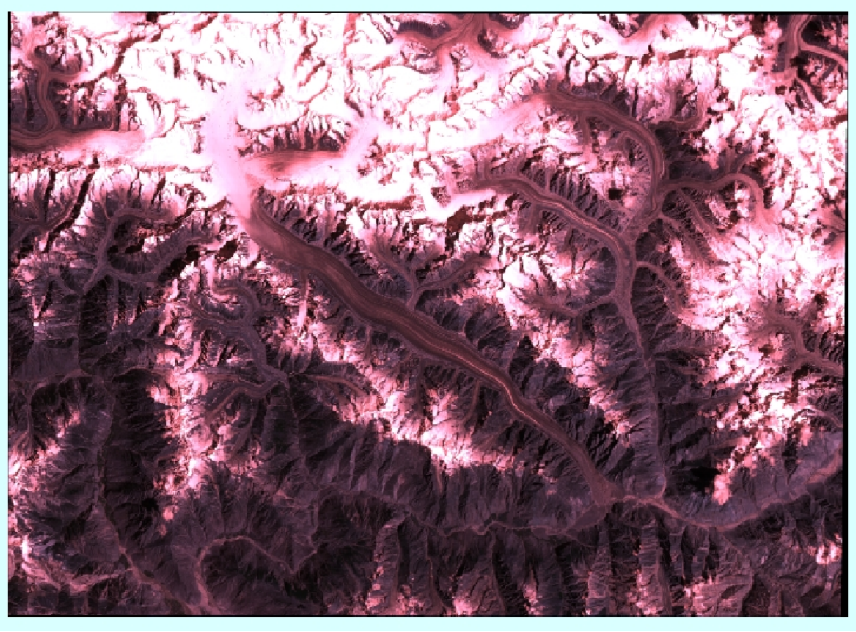
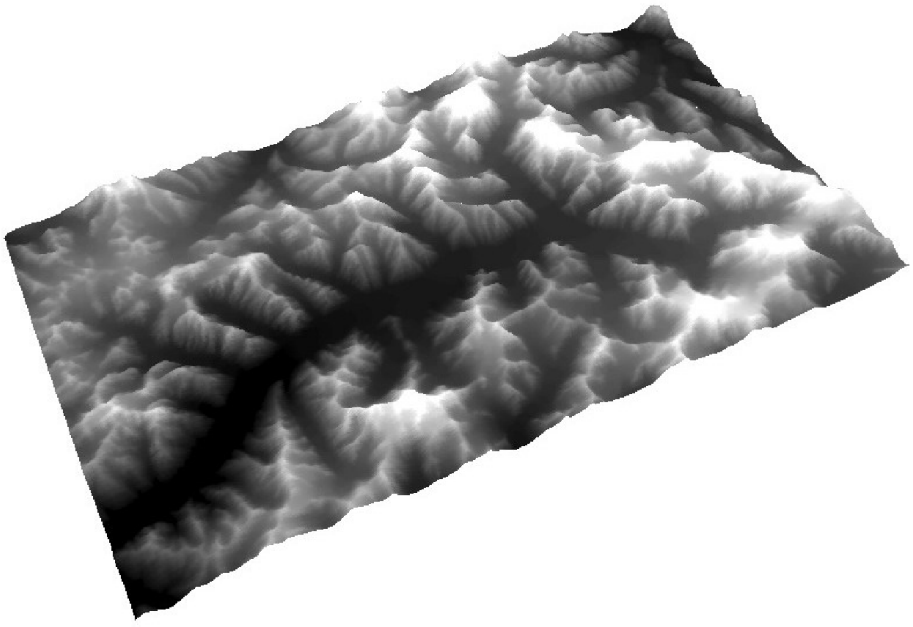


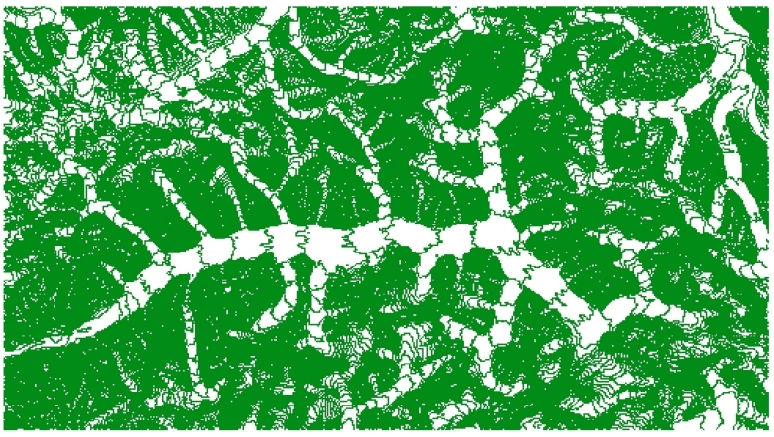
APPENDIX 2(A): BAND RATIO RESULTANT OF BALTORO GLACIER

APPENDIX 2(B): RESULTANT OF SHAPE FILE OF BALTORO GLACIER

APPENDIX 2(C): DIGITAL ELEVATION MODEL OF BALTORO GLACIER



APPENDIX 2(D): DIGITIZATION OF CONTOURS OF BALTORO GLACIER



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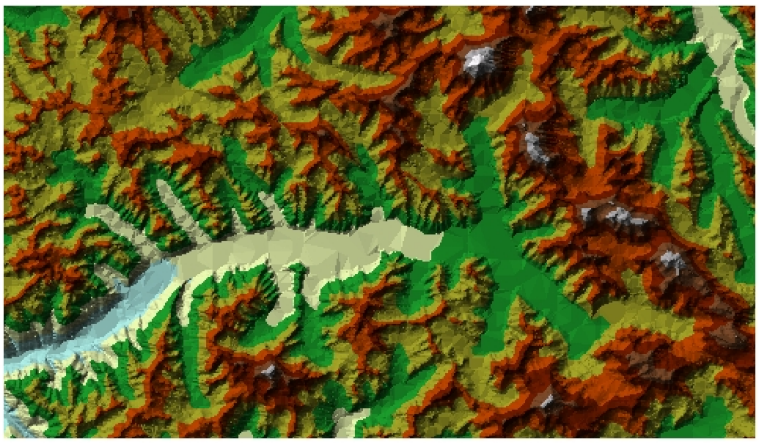
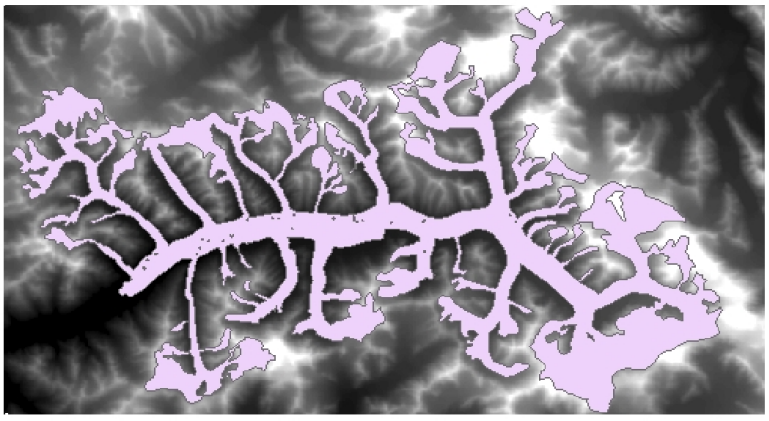
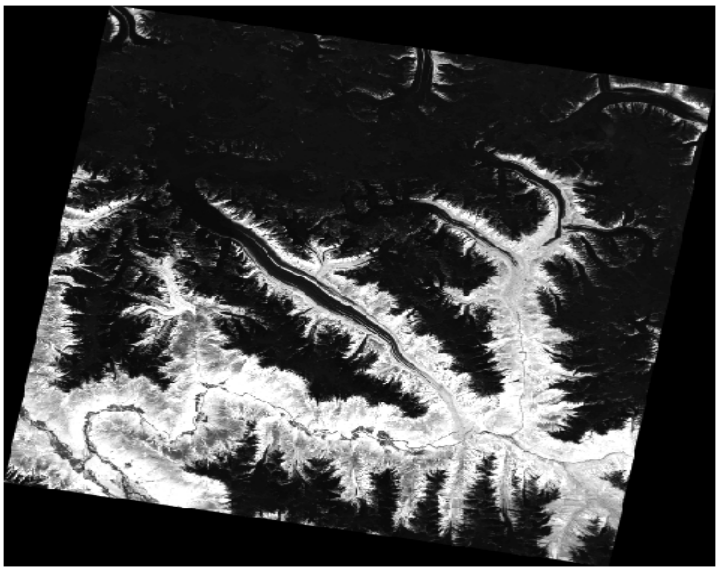


APPENDIX 2(F): EXTRACT BY MASK OF BALTORO GLACIER

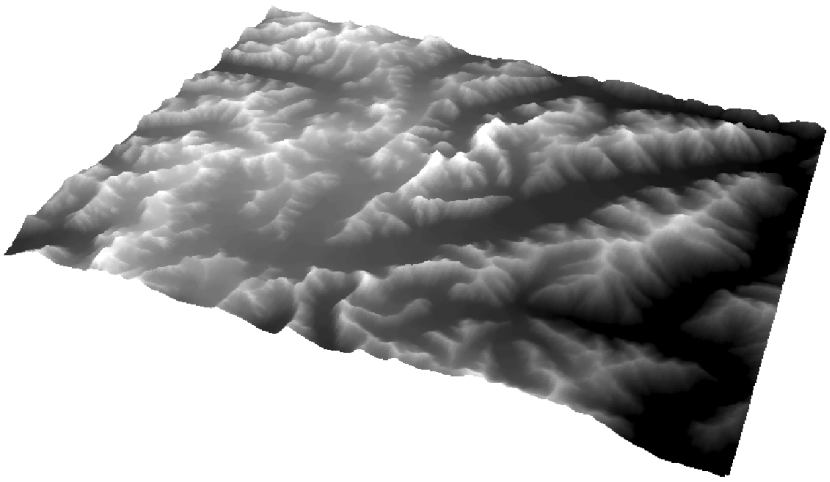


APPENDIX 3(A): BAND RATIO RESULTANT OF BIAFO GLACIER



APPENDIX 3(B): RESULTANT OF SHAPE FILE OF BIAFO GLACIER

APPENDIX 3(C): DIGITAL ELEVATION MODEL OF BIAFO GLACIER



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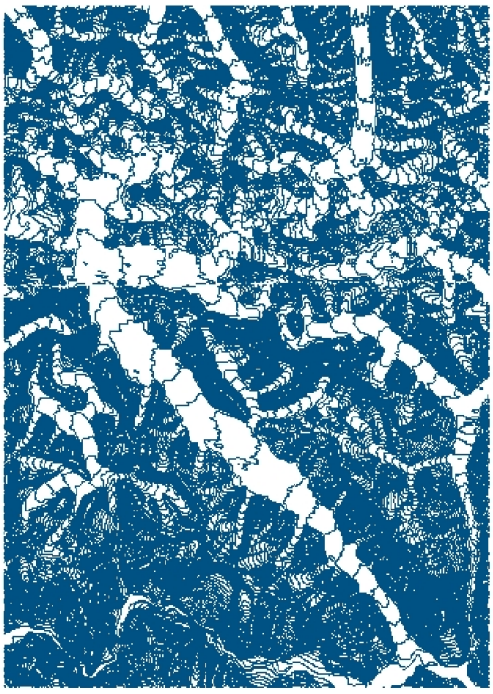

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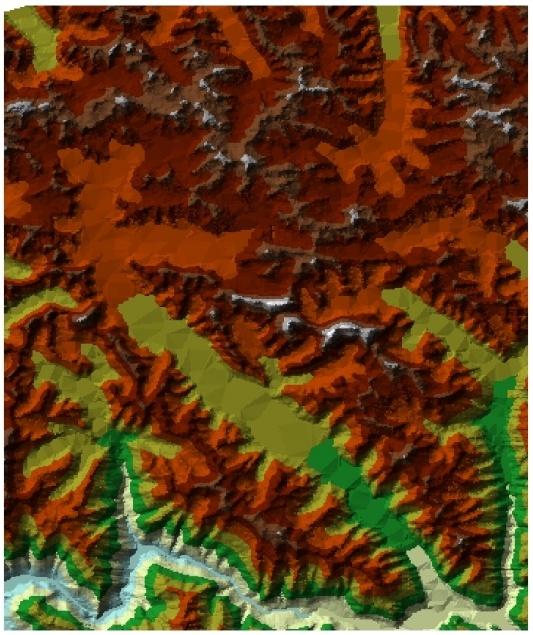

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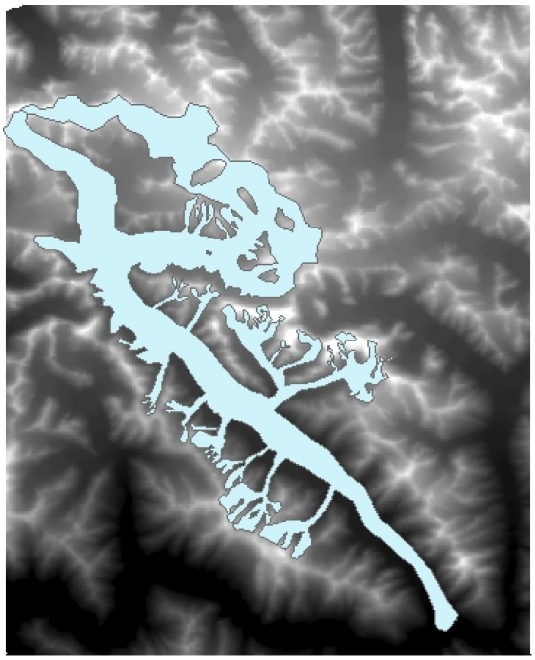
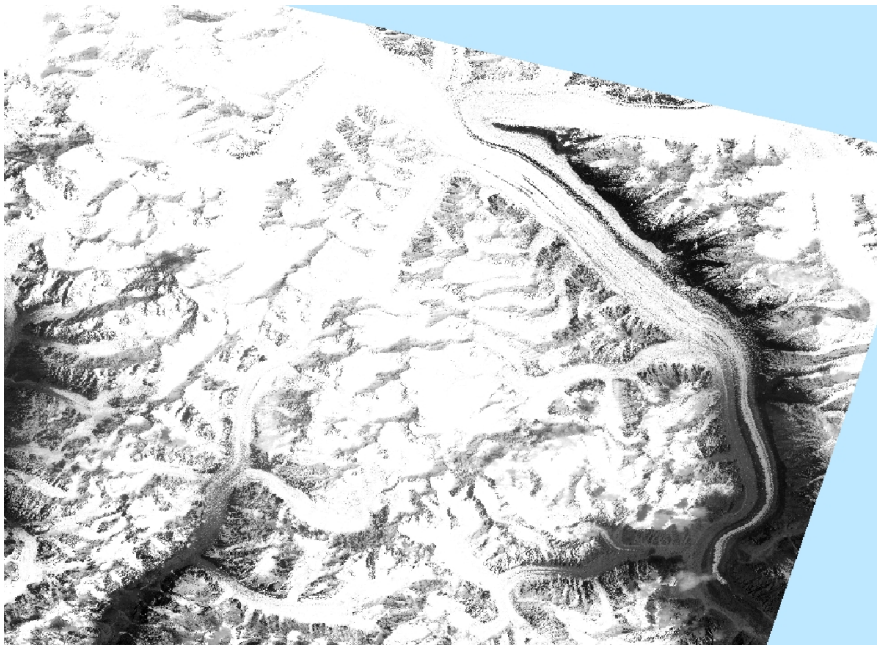
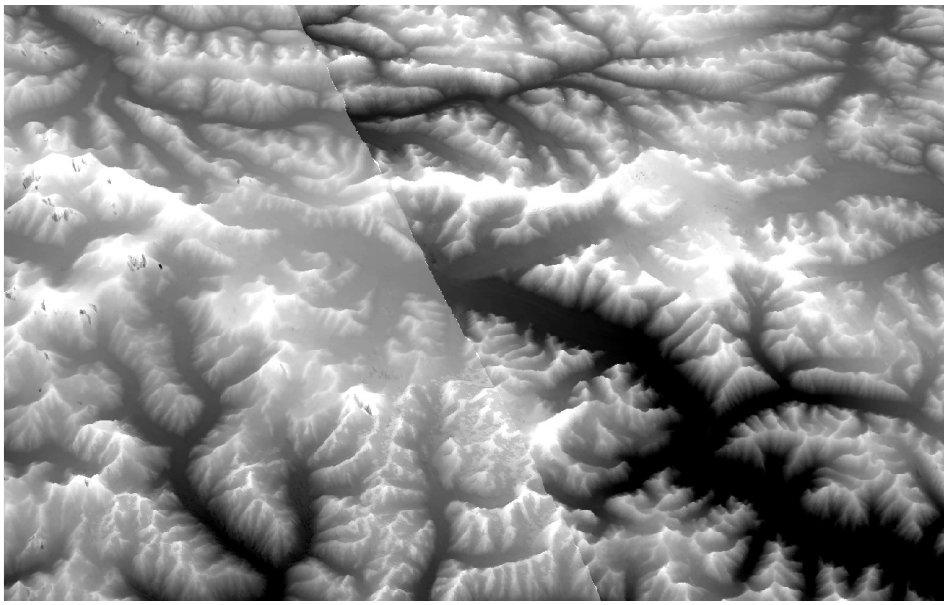


APPENDIX 4(A): BAND RATIO RESULTANT OF SIACHEN GLACIER



APPENDIX 4(B): RESULTANT OF SHAPE FILE OF SIACHEN GLACIER

APPENDIX 4(C): DIGITAL ELEVATION MODEL OF SIACHEN GLACIER



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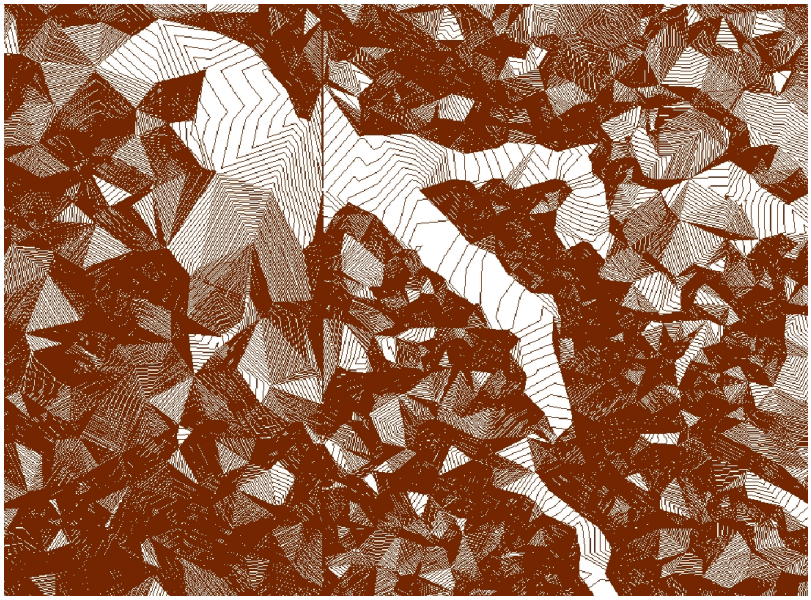

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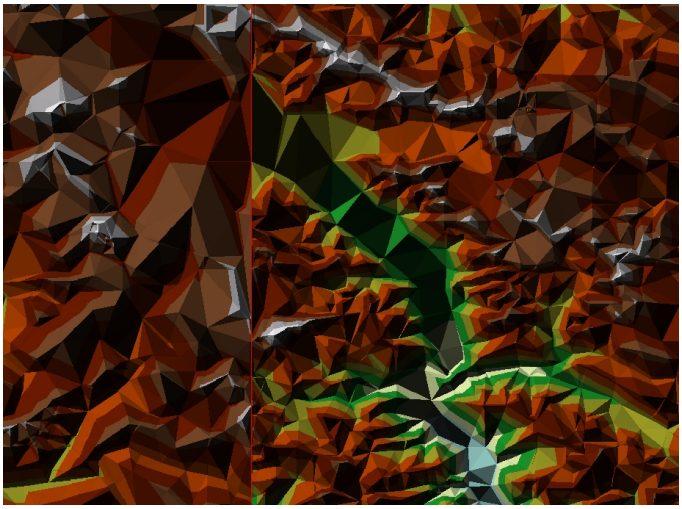

APPENDIX 4(F): EXTRACT BY MASK OF SIACHEN GLACIER

ACRONYMS

ADRG	ARC Digitized Raster Graphics
DEM	Digital Elevation Model
DHM	Department of Hydrology and Meteorology
DMA	Defense Mapping Agency
ERTS	Earth Resources Technology Satellite
TM	Thematic Mapper
FCNA	Force Comd Northern Authority
FPSP	Flood Protection Sector Study
FWC	Flood Warning Centre
Ha.	Hectares
HKH	Hindukush-Himalaya-Karakoram
IBIS	Indus Basin Irrigation System
LANDSAT	Land Resources Satellite
NIMA	National Image and Mapping Agency
PMD	Pakistan Meteorological Department
SRTM	Shuttle Radar Topographic Mission
SUPARCO	Space and Upper Atmospheric Study Commission
WAPDA	Water and Power Development Authority
WECS	Water and Energy Commission Secretariat
XS	Multispectral Mode Sensor System (SPOT)

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Role of Secondary School Career Guidance on Achieving National Manpower Development in Kenya

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ABSTRACT: Students in secondary schools need career guidance to make informed career choices which will contribute to the skilled manpower needs of the economy. This study investigated the role of secondary school career guidance on achieving national manpower development in Kenya. The study was conducted in secondary schools in three Counties in Kenya namely: Nakuru, Kisii and Migori. The study used descriptive cross section survey research design. The target population was all students and teachers in the three counties. The accessible population was all the form four students, teacher counsellors and head teachers. Public County, Sub County and Private secondary schools were used as sampling units. Simple proportionate random sampling was used to select 32 secondary schools in the three counties. A sample of 429 respondents comprising of 365 students 32 head teachers and 32 teacher counsellors was used. Three questionnaires: Student Questionnaire (SQ), Teacher Counsellor Questionnaire (TCQ) and Head Teacher Questionnaire (HQ) were used to collect data. Reliability of the instruments was estimated by use of Cronbach` alpha coefficient. Reliability coefficient of 0.78 for (SQ), 0.81 for (TCQ) and 0.79 for (HQ) were obtained. The hypotheses was tested using Pearson Product Moment Correlation Coefficient. The findings indicate that there was a positive and statistically significant relationship between students and teacher counsellors` perceptions on the effectiveness of guidance services. The findings further indicate a relationship between the school guidance programme and students' career choices in National Manpower Development and a relationship of the roles played by teacher counsellors, and head teachers in the influencing students` career choice. It is recommended that all secondary school students be provided with equal opportunities to access effective career guidance services.

KEYWORDS: Career, guidance, manpower, economy.

1 INTRODUCTION

School Career guidance programme provides professional services to students to enable them make appropriate decisions on their future careers. Downing (1968) explained that guidance services are an organized set of specific services established as an integral part of the school programme. These services are designed to promote the development of students and assist them move towards a realization of sound wholesome adjustment and maximum accomplishment according to their potentialities. They assist them to understand, accept themselves and utilize their ability, aptitudes and interests to acquire skills which will make them become useful members of society. The counseling needs of students are enormous be they boarders in their respectful schools or day scholars. Apart from other areas of concern such as psychological, social and financial needs of students, career choice becomes an important issue directly or indirectly related to these factors. This leads to the need for both group and individual counseling to supplement each other (Gladding, 2004).

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At secondary school level, Europe is at varying degrees of awareness of the fact that complete reliance on procedures and outlook of 19th century is no longer adequate. Education for national development is important. Western European countries are faced with challenges of ensuring that secondary school education produces school leavers ready to train in various skills to meet challenges of changing needs of societies. It is hoped that in developing countries education can ease tension caused by socio-economic challenges. Education systems especially at secondary school level should recognize the need for new skills to meet the challenges of the 21st century (Jaiswal, 2011)

In developing countries like Kenya career guidance services are important in realizing skilled manpower in various sectors to accomplish projected development plans as stated in vision 2030. The dependence on expatriates hired from developed countries can be reduced considerably as Kenya`s vision is to be an industrialized, middle level income country by the year 2030. (GOK, 2007). In this approach, national manpower development is guided by three important pillars: the social pillar, the political pillar and the economic pillar. The first and immediate challenge is to meet the human resource requirements by producing a larger workforce with many skills for the rapidly changing and diverse economy. The skills learnt will make students more productive and satisfying in an expanding and a middle income industrialized nation with a diverse economy. The curriculum in secondary schools has core subjects for all students and a few elective subjects. To select subjects to study, students` abilities, interests and goals should be considered. A student may have many abilities and interests and hence have difficulties in deciding which subjects will be most useful for him/her in the long run. A student will need to understand his/her curricular choices to meet individual career objectives. Chances of being unrealistic are high especially when the interests require higher level of abilities (Kinai, 2005). To achieve this objective teacher counselors should avail information about careers and the world of work to the students. Career guidance in schools is necessary so that students pursue relevant, market oriented and competitive careers. Students should also aim at job creation in various sectors than training to become job seekers. Among the earmarked sectors to expand and continually develop by 2030 are: education, health, tourism, agriculture, ICT and science and technology. The Ministry of Education, in conjunction with the Teachers Service Commission emphasize the training of teachers in guidance and counselling to assist students play a role in national manpower development and face the challenges in life. This is a positive move considering the type of education offered in the country in early years of independence (GOK, 2007)

The Kenya Education Commission of 1964 (GOK, 1964) discusses how education was provided to people living in Kenya based on racial lines; Europeans, Asians and Africans. In this report, it was recommended that schools should provide guidance and counselling services to students and teachers to enable them overcome challenges in life. Kenya aims to create a globally competitive and adaptive human resource base to meet the requirements of vision 2030. Skills can be developed in various areas such as: science, ICT, technology engineering and medical. This can successfully be done by students selecting careers which offer training in skills that are in line with the country`s economy guided by vision 2030. Although guidance and counseling is being offered in schools, the practice does not exist in depth nor is it being provided in a coherent and comprehensive manner. Specifically, it does not address in a holistic way career guidance, personal development and educational mentoring. Career teacher stiil need more skills to provide this support. Teacher, parents and other educational partners need to work together to provide support and training to assist student join the world of work (GOK, 2012). Guidance and counselling is emphasized in schools by many countries so as to address their manpower development needs. Kinai (2005) asserts that this is a positive development more especially in the developing countries. She states that in Ghana, students are advised in their third form in secondary level to select either arts or science based careers depending on their abilities. Students make decisions on how to contribute to their own life and country's economy and development in general. She further indicates that similar efforts are being made by Latin America and South American countries like Bolivia and Columbia. In 1970, the Bolivian Educational code prescribed that principals of schools and their teachers were to attend short courses to enable them provide educational and vocational guidance to students. Kinai further reports that in Columbia, guidance services in vocational and educational programmes are provided as the country sets aside funds for training and buying materials for teachers to assist them guide students. In 1977, the government of Nigeria saw the need for formal and modern guidance and counseling in the education sector and provided for it in the National Policy on Education 2004 (Journal of Education and Practice Vol 4 No 3 of 2013). Many young people were found to be ignorant about career prospects, and in view of this problem, career counselors were appointed to cover both primary and post primary learning institutions. This was a remarkable step towards ensuring that students made a proper career choice through the assistance of guidance and counseling services.

Wachanga, Githua and Keraro (1999) carried out a study in Egerton University on students`s perceptions on courses they take and their career expectations. The findings from this study revealed that many students were not sure of the careers to join on completion of the courses they were undertaking. Indeed there was a mismatch between the courses they were taking and preferred careers on completion of their university studies. This is a clear indication that there is an urgent need of guidance of students who join university without a clear cut career choice. It becomes frustrating when students join

universities and take up available opportunities and pursue careers whose future prospects they are not sure of. The study reveals a dire need for career guidance and counseling for school leavers. In Kenyan schools guidance as a practice needs to be intensified. Students hardly receive sufficient guidance and counselling services on career choices at the right time. Indeed, to date some of the students who qualify to join universities in Kenya and are selected through the Joint Admission Board (JAB) are given a second chance to revise the selection of courses they would like to pursue at the universities. Such a situation should not arise if students have enough information on career selection early enough. It is expected that youngsters should set their life goals early enough through role models, information provided by guidance and counselling departments and school curricula. Once guided and counseled students stand to benefit by selecting careers of their choice. The economy too stands to gain by having quality and well qualified personnel in various fields.

The Kenya Government`s Five Year Development Plan 1978 (GOK, 1979-1983) recommended that guidance and counselling be incorporated into the teacher training curricular at both college and university levels. The policy was implemented but according to the report on the National Commission on Educational Objectives and Policies (ROK, 1976) the content was inadequate to prepare effective counsellors. It recommended the incorporation of a compulsory course in guidance and counselling in all teacher education programmes. This was reinforced by the Report of the Presidential Working Party on Education and Manpower Training for the Next Decade and Beyond (Kenya Republic, 1988) which recommended that the Kenya Institute of Education (KIE) develop curricula on guidance and counselling. This was a turning point in the Ministry of Education as the need for the guidance and counselling programmes in Kenyan schools became more urgent. A report on Totally Integrated Quality Education and Training (GOK, 2002) proposed that an early start on career guidance for students is likely to have a greater impact. Getting a job requires certain educational and professional qualifications and preparation leading to the need for guidance in career choice by an individual. Students need for assistance in preparation for a career through relevant subject selection. Students need to develop an integrated picture of themselves and the role they need to play in a developing world. New occupations are emerging and it therefore becomes essential that students are helped in acquiring a clearer perspective of the changes that are taking place. It will help students to think big, work hard and aim higher in the choice of future careers. Carson (1996) argues that children who excel early and stay motivated have a higher chance of educational success. In view of the significant role of the guidance and counseling services offered in secondary schools, students should be assisted to make informed choices on their future careers.

Students face problems in selecting careers. In many cases they make wrong or poor choices uncertain of what the selected careers will lead to. Some of the high school graduates join universities or colleges with little information about the future prospects the selected courses will offer**.** Lack of enough information forces students to change career choices midway after poor performance leading to discomfort. This further makes the students to become frustrated, dissatisfied and seek for new avenues. Such students may drop out of institutions because of frustration. It is not clear how much time and resources are allocated for career guidance services offered in secondary schools necessitating this study to investigate the Role of Secondary School Career Guidance on Achieving National Manpower Development in Kenya

2 LITERATURE

Government of Kenya (2000) pointed out that Kenyan institutions of learning had not successfully inculcated a positive attitude toward career development. It recommended a new approach in view of improving the situation. This was to make guidance and counseling attractive so that learners go for the services. Unemployment and poor performance in public and private sectors in the country are likely to have been caused by lack of skilled workforce. This was likely caused by lack of proper guidance and counseling. Higher education and training is key to a developing economy as a source of production of trained and educated personnel to meet the needs of the country`s economy. Higher education and training leads to the production of skilled personnel which are in line a rapidly changing society. Areas of development include ICT, technology and sciences. School guidance programme is key to the success of effective guidance Maitra (2007). Makinde (1984) points out that guidance and counseling in Africa will bear fruit only if it focuses on educational and career planning skills. In Kenya, the government regularly reviews curricula to meet the ever changing needs of learners and the country`s manpower needs. Kenya`s education system which was inherited from the British system of education has gone through many changes geared towards the provision of quality education leading to the production of people with market oriented and competitive skills. Bogonko (1994) argues that for Kenya to have students with relevant skills to meet the manpower demands, the country aimed at re-orienting the secondary school curriculum towards Science and Technology. By 1990, progress had been made to ensure that secondary schools had laboratories which were well equipped in most of the secondary schools to produce science graduates for manpower needs. At this time Kenya needed manpower with skills to replace expatriates. Secondary education was particularly regarded as the most important stage in education system which could help in solving the manpower constraints of the country. Expansion of education at this level was emphasized in Sessional Paper 10 of 1995 which noted that the immediate objectives in education were to expand secondary level facilities to be able to produce the

required manpower. In curriculum diversification, Sifuna and Otiende (2006) propose that once schools produce the manpower needed by a developing country, then the pace of economic development in Kenya could be accelerated. They note that a major step in education has been diversification of the curriculum to make sure that the academic world has room for vocational education giving students a chance to acquire vocational skills of their choice. However, the challenge of producing the required human resource is not yet over. This means the country should continue producing manpower to cater for all sectors Nasibi (2006). Diversification is said to free students from being locked into one curriculum and by so doing provide a wide set of future career options.

In order for career guidance and counseling to make significant contribution to national manpower development, it must impart significantly high level of career awareness which will lead to appropriate career planning and decision making, Luzzo, James and Luna (1996) found out that students who received an additional retraining exhibited significant changes in their career beliefs and exploration behaviors. This implies that career guidance and counseling leads to deeper and wider understanding of one`s personality and the choice of career in general. One of the major objectives of education is to produce manpower for a country`s economic development. Soon after attaining independence, Kenya embarked on education expansion aimed at providing qualified personnel for the growing economy, administration and management of government businesses to reflect an independent state (Sifuna, 1990). While aiming at Africanizing of governance and the economy, the government through the education sector encouraged Africans to take up training which would eventually lead to appropriate career roles (Sifuna, 1990) This is being achieved through the current system of education 8.4.4 which led to the establishment of Moi University as a second university to produce graduates with skills to meet manpower requirements needed in the developing the country. The 8.4.4 system with its emphasis on technical and vocational training of students for manpower development and self-employment was initiated to make Kenya train enough manpower (Sifuna, 1990). Education needs to make people who go to school fit in the world of work to contribute to the national economy. This means that a linkage should be built between education and work so that individual growth, development and achievement can be achieved through them. Parents should be at the forefront encouraging students to take up careers of their own interest rather than forcing some career choice on them.

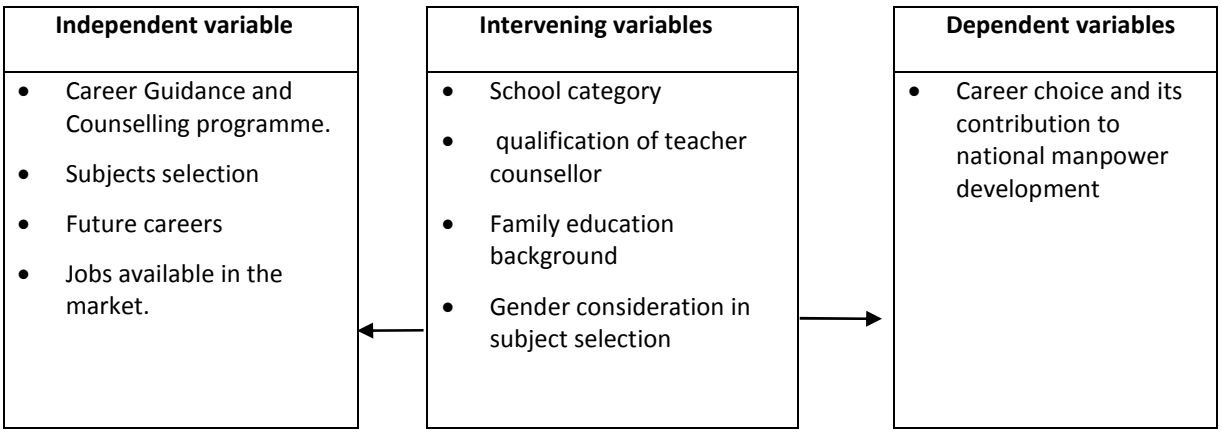
After completing secondary education, students often find themselves at crossroads. Most school leavers find themselves devoid of adequate information to prepare for the next stage of their lives and more often than not, land on a career for which they have no aptitude and regret throughout their lives for having made a wrong choice. In most cases, parents who influence their children`s career choice have no proper information or are not fully conversant with the opportunities available after school (Kurgat, 2005)

If schools could produce the manpower needed by a developing country, then the pace of economic development in Kenya could be accelerated. To achieve this, students should be made aware of the needs of the country as clearly spelt out the national education goals. The career development facilitators in schools need immense knowledge of the rapidly changing world. The continuing learning should challenge the learning of the past and bring about newer and broader perspective of career understanding in line with the dynamic, local, national and international trends (Patton & Mahon, 1999). The greatest challenge for schooling today is that the students do not see the link between schooling; careers and societal education ideals and values do not necessarily focus on the learner (Ogola, 2002). The gap may be filled if career guidance services in school are provided, enabling learners to contextualize the education process into life outside school.

The Presidential Working Party on Education and Manpower Training for the Next Decade and Beyond (GOK, 1981) was the next important commission which made recommendation on manpower survey and proposed the need to be a continuous process to determine accurate data for effective planning, development and utilization of human resources. The commission also recommended that teachers appointed to coordinate guidance and counseling programmes in schools get additional training to become more effective in their work. The head teachers were to ensure that all students in school had access to guidance and counseling services. Each school was to establish a guidance and counseling committee headed by a teacher appointed by the head teacher. It was also recommended that the Kenya Institute of Education be charged with the responsibility of developing a suitable and relevant guidance and counseling syllabus.

The ministry of Education Working Committee on Guidance and Counseling in Schools (GOK, 2000) set a program on information flow in two directions, opportunity structures available and qualifications expected from school leavers. This was set in a career booklet. Each year students got sufficient copies to guide them on careers in various universities and colleges. Students have to makes selection of opportunities available and work for them. Ndambuki and Mutie (2007) assert that due to lack of guidance and counselling, many students go to school and leave without any idea of the kind of jobs they should train for Other students move from job to job once they are employed simply because they lacked enough guidance and counselling when at school.

CONCEPTUALIZATION



The above variables interact in both directions to effectively influence guidance and counselling services in secondary schools. The effective management of resources is key to effective services. The students` perception and appreciation of services rendered will be greatly influenced by the school administration, attention given to students, utilization and management of resources. The intervening variables will be controlled through the random sampling of respondents, giving the students equal chances under all conditions.

The purpose of the study was to investigate how career guidance services are contributing to national manpower development. The hypothesis was testedusing chi- square.

3 METHOD

The study used a cross-section survey design. This design was ideal for the study as it allowed for the use of different groups of respondents to study various variables at a given time. Cross section research design allows the researcher to assemble several study groups or samples selected from the same population and record the variable measures for each group. The study was conducted in three counties: Nakuru, Kisii and Migori in Kenya. The three counties were purposively sampled because of their location and socio-economic activities which take place such as flower farming and associated industries (food crop farming, flower farming, tea growing and processing, sugar cane farming and sugar processing) and fishing. These economic activities are likely to lure school leavers with casual jobs which would negatively impact on their aspirations for future more professional and challenging careers. Random sampling was used to select 365 form four student respondents in 32 secondary schools. Purposive sampling was used to select 32 head teachers and 32 teacher counselors. This was ideal because of the positions they hold and services they render in respect of students` guidance and counseling in their respective schools. The total sample was 429: 365 students. 32 head teachers and 32 teacher counsellors. Three questionnaires: the Student Questionnaire (SQ), the Teacher Counsellor Questionnaire (TCQ) and the Head teacher Questionnaire (HQ) were developed by the researcher and used for data collection. Quantitative data was analyzed by the use of inferential statistics. Pearson Product Moment Correlation Coefficient was used to test the study hypotheses and the results were accepted or rejected at an alpha level of 0.05. Ho1 There is no statistically significant relationship between career guidance programmes and national man power development was tested using Pearson Correlation.

4 RESULTS, INTERPRETATION AND DISCUSSION

Table 1: Students Career Choice Preparation

Career Preparation	SA	A	NS	D	SD
Preparation of students for future career	45.5	34.0	7.9	9.6	3.0
Career guidance to help students choose a career	36.4	36.5	8.2	14.8	4.1
Teacher counselor as a role model	39.5	27.8	6.8	15.9	10.0
Guest speakers assisted students know marketable careers	41.6	35.1	6.6	12.6	4.1
Guest speakers assisted students choose a career	47.2	32.5	8.4	7.5	4.4

Results in table 13 shows that a majority of students (89%) were well prepared for future careers because of the career information they received from teacher counselors organized by guidance and counseling department. Most of the students (72%) agreed that they were able to choose careers because of the efforts of teacher counselors compared to (28%) who disagreed. Most of the students (67%) agreed that teacher counselors were their role models. Most of the students (79%) agreed that guest speakers who visited schools and talked to them in choosing market careers compared to (11.9%) who disagreed and (8.4%) who were not sure.

Table 2: Students Level of Preparedness for their Future Career

Table 2 below shows the extent to which students are prepared for their future careers. It also shows the level of commitment of teacher counselors to make sure that students understand what subjects are required in particular careers. The study used Likert Scale of 5 – Strongly Agree (SA), 4 – Agree (A), 3 – Not Sure (NS), 2 – Disagree (D) and 1 - Strongly Disagree (SD)

Outcome of Career Education	SA	A	NS	D	SD
The students are prepared for future career	45.5	34.0	7.9	9.6	3.0
Career guidance has helped students choose a career	36.4	36.5	8.2	14.8	4.1
Teacher Counselor has remained a model	39.5	27.8	6.8	15.9	10.0
Speakers assisted students understand marketable career	41.6	35.1	6.6	12.6	4.1
Speakers assisted students choose a career	47.2	32.5	8.4	7.5	4.4

The information collected as indicated in table 28 showed that majority of the students (89.5%) agreed that they were more prepared for future careers because of the career education they received from the career guidance department compared to (12.6%) who disagreed and (7.9%) who were not sure. Majority of the students (72.9%) agreed that they were able to choose careers because of the efforts of the career guidance department compared to (28.9%) who disagreed and (8.2%) who were not sure. Majority of the students (67.3%) agreed that teacher counselors have always remained their role models as far as career choice was concerned compared to (16.9%) who disagreed and (6.8%) who were not sure. Majority of the students (76.7%) agreed that speakers who visited their schools assisted them in understanding marketable careers compared to (16.7%) who disagreed and (6.6%) who were not sure. Majority of the students (79.7%) agreed that speakers who visited their schools assisted them in choosing marketable careers compared to (11.9%) who disagreed and (8.4%) who were not sure.

Information gathered from the field shows that students in the secondary schools in the three counties had positive perception on the outcome of career guidance programme in their schools and more especially on their preparation for future careers, the students were able to choose careers because of the efforts of the career guidance department. The teacher counselors have always remained their role models as far as career was concerned. The speakers who visited their schools assisted them in understanding details on how to select marketable careers and also assisted them in choosing marketable careers.

Table 3: Adequacy of Career Programme in National Manpower Needs

Table 3 below shows the extent to which schools are prepared to train graduates to support the country`s manpower needs as clearly stipulated in Sessional paper 1 of ( 2005) on the need for development of quality human resource to meet the country`s manpower needs.

National Manpower Development (NMD)	SA	A	NS	D	SD
Head Teachers support CGC program on NMD	21.9	53.1	9.4	12.5	3.1
Head Teacher gives Teacher Counselor Support	31.3	62.5	-	6.2	-
Head Teacher Support external Career Speakers	40.6	37.5	9.3	6.3	6.3
ICT and hotel are popular careers	15.6	43.8	18.8	18.8	3.0
Engineering and medical are popular careers	15.6	46.9	12.5	9.4	15.6
Computer Technology are popular careers	8.5	11.3	9.6	35.3	35.3
Marine Science has become popular careers	6.3	8.3	23.1	38.5	23.8
Aeronautical Engineering are popular careers	4.6	9.2	21.7	41.6	22.9
University Lecturing has become popular careers	39.5	41.5	8.5	5.8	4.7
Students are taking career in leadership	47.2	42.8	-	4.2	5.8

Information collected from the study as shown in table 30 above indicated that majority of the Head teachers (75.0%) agreed that Career Guidance and Counseling Program on National Manpower Development gets support from their administration compared to (15.6%) who disagreed and (9.4%) who were not sure. In terms of giving support to the teachers counselors, the majority of the Head Teachers (93.8%) agreed that they give the required support compared to (6.2%) who did not give support. The majority of the Head teachers (78.1%) agreed that through their support, the Teacher Counselors were able to arrange for speakers from outside to speak to students on careers in various fields such as; science, medical and engineering compared to (12.6%) who did not agree and (9.3%) who were not sure whether head teachers gave this particular support. In terms of students developing interest in various subjects, the majority of the Head Teachers (59.4%) agreed that students in their schools had interest in ICT and Hotel Industry, (63.5%) agreed that students in their schools had interest in career in sciences like engineering and medical, (81.0%) agreed that students in their schools wanted to further their education so that they become university lecturers and (90.0%) of the Head teachers agreed that students in their schools were already taking careers in leadership. Conversely, the study established that the majority of the Head Teachers (70.6%) indicated that students were interested in careers in Computer Technology, (62.3%) observed that the students in their schools have never selected marine sciences as a career and majority of Head teachers observed that aeronautical engineering courses were not popular in their schools.

This information indicted that in terms of the National Manpower Development, the career guidance in schools had played the following roles; Career Guidance and Counseling Program on National Manpower Development which got support from school administration. The Head Teachers gave the necessary support to the Teachers Counselors in running the career programs as a way of enhancing the success of National Manpower Development. Through the support of the Head teachers, the Teacher Counselors were able to arrange for speakers from outside to speak to students on career in various field as; science, medical and engineering as a way of popularizing the careers for the National Manpower Development. As a way of supporting the National Manpower Development goals leading to the success of vision 2030 the students had developed interest in the careers in the following areas; ICT and Hotel Industry, sciences like engineering and medical, university lecturers and leadership. The general trend in career choice is encouraging and positive to meet the country manpower needs leading the landmark achievement of vision 2030 which will make Kenya a middle industrialized economy.

The career guidance programmes in secondary schools is solely under the management of the Teacher Counselor through the support of the Head teacher and it is his/her duty to make sure that the program is not only functioning but also adequate. The key variables used to analyze this objective included: the Teacher Counselor`s role in providing information to the students on careers that lead to helping the students get jobs, inspiring students to consider careers of their interests which area popular in the job market, encouraging students in taking more challenging careers, explaining to students how science related careers will be useful in the future. The teacher counselor should make sure that the career centers have enough materials that enhance manpower development and encourage parents to regularly visit schools in relation to their children career. They should explain to students on the importance of ICT and technical subjects in career development, availability of enough materials for counseling services in, consultation with other teachers regarding students` career selection in relation to National Manpower Development. The teacher counselor should encourage students to choose career in agriculture, medical sciences and marine sciences which are of high demand in the realization of Vision 2030.

Table 4: Adequacy of Career Programs to Support National Manpower Development

Adequacy of CG Programmes	SA	A	NS	D	SD
Key subject areas for getting a job	21.9	50.0	9.4	15.6	3.1
Selection of popular career of interest	21.9	46.9	9.4	18.8	3.0
Taking up challenging careers	12.5	46.9	12.5	28.1	-
Science subjects are important	18.8	50.0	12.4	9.4	9.4
School Career Centers has enough counseling material	3.1	12.5	5.6	60.2	18.6
Parents visit schools for consultation	9.6	7.3	-	45.7	37.4
Importance of ICT, Technical and Industrial Education	15.6	48.8	12.6	13.8	9.2
Career Resource Centre has enough materials	11.7	6.4	-	42.8	39.1
Consultation for career selection for NMD	12.5	56.3	9.4	18.8	3.0
Encourage students to choose career in Agriculture	43.7	-	-	31.3	25.0
career in Medical and marines sciences are popular	15.6	50.0	12.5	21.9	-

The majority of the Teacher Counselors (71.9%) agreed that they had adequately informed the students on the key sectors where they could get jobs. These sectors included Engineering, Health, Education, ICT, Medical, Agriculture, Tourism and Hotel Industry compared to (18.7%) who did not and (9.4%) who were not aware of this role. (68.8%) of the teacher Counselors had adequately informed the students to select popular careers of their interest among them were careers in Health, ICT, Hotel Industry, Engineering and Agriculture compared to (21.8%) who did not and (9.4%) who were not aware that this should be done. (59.4%) of the Teacher Counselors had adequately encouraged the students to take challenging careers like medicine, Architect, Marine Engineering, ICT and General Engineering compared to (28.1%) who did not and (12.5%) who were not aware. Majority of the Teacher Counselors (68.8%) adequately explained to students the importance of science course in the future careers compared to (18.8%) who did not and (12.4%) who were not sure. Majority of the Teacher Counselors (64.4%) adequately explained to students the importance of ICT, Technical and Industrial Education career that they could purse as a way of enhancing National Manpower Development compared to (23.0%) who did not and (12.6%) who were not sure. Majority of the Teacher Counselors (68.8%) adequately consulted with other members of the staff regarding students career selection in relation to National Manpower Development compared to (21.8%) who did not and (9.4%) who were not sure. Lastly majority of the Teacher Counselors (60.6%) adequately encouraged students to take careers in Medical and Marine Sciences in relation to National Manpower Development compared to (21.9%) who did not and (12.5%) who were not sure.

Despite the fact that the Teacher Counselors in the secondary schools had made a lot of effort to make students gain important information on selection of careers leading National Manpower Development, the programmes still had the following challenges: majority of the Teacher Counselors (78.8%) agreed that the school career resource centre did not have adequate materials in career counseling as the required equipment towards enhancing the National Manpower Development compared to (15.6%) whose centers had adequate resource and (5.6%) who were not sure. Majority of the Teacher Counselors (83.1%) agreed that the parents regularly visited the schools for consultation on their children careers required in National Manpower Development compared to (16.9%) who were not sure. Majority of the Teacher Counselors (56.3%) did not adequately encourage students to take career in Agriculture towards enhancing the National Manpower Development compared to (43.7%) who were able to encourage them.

The study therefore got information showing that the career programmes in secondary schools in Kisii, Migori and Nakuru Counties were adequate in enhancing the National Manpower Development in the following particular areas; the students had adequate information on the key sectors where they could get jobs including Engineering, Health, Education, ICT, Medical, Agriculture, Tourism and Hotel Industry. Secondly, the students had adequate information on how to select popular careers of their interest among Health, ICT, Hotel Industry, Engineering and Agriculture. Third, the students were adequately encouraged by the Teacher Counselors to take challenging careers like medicine, Architect, Marine Engineering, ICT and General Engineering. Fourth, the Teacher Counselors adequately explained to students the importance of science courses in the future careers. Fifth, the students had adequate explanation on the importance of ICT, Technical and Industrial Education careers that they could purse as a way of enhancing National Manpower Development. Sixth, the Teacher Counselors had adequate consultation with other members of the staff regarding students' career selection in relation to National

Manpower Development. Seventh, the students had adequate encouragement to take careers in Medical and Marine Sciences in relation to National Manpower Development. The information from field data collected, supports the effort the country is making to produce sufficient manpower to support the nation`s development. Since Kenya got her independence, a lot of efforts to produce sufficient manpower to support economic growth is has been made. GOK (1964) made the first move to have manpower supporting the country`s development. A lot more has taken place since then till the latest move steered by vision 2030 clearly states that Kenya needs to have sufficient human workforce to develop.

H_{O1} there was no statistically significant relationship in the roles played by teacher counselors, and head teachers in the influence of students' career choice. The independent variable was the school career guidance programme and the dependent variable was the students` perception on the career guidance programme. All the frequencies of perceptions were extracted in a separate SPSS data view and a chi square was was run.

The analysis confirmed that there was a positive Pearson Correlation of 0.68 between school career guidance programme and students perception on the programme. The students rated this programme. The degree of freedom (Sample Size- 2) (405-2) was403. The critical Pearson Correlation Value at 403 degree of freedom was 0.082. Since the calculated Pearson Correlation Value was far much greater than the critical value at <0.05, there was a positive significant correlation between the two population perceptions leading to a relationship. This therefore means that the hypothesis that there was no statistically significant relationship in the roles played by teacher counselors, and head teachers in the influence of students career was rejected. Both teacher counsellors and head teachers positively observed that career guidance services were beneficial to the secondary school students in preparing them for their future career.

5 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 SUMMARY

The development of indigenous manpower to serve as the propelling force for national growth and development is no doubt a key to Kenya's socio-economic and political development engraved in the Vision 2030. It is important to note that this can only be achieved when the students at secondary school choose post secondary school careers that can make Kenya achieve this important obligation. The main purpose of the study was to investigate the Role of Secondary School Career Guidance in achieving National Manpower Development in Kenya.

5.2 CONCLUSION

The study established the existence of a relationship between the two variables. This was proved by r and led to the rejection of the null hypothesis that there was no statistically significant relationship on the roles played by teachers and members of staff in the influence of career guidance services. The teachers played a vital role in providing materials for reference as well as services giving it a positive relationship. Students selected subjects leading to careers such as ICT, agriculture, medical, technical, sciences and advancement in education for leadership jobs and teaching at universities. This showed positive relationship in perception by both students and teachers on the guidance programme.

5.3 RECOMMENDATIONS

It was established that students needed motivation to develop a positive perception towards a guidance programme in school. Students needed encouragement to voluntarily seek guidance services on careers especially on marketable career choices in areas such as ICT, Engineering, Medical, Technical, Hotel industry, Agriculture. Teacher counselors need to strengthen their skills in counseling by going for further studies and training in skill development in career guidance related to national manpower development needs in line with Vision 2030. The teacher counselor`s workload needs to be manageable to allow him/her have enough time to perform duties in guidance and counseling. The support from staff members in schools on the guidance programme needed to be enhanced to make sure that the guidance services rendered are effective to students make good career choices.

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Adequacy of Career Guidance Resources in secondary schools in Nakuru, Kisii and Migori Counties, Kenya

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ABSTRACT: Students in secondary schools need career guidance to make informed career choices which will contribute to the skilled manpower needs of the economy. This study investigated the adequacy of career guidance resources in secondary schools in Kenya. The study was conducted in secondary schools in three Counties in Kenya namely: Nakuru, Kisii and Migori. The study used descriptive cross section survey research design. The target population was all students and teachers in the three counties. The accessible population was all the form four students, teacher counsellors and head teachers. Public County, Sub County and Private secondary schools were used as sampling units. Simple proportionate random sampling was used to select 32 secondary schools in the three counties. A sample of 429 respondents comprising of 365 students 32 head teachers and 32 teacher counsellors was used. Three questionnaires: Student Questionnaire (SQ), Teacher Counsellor Questionnaire (TCQ) and Head Teacher Questionnaire (HQ) were used to collect data. Reliability of the instruments was estimated by use of Cronbach` alpha coefficient. Reliability coefficient of 0.78 for (SQ), 0.81 for (TCQ) and 0.79 for (HQ) were obtained. The hypotheses was tested using Chi- square. The findings indicate that there was a positive and statistically significant relationship between students and teacher counsellors` perceptions on the effectiveness of guidance services. The findings further indicated the school administration provided valuable support to the teacher counselors to make sure that they had enough materials and time to manage the guidance programme. Schools started resource centres and did their best to equip them through the support of school administration, parents and other well wishers, but the findings showed that not all schools had enough equipment and reading materials. It is recommended that the school resource centre should be more equipped to support the guidance programme.

KEYWORDS: Career, Guidance, economy, resources, resource center.

1 INTRODUCTION

School Career guidance programme provides professional services to students to enable them make appropriate decisions on their future careers. Downing (1968) explained that guidance services are an organized set of specific services established as an integral part of the school programme. These services are designed to promote the development of students and assist them move towards a realization of sound wholesome adjustment and maximum accomplishment according to their potentialities. They assist them to understand, accept themselves and utilize their ability, aptitudes and interests to acquire skills which will make them become useful members of society. The counseling needs of students are enormous be they boarders in their respectful schools or day scholars. Apart from other areas of concern such as psychological, social and financial needs of students, career choice becomes an important issue directly or indirectly related to these factors. This leads to the need for both group and individual counseling to supplement each other (Gladding, 2004).

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At secondary school level, Europe is at varying degrees of awareness of the fact that complete reliance on procedures and outlook of 19th century is no longer adequate. Education for national development is important. Western European countries are faced with challenges of ensuring that secondary school education produces school leavers ready to train in various skills to meet challenges of changing needs of societies. It is hoped that in developing countries education can ease tension caused by socio-economic challenges. Education systems especially at secondary school level should recognize the need for new skills to meet the challenges of the 21st century (Jaiswal, 2011)

In developing countries like Kenya career guidance services are important in realizing skilled manpower in various sectors to accomplish projected development plans as stated in vision 2030. The dependence on expatriates hired from developed countries can be reduced considerably as Kenya`s vision is to be an industrialized, middle level income country by the year 2030. (GOK, 2007). In this approach, national manpower development is guided by three important pillars: the social pillar, the political pillar and the economic pillar. The first and immediate challenge is to meet the human resource requirements by producing a larger workforce with many skills for the rapidly changing and diverse economy. The skills learnt will make students more productive and satisfying in an expanding and a middle income industrialized nation with a diverse economy. The curriculum in secondary schools has core subjects for all students and a few elective subjects. To select subjects to study, students` abilities, interests and goals should be considered. A student may have many abilities and interests and hence have difficulties in deciding which subjects will be most useful for him/her in the long run. A student will need to understand his/her curricular choices to meet individual career objectives. Chances of being unrealistic are high especially when the interests require higher level of abilities (Kinai, 2005). To achieve this objective teacher counselors should avail information about careers and the world of work to the students. Career guidance in schools is necessary so that students pursue relevant, market oriented and competitive careers. Students should also aim at job creation in various sectors than training to become job seekers. Among the earmarked sectors to expand and continually develop by 2030 are: education, health, tourism, agriculture, ICT and science and technology. The Ministry of Education, in conjunction with the Teachers Service Commission emphasize the training of teachers in guidance and counselling to assist students play a role in national manpower development and face the challenges in life. This is a positive move considering the type of education offered in the country in early years of independence (GOK, 2007)

The Kenya Education Commission of 1964 (GOK, 1964) discusses how education was provided to people living in Kenya based on racial lines; Europeans, Asians and Africans. In this report, it was recommended that schools should provide guidance and counselling services to students and teachers to enable them overcome challenges in life. Kenya aims to create a globally competitive and adaptive human resource base to meet the requirements of vision 2030. Skills can be developed in various areas such as: science, ICT, technology engineering and medical. This can successfully be done by students selecting careers which offer training in skills that are in line with the country`s economy guided by vision 2030. Although guidance and counseling is being offered in schools, the practice does not exist in depth nor is it being provided in a coherent and comprehensive manner. Specifically, it does not address in a holistic way career guidance, personal development and educational mentoring. Career teacher stiil need more skills to provide this support. Teacher, parents and other educational partners need to work together to provide support and training to assist student join the world of work (GOK, 2012). Guidance and counselling is emphasized in schools by many countries so as to address their manpower development needs. Kinai (2005) asserts that this is a positive development more especially in the developing countries. She states that in Ghana, students are advised in their third form in secondary level to select either arts or science based careers depending on their abilities. Students make decisions on how to contribute to their own life and country's economy and development in general. She further indicates that similar efforts are being made by Latin America and South American countries like Bolivia and Columbia. In 1970, the Bolivian Educational code prescribed that principals of schools and their teachers were to attend short courses to enable them provide educational and vocational guidance to students. Kinai further reports that in Columbia, guidance services in vocational and educational programmes are provided as the country sets aside funds for training and buying materials for teachers to assist them guide students. In 1977, the government of Nigeria saw the need for formal and modern guidance and counseling in the education sector and provided for it in the National Policy on Education 2004 (Journal of Education and Practice Vol 4 No 3 of 2013). Many young people were found to be ignorant about career prospects, and in view of this problem, career counselors were appointed to cover both primary and post primary learning institutions. This was a remarkable step towards ensuring that students made a proper career choice through the assistance of guidance and counseling services.

Wachanga, Githua and Keraro (1999) carried out a study in Egerton University on students`s perceptions on courses they take and their career expectations. The findings from this study revealed that many students were not sure of the careers to join on completion of the courses they were undertaking. Indeed there was a mismatch between the courses they were taking and preferred careers on completion of their university studies. This is a clear indication that there is an urgent need of guidance of students who join university without a clear cut career choice. It becomes frustrating when students join

universities and take up available opportunities and pursue careers whose future prospects they are not sure of. The study reveals a dire need for career guidance and counseling for school leavers. In Kenyan schools guidance as a practice needs to be intensified. Students hardly receive sufficient guidance and counselling services on career choices at the right time. Indeed, to date some of the students who qualify to join universities in Kenya and are selected through the Joint Admission Board (JAB) are given a second chance to revise the selection of courses they would like to pursue at the universities. Such a situation should not arise if students have enough information on career selection early enough. It is expected that youngsters should set their life goals early enough through role models, information provided by guidance and counselling departments and school curricula. Once guided and counseled students stand to benefit by selecting careers of their choice. The economy too stands to gain by having quality and well qualified personnel in various fields.

The Kenya Government`s Five Year Development Plan 1978 (GOK, 1979-1983) recommended that guidance and counselling be incorporated into the teacher training curricular at both college and university levels. The policy was implemented but according to the report on the National Commission on Educational Objectives and Policies (ROK, 1976) the content was inadequate to prepare effective counsellors. It recommended the incorporation of a compulsory course in guidance and counselling in all teacher education programmes. This was reinforced by the Report of the Presidential Working Party on Education and Manpower Training for the Next Decade and Beyond (Kenya Republic, 1988) which recommended that the Kenya Institute of Education (KIE) develop curricula on guidance and counselling. This was a turning point in the Ministry of Education as the need for the guidance and counselling programmes in Kenyan schools became more urgent. A report on Totally Integrated Quality Education and Training (GOK, 2002) proposed that an early start on career guidance for students is likely to have a greater impact. Getting a job requires certain educational and professional qualifications and preparation leading to the need for guidance in career choice by an individual. Students need for assistance in preparation for a career through relevant subject selection. Students need to develop an integrated picture of themselves and the role they need to play in a developing world. New occupations are emerging and it therefore becomes essential that students are helped in acquiring a clearer perspective of the changes that are taking place. It will help students to think big, work hard and aim higher in the choice of future careers. Carson (1996) argues that children who excel early and stay motivated have a higher chance of educational success. In view of the significant role of the guidance and counseling services offered in secondary schools, students should be assisted to make informed choices on their future careers.

Students face problems in selecting careers. In many cases they make wrong or poor choices uncertain of what the selected careers will lead to. Some of the high school graduates join universities or colleges with little information about the future prospects the selected courses will offer**.** Lack of enough information forces students to change career choices midway after poor performance leading to discomfort. This further makes the students to become frustrated, dissatisfied and seek for new avenues. Such students may drop out of institutions because of frustration. It is not clear how much time and resources are allocated for career guidance services offered in secondary schools necessitating this study to investigate adequacy of career guidance resources in secondary schools in Kenya.

2 LITERATURE

Government of Kenya (2000) pointed out that Kenyan institutions of learning had not successfully inculcated a positive attitude toward career development. It recommended a new approach in view of improving the situation. This was to make guidance and counseling attractive so that learners go for the services. Unemployment and poor performance in public and private sectors in the country are likely to have been caused by lack of skilled workforce. This was likely caused by lack of proper guidance and counseling. Higher education and training is key to a developing economy as a source of production of trained and educated personnel to meet the needs of the country`s economy. Higher education and training leads to the production of skilled personnel which are in line a rapidly changing society. Areas of development include ICT, technology and sciences. School guidance programme is key to the success of effective guidance Maitra (2007). Makinde (1984) points out that guidance and counseling in Africa will bear fruit only if it focuses on educational and career planning skills. In Kenya, the government regularly reviews curricula to meet the ever changing needs of learners and the country`s manpower needs. Kenya`s education system which was inherited from the British system of education has gone through many changes geared towards the provision of quality education leading to the production of people with market oriented and competitive skills. Bogonko (1994) argues that for Kenya to have students with relevant skills to meet the manpower demands, the country aimed at re-orienting the secondary school curriculum towards Science and Technology. By 1990, progress had been made to ensure that secondary schools had laboratories which were well equipped in most of the secondary schools to produce science graduates for manpower needs. At this time Kenya needed manpower with skills to replace expatriates. Secondary education was particularly regarded as the most important stage in education system which could help in solving the manpower constraints of the country. Expansion of education at this level was emphasized in Sessional Paper 10 of 1995 which noted that the immediate objectives in education were to expand secondary level facilities to be able to produce the

required manpower. In curriculum diversification, Sifuna and Otiende (2006) propose that once schools produce the manpower needed by a developing country, then the pace of economic development in Kenya could be accelerated. They note that a major step in education has been diversification of the curriculum to make sure that the academic world has room for vocational education giving students a chance to acquire vocational skills of their choice. However, the challenge of producing the required human resource is not yet over. This means the country should continue producing manpower to cater for all sectors Nasibi (2006). Diversification is said to free students from being locked into one curriculum and by so doing provide a wide set of future career options.

After completing secondary education, students often find themselves at crossroads. Most school leavers find themselves devoid of adequate information to prepare for the next stage of their lives and more often than not, land on a career for which they have no aptitude and regret throughout their lives for having made a wrong choice. In most cases, parents who influence their children`s career choice have no proper information or are not fully conversant with the opportunities available after school (Kurgat, 2005)

If schools could produce the manpower needed by a developing country, then the pace of economic development in Kenya could be accelerated. To achieve this, students should be made aware of the needs of the country as clearly spelt out the national education goals. The career development facilitators in schools need immense knowledge of the rapidly changing world. The continuing learning should challenge the learning of the past and bring about newer and broader perspective of career understanding in line with the dynamic, local, national and international trends (Patton & Mahon, 1999). The greatest challenge for schooling today is that the students do not see the link between schooling; careers and societal education ideals and values do not necessarily focus on the learner (Ogola, 2002). The gap may be filled if career guidance services in school are provided, enabling learners to contextualize the education process into life outside school.

The Presidential Working Party on Education and Manpower Training for the Next Decade and Beyond (GOK, 1981) was the next important commission which made recommendation on manpower survey and proposed the need to be a continuous process to determine accurate data for effective planning, development and utilization of human resources. The commission also recommended that teachers appointed to coordinate guidance and counseling programmes in schools get additional training to become more effective in their work. The head teachers were to ensure that all students in school had access to guidance and counseling services. Each school was to establish a guidance and counseling committee headed by a teacher appointed by the head teacher. It was also recommended that the Kenya Institute of Education be charged with the responsibility of developing a suitable and relevant guidance and counseling syllabus.

The ministry of Education Working Committee on Guidance and Counseling in Schools (GOK, 2000) set a program on information flow in two directions, opportunity structures available and qualifications expected from school leavers. This was set in a career booklet. Each year students got sufficient copies to guide them on careers in various universities and colleges. Students have to makes selection of opportunities available and work for them. Ndambuki and Mutie (2007) assert that due to lack of guidance and counselling, many students go to school and leave without any idea of the kind of jobs they should train for Other students move from job to job once they are employed simply because they lacked enough guidance and counselling when at school.

In some cases, teacher counselors can start involving parents in career guidance by creating a parent resource library. This is when some parents are consulted and invited to give talks to students on careers. Parents who have special training in various fields can talk to students on their respective areas giving tips to students on their education and future careers. Parents need to have up to date and accurate information on careers to advise their children on the changing career opportunities according to the changing needs in society Mutie and Ndambuki (2007).

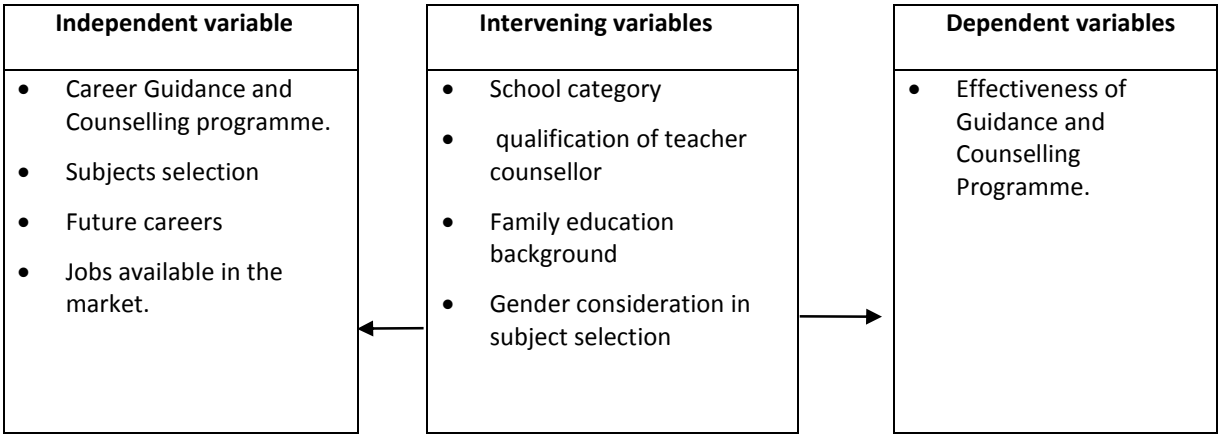
A counsellor should collect and disseminate information concerning career opportunities for the future education and training Nasibi (2006). This can be done through various activities, seminars, career exhibitions, orientation visits and supply of materials at resource centers. This will help in the dissemination of information concerning careers, opportunities for further education and training. A teacher counsellor provides referrals work to other professionals for advice and more information. There is need for a teacher counselor to work closely with other staff members for support and any advice on student data and their future prospects. He/she needs to provide curricula guidance which includes subject options, choice of courses and providing personal counselling.

Herr and Cramer(1972) proposed a systems approach that linked valued outcomes to specific elements in a comprehensive guidance and counselling programme. In their view, when building a comprehensive programme, school counsellors need to connect specific resources for different types of learners under different school conditions for promoting the learners for different purposes. Depending on the types and needs of the learner, either didactic or student –centered approaches would produce the best results. Sindabi (1992) asserted that guidance and counseling is important as a response

to development of a community and can positively influence the social status and roles of individuals. A well planned guidance and counselling programme should provide for the development needs of the youth and lead to a production of a country`s skilled manpower according to needs of a country at that time. Guidance programme as part of education requires careful and consistent development. This ensures that the programme responds to unique needs of clients. It provides benefits to students by addressing their urgent needs covering areas like career, emotional, social and psychological needs. The programme should involve all members of staff and assign them roles to strengthen guidance services and help students develop into full human beings capable of maximizing their potential characteristics in career- related aspects (UNESCO, 1998).

In India, a report on education Bishop (1985) realized that if education was to contribute towards economic growth and earn a good yield on its investment, then the quality of education and its character must change. Education can be academic but skill-based to increase national wealth. Students should select a subject combination which gives hope for their future. Developing countries should adopt a mixed production of school graduates to produce a balanced human resource needed in the country. The production of graduates like lawyers, teachers and administrators should be balanced with the production of engineers, technicians, agriculturists and nurses.

CONCEPTUALIZATION



The above variables interact in both directions to effectively influence guidance and counselling services in secondary schools. The effective management of resources is key to effective services. The students` perception and appreciation of services rendered will be greatly influenced by the school administration, attention given to students, utilization and management of resources. The intervening variables will be controlled through the random sampling of respondents, giving the students equal chances under all conditions.

Purpose of the study was to investigate how resources are used in the effectiveness of guidance services and its contribution to national manpower development.the hypothesis was tested using Chi- square.

3 METHOD

The study used a cross-section survey design. This design was ideal for the study as it allowed for the use of different groups of respondents to study various variables at a given time. Cross section research design allows the researcher to assemble several study groups or samples selected from the same population and record the variable measures for each group. The study was conducted in three counties: Nakuru, Kisii and Migori in Kenya. The three counties were purposively sampled because of their location and socio-economic activities which take place such as flower farming and associated industries (food crop farming, flower farming, tea growing and processing, sugar cane farming and sugar processing) and fishing. These economic activities are likely to lure school leavers with casual jobs which would negatively impact on their aspirations for future more professional and challenging careers. Random sampling was used to select 365 form four student respondents in 32 secondary schools. Purposive sampling was used to select 32 head teachers and 32 teacher counselors. This was ideal because of the positions they hold and services they render in respect of students` guidance and counseling in their respective schools. The total sample was 429: 365 students. 32 head teachers and 32 teacher counsellors. Three questionnaires: the Student Questionnaire (SQ), the Teacher Counsellor Questionnaire (TCQ) and the Head teacher Questionnaire (HQ) were developed by the researcher and used for data collection. Quantitative data was analyzed by the

use of inferential statistics. Chi- square was used to test the hypothesis and the results were accepted or rejected at an alpha level of 0.05. Ho1 There is no statistically significant relationship between resource availability and students career choice.

4 RESULTS, INTERPRETATION AND DISCUSSION

Table 1: Equipment of the Department of Guidance and Counseling

Response	Frequency	Percent
Available	7	21.9
Not Available	25	78.1
Total	32	100.0

Table 1 above provides details on how much departments of guidance and counseling are prepared to guide students in career counseling.

The majority of the Teachers Counselors (78.1%) observed that the departments of guidance and counseling were not equipped with resource materials on guidance and counseling compared to (21.9%) who reported to the contrary. This information indicated that there was a gap in terms of guidance and counseling reading materials. The school through its annual budgeting could entrench the guidance and counseling materials in the budget and also make sure that such reading materials are used by the Teachers Counselors in their duties of career guidance and counseling. It is important that resource centers are well equipped with materials for use by both teachers and students. Details on subject requirements and selection to be trained in various fields are crucial in guidance and counseling on career choice.

Table 2: Career Guidance Resource Availability

Resource	SA	A	NS	D	SD
Resource centre well equipped	12.8	9.0	7.0	38.5	32.7
Time allocated for career guidance	38.4	31.8	8.4	13.7	7.7
Well informed teacher counselor	31.5	35.1	19.7	9.9	3.8
Good career arrangement	32.6	33.6	13.8	15.1	4.9

Majority of the students under the study (71.2%) disagreed that the career resource centre in their school were well equipped with relevant and up to date resource materials on career development for enabling students select appropriate career choices compared to (21.8%) who disagreed and (7.0%) who were not sure. Majority of students (70.2%) agreed that their schools allocated adequate time for career guidance compared to (21.4%) who disagreed and (8.4%) who were not sure. Majority of students (66.6%) agreed that teacher counselors were well informed of his work as career guidance compared to (13.7%) who disagreed and (19.7%) who were not sure. Majority of students (66.2%) agreed that they liked the arrangements the school had made on career guidance activities compared to (20.0%) who disagreed and (13.8%) who were not sure.

This information collected indicated that the students had positive perception on the following as far as career resource allocation in their respective schools were concerned: the schools allocated adequate time for career guidance, the teacher counselors were well informed of their work in career guidance and that the students liked the arrangements the school had made on career guidance activities.

Table 3: Chi-Square Test on relationship between resource availability and students career choice

Variable	Calculated Chi-Square	Critical Chi-Square	df
Students' career choices	142.310	24.996	15
Teacher Counsellors' Perception	10.000	22.362	13

Source: Field Data (2013)

Ho1 There is no statistically significant relationship between resource availability and students career choice. The analysis of this hypothesis established that the calculated chi-square for students' career choices was 142.310 whereas the critical chi-square was 24.996 at 15 degree of freedom. The calculated chi-square for resource adequacy was 10.000 whereas critical

chi-square was 22.362 at 13 degree of freedom. Since the calculated chi-square was far much greater than the critical chi-square in the students' career choices whereas for resource availability the calculated chi-square was far much less than the critical chi-square, there was no significance relationship between the students' career choices and resource availability therefore leading to the acceptance of the hypothesis that there is no statistically significant relationship between students and teacher counselors` perceptions on the effectiveness of guidance services offered in secondary schools. The test confirmed that the students' career choices were not influenced by guidance and counseling resource availability indicating a need both to improve on guidance and counseling resources and also design such resources in a way that they can positively influence students' career choices.

5 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 SUMMARY

The development of indigenous manpower to serve as the propelling force for national growth and development is no doubt a key to Kenya's socio-economic and political development engraved in the Vision 2030. It is important to note that this can only be achieved when the students at secondary school choose post secondary school careers that can make Kenya achieve this important obligation. The main purpose of the study was to investigate adequacy of career guidance resources in secondary schools in Kenya.

5.2 CONCLUSION

The study established an existed a relationship between the two variables. Since the calculated chi-square was far much greater than the critical chi-square in the students' career choices whereas for resource availability the calculated chi-square was far much less than the critical chi-square, there was no significance relationship between the students' career choices and resource availability therefore leading to the acceptance of the hypothesis that there is no statistically significant relationship between students and teacher counselors` perceptions on the effectiveness of guidance services offered in secondary schools. The test confirmed that the students' career choices were not influenced by guidance and counseling resource availability indicating a need both to improve on guidance and counseling resources and also design such resources in a way that they can positively influence students' career choices. The school administration provided valuable support to the teacher counselors to make sure that they had enough materials and time to manage the guidance programme. Schools started resource centres and did their best to equip them through the support of school administration, parents and other well wishers, but the findings showed that not all schools had enough equipment and reading materials.

5.3 RECOMMENDATIONS

Teacher counselors needed to strengthen their skills in counseling by going for further studies and training in skill development in career guidance related to national manpower development needs in line with Vision 2030. The teacher counselor`s workload needs to be manageable to allow him/her have enough time to perform duties in guidance and counseling. The support from teacher counsellors and head teachers in schools on the guidance programme should be enhanced to make sure that the guidance services rendered are effective to all students to make good career choices. The school resource centre should be more equipped to support the guidance programme. This can be done with increased number and wide variety of reference materials. The working space and time allocation in the timetable needed to be made conducive to the students, teacher counselors and school administration to be able to do their work effectively. The school administration should allocate resources and finances to support the students and teachers in their search for more information on careers. More support from other development partners and the ministry of Education is needed to support and strengthen the functioning of the programme.

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Vulnérabilité à La Pollution des Eaux Souterraines : Statique ou Dynamique ? Application à la Nappe de R'Mel (Maroc)

[Vulnerability of the Groundwater Pollution: Static or Dynamic? Application of R'Mel's Aquifer (Morocco)]

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ABSTRACT: Vulnerability maps of groundwater pollution are basic tools for land use planning. However, some of the parameters taken into account by the different methods of vulnerability assessment may vary over time such as recharge, rainfall, groundwater level, etc. In the present work, through the application of the DRASTIC method to evaluate the intrinsic vulnerability of the porous aquifer R'Mel (Morocco), and using the data of three different years, we showed that intrinsic vulnerability varies from one year to another, i.e. that it is dynamic. For this we compared the years 2000, 2003 and 2005 selected for their different rainfall. The sensitivity maps obtained are different from one year to the next and the errors margins determined for each map are low and slightly different. Furthermore, the sensitivity analysis showed that the effect of parameters on the final vulnerability index changes from one map to another and that all parameters are necessary to apply the DRASTIC method. Analysis of these maps shows great variability in the spatial distribution of the degree of vulnerability, and that the proportions of areas occupied by the different classes vary also from one year to another. These vulnerability maps developed by the application of the model DRASTIC, are dynamic and therefore they can compromise the protection of resources.

KEYWORDS: Vulnerability, dynamic, DRASTIC, groundwater mapping, R'Mel's aquifer, Morocco.

RESUME: Les cartes de vulnérabilité à la pollution des eaux souterraines sont des outils de base en matière d'aménagement des territoires. Toutefois, certains paramètres pris en compte par les différentes méthodes d'évaluation de la vulnérabilité sont susceptibles de varier dans le temps tels que la recharge, la pluviométrie, le niveau piézométrique, etc. Dans ce travail, à travers l'application de la méthode DRASTIC à l'évaluation de la vulnérabilité de l'aquifère poreux de R'Mel (Maroc), et en utilisant les données relatives à trois années distinctes, nous avons montré que la vulnérabilité intrinsèque est variable d'une année à l'autre, càd qu'elle est dynamique. Pour cela nous avons considéré les années 2000, 2003 et 2005 choisies pour leurs pluviométries différentes. Les cartes de vulnérabilité obtenues sont différentes sur les trois années et les marges d'erreurs déterminées sur chacune des cartes sont faibles et légèrement différentes. Par ailleurs, l'analyse de sensibilité effectuée a montré que l'effet des paramètres sur l'indice final de vulnérabilité change d'une carte à l'autre et que tous les paramètres sont nécessaires pour le modèle DRASTIC. L'analyse de ces cartes montre une grande variabilité de la répartition spatiale des degrés de vulnérabilité. Egalement les superficies occupées par les différentes classes varient sur les trois années. Ces cartes de vulnérabilité élaborées par l'application du model DRASTIC, s'avèrent dynamiques et par conséquent elles peuvent compromettre la protection des ressources.

MOTS-CLEFS: Vulnérabilité, dynamique, DRASTIC, eaux souterraines, cartographie, R'Mel, Maroc.

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1 INTRODUCTION

Le terme de vulnérabilité intrinsèque est utilisé pour caractériser la sensibilité des eaux souterraines aux pollutions. Il prend en considération les caractéristiques géologiques, hydrologiques et hydrogéologiques du milieu naturel indépendamment de la nature du polluant et de l'occupation du sol. La vulnérabilité spécifique, quant à elle, est utilisée pour définir la sensibilité d'un aquifère vis à vis d'un polluant ou d'un groupe de polluants. Il prend donc en considération les propriétés spécifiques des polluants et leurs relations avec les différents facteurs influençant la vulnérabilité intrinsèque [1].

La vulnérabilité intrinsèque d'une eau souterraine est une notion relative du fait qu'elle dépend des caractéristiques du milieu physique naturel qui peuvent changer selon les particularités et les diversités des territoires [2]. Les facteurs intervenants pour sa détermination sont de deux types: ceux qui varient avec le temps (épaisseur de la zone non saturée, occupation des sols, recharge,…) et ceux qui ne varient pas (topographie, type de sol,….).

Plusieurs méthodes d'évaluation de la vulnérabilité ont été élaborées à travers le monde, regroupées dans les trois classes suivantes:

- Les Méthodes analytiques et relations analogiques*;*
- Les Méthodes cartographiques ou comparatives;
- Les Méthodes à systèmes paramétrés ou méthodes paramétriques (empiriques).

Parmi les méthodes de cartographie à systèmes paramétrés, les méthodes de pondération et d'indexation des critères sont les plus utilisées à l'heure actuelle [3], [2]. Malgré qu'elles soient subjectives et présentent la vulnérabilité intrinsèque de manière qualitative, ces méthodes sont rapides et faciles à mettre en œuvre. Cependant, en l'absence de concept quantitatif basé sur des paramètres ayant une signification physique, la validation des cartes de vulnérabilité élaborées par ces méthodes reste encore problématique. Par ailleurs, la comparaison des cartes obtenues par l'application de plusieurs approches peut être considérée en partie comme technique d'évaluation de leurs fiabilités sachant que l'application de plusieurs approches sur un site donné conduit généralement à des résultats fort contrastés [4], [5].

Les auteurs de la plupart de ces méthodes considèrent que la vulnérabilité est indépendante du temps «statique» et que les conditions de protection naturelle des eaux souterraines ne varient pas [6], [7], [8]. En effet, la vulnérabilité intrinsèque d'un aquifère ne dépend que des facteurs physiques naturels qui assurent sa protection. Ces facteurs ont été jugés peu susceptibles de varier dans le temps [9]. Cependant d'autres paramètres, utilisés dans ces méthodes, sont susceptibles de changer dans le temps tels que l'épaisseur de la zone non saturée, recharge…etc.

L'objectif de ce travail est de montrer que la vulnérabilité intrinsèque d'un aquifère, évaluée par la méthode DRASTIC sur trois années distinctes, est dynamique et change en fonction du temps. Cette application a été réalisée sur l'aquifère poreux de R'Mel (Maroc) pour les années 2000, 2003 et 2005. Cet aquifère côtier, d'environ 245 km² de superficie, constitue la réserve la plus importante en eau souterraine de la partie Nord-Ouest du Maroc. Il se trouve menacé par des pollutions aussi variées que leurs sources du fait que la région a connu une intensification des activités agricoles et industrielles.

2 MATERIEL ET METHODES

La méthodologie suivie dans ce travail s'est basée sur une étude comparative des cartes de vulnérabilité interprétées, pour la nappe de R'Mel, par la méthode DRASTIC sur trois années hydrologiques.

Vu la grande variabilité spatio-temporelle du régime pluviométrique de la zone d'étude, nous avons opté pour la cartographie de la vulnérabilité sur trois périodes choisies pour leurs pluviométries typiques : d'une année sèche (2000), d'une année moyenne (2005) et d'une année humide (2003).

2.1 Description de la méthode DRASTIC

La méthode DRASTIC est une méthode multicritère relativement simple d'application peu coûteuse et les paramètres qu'elle emploie sont disponibles et faciles à évaluer. Elle évalue les conditions de transfert selon lesquelles une pollution type peut atteindre la surface de la nappe. Elle se base sur l'évaluation de sept paramètres: **D** : Depth to water (profondeur de la surface piézométrique), **R** : net recharge (infiltration efficace) ; **A** : Aquifer media (formation aquifère); **S**: Soil media (type de sol); **T** : Topography (pente du terrain); **I** : Impact of the vadose zone (incidence de la zone non saturée) et **C** : hydraulic conductivity (conductivité hydraulique de l'aquifère).

Le modèle DRASTIC a été originalement développé aux États-Unis afin de permettre l'évaluation du potentiel de pollution des nappes d'eaux souterraines [10]. Le développement du modèle est basé sur quatre hypothèses majeures:

- Les sources de la contamination potentielles se trouvent à la surface du sol;
- Le contaminant présente la même mobilité que l'eau souterraine (Polluant parfaitement conservatif);
- La nature des contaminants potentiels n'est pas considérée dans la définition de la vulnérabilité (par conséquent, pour évaluer s'il y a un risque qu'une activité contamine l'eau souterraine dans une zone vulnérable, il faut également considérer la nature des contaminants et leur comportement dans l'environnement);
- Le territoire d'application couvre plus de 0,4Km^2.

L'indice DRASTIC est calculé par la sommation pondérée du produit des côtes et des poids pour chacun des paramètres en appliquant la relation (1) suivante :

$$I_{DRASTIC} = DnDp + RnRp + AnAp + SnSp + TnTp + InIp + CnCp \quad (1)$$

Où D, R, A, S, T, I, C, sont les paramètres cités plus haut

n : notation accordée à chaque paramètre;

p : facteur de pondération accordé à chaque paramètre.

Ce facteur de pondération (de 1 à 5) est attribué à chaque paramètre selon son importance relative dans l'estimation de la vulnérabilité de la nappe (Tab. 1). L'indice DRASTIC final obtenu permet de caractériser le degré de vulnérabilité d'un secteur donné de la nappe. Il varie entre 23 et 226. La vulnérabilité est d'autant plus importante que l'indice ($I_{DRASTIC}$) calculé est élevé.

Tableau 1. Poids et mode d'acquisition des sept paramètres de la méthode DRASTIC.

Paramètre	Poids	Type de données	Source de données
D	5	profondeur de la nappe (Janvier 2000, Mars 2003 et Janvier 2005)	ORMVAL et ABHL
R	4	Pluviométries et Températures moyenne mensuelles (2000,2003 et 2005)	ORMVAL et ABHL
A	3	Les données de forages	DGH et ABHL
S	2	Les données des Profils pédologiques	ORMVAL
T	1	Carte Topographique 1/50' 000 (Larache et Lalla Mimouna)	ORMVAL
I	5	Données de forages	DGH et ABHL
C	3	Les essais de pompages	DGH

2.2 Analyse de sensibilité et analyse de la méthode DRASTIC

La Méthode DRASTIC évalue la vulnérabilité en utilisant la somme pondérée de sept paramètres. Plusieurs scientifiques affirment que la subjectivité liée au système de notation et de pondération du modèle DRASTIC peut fortement affecter les résultats des indices de vulnérabilité [11]. D'autres révèlent que la vulnérabilité des eaux souterraines peut être élaborée sans faire appel à tous ces paramètres [12] et [13]. L'analyse de sensibilité fournit des informations précieuses sur l'influence des valeurs de notation et de pondération attribués à chaque paramètre et aide l'analyste à juger de l'importance des éléments subjectifs [3].

Deux tests de sensibilité peuvent être effectués : «the map removal sensitivity analysis» [14] et « the single parameter sensitivity analysis» [11]. Le premier test permet de mesurer la sensibilité de la carte de vulnérabilité, en supprimant successivement un ou plusieurs paramètres. Le second test est utilisé pour évaluer l'impact respectif des sept paramètres sur l'indice de vulnérabilité. Il est basé sur la comparaison entre les poids effectifs attribués aux paramètres et leurs poids théoriques. Le but de ce processus d'analyse est de faire un classement des paramètres les plus importants du modèle et auxquels une attention particulière doit être accordée lors de leur collecte ou de leur détermination sur le terrain.

L'analyse de la méthode DRASTIC à travers les sept paramètres utilisés, nous a permis d'identifier deux paramètres statiques, indépendants du temps, (topographie «T» et le type de sol «S») et cinq paramètres dynamiques, qui changent dans le temps, soit la profondeur de la nappe «D», l'infiltration efficace «R», la formation de l'Aquifère «A», l'Impact de la zone non saturée «I» et la conductivité hydraulique de l'aquifère «C»). En effet, la variation spatio-temporelle de la pluviométrie et de la température entraîne une variation de la lame d'eau infiltrée et par extension du niveau piézométrique. L'augmentation de la lame d'eau infiltrée diminue la profondeur à la nappe et augmente l'épaisseur de la zone saturée et en conséquence la variation des horizons qui la composent (la variation de la lithologie des horizons constituant la zone saturée, car la zone présente une grande hétérogénéité de facies). Cette variabilité engendrera en conséquence des variations dans le temps de ces cinq paramètres.

2.3 APPLICATION À LA NAPPE DE R'MEL

2.3.1 Présentation de la zone d'étude

La nappe de R'Mel est située au Nord Ouest du Maroc, elle fait partie du bassin du Bas-Loukoss au sud de la ville de Larache. Elle s'étend sous une superficie de 240 km^2 environ. Elle est limitée par l'océan Atlantique à l'Ouest, l'Oued Loukoss à l'Est et par les affleurements marneux Mio-Pliocène au Sud. Elle est drainée par trois Oueds: Sakh-Sokh, Smid El Ma et El Kihel (Fig. 1).

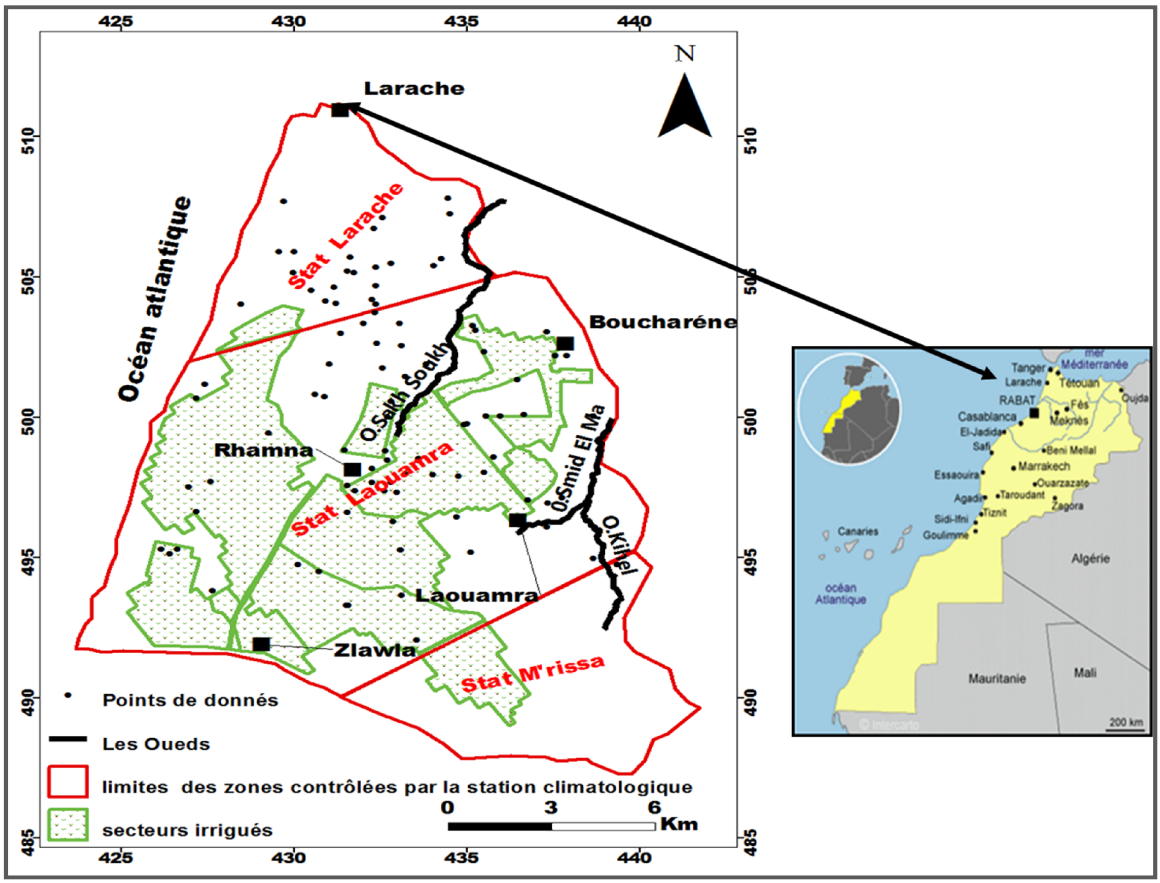

Fig. 1 Localisation de la nappe de R'Mel et la répartition des point de données

La zone d'étude peut être classée dans le domaine du climat méditerranéen subhumide caractérisé par un été chaud et sec et un hiver tempéré et humide. La température moyenne annuelle varie entre 11°C en hiver et 25°C en été et la pluviométrie annuelle moyenne est de 700mm répartie entre octobre et avril [15].

Les résultats des campagnes géophysiques et les données extraites des logs des forages ont mis en évidence deux unités aquifères poreuses constituées essentiellement de sables dunaires du Quaternaire récent, et des grès coquilliers du Plio-Villafranchien. Ces deux unités hydrogéologiques sont généralement séparées par une couche sablo-argileuses ou argileuses

du villafranchien de perméabilité et d'épaisseur variable. Le substratum de la nappe de R'Mel est constitué essentiellement par des marnes bleues du Mio-Pliocène [16].

2.3.2 Cartographie des paramètres DRASTIC

Pour montrer que la vulnérabilité à la pollution d'un aquifère est dynamique, nous avons besoin de données relatives à des périodes caractérisées par une nette variabilité du régime pluviométrique. Pour cette raison nous avons choisi les années 2000, 2003 et 2005. Ces données nous ont été fournies par l'Agence du Bassin hydraulique du Loukkos (ABHL) et l'Office Régionale de la Mise en Valeur Agricole de Loukkos (ORMVAL).

2.3.2.1 Paramètres statiques

- ***Type de Sol***

Le sol a un impact considérable sur la quantité et la qualité d'eau qui pourra s'infiltrer pour atteindre la nappe et par voie de conséquence sur la migration verticale des polluants à travers la zone non saturée [17]. Il influence ainsi le temps de migration des contaminants vers la nappe [18]. L'étude pédologique des sols du plateau du R'Mel réalisée par l'Office Nationale des Irrigations en 1963, a montré que les sols de la zone étudiée font partie de deux classes selon leur matériau original :

a- sols peu évolués sur roche-mère complexe, caractérisée en surface par une texture sableuse et la présence à une profondeur variable d'un squelette gréseux assez dense (les formations dunaires anciennes) ;

b- sols rouges méditerranéens, formés essentiellement de sable fin sur roche mère sableuse non calcaire.

En l'absence d'une carte pédologique de toute la zone d'étude, une carte des sols a été élaborée par interpolation IDWA (Inverse Distance Weighted Averaging) en tenant compte des données pédologiques au niveau des seize profils types choisis dans la zone. La carte obtenue montre que le sol peu évolué est le plus représenté : il occupe 78% de la superficie totale et recouvre la majeure partie de l'aquifère. Le sol méditerranéen (sable fin) ne couvre que 22%, et se localise au Nord et au Nord Est de la plaine entre les oueds Sakh Soukh et Smid El Ma.

- ***Topographie***

La digitalisation des courbes de niveau et des points côtés, que nous avons réalisée et à partir des cartes topographiques aux 1/50'000 de Larache et de Lalla Mimouna, a servi à la génération du modèle numérique de terrain (MNT), au pas de 88 m (sous le format TIN). La carte obtenue montre que la quasi-totalité de la région est caractérisée par une très faible pente comprise entre 0 et 6% (Fig. 2).

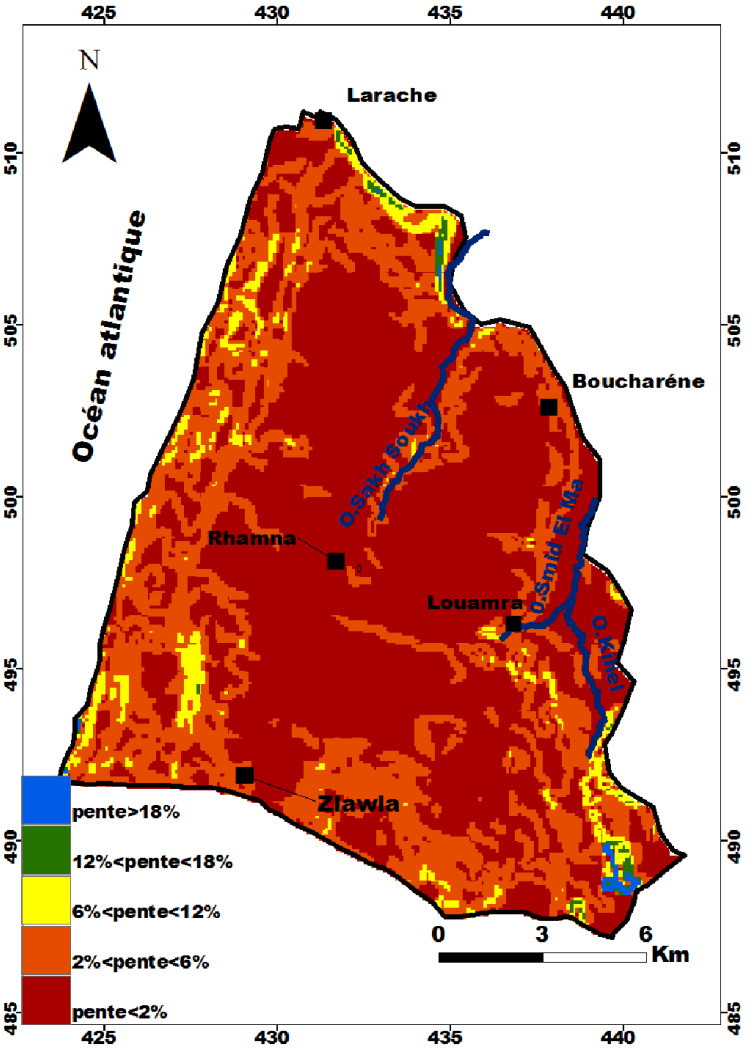

Fig. 3. Carte de pente de la nappe de R'Mel

2.3.2.2 Paramètres dynamiques (dépendants du temps)

Pour les cinq paramètres dépendants du temps, nous avons élaboré pour chaque paramètre trois cartes correspondant aux trois années hydrogéologiques choisies : 2000, 2003 et 2005.

- ***Profondeur de la nappe (épaisseur de la zone non saturée)***

Le paramètre profondeur de la nappe représente la distance verticale traversée par un contaminant depuis la surface du sol jusqu'à la nappe ; il correspond à l'épaisseur de la zone non saturée. Ce paramètre a été obtenu par interpolation des données mesurant la profondeur du niveau de l'eau en période des hautes eaux sur les trois années (janvier 2000, Mars 2003 et Janvier 2005). La variation spatio-temporelle de ce paramètre est représentée, selon sept classes avec les pourcentages de leurs superficies, dans le Tab. 2.

- ***Recharge***

La recharge de la nappe s'opère principalement par l'infiltration des précipitations et des eaux d'irrigation. Elle est déterminée par le bilan hydrique sue une année hydrologique (de septembre à Aout). Pour ce faire, nous avons utilisé les données de trois stations climatologiques (Larache, Laouamra et M'rissa) (Fig. 1) correspondant aux trois années choisis (2000, 2003 et 2005). Ce bilan fait intervenir la pluviométrie, l'évapotranspiration potentielle et réelle (calculée par la méthode de Thornthwaite) et la réserve facilement utilisable (RFU), estimé par la formule de Hallaire. Il convient de noter

que le ruissellement de surface a été négligé en raison de la nature sableuse du sol et des faibles valeurs de pentes de la nappe de R'Mel. Les cartes de recharge de la nappe ont été obtenues par interpolation IDWA des valeurs d'infiltration efficace estimées en chacun des points de données. Les retours des eaux d'irrigation n'ont pas été pris en compte dans cette partie de l'étude, car nous n'avons pas pu obtenir de données fiables pour chacune des années considérées dans cette étude. Les cartes de recharge obtenues pour les trois années ne sont pas similaires et les superficies occupées par les différentes classes de la recharge diffèrent d'une année à l'autre (Tab. 2 et Fig. 3).

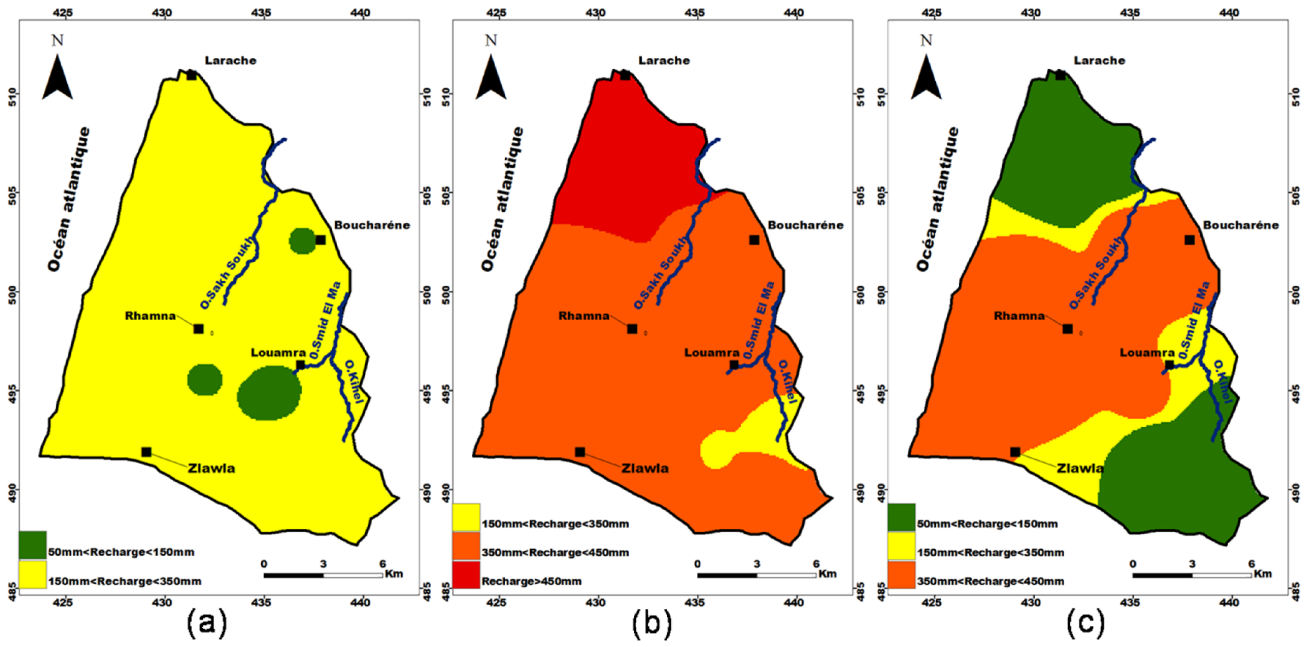

Fig. 3 Cartes de recharge de la nappe de R'Mel (a) : en 2000 ; (b) : en 2003 et (c) : en 2005

➢ ***Impact de la zone non saturée et de la formation aquifère***

Ces deux paramètres ont été obtenus par corrélation et interpolation IDWA des données lithologiques de 98 forages et des niveaux d'eau des piézomètres réalisés dans la zone d'étude. Le calcul de la note finale accordée à ces deux paramètres résulte de l'application de la relation (2) suivante:

$$N = \sum_{i=1}^{n} \frac{(Ni \times Ei)}{Et} \qquad (2)$$

N : notation finale donnée à un forage;

Ni : notation de la formation i par la méthode DRASTIC;

n : nombre de couches de la zone saturée;

Ei : épaisseur de la formation i;

Et : épaisseur totale de la zone saturée;

➢ ***Conductivité hydraulique***

Ce paramètre dépend de la nature et de la texture des matériaux composant l'aquifère. Plus un réservoir comporte d'éléments détritiques grossiers, plus sa perméabilité est élevée et par conséquent la pollution peut se propager plus facilement dans l'aquifère [19]. Toute variation du niveau piézométrique engendrera une variation dans la lithologie de l'aquifère et de son épaisseur. Par conséquent, la conductivité hydraulique de l'aquifère pourrait changer en fonction du temps. Toutefois, nous ne disposons pas de données assez représentatives pour les trois années choisies pour pouvoir élaborer une carte significative de ce paramètre. Par ailleurs, l'interpolation IDWA des données ponctuelles de tous les essais

de pompage réalisés dans cette zone d'étude, nous a permis d'obtenir une répartition spatiale moyenne de la conductivité hydraulique de la nappe de R'Mel (paramètre «C» de DRASTIC). Ces essais donnent des valeurs de conductivité comprises entre 3.10^{-6} et $3,7.10^{-4}$m/s [20].

3 RÉSULTATS ET DISCUTIONS

3.1 Cartes de vulnérabilité de la nappe de R'Mel

Les cartes de vulnérabilité élaborées sur les trois années (2000, 2003 et 2005), par la combinaison des sept cartes thématiques conformément à l'application de la méthode DRASTIC montrent qu'il y a un changement dans la répartition spatiale des classes de vulnérabilité de la nappe d'une année à l'autre (Fig. 4 ; Tab. 2).

Tableau 2. Variation des classes de la Profondeur de la nappe, de la recharge et des pourcentages des superficies occupées par les différentes classes de la nappe de R'Mel pour chaque année

Classes de la profondeur de la nappe	Superficies en %			**Classes de recharge**	Superficies en %			**Valeur de l'Indice DRASTIC**	**Classe de Vulnérabilité**	Superficies en %		
	2000	**2003**	**2005**		**2000**	**2003**	**2005**			**2000**	**2003**	**2005**
< 1,5 m	34%	12%	18%	**50 – 150**	5%	_	32%	**ID < 120**	Faible	5%	4%	12%
1,5 à 4,5m	23%	33%	28%	**150 - 350**	95%	4%	15%	**120 < ID < 140**	Moyenne	28%	17%	32%
4,5 à 9m	15%	21%	15%	**350 – 450**	_	78%	53%	**140 < ID < 160**	Forte	66%	61%	47%
9 à 15m	18%	16%	21%	**450 - 650**	_	18%	_	**ID > 160**	Très Forte	1%	18%	9%
15 à 22m	5%	11%	9%									
22 à 30m	3%	1%	3%									
> 30m	2%	6%	6%									

Les zones de forte à très forte vulnérabilité occupent la majorité de la superficie de la plaine avec 79% pour l'année 2003 (l'année humide) (fig. 4 (b)). Elles gouvernent principalement le centre, le Sud-Est, le Sud-Ouest et l'extrême Nord de la plaine. Cependant, pour les deux autres années, ces classes se serrent pour n'affecter que 67% et 56% de la surface totale de la nappe respectivement en 2000 et 2005 (fig. 4 (a) et (c)). Les zones de faible et de moyenne vulnérabilité occupent respectivement 33%, 21% et 44% de la superficie totale de la nappe pour les années 2000, 2003 et 2005. Pour la carte de 2005 (fig. 6 (c)), ces zones occupent une large superficie au Nord de la plaine dans la zone située entre Boucharéne, Larache et la zone côtière, et une faible superficie située au Sud-Est en limite de la nappe d'Ouled-Ogbane. Toutefois, ces deux classes (faible et moyenne) régressent au profit de la classe de forte vulnérabilité pour les deux autres années 2000 et 2003.

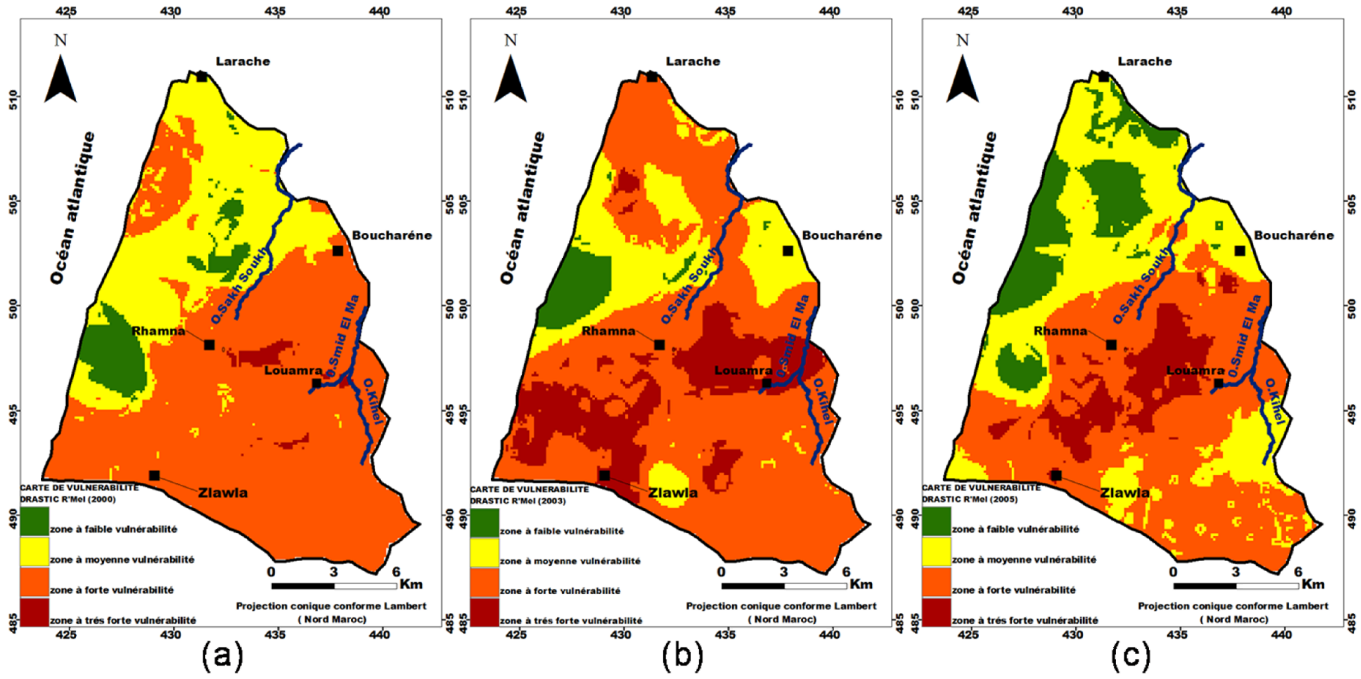

Fig. 4. : Cartes de vulnérabilité intrinsèque de la nappe de R'Mel par la méthode DRASTIC (a) : 2000 ;(b) : 2003 et (c) : 2005

Les incertitudes sur les cartes de vulnérabilité ont été estimées en se basant sur le rapport des sommes des incertitudes des sept paramètres sur l'indice moyen de DRASTIC [21]. Les marges d'erreur déterminées pour chacune des cartes sont faibles et légèrement différentes d'une année à l'autre (Tab. 3). Elles varient entre 3,3 %, 3,8% et 4,1% pour les cartes réalisées respectivement en 2000, 2003 et 2005.

Tableau 3. Estimation des incertitudes sur les paramètres et les cartes DRASTIC en 2000, 2003 et 2005

	D	R	A	S	T	I	C	TOT
coefficient de pondération	5	4	3	2	1	5	3	23
Incertitude_des paramètres_DRASTIC en 2000	1,35	0,68	0,249	1,12	0,1	0,65	0,57	4,719
ID_DRASTIC_ 2000_ Moyen	38,45	19,6	18,45	16,68	9,36	34,9	6,84	144,28
Incertitude_ Carte_ DRASTIC_ 2000								3,27%
Incertitude_des paramètres_DRASTIC en 2003	2	1,08	0,252	1,12	0,1	0,6	0,57	5,722
ID_DRASTIC_ 2003_ Moyen	34,4	29,04	18,45	16,68	9,36	35,05	6,84	149,82
Incertitude_ Carte_ DRASTIC_ 2003								3,82%
Incertitude_des paramètres_DRASTIC en 2005	1,45	1,88	0,198	1,12	0,1	0,5	0,57	5,818
ID_DRASTIC_ 2005_ Moyen	33,8	21,64	18,42	16,68	9,36	34,7	6,84	141,44
incertitude_ Carte_ DRASTIC_ 2005								4,11%

L'analyse des surfaces par classes d'indice de vulnérabilité, faite par comparaison des cartes deux à deux, a révélé que les deux cartes 2000 et 2003 et les deux cartes 2005 et 2003 ont été évaluées par un indice identique sur 55% de la superficie totale de la nappe. Alors que les deux cartes de 2000 et 2005 présentent un indice identique sur 60% de la surface. La proportion d'accord entre les trois cartes a été évaluée par le test de Kappa [22]. Ce test a montré que les valeurs d'accord observées indiquent un degré d'accord modéré entre les trois cartes (faite deux à deux). Tandis que les valeurs d'accord non dues au hasard (coefficient de Kappa) sont faibles pour les deux cartes 2003 et 2000 (k=0,17) et moyenne pour les deux cartes 2003 et 2005 (k=0,29) et les deux cartes 2000 et 2005 (k=0,31).

3.2 Analyse de sensibilité

L'analyse de sensibilité réalisée par la suppression à chaque fois d'un paramètre, a révélé que généralement ce sont les paramètres profondeur à la nappe, impact de la zone non saturée et conductivité hydraulique qui affectent le plus la variation de l'indice de vulnérabilité pour les années 2000 (année sèche) et 2005 (année moyenne). Pour l'année humide 2003, c'est la suppression des paramètres conductivité hydraulique, profondeur à la nappe et recharge qui cause une grande variation de l'indice de vulnérabilité. En revanche, le modèle DRASTIC est sensible à la suppression du paramètre «Topographie» pour les trois cartes. Ce résultat est dû au faite que ce paramètre est statique et son effet est identique pour les trois années. La suppression du paramètre formation de l'aquifère «A» affecte moins la variation de l'indice de vulnérabilité pour les deux cartes de 2003 et 2005 avec des indices de variation moyenne respective de 0,34 et 0,37. Toutefois, pour la carte réalisée en 2000 (année sèche), c'est le paramètre recharge de la nappe «R» qui affecte moins la variation de l'indice de vulnérabilité avec une valeur moyenne de 0,19 (Tab. 4).

Tableau 4. Les statistiques du test « Map removal sensitivity analysis »

Paramètre supprimé	Moyenne en 2000	Moyenne en 2003	Moyenne en 2005
D	1,96	1,52	1,62
R	0,19	0,99	0,75
A	0,32	0,34	0,37
S	0,5	0,62	0,47
T	1,3	1,41	1,25
I	1,7	0,79	1,92
C	1,5	1,61	1,46

La suppression successive, un par un, des paramètres ayant une faible influence sur la variation de l'indice de vulnérabilité n'a montré aucune cohérence dans la tendance des moyennes de l'indice de variation (Tab. 5). Ce qui montre que les sept paramètres sont nécessaires dans le modèle DRASTIC, comme il a été signalé dans certaines études antérieures [11], [23], [24], [25], [26], [27].

L'application du test "the single paramter sensitivity analysis" a montré que les paramètres profondeur à la nappe, impact de la zone non saturée, type de sol et topographie, sont les paramètres qui influencent plus la vulnérabilité. En effet, leurs poids effectifs moyens sont supérieurs à leur poids théoriques (Tab. 6). D'autre part, le poids effectif (19,59%) du paramètre recharge, pour l'année humide (2003), est supérieur à son poids théorique (17,39%).

Tableau 5. Les statistiques du test « Map removal sensitivity analysis »

Les paramètres utilisés	Moyenne 2000	Les paramètres utilisés	Moyenne 2003	Les paramètres utilisés	Moyenne 2005
D, A, S, T, I et C	0,19	D, R, S, T, I et C	0,34	D, R, T, I, C et S	0,37
D, T, I, C et S	0,53	D, R, T, C et I	0,98	D, T, I, C et R	0,92
D, I, C et T	1,31	D, T, C et R	1,3	D, I, C et T	1,35
D, I et C	4,14	D, C et T	3,69	D, I et C	3,39
D et C	10,7	D et C	3,39	D et I	9,17
D	10,57	C	12,76	I	9,33

Tableau 6. Les statistiques du test « **the single parameter sensitivity analysis** »

Paramètre	Poids Théorique	2000		2003		2005	
		Moyenne	Standard Déviation	Moyenne	Standard Déviation	Moyenne	Standard Déviation
D	21,73%	**26,07%**	7,23	**22,39%**	7,74	**23,21%**	8,54
R	17,39%	**13,72%**	1,83	**19,59%**	3,27	**15,68%**	4,9
A	13,04%	**12,89%**	1,72	**12,43%**	1,75	**13,19%**	2,24
S	8,69%	**11,64%**	2	**11,20%**	1,88	**11,94%**	2,25
T	4,34%	**6,53%**	1,04	**6,29%**	1	**6,67%**	1,09
I	21,73%	**24,34%**	2,73	**23,56%**	2,86	**24,77%**	3,27
C	13,04%	**4,81%**	2,56	**4,57%**	2,21	**4,91%**	2,52

4 CONCLUSION

Dans ce travail nous avons réalisé des cartes de vulnérabilité de la nappe de R'Mel par l'application de la méthode DRASTIC sur trois années différentes 2000, 2003 et 2005. Ces années ont été choisies principalement pour leur régime pluviométrique contrasté. L'analyse des cartes obtenues pour la nappe de R'Mel a montré une grande variabilité de la répartition spatiale des degrés de vulnérabilité d'une année à une autre. La carte de vulnérabilité élaborée pour l'année humide parait la plus sécurisante.

À travers cette application, ce travail a l'originalité de montrer que la vulnérabilité d'un aquifère est dynamique : elle est variable dans le temps. Ceci s'explique par le fait que certains paramètres pris en compte par la méthode DRASTIC évoluent aussi avec le temps (profondeur à la nappe, recharge, impact de la zone non saturée, lithologie de l'aquifère et conductivité hydraulique). Ces variations peuvent être dues en l'occurrence aux variations du régime pluviométrique qui est lié aux conditions climatiques. Pour cela, les cartes de la vulnérabilité, élaborées par des méthodes dont certains paramètres sont susceptibles de varier dans le temps, doivent être utilisées avec beaucoup de prudence, car elles peuvent compromettre la protection des ressources en eaux.

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The Emerging Technology in The Sector of Food Technology- The Non-Thermal Technology

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ABSTRACT: This papers details the different non-thermal technology and processing impact on food. The different technology included are ultraviolet light, ionizing radiation, pulse electric field, natural antimicrobials, hurdle technology, high pressure processing, carbon dioxide treatment, plasmas technology and pulse X-rays.

KEYWORDS: Ultraviolet light, Pulse Electric Field, Hurdle technology, High Pressure Processing, Plasmas Technology and Pulse X-rays.

1 INTRODUCTION

Non-thermal processing (NTP) treatments are gentler than thermal treatments, with targeted function for certain microbial inactivation and quality of products. The ability to retain flavor and aroma after NTP application is a huge advantage for Asian foods which often have stronger taste and aroma compared to Western foods. The vast variety of flavorful food in Asia such as fruits and fruit juices, sauces and seasonings, cereals, grains, flour and starches, seafood and meat products, snacks, and traditionally preserved foods (fermented, salted, added sugar) creates potential for the commercial application of NTP technologies. Some of these technologies are suitable for small scale entrepreneurs and some are suitable for large businesses. Besides cost, suitability of the technology and the targeted objective of processing the product must also be evaluated.

1.1 ULTRAVIOLET LIGHT

Irradiation using non-ionizing rays, especially ultraviolet (UV)-C (wavelengths of 220–300 nm with 90% emission at 253.7 nm) has been approved as a non thermal method by the U.S. Food and Drug Administration (FDA) for surface sterilization (US Food and Drug Administration (2007)). This technique has been used extensively to decontaminate food surfaces directly or other materials which come in contact with food surfaces. The main industrial application of UV is its use in disinfection of drinking water. The mechanism of action of UV light involves the interruption of bacterial replication due to the formation of thymine dimers in the bacterial chromosome either killing them or making them unable to reproduce. Chun et al., (2009) reported a reduction of 2.02 logs of *S*. Typhimurium in sliced ham upon the application of 8000 J/m2 of UV-C whereas in the case of chicken breasts a reduction of only 1.19 logs were observed upon the application of 5 kJ/m2 UV-C radiation (Chun et al., 2010). At the same time, storage of UV-C treated chicken breasts resulted in an increase in the TBARS values and a negligible change in the Hunter L, a and b values for the product. The effects of UV-C on the quality attributes and decontamination efficiency against *Salmonella* Enteritidis were evaluated in different egg fractions (de Souza and Fernández, 2011). In terms of quality attributes, UV-C did not affect the viscosity and the pH however, browning due to maillard reaction was detectable in egg yolk and whole egg at low UV-C doses. The TBARS value was not significantly different to untreated samples. At the same time, a reduction of 5.3, 3.3 and 3.8 log was achieved under dynamic conditions (9.22 J/cm2, 39 min) in egg white, egg yolk and whole egg, respectively. The main drawback of UV irradiation is that it is a surface sterilization

method. The efficiency of the treatment will strongly depend on the actual location of the bacterial contaminant as well as the composition, surface topography and transmissivity of the food (Allende et al., 2006). Moreover, the penetration of UV in liquid foods will strongly depend on the characteristics of the liquid product. The presence of solid particles and other components can seriously hinder the penetration. In addition the actual physical arrangement, power and wavelength of the UV source will also play a significant role. Besides, care has to be taken while using short wave UV regarding the damage that it can cause to human eyes in addition to being a cause of skin cancers and burns in humans upon excessive exposure.

Ultraviolet radiation has been used for several years as a physical disinfection medium for air, surfaces and liquids. During processing and storage of liquid foods, contamination can take place in many different contact points (incoming raw materials, storage vessels, air in storage vessels, equipments, rinse water, drinking water and water to be added to foods). UV irradiation can and has been used at these contact points to reduce microbial load and minimize contamination (Ngadi *et al*., 2004). UV light (254 nm) can be used to inactivate many types of organisms, including viruses and has been used for many years in pharmaceutical, electronic, and aquaculture industries as a disinfection medium. Microorganisms exposed to UV light are affected at the DNA (deoxyribonucleic acid) level. Thus, the injured reproduction systems of cells lead to their death. Exposure to UV light can be applied at different doses for pasteurization of liquid foods or disinfection of solid foods (Guerrero-Beltr·n and Barbosa- C·novas, 2004). Fresh fruit and vegetable products in pumpable form can be processed using UV light to reduce food-borne microbial load. Most of these products are commonly pasteurized but unfortunately, heat from thermal pasteurisation can negatively change the taste and flavor of such products. However, when using very high UV doses for food disinfection, loss of nutritional value and undesirable appearance, may take place (Mohd Adzahan, 2006; Gardner and Shama, 2000). FDA has approved UV irradiation (21 CFR 179.39) for use on fruit and vegetable juices and juice products to achieve the 5-log reduction of target microorganisms such as *E.coli* O157:H7 or *Cryptosporidium parvum* as part of HACCP rule compliance (CFR, 2000). Processors also may use chemical antimicrobial agents, such as certain sanitizers, on the surface of citrus fruit as long as FDA has approved the chemical agent. It has a relatively lower initial investment compared to heat pasteurization and the equipment is easy to operate (Worobo *et al.*, 1998; Choi and Nielsen, 2004). In addition, UV pasteurizers do not take up a lot of floor space and losses of ascorbic acid, thiamine, riboflavin, pyridoxine and nicotinic acid due to UV exposure at 14 mJ/cm2 are comparable to those in heat treated juices (Mohd Adzahan, 2006). In the cases of quality and consumer acceptability tests, there seemed to be little difference between cider samples that were untreated and those that were UV-pasteurized (Choi and Nielsen, 2004; Tandon *et al*., 2003), which is an indication of the fresh-like product quality. Guava, papaya, and pineapple juices are high in ascorbic acid and exposure to heat treatment will diminish their nutritional value. These juices may be suitable for UV processing as long as they do not have high initial microbial populations, particulate materials and organic compounds. Such properties will prevent low transmissivity of UV light (Guerrero-Beltran and Barbosa-C·novas, 2004) and hamper consistent exposure of UV energy throughout the juice. Processing helps to reduce initial counts of yeast and mold in the juice or filtering the juice through membrane technologies before UV irradiation will result in higher efficiency for microbial inactivation by UV light (254 nm). Clear and less turbid juices such as coconut water, sugarcane and chrysanthemum juice all have the potential for UV application as a more economical alternative to heat pasteurization. Rice and soy milk are also potential products for UV treatment but no data has been published on UV treatment of these drinks. A greater than 5-log reduction of *Listeria monocytogenes* was achieved when goat milk is exposed to a cumulative UV dose of 1.6 mJ/cm2 (Matak *et al*., 2005). Shelf life of UV treated mango nectar lasted for 20 days with almost no microbial growth. The nectar maintained yellow and orange-yellow colors, after 26 days of storage and polyphenoloxidase activity remained constant after 30 days. However, the lower the flow rate during UV treatment, the higher the browning of nectar during storage. The maximum log reduction (CFU/mL) in UV treated (30 min of UV exposure at 0.451 liter/ min) mango nectar was 2.71 and 2.94 for total microbial count and yeast count, respectively (Guerreo-Beltr·n and Barbosa-C·novas, 2006). There is still a lot of room for research and improvement in this area and it is crucial that studies are conducted on variables such as flow rate, exposure time, type of fruit product, color of fluid and composition of the beverage in order to ensure reduced microbial load, increased shelf life and nutritious with acceptable taste.

1.2 IONIZING RADIATION

New regulations by USDA-APHIS allow countries such as Chile, Brazil Philippines, Malaysia and Thailand to export fruits and vegetables to the United States which increases the capability of these countries in food irradiation (CFR, 2001). Gamma and electron beam irradiation are used to inhibit the sprouting of vegetables, extension of shelf life of fresh produce, control of pathogenic organisms, insect and microbial disinfestations and sterilization of food and food packaging materials (Kanatt *et al*., 2005; Chouliara *et al*., 2006; Javanmard *et al*., 2006). Irradiation of food up to an overall dose of 10 kGy is accepted in several countries for commercial food processing (Lacroix and Quattara, 2000). However, the formation of metmyoglobin when meat was exposed to higher dose was reported (Brewer, 2004). Sausages made from fermented, uncooked pork

wrapped in a banana leaf (Nham) are considered a great delicacy in Thailand which has frequently caused intestinal illness due to bacterial contamination. Fortunately, this is no longer the case as irradiation has provided an efficient way of making Nham safe for Thai consumers. Som tam is a popular spicy papaya salad originating from Laos and the Isan region of northeastern Thailand. The main ingredients are fermented fish and salted crab. The ingredients are now irradiated for export. Onions are a highly marketed produce in Thailand, and because of the climate, shelflife is fairly limited during storage in markets and households. An alternative to systemic chemical treatment (e.g. maleic hydrazide) for sprouting inhibition is the application of absorbed doses of ionizing radiation of about 1 kGy (Biramontri *et al*., 1989). Effect of gamma irradiation combined with hot water dip and transportation from Thailand to Canada improved the shelfe-life, biochemical and physical characteristics of Thai mangoes (Nahng Glahng Wahn variety) (Gagnon *et al*., 1993). Reibroy *et al*. (2007) studied the effect of irradiation on properties and storage stability of Som-fug produced from bigeye snapper. It was found that the irradiation at low dose (2 kGy) could be used to control the over fermentation of Som-fug up to 20 days at 4oC without adverse effects on quality and acceptability.

The use of ionizing radiation as a means of food preservation is being extensively researched and is approved in many countries such as the United States, France, Netherlands and Canada. The use of radiation dose up to 7 kiloGray (kGy) has been sanctioned by WHO as safe. The critical target of ionizing radiation is the bacterial DNA. Gamma rays, X-rays and electron beam are the most common types of ionizing radiation. Gamma radiation is generated using radioactive isotopes such as cobalt-60 or Cesium-137 (FDA approved) whereas for electron beam high speed electrons are generated using electricity. Generation of X-rays involves interposition of a metal target between the food and the electron beam. The choice of use between e-beam and X-ray is typically made as an exchange between efficiency and product penetration depth. Unlike gamma radiation, the processing time using electron beam is very short and the technique does not produce radioactive waste. The effect of both techniques on the quality is minimal as no heat is generated during the process. However, electron beam can penetrate only up to 8 cm in foods which is its major limitation. Nonetheless both these techniques are being studied for eliminating *Salmonella*. Irradiation in the range of 2-3 kGy has been used for the elimination of *Salmonella* in meat products. Park et al. (2010) reported lower total aerobic counts in gamma rays treated beef sausage patties as compared to electron beam treated samples. Reduction of 3.78 and 2.04 logs has been reported using electron beam irradiation (2 kGy) for *S.* Typhimurium inoculated in sliced ham (Song et al., 2011) and powdered weaning foods (Hong et al., 2008), respectively whereas Martins et al., (2004) reported a 4 log reduction in a cocktail of *Salmonella* strains using 1.7 kGy in watercress thereby showing the applicability of gamma radiation in salad vegetables. Application of 3 kGy electron beam resulted in a reduction of 6.75 and 4.85 logs of *S*. Tennessee and *S*. Typhimurium inoculated in Peanut butter (Hvizdzak et al., 2010). In contrast, irradiation by electron beam was found to be an unacceptable method for destroying *Salmonella* on raw almonds (Prakash et al., 2010). A dose of 5 kGy was reported to be required for achieving a 4 log reduction whereas radiation intensity higher than 2.98 kGy induced significant sensory changes in raw almonds (Prakash et al., 2010). Mahmoud (2010) reported 3.7 logs reduction in *S*. enterica per tomato upon the application of 0.75 kGy X-rays. Increasing the dose to more than 1 kGy resulted in more than 5 logs reduction. X-ray has shown to result in more than 6 logs reduction in ready to eat shrimps (Mahmoud, 2009) and spinach leaves and shredded iceberg lettuce (Mahmoud et al., 2010). However, several adverse effects (lipid oxidation, textural degradation) caused by ionizing radiation have prevented this technology from being extended. Especially, lipid oxidation of meat products by irradiation is the most important factor for quality decline. An increase in the off-odors of irradiated ground pork and pork chops upon refrigerated storage were observed (Ohene-Adjei et al., 2004). The negative effects of gamma radiation on the appearance and color of chicken breasts, pork loin and beef loin, has also been reported (Kim et al., 2002). Additionally just like other inactivation techniques, *S*. Typhimurium has been reported to develop resistance against the radiation if the cells are repeatedly processed with electron beam at sub-lethal doses (Tesfai et al., 2011). Although irradiation has a high potential to be used for food preservation, its use is limited by an uncorroborated view that irradiated foods are not well accepted by the public as safe and desirable.

1.3 PULSED LIGHT PROCESSING

The FDA has approved pulsed light for the treatment of food (CFR Title 21, Sec. 179.41) for surface microorganism control, with the total cumulative treatment not exceeding 12.0 (J/cm2) and the pulse duration is no longer than 2 milliseconds (CFR, 2000). The application is suitable for surface treatment of food packaging materials, egg shells, processing equipments and production lines, sliced meats and raw or fresh cut fruits and vegetables (Szabo *et al*., 2006). Fishermen producing salted seafood products can use this technology to prevent growth of resistant microorganisms; especially so that the intensity of pulsed light is more than the sunlight. The germicidal effect appears to be due to both the high UV content and the brief heating effects which come from the infrared portion of the light. While UV causes damage to the nucleic acid and other components of the cell, the instantaneous heating of the cell results in the rupture of the cell wall, or lysing (Wekhof, 2000).

1.4 PULSED ELECTRIC FIELD (PEF)

PEF is the application of short-duration pulses (1-100ms) of field strength (10-50 kV cm-1) to a product placed between two electrodes. Recently, the continuous flow-through chambers has developed and upgrading offer possibilities (Qin *et al*., 1998). Microbial inactivation by PEF is believed to be caused by the PEF on the cell envelopes. PEF can cause formation of pores affecting the integrity and functionality of the membrane. These pores can be reversible or irreversible, depending on the degree of membrane damage (Ho and Mittal, 1996; Weaver and Chizmadzhev, 1996). Under mild pulsation conditions, the pore formation in the membrane will be reversible, whereas more drastic conditions will lead to irreversibility of this phenomenon, which will eventually result in cell death (Barbosa- C·novas *et al*., 1999). The optimum conditions of inactivation of microorganisms depend on species and processing conditions (Abram *et al*., 2003; Rodriguez-Calleja *et al*., 2006). The main parameters are electric field strength, pulsed length, number of pulses, pulse shape and starting temperature (Wouters *et al*. 2001). Physical and chemical characteristics such as pH, conductivity and ionic strength of the medium in which the microorganisms are PEF treated can influence microbial inactivation (Alvarez *et al*. 2000). Sub-lethal injury caused by PEF in *Escherichia coli* (Garcia *et al*., 2003) and the effectiveness of PEF to inactivate enzymes has been reported (Giner Segui *et al*., 2006).

Since the pulses are applied for short durations (2µs to 1 ms) the negative impact on food quality due to heat processing is highly diminished (Barbosa-Cánovas et al., 2001). The technique is more suitable for liquid or semi-liquid foods which can be easily pumped. It can be used to increase the shelf life of soups, milk, whole liquid eggs and fruit juices. PEF as a non-thermal preservation method has been implemented by Genesis Juices, Oregon, USA. The application of electric field results in cellular death due to generation of pores (electroporation) in the bacterial cell membrane without having an effect on enzymes or proteins present in foods (Wouters et al., 2001). The effectiveness of the technique will strongly depend on the treatment time, electric field strength and specific energy of the pulses. For instance, Monfort et al., (2010) achieved an inactivation of 4 log for *Salmonella* Typhimurium when 45 kV/cm of electric field was applied for 30 µs. Higher number of pulses and electric field was reported to be a stronger factor for reducing the number of *S.* Typhimurium population in orange juice (Liang et al., 2002) whereas in another study on melon and water melon juices, treatment time was found be a more important factor (Mosqueda-Melgar et al., 2007). Treatment of watermelon and melon juice with PEF resulted in a reduction of 4.27 log (at 2000 µs and 100 Hz) and 3.75 log (at 1250 µs and 175 Hz) of *S.* Enteritidis, respectively (Mosqueda-Melgar et al., 2007). In contrast, Liang et al. (2002) reported a 5 log reduction of *S.* Typhimurium in orange juice exposed to a PEF of 90 kV/cm at a temperature of 55 °C. However, the higher reduction could be a result of combination of higher acidity of orange juice in addition to relatively higher temperature and high intensity of the PEF applied. Although the technique is useful, inactivation has only been achieved in the range of 3-4 logs.

1.5 NATURAL ANTIMICROBIALS

Since ancient times, spices and herbs have been used for preventing food spoilage and deterioration, and also for extending food shelf life. The antimicrobial effect of these components is a result of an increase in the permeability of the cytoplasmic membrane which leads to the loss of cellular constituents. At the same time, plant secondary metabolites such as essential oils and natural plant extracts have also been reported to have antibacterial, antifungal and anti-insecticidal properties. Extracts from capsicum, seaweeds and green tea have been found to inhibit the growth of *Salmonella* spp. in-vitro. Studies are also available wherein inhibitory effect of plant extracts was evaluated against *Salmonella* inoculated in minced beef, salad vegetables, fresh cut apples and minced sheep meat.

1.5.1 EXTRACTS FROM VEGETABLES

Vegetable extracts have shown a good potential when applied under laboratory conditions in culture media. For instance, application of 6% seaweed extract was shown to result in complete inhibition of *S. abony* whereas 3% extract resulted in 93% inhibition (Gupta et al., 2011). In contrast, 2.8% methanolic extract from Irish York cabbage was shown to result in only 64% inhibition of *S. abony* (Jaiswal et al., 2011). Xu et al. (2007) reported a minimal inhibitory concentration (MIC) of 15µl of grapefruit seed extract to inhibit *Salmonella*. Careaga et al. (2003) reported that a minimum concentration of 1.5 ml of capsicum extract per 100g of meat was needed in order to prevent the growth of *S.* Typhimurium inoculated in minced beef. Karapinar and Sengun (2007) evaluated the antimicrobial activity of koruk (unripe grape—*Vitis vinifera*) juice against *S*. Typhimurium on cucumber and parsley samples which resulted in 1-1.5 log reduction upon immediate contact with korak juice and the reduction increased as the time of exposure of the vegetables to the juice increased. The antimicrobial efficacy of plant extracts has been attributed to the presence of phenolic compounds, quinones, alkaloids, flavanols/flavonoids and lectins. Solubility of the extract in the food systems and the pH of the extract are important factors determining their efficacy

in foods. Mechanism of action of these phenolic compounds involves alteration in the cell morphology which results in a disruption of the cytoplasmic membrane and leakage of cell constituents. Although the use of vegetable extracts for controlling the growth of *Salmonella* is promising the actual application in foods is in its budding stage.

1.5.2 EXTRACTS OF HERBS AND SPICES

In addition to providing flavor and fragrance, spices and herbs have also antimicrobial potential and thus can be used for preventing food deterioration and shelf life extension. Sumac, rosemary, sage, basil and ginger are some of the spices commonly being used for imparting antimicrobial effects on food. The flower, buds, leaf, stem or bark of these plants contains aromatic oily liquid which is the essential oil (EO). These EO are rich in phytochemicals such as terpenoids, polyphenols, flavonoids, antocyanin and organic acids which are responsible for the antimicrobial activity. Compounds such as carvacrol, citral, thymol, eugenol and citric acid have been shown to inhibit the growth of *Salmonella*. Eugenol has been reported to strongly inhibit the growth of *Listeria monocytogenes*, *Salmonella Enteritidis*, *Escherichia coli* and *Staphylococcus aureus.* Carvacrol and thymol are reported to be the principal constituents of EO of certain herbs. Burt et al. (2007) evaluated the antimicrobial activity of carvacrol vapour against *S.* Enteritidis on pieces of raw chicken. UV sterilized chicken pieces treated with carvacrol vapour (2 µl) showed reduced viable numbers of salmonellae at 4, 20 and 37 °C and a concentration of 4 µl resulted in a complete elimination of all viable cells in a minimum of 3 h at 37 °C. Govaris et al. (2010) studied the antimicrobial effect of oregano EO, nisin and their combination against *S.* Enteritidis in minced sheep meat during refrigerated storage (4 or 10 °C) for 12 days. Addition of nisin, at 500 or 1000 IU/g, proved insufficient to inhibit *S.* Enteritidis. The addition of oregano EO at 0.9% caused the population of *S.* Enteritidis to be maintained below 1 log cfu/g whereas a combination of 0.9% oregano EO and nisin at 500 or 1000 IU/g showed a bactericidal effect. The addition of 0.6% or 0.9% EO was found to be organoleptically acceptable also. EOs have also been applied for the elimination of *Salmonella* on fresh tomatoes. Gündüz et al. (2010) tested the antimicrobial potential of essential oil extracts on tomatoes. The tomatoes were inoculated with the nalidixic acid resistant strain of *Salmonella* Typhimurium ATCC 13311 and treated for 5-20 min with water extracts of sumac or oregano oil. Tomatoes treated with 100 ppm oregano or 4% sumac extract resulted in 2.78 and 2.38 log reduction, respectively. Hayouni et al. (2008) studied the antimicrobial effect of extracts from *Salvia officinalis* L. and berries of *Schinus molle* L against *S. anatum* or *S.* Enteritidis inoculated on minced beef meat. Concentrations in the range of 0.02-0.1% showed bacteriostatic effect against both the bacteria by the extracts from *S. officinalis* and *S. molle* for over 15 days. In case of *S. molle*, the bacteriostatic effect was seen up to a concentration of 1%. At concentrations higher than 1.5% for *S. officinalis* and 2% for *S. molle*, immediate bactericidal effect was observed with a 2.6 log cfu /g reduction at 1.5% *S. officinalis* and 1 log cfu/g at 2% *S. molle*. However, sensory analysis of meat containing more than 2% of *S. molle* and 1.5% of *S. officinalis* showed a distinguished effect on the flavour and taste. In order to reduce the amount of EO being used, combinations of EO with NaCl were studied. The use of 0.1% or 1.5% *S. officinalis* with 6% or 4% NaCl or 0.1% or 1.5% *S. molle* with 4 or 8% Nacl could effectively eliminate *S. anatum* from refrigerated raw beef (Hayouni et al., 2008). The positive effect of spices on the inactivation of *S*. Typhimurium DT104 was observed when in direct contact, however, the activity reduced when added to food system such as ground beef (Uhart et al., 2006). Utilization of packaging materials containing these antimicrobial compounds is also becoming an attractive option in the food industry. However, a major limitation in using the EO in foods is the effect they have on the sensory properties of foods. At times, the concentration required to show the antimicrobial effect can surpass the organoleptically levels resulting in alteration in the flavor of foods.

1.6 HURDLE TECHNOLOGY OR SYNERGISM

Hurdle approach or the process of using multiple technologies is an effective approach to improve microbial decontamination in comparison to that of a single technology alone. Deliberate and intelligent combination of preservative treatments can help in maintaining the quality of food and delivering almost similar levels of microbial destruction as conventional methods alone. At the same time it warranties to counteract the negative effect of individual technologies on food quality. The choice of hurdles will strongly depend on the type of food it is being applied to in addition to the mode of inactivation. Potential synergistic effects among different technologies have been reported to be more effective than individual technologies applied alone. The outer membrane of gram negative cells prevents the entry of hydrophobic compounds. A combined treatment of heat and irradiation can result in sub-lethal injury to the cells. The sublethally injured cells can be more vulnerable to attack by antimicrobial compounds thereby reducing the dose of each individual technique.

For instance, combined effect of UV-C (0.5 J/cm2) and potassium lactate, lauric arginate ester and sodium diacetate (FDA approved) resulted in a 3.6-4.1 log reduction of *Salmonella*, *L. monocytogenes* and *Staphylococcus aureus* on the surface of frankfurters (12 weeks storage at 10 °C). In addition, UV-C and antimicrobials had no significant impact on frankfurter color or texture (Sommers et al., 2010). Amiali et al. (2007) studied the synergistic effects of temperature, treatment time and

electric field strength on inactivation of *S.* Enteritidis and *Escherichia coli* O157:H7 in egg yolk. A 5 log reduction in the population of *E. coli* O157:H7 and *S. enteritidis* was observed at an electric field of 30 kV cm−1 and 40 °C. Exposure of egg shells contaminated with *S.* Enteritidis with UV radiation (1,500 to 2,500 µW/cm2) followed by ozone (5 lb/in2 gauge for 1 min) resulted in an inactivation of 4.6 logs or more in a total treatment time of 2 min (Roriguez-Romo and Yousef, 2005). Although the individual treatments resulted in similar reductions, however exposure time and pressure were comparatively higher. Combined treatment of lactic and acetic acid with super critical CO2 resulted in 2.33 log cfu/cm2 reduction in *S.* Typhimurium in fresh pork which was higher as compared to these treatments being applied individually (Choi et al., 2009b). Application of PEF (25kV/cm, 250 µs in pulses of 2.12 µs) followed by heat treatment at 55 °C for 3.5 min increased the inactivation of *Salmonella* Enteritidis inoculated into liquid whole egg from 1 logs to 4.3 logs (Hermawan et al., 2004). The combination treatment had no effect on the color, pH, viscosity and brix of the treated samples and had a longer shelf life in comparison to heat treated samples. High pressure applied in combination with other agents such as heat or antimicrobial agents can be effectively used to increase microbial inactivation. Individual and combined effects of HPP and nisin treatment on relative resistance, viability and cellular components on *S.* Enteritidis (strains: FDA and OSU 799) was evaluated in culture media. High pressure up to 200MPa and nisin (200 IU/ml) when applied separately did not have any effect on the viability of either strain. However, application of high pressure (500 MPa) or a combination of nisin with a pressure of 350MPa (OSU 799 strain) and 400 MPa (FDA strain) resulted in an 8 log reduction (Lee and Kaletunç, 2010). Penetration of nisin into the cells was assisted by the pressure and thereafter the additive effect of two hurdles resulted in inactivation to be achieved at a lower value than when the technique was applied separately. Viedma et al. (2008) studied the synergistic effects of antimicrobial peptide enterocin AS-48 and high-intensity-PEF treatment (35 kV/cm, 150 Hz, 4 µs and bipolar mode) on the inhibition of *S. enterica* CECT 915 in apple juice. A combination of high intensity PEF (1000 µs) and AS-48 (60 µg/ml) and a treatment temperature of 40 °C resulted in 4.5 log reduction. The sequence of the synergistic treatments was an important factor as the inhibition was observed only when HIPEF was applied in the presence of previously-added bacteriocin. Since both, enterocin AS-48 and high pressure PEF, act on the bacterial cytoplasmic membrane, synergism between them could be a result of enhanced permeability of bacterial cytoplasmic membrane.

1.7 HIGH PRESSURE PROCESSING (HP)

High pressure processing (HPP) is a food processing method involving the application of pressure throughout the food. The technique is independent of the shape of food and can be used for both solid and liquid samples. Pressures in the range of 100-800 MPa are generally applied with temperatures ranging from 0-100 °C. The main target for HPP is the bacterial cytoplasmic membrane. In addition to the loss of solute, enzyme inactivation and protein coagulation might also occur as a result of excess pressure. HPP technique has been used for reducing or eliminating *Salmonella* in foods or culture media. Reduction of 6.5-8.2 logs in *Salmonella* inoculated in UHT whole milk was achieved at a pressure of 600 MPa for 10 min and 21.5 °C (Chen et al., 2006). Several instances regarding the growth of *Salmonella* spp. On the surface of tomatoes have been reported. HPP has been applied for the removal of this bacterium from the tomatoes surface. Application of pressures in the range of 350-550 MPa has been reported to result in 0.46-3.67 log reduction in *S. enterica* serovar Braenderup inoculated on diced and whole tomatoes (Maitland et al., 2011). Exposure to a pressure of 550 MPa for 2 min resulted in a reduction of several *S. enterica* serovars (Baildon, Gaminara, Michigan and Typhimurium) in the range of 4 log cfu/ml or greater for broth, water and apple juice (Whitney et al., 2007). Time did not seem to be an important factor when HPP was applied in a chicken meat model system. Treatment at 400 MPa for 2 min and 20 °C resulted in an inactivation between 3.26 and 4.35 log in a chicken meat model system (Escriu and Mor-Mur, 2009). The applicability of HPP as a preservation method against *Salmonella* has also been evaluated for products with lower water activity such as raw almonds. Goodridge et al. (2006) studied the effect of continuous and oscillatory HPP treatment on the viability of two *Salmonella* Enteriditis strains (FDA and PT30) inoculated onto raw almonds. Continuous pressurization of raw almonds resulted in less than one log reduction whereas the oscillatory process provided 1.27 and 1.16 log reduction for FDA and PT30 strains, respectively. However, a reduction of 3.37 logs was achieved when the almonds were directly suspended in water and then given the treatment. The effect was attributed to the fact that low water activity provided a protective effect to the bacterial cells. Application of HPP to orange juice resulted in 7-log inactivation of *Salmonella* at 600 MPa and 20 °C (Bull et al., 2004) and 615MPa and 15 °C (Teo et al., 2001) for 60 s. At the same time, HPP was reported not to have any significant effect on the quality parameters of orange juice such as titratable acid content, °Brix, viscosity, alcohol insoluble acids, color, ascorbic acid and β- carotene concentrations (Bull et al., 2004). However, the application of high pressure at high temperatures may result in undesirable changes in the quality of many foods. Moreover, in the case of meat products, high pressure can increase the susceptibility of meat products to attack by oxygen thus resulting in increased lipid oxidation. For instance, Ma et al. (2007) reported almost 5-fold increase in TBARS values after 7 days storage at 4 °C in beef exposed to a pressure ≥400MPa. In other studies, pressures higher than 300 or 400 MPa (at ambient temperatures) caused increased rate of oxidation in pork (Cheah and Ledward, 1996) and cod muscles (Angsupanich and Ledward, 1998), respectively. McArdle et al. (2011) reported detrimental

effect of HPP at 600MPa on texture, oxidation and water binding properties of beef. However lower TBARS and cook loss for beef processed by HPP were obtained as compared to raw or conventional heat processed samples. Besides, HPP carried out at high temperatures can cause cell wall breakdown and result in loss of cell turgidity. In addition, large-scale industrial application will only be possible if the technique becomes economical. The treatment time and the pressures applied are the major factors involved in deciding the cost and in achieving the desirable microbial inactivation. Hence, it is important to optimize conditions wherein minimal pressure is applied for the shortest time so that a food product with a reasonable cost is obtained.

Sauces and seasonings play a significant role in Asian dishes. Most of these products have been either fermented, salted, dried or added sugar or acid for preservation purposes. Despite that, due to microbial resistance to traditionally harsh conditions, further preservation is needed. A method which is suitable for reducing microbial counts in sauces and seasonings is high pressure processing (HP). Research on HP applications have been done on juices, seafood, pork, milk, fruit jams and eggs (Berlin *et al*., 1999; Linton *et al*., 1999; Patterson and Kilpatrick., 1998; PrÈstamo *et al*., 1999; Mussa *et al*., 1999; Yuste *et al*., 1999; Ponce *et al*., 1999). Surimi gels from Pacific whiting obtained by HP were less opaque than traditionally heat set gels and had higher stress and strain values than those of heat set gels (Chung *et al*., 1994). Guacamole, a product made from avocado has high fat content and very low acid and has been processed using HP and commercialized (San Martin *et al*., 2002). The durian fruit has high fat content and low acid just like guacamole. 'Tempoyak', a fermented Malay side dish made from this fruit may be suitable for commercialization using HP processing. Durian has a variety of volatile flavor compounds or/and aroma and its texture, taste and smell can be altered by heat (Voon *et al.,* 2006), which is the reason why NTP should be seriously considered as an alternative to a thermal process. Nuts have the potential of causing harmful diseases such as salmonellosis as well as intoxication from aflatoxins. Reports on raw almonds treated with high hydrostatic pressure to reduce *Salmonella enteriditis* have proven effective and the same application can be used on peanuts and other nuts, soybeans and legumes. This is done by suspending the food to be pressurized directly in the pressurizing medium (water) which would increase the Aw of the food, leading to an improved reduction in the concentration of vegetative bacteria (Goodridge *et al*., 2006). A type of soybean vegetable protein that Asians have long consumed and its intake is increasing in other countries is known as tofu. High pressure treatment of tofu at 400 MPa at 5oC for 5, 30, and 45 min showed reduction of the Gram-negative and Gram-positive microorganisms without causing any negative effects in terms of its sensory properties. Micrographs on the cryofracture observed with a cryoscanning electron microscope revealed a more compact structure after pressure compared with that of untreated samples, but the aggregates in the treated samples were more disperse (PrÈstamo *et al*., 2000). One study reported that soybean-towater ratio of 1:8 ratio at pH 7 led to pressurized soymilks which have color and viscosity properties similar to the untreated soymilk, with enhanced emulsion stability (Lakshmanan *et al*., 2006).

1.8 CARBON DIOXIDE TREATMENT

1.8.1 DENSE PHASE CARBON DIOXIDE (DP-CO2)

DP-CO2 or supercritical and liquid CO2 is a cold pasteurization method that affects microorganisms and enzymes through molecular effects of CO2 under pressure and suitable for juices and dairy based beverages. Pozo-Insfran *et al*. (2006) reported that thermal pasteurization decreased anthocyanins (16%), soluble phenolics (26%), and antioxidant capacity (10%) whereas no changes were observed for DP-CO2 Muscadine grape juices including its sensory attributes. Application of DP-CO2 extraction includes extraction of lycopenes from tomatoes, removal of caffeine from tea or coffee, extraction of flavor and aroma from hops in breweries, freeze-drying of vegetables and removing fat from animal products such as powdered eggs. The pharmaceutical industry also uses DP-CO2 extraction to remove medicinal compounds from herbs.

1.8.2 HIGH PRESSURE CARBON DIOXIDE (HPCD)

High pressure carbon dioxide (HPCD) is another upcoming treatment that is being extensively used as a non-thermal technique for food pasteurization. The process is not only environmentally friendly due to the non-toxic nature of carbon dioxide but also involves application of lower CO2 pressure as compared to those employed for HPP. The use of lower pressures makes this technique an energy-saving process. The major factor involved in the destruction is CO2 although pressure helps in greater penetration of CO2 in the cells. Lethality imparted by pressurized CO2 is a result of disassociation of CO2 (in foods with high water content) into reactive ions such as carbonates (CO32-), bicarbonates (HCO3-) and hydrogen (H+). These reactive ionic species can then have an effect on the permeability of the cell membrane and properties of cell constituents. In addition, generation of carbonic acid (H2CO3) in the water present in food products further results in a reduction in the pH of the food products enhancing the penetration of CO2 (Wei et al., 1991).

Studies involving the use of HPCD for the inactivation of *S.* Typhimurium (Kim et al., 2007; Erkmen and Karaman, 2001; Erkmen 2000; Wei et al., 1991) have clearly reported the microbial strain, pressure applied, pH of the medium, type of medium and temperature to be important factors for the inactivation. *S.* Typhimurium in orange juice was effectively reduced by 5-6 logs when subjected to continuous dense phase carbon dioxide (DPCD) for 10 min at 21–107 MPa and 25 °C (Kincal et al., 2005) whereas in another study reduction as high as 8 logs was achieved when the growth media was changed to physiological saline (PS) or phosphate buffer solution (Kim et al., 2007). Kim et al. (2007) also analyzed the structural changes in *S.* Typhimurium cells upon the application of super-critical CO2. A complete loss of colony forming activity was observed for the treated cells with a formation of veins and small vesicles on the surface. TEM images showed the inner areas to be highly disrupted accompanied by a membrane deformation. In addition, shrinking and uneven dispersion of cytoplasmic materials was also observed (Figure 1). Liao et al. (2010) obtained a remarkable reduction of 5 logs for *S.* Typhimurium when carrot juice was subjected to DPCD treatment. Both temperature and pressure had a noticeable effect as the inactivation was enhanced with increasing pressure at a constant temperature or increasing temperature at a constant pressure. In contrast, inactivation of *S*. Typhimurium in PS or PS containing 10% brain–heart infusion (PS-BHI) broth was completed in 35 min in PS whereas it took 140 min in the case of PS-BHI (Erkmen, 2000). Besides, the previous study reported the presence of two phases during the destruction characterized by a slow rate of reduction in the cell number which increased sharply at the later stage. Erkmen and Karaman (2001) observed that the exposure time required to achieve the same level of *Salmonella* inactivation was drastically reduced as the pressure during the inactivation increased. Complete inactivation of *Salmonella* was reported in egg yolk, 94-98% in chicken meat strips and limited inactivation in whole egg at a pressure of 13.7 MPa at 35 °C for 2 h (Wei et al., 1991). The variation in the results clearly indicates the complex nature of food systems. A treatment of 14 MPa at 45 °C for 40 min resulted in a 34.48% and 32.74% reduction for *S.* Typhimurium in soy sauce and hot-pepper paste marinated pork products, respectively (Choi et al., 2009a). However, the technique is more suitable for liquid foods as the diffusion of CO2 into solid samples becomes a limitation due to the absence of agitation in solid foods. Also, high concentrations of CO2 can cause darkening of color of certain animal products due to the formation of metmyoglobin. Due to the complex nature of foods conflicting results are available on the effect of HPCD on sensory, chemical and physical properties of foods. In spite of the potential advantages of HPCD more research is needed to monitor and quantify sensory and chemical characteristics of foods undergoing this preservation technique.

1.9 ULTRASOUND

1.9.1 INTRODUCTION

Ultrasound is energy in the form of sound waves with a frequency greater than 20 kHz. It has proven bactericidal effects, especially when combined with other microbial reduction strategies such as mild heating or pressure. A combination of pressure, thermal and ultrasound is called mano-thermosonification (MTS) and this combination has been proven to be more effective in reducing pathogenic microorganisms and in retaining quality of juices (Kuldiloke, 2002). Ultrasound treatment (sonifier probe at 20 kHz, 100% power level, 150 W acoustic power, 118 W/cm2 acoustic intensity) combined with mild heat (57oC) for 18 min resulted in a 5-log reduction of *L. monocytogenes* in ultrahigh-temperature milk, a 5-log reduction in total aerobic bacteria in raw milk, and a 6-log reduction in *E. coli* O157:H7 in pasteurized cider (D'Amico *et al*., 2005). Ultrasound is now applied to food products for microbial an enzyme inactivation and for food extraction via mechanical actions. Ultrasonic cavitation produces shear forces which breaks cells mechanically and allows material transfer from cell into solvents. Particle size reduction by the cavitation increases the surface area in contact between liquid and solid phases, an advantage when extraction of compounds is expected. The technology has been used for extraction of phenolic compounds from vacuolar structures by disrupting plant tissues, extraction of lipids and proteins from seeds, emulsification, viscosity improvement, homogenization and improvement of dispersion stability in liquid foods. This technology has also been used for salads, vegetables, fresh poultry, sauces, confectionaries, beverages, juices and purees, dairy products, as well as for sanitized washing and for waste water treatment. For poultry products, ozone in combination with ultrasound is an option to reduce microbial counts. Ozone can be used for both the products and also the equipment and facility, doesn't leave a residue, eliminates the storage problems associated with peroxide, chlorine dioxide and other sanitizers and is more effective in reducing pathogen loads (Ngadi *et al*., 2004).

Ultrasound when propagated through a biological structure, induces compressions and depressions of the medium particles and a high amount of energy can be imparted. In dependence of the frequency used and the sound wave amplitude applied a number of physical, chemical and biochemical effects can be observed which enables a variety of applications [Got et al. 1999, Knorr et al. 2004, Ultrasound... 1998]. Ultrasound has been used for a variety of purposes that includes areas as diverse as communication with animals (dog whistles), the detection of flaws in concrete buildings, the synthesis of fine chemicals and the treatment of disease. Despite its wide-ranging uses and exciting developments the study of ultrasound is a

young science. The oldest application, the exploitation of diagnostic ultrasound only dates back to the beginning of the 20th century and ultrasound in processing is even more recent in origin [Mason 2003]. In nature bats and dolphins use low-intensity ultrasound pulses to locate prey; while certain marine animals use high-intensity pulses of ultrasound to stun their victims before capture. In the food industry, a similar division into two distinct categories of ultrasound applications is made [Fellows 2000, McClements 1995]. For the classification of ultrasound applications the energy amount of the generated sound field, characterised by sound power (W), sound intensity (W·m-2) or sound energy density (Ws·m-3), is the most important criterion [Knorr et al. 2004]. The uses of ultrasound are broadly classified into two groups. Low energy (low power, low-intensity) ultrasound applications involve the use of frequencies higher than 100 kHz at intensities below 1 W·cm-2. Low-intensity ultrasound uses a so small power level that the ultrasonic waves cause no physical or chemical alterations in the properties of the material through which the wave passes, that is it is generally non-destructive. They are successfully used for non-invasive monitoring of food processes. The most widespread application of low- intensity ultrasound in the food industry is as an analytical technique for providing information about the physicochemical properties of foods, such as composition, structure and physical state [Fellows 2000, Jayasooriya et al. 2004, Knorr et al. 2004, McClements 1995]. Ultrasound has advantages over other traditional analytical techniques because measurements are rapid, non-destructive, precise, fully automated and might be performed either in a laboratory or on line. One of the most widespread and most promising ultrasonic applications is the utilization of ultrasound for composition measurement. Ultrasonic velocity in fish tissues, chicken and raw meat mixtures can be related to its composition using semi-empirical equations [Simal et al. 2003]. The other group is high energy (high power, high-intensity) ultrasound which uses intensities higher than 1 W·cm-2 (typically in the range 10-1000 W·cm-2) at frequencies between 18 and 100 kHz [McClements 1995, Ultrasound... 1998]. Physical, mechanical or chemical effects of ultrasonic waves at this range are capable of altering material properties (e.g. physical disruption, acceleration of certain chemical reactions) [Jayasooriya et al. 2004]. High-intensity ultrasound has been used for many years to generate emulsions, disrupt cells and disperse aggregated materials. More recently various areas have been identified with greater potential for future development, e.g. modification and control of crystallization processes, degassing of liquid foods, enzymes inactivation, enhanced drying and filtration and the induction of oxidation reactions [Knorr et al. 2004, McClements 1995, Roberts 1993, Zheng and Sun 2006]. The beneficial use of the sound energy is realized through the various effects the ultrasound generates upon the medium where it transmits. Physical, mechanical or chemical effects of ultrasonic waves at this range are capable of altering material properties through generation of immense pressure, shear and temperature gradient in the medium through which they propagate. During the sonication process, longitudinal waves are created when a sonic wave meets a liquid medium, thereby creating regions of alternating compression and expansion. These regions of pressure change cause cavitation to occur, and gas bubbles are formed in the medium. These bubbles have a larger surface area during the expansion cycle, which increases the diffusion of gas, causing the bubble to expand. A point is reached where the ultrasonic energy provided is not sufficient to retain the vapour phase in the bubble; therefore, rapid condensation occurs. The condensed molecules collide violently, creating shock waves. These shock waves create regions of very high temperature and pressure, reaching up to 5500°C and 50 MPa. Cavitation can result in the occurrence of microstreaming which is able to enhance heat and mass transfer [Jayasooriya et al. 2004, Zheng and Sun 2006]. The ability of ultrasound to cause cavitation depends on ultrasound characteristics (e.g. frequency, intensity), product properties (e.g. viscosity, surface tension) and ambient conditions (e.g. temperature, pressure) The ultrasound intensity required to cause cavitation increases markedly above about 100 kHz [Williams 1983].

1.9.2 APPLICATIONS IN THE FOOD INDUSTRY

Developments in the application of ultrasound in processing began in the years preceding the Second World War when it was being investigated for a range of technologies including emulsification and surface cleaning. By the 1960s the industrial uses of power ultrasound were accepted and being used in cleaning and plastic welding which continue to be major applications [Mason 2003]. The possibility of using low-intensity ultrasound to characterize foods was first realized over 60 years ago; however, it is only recently that the full potential of the technique has been realized [Povey and McClements 1988]. There are a number of reasons for the current interest in ultrasound. The food industry is becoming increasingly aware of the importance of developing new analytical techniques to study complex food materials, and to monitor properties of foods during processing; ultrasonic techniques are ideally suited to both of these applications. Ultrasonic instrumentation can be fully automated and make rapid and precise measurements. Ultrasound is non-destructive and non-invasive, can easily be adapted for on-line applications, and used to analyse systems that are optically opaque [McClements 1995]. Within food technology we can find almost all of the examples of processing to which ultrasound can be applied. Until recently the majority of applications of ultrasound in food technology involved non-invasive analysis with particular reference to quality assessment. Such applications use techniques that are similar to those developed in diagnostic medicine, or non-destructive testing, using high frequency low power ultrasound. Examples of the use of such technologies are found in the location of foreign bodies in food, the analysis of droplet size in emulsions of edible fats and oils and the determination of the extent of

crystallization in dispersed emulsion droplets [Mason et al. 1996]. The relationship between measurable ultrasonic properties of foods (velocity, attenuation coefficient and impedance) and their physicochemical properties (composition, structure and physical state) is the basis of the ultrasonic analysis. This relationship can be established either empirically by preparing a calibration curve relating the property of interest to the measured ultrasonic property, or theoretically by using equations describing the propagation of ultrasound through materials [McClements 1995]. By monitoring the attenuation of an ultrasound pulse has proved possible to determine the degree of homogenisation of fat within milk. The measurement of ultrasound velocity in conjunction with attenuation can be used to estimate the degree of emulsification in such materials. It is possible to determine factors such as the degree of "creaming" of a sample, i.e. the movement of solid particles/fat droplets to the surface. Such information gives details, for example, of the long term stability of fruit juices and the stability of emulsions such as mayonnaise. The combination of velocity and attenuation measurements shows promise as a method for the analysis of edible fats and oil as well as for the determination of the extent of crystallization and melting in dispersed emulsion droplets [Mason et al. 1996].

In recent years food technologists have turned their attention to employment of power ultrasound in processing. Its history can be traced back to 1927 when a paper entitled "The chemical effects of high frequency sound waves I. A preliminary survey" was published [Richards and Loomis 1927]. Physical, mechanical, or chemical effects of ultrasonic waves at this range are capable of altering material properties (e.g., disrupting the physical integrity, acceleration of certain chemical reactions) through generation of immense pressure, shear, and temperature gradient in the medium through which they propagate [Ultrasound... 1998]. High power ultrasonic applications generally depend on complex vibration induced effects in the propagating media, which produces cavitation in liquids or biological tissue. In addition to cavitation, ultrasound is able to weaken the physical structure of the material or medium, provided the dimensions of the media are similar to those of the ultrasonic wavelength used [Got et al. 1999]. One of the major long-established industrial applications of power ultrasound is for cleaning and it has proved to be an extremely efficient technology [Mason et al. 1996]. Surface cleaning is applicable to a wide range of disciplines and applications (e.g. sensors, filters, substrates, reactors, catalysers and heat exchangers). Ultrasound has been shown to be particularly effective for in situ cleaning in conjunction with chemical treatment and offers such advantages as: reduced chemical consumption, reduction of direct worker contact with hazardous cleaning chemicals/substances, enhanced cleaning speed, cleaning consistency – the ultrasonic activity is micro in nature and reaches all areas of complex configurations for uniform cleaning, automatic operation and control savings in energy costs, labour and floor space [Mason 2003].

Possible applications of power ultrasound in the food industry are very wide ranging. One of the earliest uses of power ultrasound in processing was in emulsification. Emulsions generated with ultrasound are often more stable than those produced conventionally and often require little, if any, surfactant [Mason et al. 1996]. Investigations have shown that the use of ultrasound as a processing aid can reduce the production time of yoghurt of up to 40%. Moreover, sonication reduced the normal dependence of the process on the origin of milk as well as improved both the consistency and the texture of the product. It was also found that fish egg exposure to ultrasound of frequency 1 MHz for 35 min, three times a day resulted in the reduction in hatch time for loach from 72 to 60 hours. Several reports in the literature suggest that ultrasonic treatment of seeds before sowing is an effective method of improving crop yield [Mason et al. 1996]. One of the original uses of power ultrasound in biochemistry was to break down biological cell walls to liberate the contents. Subsequently it has been shown that power ultrasound can be used to activate immobilized enzymes by increasing the transport of substrate to the enzyme. As far as enzymes are concerned, ultrasound can also be employed as a method of their inhibition [Mason et al. 1996]. Chambers [1937] reported that pure pepsin was inactivated by sonication probably as a result of cavitation. By applying ultrasound for over three hours, the original activity of peroxidase, responsible for the development of off-flavours and brown pigments, was progressively reduced by 90% [Mason et al. 1996]. The use of power ultrasound significantly improves the extraction of organic compounds contained within the body of plants and seeds. The mechanical effects of ultrasound provide a greater penetration of solvent into cellular materials and improve mass transfer [Mason et al. 1996]. Additional benefit results from the disruption of biological cell walls to facilitate the release of contents. Combined with this effect is enhanced mass transfer, due to the effects of microstreaming which results in a more efficient method for sugar extraction [Chendke and Fogler 1975]. The sonication accelerated sugar diffusion and gave the higher level of dry matter content and sugar content in juice [Stasiak 2005]. In some cases sonication increased the efficiency of extraction at lower temperatures producing a purer product in a shorter time [Mason et al. 1996]. By using of ultrasound extraction of tea solids from leaves was improved by nearly 20%. Authors noticed that the majority of material was extracted in the first 10 minutes of sonication [Mason and Zhao 1994]. Zayas [1986] reported that an increased yield of the enzyme rennin from calf stomachs has been achieved by using ultrasound. Moreover, the activity of ultrasonic extract was found to be slightly increased in comparison with normal technology. Power ultrasound has proved to be extremely useful in crystallization processes. It serves a number of roles in the initiation of seeding and subsequent crystal formation and growth [Mason et al. 1996, Stasiak and Dolatowski 2007]. Ultrasound has also been applied to filtration. As a result, the moisture content of slurry containing 50% water was

rapidly reduced to 25%; whereas conventional filtration achieves a limit of only 40% [Mason et al. 1996]. Another example of ultrasound application of potentially great commercial importance is acoustic drying. Ultrasonically enhanced drying can be carried out at lower temperatures than the conventional methodology which reduces the probability of oxidation or degradation in the material. By employing ultrasound the heat transfer between a solid heated surface and a liquid is increased by approximately 30-60% [Ensminger 1988].

Power ultrasound has proved itself an effective method in assisting food freezing and its benefits are wide-ranged. In addition to its traditional application in accelerating ice nucleation process, it can also be applied to freeze concentration and freeze drying processes in order to control crystal size distribution in the frozen products. If it is applied to the process of freezing fresh foodstuffs, ultrasound can not only increase the freezing rate, but also improve the quality of the frozen products. Application of power ultrasound can also benefit ice cream manufacture by reducing crystal size, preventing incrustation on freezing surface, etc. [Zheng and Sun 2006]. Among other applications are improvements in the extraction of flavourings, filtration, mixing and homogenization and the precipitation of airborne powders, destruction of foams which cause general difficulties in process control e.g. in fermentation [Ultrasound... 1998]. As a result of continued research interest and development in instrumentation, novel applications such as oxidation of unsaturated oils, aging of alcoholic beverages, hydration of acetylene, decalcification of bone, hydrolysis of esters have been developed [Mason 1999, McClements 1995].

1.9.3 ULTRASONIC INACTIVATION OF MICROORGANISMS

The most common techniques currently used to inactivate microorganisms in food products are conventional thermal pasteurization and sterilization. Thermal processing does kill vegetative microorganisms and some spores; however, its effectiveness is dependent on the treatment temperature and time. However, the magnitude of treatment, time and process temperature is also proportional to the amount of nutrient loss, development of undesirable flavours and deterioration of functional properties of food products. High power ultrasound is known to damage or disrupt biological cell walls which will result in the destruction of living cells. Unfortunately very high intensities are needed if ultrasound alone is to be used for permanent sterilization. However, the use of ultrasound coupled with other decontamination techniques, such as pressure, heat or extremes of pH is promising. Thermosonic (heat plus sonication), manosonic (pressure plus sonication), and manothermosonic (heat plus pressure plus sonication) treatments are likely the best methods to inactivate microbes, as they are more energy – efficient and effective in killing microorganisms. The advantages of ultrasound over heat pasteurization include: the minimizing of flavour loss, greater homogeneity and significant energy savings [Mason et al. 1996, Piyasena et al. 2003]. A considerable amount of data exists regarding the impact of ultrasound on the inactivation of microorganisms [Piyasena et al. 2003]. The effectiveness of an ultrasound treatment is dependent on the type of bacteria being tested. Other factors are amplitude of the ultrasonic waves, exposure time, volume of food being processed, the composition of food and the treatment temperature. Bactericidal effects of ultrasound were observed while suspended in culture medium [Davies 1959]. According to Lillard [1993] Salmonellae attached to broiler skin were reduced upon sonication in peptone at 20 kHz for 30 min. Results of research carried out by Dolatowski and Stasiak [2002] proved that ultrasound processing was having a significant influence on microbiological contamination of meat. There are a large number of potential applications of high intensity ultrasound in the food industry. Applications of both high- and low-frequency ultrasound in the food industry have already been shown to have considerable potential for either modifying or characterising the properties of foods. In many instances, techniques based on ultrasound have considerable advantages over existing technologies.

1.10 OZONE PROCESSING

Ozone has a highly biocidal effect and a wide antimicrobial spectrum for food preservation technology. In the food industry, ozone has been routinely used for washing and storage of fruits and vegetables by gaseous treatment. With the recent FDA approval of ozone as a direct additive to food, the potential of ozonation in liquid food applications has increased (Cullen *et al.*, 2009). Ozone as an antimicrobial agent has numerous potential applications in the food industry because of its advantages over traditional antimicrobial agents such as chlorine and potassium sorbates. Ozone processing within the food industry has been carried out on solid foods by either gaseous treatment or by washing with ozonated water. However, with the FDA approval of ozone as a direct additive to food, the potential of ozonation in liquid food applications has begun to be exploited. A number of commercial fruit-juice processors in the USA have begun to employ ozone to meet the recent FDA mandatory 5 log reduction of the most resistant pathogens in their finished products. This practice has resulted in industry guidelines being issued by the FDA for the ozonation of apple juice (FDA, 2004). The FDA's approval of ozone as a direct additive to food in 2001 triggered interest in ozone applications, with a number of commercial fruit juice processors in the US and Europe employing ozone for pasteurization, resulting in industry guidelines being issued by the United States Food and

Drug Administration (USFDA, 2004). The use of ozone application for the disinfection or storage of various exotic fruits or their products, including kiwi fruit, has been reported (Graham & Tyman, 2002; Hur *et al.*, 2005; Oztekin *et al.*, 2006; Whangchai *et al.*, 2006; Akbas & Ozdemir, 2008; Zorlugenc *et al.*, 2008; Barboni *et al.*, 2010; Meyvaci *et al.*, 2010). However, most of the reported studies are limited to the microbiological analysis of exotic fruits. Ozone at concentrations of 0.15–5.0 ppm has been shown to inhibit the growth of spoilage bacteria as well as yeasts (Jay *et al.*, 2005). Ozone has been investigated for fruit juice processing applications, including apple cider (Steenstrup & Floros, 2004; Choi & Nielsen, 2005). Torres *et al.* (2011) reported that apple juice color, rheological properties and phenolic content were significantly influenced by ozonation. Thus, although ozonation can be employed as a preservation technique for processing apple juice, its impact on the nutritional and quality parameters of the juice should be considered.

Willams *et al.* (2005) studied the effect of ozone in combination with dimethyl dicarbonate and hydrogen peroxide for orange juice preservation. They reported that a 5-log reduction of *E. coli* O157:H7 could be achieved by using ozone in combination with dimethyl dicarbonate. Similarly, Patil *et al.* (2009) reported a 5-log reduction of *E. coli* NCTC 12900 in <7 min in orange juice. Steenstrup and Floros (2004) reported that the overall inactivation of *E. coli* O157:H7 by ozone is rapid enough for practical application in apple juice production. Excess ozone auto-decomposes rapidly to produce oxygen, and thus, it leaves no residues in food. The half-life of ozone in distilled water at 20 °C is approximately 20-30 min (Khadre *et al.*, 2001). The applications of ozone in fruit and vegetable processing were extensively reviewed by Karaca and Velioglu (2007). Tiwari *et al.* (2008a), Tiwari *et al.* (2009a) and Tiwari *et al.* (2009b) recently highlighted that the nutritional quality depends on the ozone control parameters of concentration and gas flow rate. Achieving rapid microbial inactivation using optimized control parameters while retaining the nutritional quality is important. Patial *et al.* (2010) stated that overall, the gaseous ozone treatment applied to orange juice resulted in a population reduction of 5 log cycles within a time range that varied between 5 and 9 min. Table 2 lists recent studies on ozone application in fruit juices, whole fruits and vegetables. Although the ozonation of liquid foods is still in its infancy, it has been reported for the processing of various fruit juices, including apple cider (Steenstrup & Floros, 2004; Choi & Nielsen, 2005; Williams *et al.*, 2005) and orange juice (Angelino *et al.*, 2003; Tiwari *et al.*, 2008a). Ozone is extensively applied in the treatment of water and wastewater due to its powerful oxidation and disinfection capabilities. Ozone as an oxidant is used in natural water treatment, washing and disinfecting of fruits and vegetables and juice processing to inactivate pathogenic and spoilage microorganisms (Muthukumarappan *et al.*, 2000).

Increasing consumer demand for fresh products, which are usually refrigerated, has led the food industry to develop alternative processing technologies. The goal is to produce food with minimal nutritional, physicochemical or organoleptic changes induced by these technologies (Esteve & Frígola, 2007) while maintaining safety profiles with respect to the pathogens of concern. Ozone is a triatomic allotrope of oxygen and is characterized by a high oxidation potential that conveys bactericidal and virucidal properties (Burleson *et al*., 1975; Kim *et al.*, 1999). Ozone inactivates microorganisms through oxidization, and residual ozone decomposes to nontoxic products (i.e., oxygen), making it an environmentally friendly antimicrobial agent for use in the food industry (Kim *et al.*, 1999). In the gas or aqueous phase, ozone has been used to inactivate microorganisms and decontaminate meat, poultry, eggs, fish, fruits, vegetables and dry foods (Fan *et al.*, 2007).

1.11 PLASMA TECHNOLOGY

1.11.1 PLASMA DEFINITION, GENERATION AND CLASSIFICATION

Plasma is ionized gas, that consists of a large number of different species such as electrons, positive and negative ions, free radicals, gas, atoms, molecules in the ground or excited state and quanta of electromagnetic radiation (photons). It is considered to be the forth state of matter in the world. It can be generated in the large range of temperature and pressure by means of coupling energy to gaseous medium. This energy can be mechanical, thermal, nuclear, radian or carried by an electric current. These energies dissociate the gaseous molecules into collection of ions, electrons, charge – neutral gas molecules and other species. Depending on the type of energy supply and amount of energy transferred to the plasma, density and temperature of the electrons are changed. These lead Plasma to be distinguished into two groups, high temperature plasma and low temperature plasma (given in table 1). High temperature plasma implies that electron, ions and neutral species are in a thermal equilibrium state. Low temperature plasma is subdivided to thermal plasma, also called local thermodynamic equilibrium plasmas (LTE) and non thermal plasma (NTP), also called non-local thermodynamic equilibrium plasmas (non-LTE). An equilibrium or near equality between electrons, ions and neutrals is the main characterization of thermal plasmas (TP). Frequently employed thermal plasma generating devices are those produced by plasma torches, and microwave devices. In generation of cold plasma most of the coupled electrical energy is channeled to electron component instead of heating entire gas stream so the temperature of heavy particle remains near the room temperature, these characteristics make it suitable to be used in processes which high temperature is not desirable.

Table 1. Classification of Plasma

Plasma	Properties	Example
High temperature plasma (Equilibrium plasma)	$Te \approx Ti \approx Tg$, $Tp = 10^{6} - 10^{8}$ K	Laser fusion plasma
	Low temperature plasma	
Thermal plasma (Quasi-equilibrium plasma)	$Te = Tg = T \leq 2 \times 10^{4}$ K $n_e \geq 10^{20}$ m^{-3}	Arc plasma
Non-thermal plasma (Non-equilibrium plasma)	$Te >> Ti \approx Tg = 300 - 10^{3}$ K $n_e \approx 10^{10}$ m^{-3}	Glow discharges

Table 2. Recent findings in the area of nonthermal plasmas for inactivation of micro-organisms and Spores

Organism	Plasma conditions	Treatment surface/ medium	Salient result	References
Escherichia coli, Staphylococcus aureus	Atmospheric plasma corona discharge, with high voltage (20kV) DC power supply	On agar plates	Changes of pH levels from alkaline to acid, upon plasma application to bacteria in water, does not play a predominant role in cell death.	Korachi et al. (2010)
Staphylococcus aureus	DC cold- atmospheric-pressure plasma microjet with compressed air as the working gas	Aqueous suspensions of the organism	First 10 min treatment led to insignificant inactivation. After 16 min *S. aureus* was completely inactivated. Effective inactivation of *S. aureus* was found to start after the pH values decreased to about 4.5.	Liu et al. (2010)
Bacillus atrophaeus, Geobacillus sterathermophilus, Clostridium sporogenes, Kocuria rhizophila, Staphylococcus aureus, Aspergillus niger	low- pressure inductively-coupled plasma (ICP) with different mixtures of gases	Glass substrates and silicon wafers coated with the organism by spraying.	All the organisms were found to be reduced by at least 4 orders of magnitude under optimized low-pressure argon plasma. Efficiency of inactivation was variable for different strains of a given species.	Von Keudell et al. (2010)
Bacillus subtilis	Oxygen and nitrogen treated using 8 Duo-Plasmalines driven by microwaves power	Microscopic slides stacked with spores	Plasma treatment of the spores caused release of DPA, generation of auxotrophic mutants, reduction in Kat X activity and damage to DNA. A biphasic model for the inactivation kinetics was proposed.	Roth et al. (2010)

1.11.2 ATMOSPHERIC PRESSURE PLASMAS (APP)

Low pressure glow discharge plasmas are of great interest in microelectronic industries but their vacuum equipment limits their application. Therefore one of the recent challenges was developing new plasma sources that can operate at or near 1 atmospheric pressure. Power sources of atmospheric pressure plasma generation can be microwave, RF (radio frequency), pulsed, AC (alternating current) or DC (direct current). Devices that have been used for plasma generation are the corona discharges, micro hollow cathode discharges, gliding arc discharge, one atmospheric uniform glow discharge, dielectric plasma needle barrier discharge (DBD), atmospheric pressure plasma jet (APPJ). Among all. DBD and APPJ are commonly used in industrial application like lightening, surface modification, etching and deposition.

1.11.3 MICROBIAL INACTIVATION MECHANISM OF PLASMA

The use of plasma as a sterilization method was first patented in 1968 and the plasma made from oxygen was first applied in 1989 after that considerable researches have been done on mechanisms of microbial inactivation by plasma agent. Interacting plasma agent with biological mater contributed to lethal action. Plasma treatment can effectively inactivate a wide range microorganisms including spores [6-8] and viruses. Effect of plasma on different microorganisms can be completely selective, meaning that it can damage pathogenic microorganisms without damaging host or it can activate different pathways in different organisms. The reactive spices in plasma have been caused the oxidative effects on the outer surface of microbial cells. Nitrogen and oxygen gas plasma are good sources of reactive oxygen- based and nitrogen-based spices such as O., O2, O3, OH, NO., NO2. Chemical rate constant of atomic oxygen for oxidation at room temperature is so higher than molecular oxygen. These act on the doubled bond of unsaturated fatty acid of membrane cell, thereby disturbing the transport of bimolecules across it. In spite of oxidation of the lipids, amino acids and nucleic acids of cells and spores are vulnerable to the action of these spices and oxidation of them cause changes that lead to microbial death or injury. In addition to reactive spices, UV photons can modify the DNA of the microorganisms and as a result disturb cell replication. The role of UV photons in inactivation of microorganisms when they are subjected to plasma was reviewed in detailed by

Boudam et al.. Many studies have found that reactive spices had the most important role in inactivation of microorganisms and the role of UV photons in plasma was minor, but these studies demonstrated that more researches need to be done over the role of UV photons in plasma. Contribution of each of the above mentioned mechanisms in inactivation microorganism depends on plasma characteristics and to the type of microorganisms. The former includes device set up (reactor geometry), voltage, gas pressure, gas composition, water content in the gas, and distance of the microorganism from the discharge glow, where the latter takes account of Gram-positive, Gram -negative, spores and other types. To cite an example, Hury et al., compared the destructive efficiency of different gas composition and temperatures on Bossilus spp. Spores. They found that oxygen-based plasma is more efficient than pure argon plasma. The other criterion that was considered is the direct exposure or remote exposure of substances from the plasma sources, The recent findings demonstrated that if the substrate which is sterelizied to be in indirect contact (remote exposure) with the plasma, the quantum of heat transmitted to a sample is reduced and many of the short-lived reactive spices do not reach the sample so the treatment cannot be efficient in microorganism inactivation.

1.11.4 COLD PLASMA

Cold plasma is a novel non-thermal food processing technology designed for the inactivation of pathogenic microoganisms and food safety improvement. CP is a ionized gas that comprises a large number of different species such as electrons, positive and negative ions, free radicals, electrons and gas atoms, photons and it is suitable to be used in processes for which high temperature is not recommended. CP could be employed in inactivation of the microorganisms on the surface of fresh and processed foods. The accumulation of charged particles can rupture the cell membrane. Oxidation of the lipids, amino acids and nucleic acids with reactive oxygen species and nitrogen species cause changes that lead to microbial death or injury. Contribution of mentioned mechanisms depends on plasma characteristics and on the type of microorganisms. CP has been applied in the food industry including for decontamination of raw agricultural products (apple, lettuce, almond, mangoes and melon), egg surface and real food system (cooked meat, cheese). However, there are few studies on the application of this technology in real food systems and on the effects of cold plasma on nutritional and chemical properties of food are not known well. Key limitations for cold plasma are the relatively early state of the technology development, the variety and complexity of the necessary equipment, and the largely unexplored impacts of cold plasma treatment on the sensory and nutritional qualities of treated foods. The treatment must be proven not to have negative impact on the organoleptic and nutritional properties of foods. Hence, it is necessary for further studies to specify the extent in which CP affect the chemical and the nutritional properties of foods and its shelf-life. Furthermore, the studies which explore the safety and cost aspects to apply into practice the CP and for scaling up this technology in food industry should be addressed to determine the applicability of this method. Combining the CP treatment with other non-thermal processes could be a possible future breakthrough in this field. In this case, synergistic effects may be more considerable, however scaling up this technology remains for the moment a challenge to be solved.

1.11.5 BENEFITS AND APPLICATIONS

Cool (or nonthermal) plasma has many potential applications for the food industry, including the dry disinfection of food surfaces (meat, poultry, fish, nuts, fruit and vegetables), powders (dried milk components, flour, herbs and spices) and seeds for sprouting (alfalfa and mung beans). The technology can also be used to disinfect surfaces of processing equipment and packaging materials. The gaseous atoms and ions of plasma are effective against bacteria, viruses, moulds and fungi. The plasma can penetrate cracks and crevices unlike other potential surface treatments such as ultraviolet light. Therefore, the technology functions more effectively over uneven or cracked surfaces such as those found on many foods (seeds, meats etc). Cool plasma has several advantages over competing preservation technologies such as irradiation, chemical sterilization (e.g. ethylene oxide) or disinfection treatments (e.g. chlorine). These can have detrimental sensory effects on treated food products or they are being phased out because of safety concerns. Although cool plasma technology is not yet used commercially on a large scale in the food industry, it has been successfully used for decades in many other industries, and is readily scaleable. Cool plasma systems for treating foods at atmospheric pressure are currently being developed and tested. Target foods include nuts, spices, flour, and horticultural produce.

1.12 PULSE X-RAYS

Pulsed X-ray is a technology that utilizes a solid state opening switch to generate electron beam x-ray pulses of high intensity. Electrons have limited penetration depth of about 5cm in food while x-ray have significantly higher penetration depths (60-400cm) depending upon the energy used.

Curry and others used a system consists of an x-ray accelerator with a thyristor charging unit, a magnetic pulse compressor, a solid state opening switch, an electron beam diode load and an x-ray convertor. The thyristor charging unit converts 3 phase current to direct current. A thyristor capacitor charging circuit is used to charge the magnetic pulse compressor. A 2-stage circuit compresses and sequentially steps up the voltage pulse before it is used to charge an inductive load. Energy from capacitor is transferred from the inductive load in approximately 100ns. A convertor is installed on the accelerator and the electron beam is converted to pulsed x-rays to allow thick samples to be processed. Curry and others used pulsed x-rays to produce up to a 3 log reduction of e-coli O157:H7 in ground beef.

1.12.1 APPLICATIONS OF PULSED X-RAYS

Use in examination of packaged food for tramp materials, inactivation of e-coli in meat also used to eliminate Salmonella from foods.

2 CONCLUSION

The non-thermal technology is the emerging technology, in demand for the processing and preservation of food in recent and coming years, in the area of food processing, food engineering and food technology. Above mentioned NTT retains the fresh quality of food for longer time, only the point of consideration is the consumer's knowledge about these technology and safety of the product they need to consume. With the increasing demand of these technology there implementation cost and the finally the product cost is going to get reduced, benefiting human kind.

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Experimental and theoretical study of the impact of quantum chemistry parameters on the behavior of the thermal degradation of organophosphorus oxide resins inufigeant

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ABSTRACT: In this study, we are interested in the development of a new model "Quantitative Structure Property Relationship" (QSPR). To illustrate the behavior inufigeant of the thermal degradation of resins oxides organophosphate based on the Quantitative Structure-Property Relationship (QSPR) and the quality of the experimental data. Subsequently, we have discussed the influence of the impact of the thermal parameters quantum chemistry on the retardant behavior of degradation of multifunctional resins (DGEBA, TGTEP, HGTEP and HGCP). Self-timer degradation prediction was made by the semi-empirical PM3 and DFT method database software Gaussian 03.

KEYWORDS: QSPR; model; Pm3; DFT; Epoxy resins; Retardant thermal degradation.

1 INTRODUCTION

The development of new materials stands of an extensive experimental work and a large number of tests under different conditions. Synthesis polymer with the desired properties is challenging which implies often much time and resources. The ability to predict the properties of final product of new materials is a large value, a guidance which speeds up the process and the cycle of development. Thermal properties are one of the most important properties of organic polymers and their complexes; they determine temperature ranges for the treatment and employ these materials and conditions front for and understand other properties. There were many methods proposed for predicting the behavior heat systems of polymers. These include empirical equations [1,2], molecular dynamics simulations [3.4], the methods semi-empirical [5] and mathematical tools including neural networks [6.7], the theory of fuzzy sets [8] and chart clues theory [9 , 10]].

In this work, we aim to correlate the electronic properties of some epoxy resins (DGEBA, TGTEP, HGTEP and HGCP) synthesized in the laboratory and hardened by dianilinemethylene (MDA), epoxy resins a certain temperature feature of thermal degradation. Subsequently, we compared the experimental results with the predicted properties for the validation of the theoretical model developed.

2 MATERIALS AND METHODS

2.1 MATERIALS

Our composite materials are formulated from matrices composed of DGEBA resins and new TGTEP, HGTEP HGCP and then cross-linked by dianilinemethylene (MDA), on the one hand, and the load and coupling agents, on the other hand. The formulations contain as charges a powder in the form of very fine particles and the calcium carbonate because of its hydrophobic nature.

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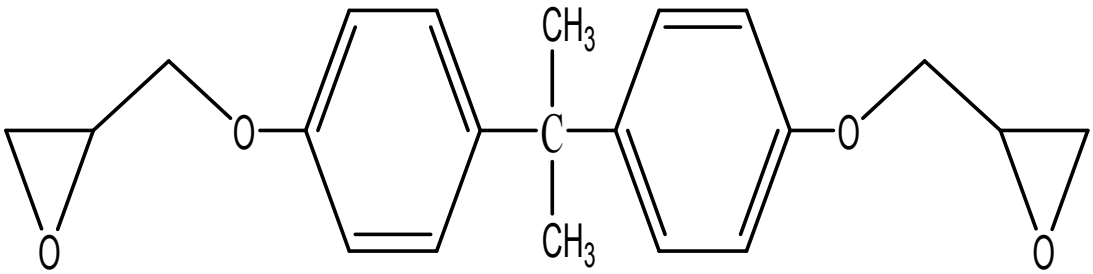


Fig 1: Diglycidyl ether of Bisphenol A (DGEBA)

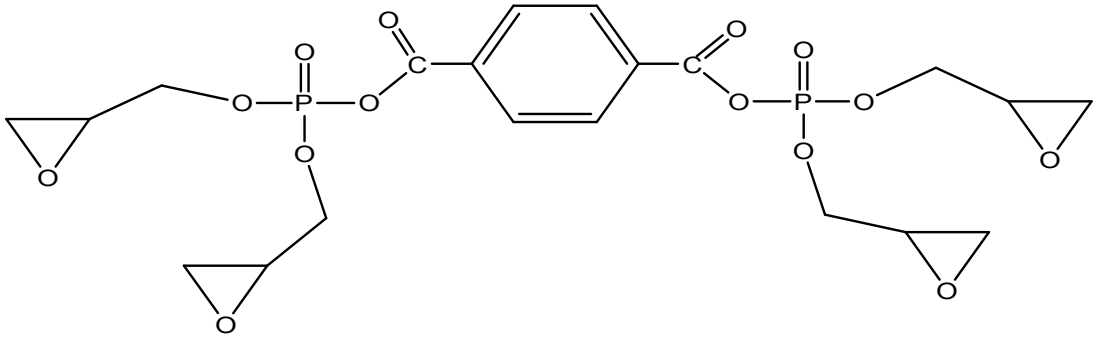


Fig 2: Tetraglycidyle terephtalydiene bias-para-ester phosphoric (TGTEP)

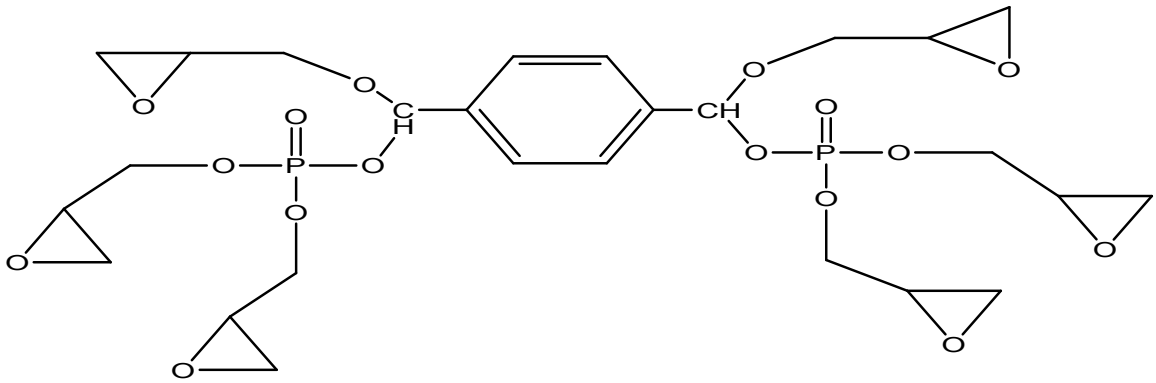


Fig 3: Hexaglycidyle terephtalydiene bias-para-ester phosphoric (HGTEP)

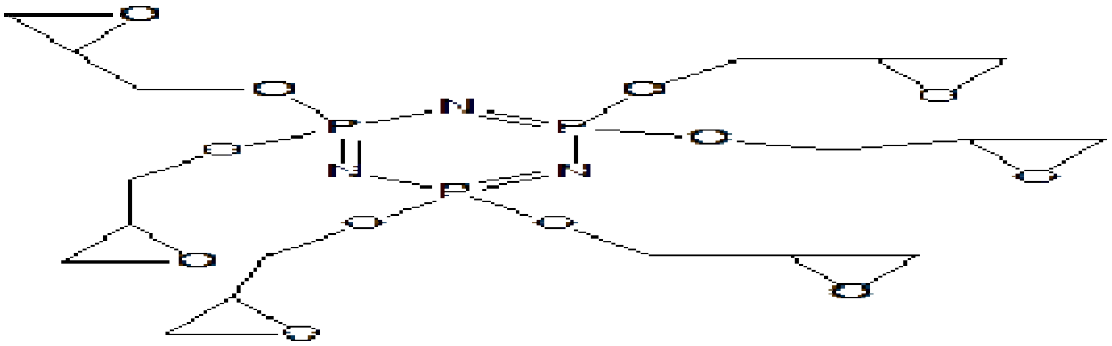


Fig 4: Synthesis of hexaglycidyl Cyclotriphosphazene (HGCP)

2.2 CALCULATION METHODOLOGY

The quantum chemical calculations have been widely used to study the reaction mechanisms [11]. They are also approved to be a very powerful tool for the study of the properties of the molecules [12, 13]. It has been shown that the physical properties may be related to the molecular structure and electronic space.

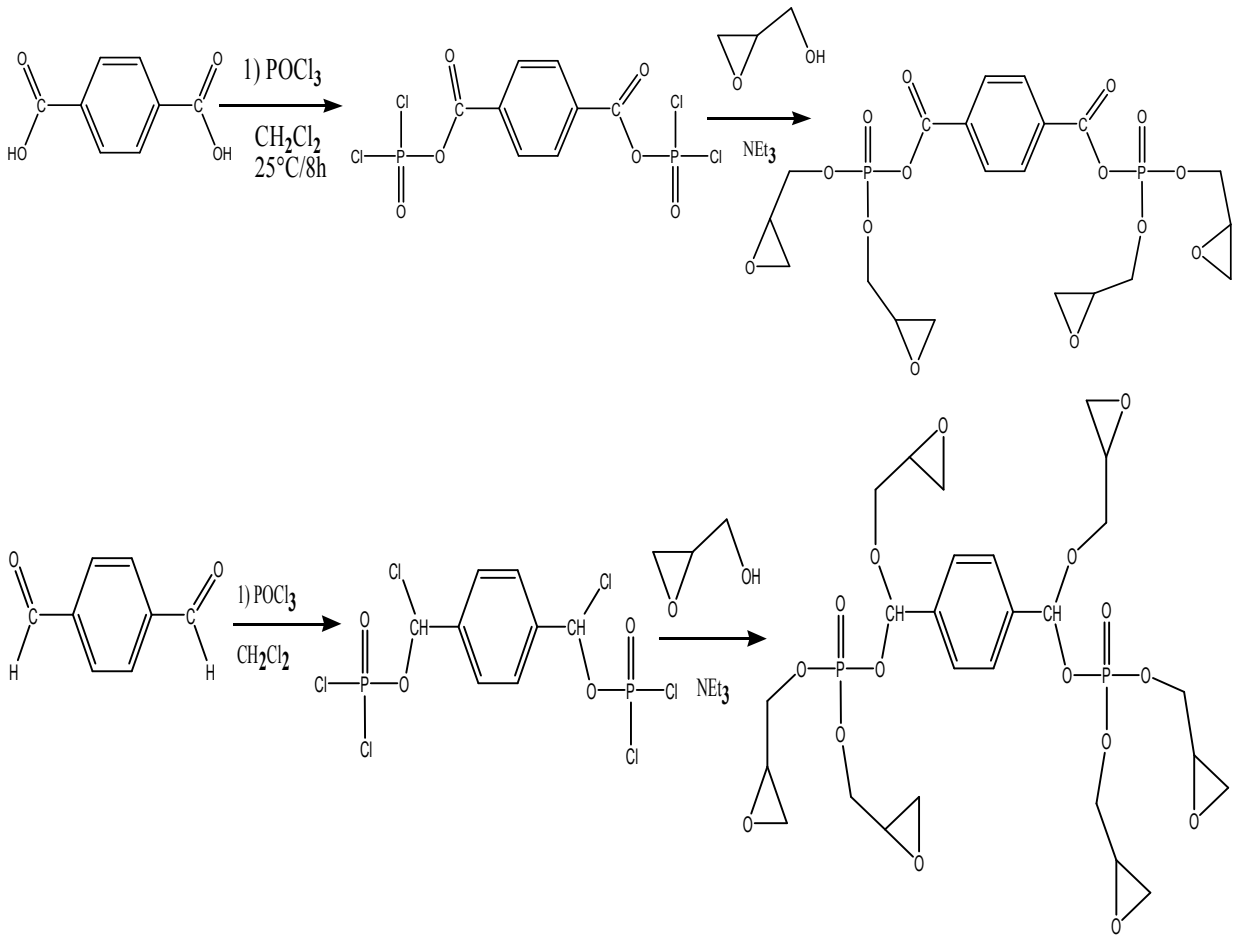
In this study, we studied the relationship between the parameters of the quantum chemistry and self-timer degradation behavior heat some epoxy resins organophosphorus synthesized in the laboratory [14, 15, 16]. The quantum chemical parameters were calculated by the semi-empirical method namely, the parametric method (PM3 and DFT), the three compounds method of Becke parameter (B3LYP) has been used on the basis of (6-31 G), all the calculations were performed by Gaussian 03.

3 RESULTS AND DISCUSSIONS

3.1 SYNTHESIS OF EPOXY RESINS

The fig (5) recollects the different phosphorus epoxy resin synthesized in the laboratory with the D GEBA as a model.

The homologs of epoxy polymer represented by fig (2 and 3) have been prepared from the reaction of the epychloridrine with the compound of terephthalaldehyde [14] as mentioned in the following reaction scheme while the DGEBA fig (1) and the hexaglycidyl cyclotriphosphazene (HGCP), fig (4) were obtained by condensation of the epychloridrine respectively on Bisphenol A and the cyclotriphosphazene hexaglycidyl.



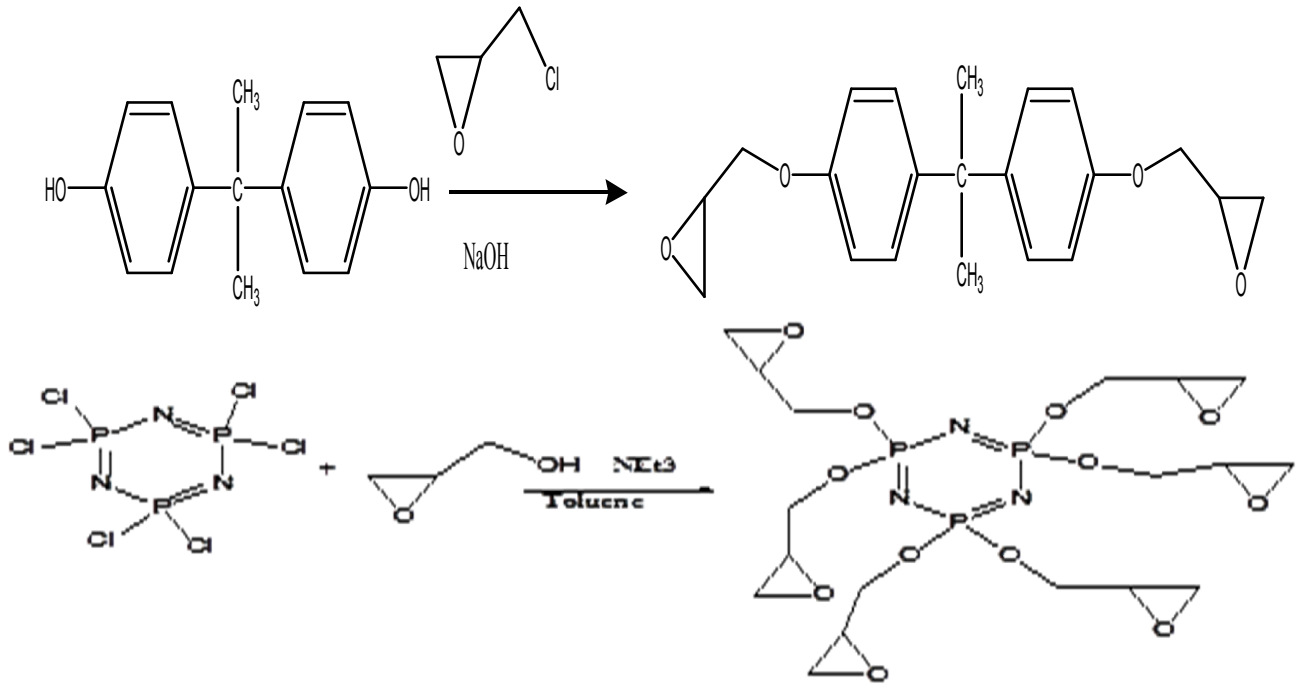


Fig 5: derivatives epoxy compound (DGEBA, HGTEP, TGTEP and HGCP)

Thermogravimetric analysis shows monocomponent composite developed as temperature, from which the degradation takes a steeper shape, is substantially identical for all three materials. Then, we classified the main features according to conventional standards,With:

Td: start temperature of decomposition (mass loss of 2%)

T 10: temperature 10% of mass loss

T 50: temperature at 50% of mass loss

Table1: Main characteristics of paralysis of one composite sample

Sample	T d ° C	T 10 ° C	T 50 ° C
DGEBA	164,34	291,79	350,44
TGTEP	205,09	391,12	430,08
HGTEP	213,18	391,11	480,66
HGCP	250,22	344,54	375,12

3.2 THEORETICAL RESULTS

To search for calculating epoxy resins organophosphorus we propose to study several descriptors on electronic and steric basis thermodynamic effect.

The calculation of descriptors has been done by two different methods. The first semi-empirical (PM3) using the MM2 and a second method based on the electron density (DFT) using the Gaussian program 03. The main results of this study are summarized in table 2.

Table2: Quantitative Structure-property of different descriptors

Molecule	Method	EHOMO (eV)	ELUMO (eV)	ΔE	M (Debye)	Log P
DGEBA	DFT	-9,68	0,05	9,73		
	PM3	-9,338	-0,167	9,171	24,09	3,835
TGTEP	DFT	-3,1926	-1,6396	1,553		
	PM3	-9,411	-1,737	7,674	8,25	2,52
HGTEP	DFT	-3,37	-1,79	1,58		
	PM3	-9,86	-0,53	9,33	13,71	13,71
HGCP	DFT	-9,52	-3,6789	5,8411		
	PM3	-5,243	-1,67	3,573		

3.3 RELATIONSHIP - PROPERTY (QSPR)

To establish a mathematical model relating the experimental temperature characteristical of thermo grams with values obtained from the study of quantum descriptors available (QSPR), we need to calculate the correlation between each descriptor and each property in the table to model parameters and their equations.

3.4 GENERAL MODEL

$$\mathbf{Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2}$$

Table 3: Model parameters

	TD		T10		T50	
	PM3	DFT	PM3	DFT	PM3	DFT
β_0	253,556	170,191	7,824	0.451	-20,338	22,663
β_1	242,483	402,436	7,440	11,360	-47,944	-13,729
β_2	280,206	491,682	14,646	14,393	-4,792	-5,175

3.4.1 CASE 1 DFT METHOD

$T_d(C°)$ **= 170, 191 + 0, 451 * E_{HOMO}+ 22, 663 * E_{LUMO}** R^2= **0.969** Equation 1

$T_{10}(C°)$ = **402, 436 + 11, 360 * E_{HOMO} -13,729 * $_{ELUMO}$** R^2= **0.998** Equation 2

$T_{50}(C°)$ = **491, 682 + 14, 393 * $_{EHOMO}$ -5, 175 * E_{LUMO}** R^2= **0.863** Equation 3

3.4.2 CASE 2 PM3 METHOD

$T_d(C°)$ = **253, 556 + 7, 824 * E_{HOMO} -20,338 * $_{ELUMO}$** R^2= **0.685** Equation 4

$T_{10}(C°)$ = **242, 483-7, 440 * $_{EHOMO}$ -47, 944 * E_{LUMO}** R^2= **0.465** Equation 5

$T_{50}(C°)$ = **280, 206-14, 646 * $_{EHOMO}$ -4,792 * $_{ELUMO}$** R^2= **0,260** Equation 6

The results of theoretical calculation which is represented in table 4

Table 4: Theoretical calculation

Method	Molecule	TD ° C	T10 ° C	T50 ° C
PM6	DGEBA	183,890282	319,965685	417,773461
	TGTEP	215,250897	395,781767	426,367269
	HGTEP	187,188955	341,253275	427,15856
	HGCP	246,499866	361,559274	365,00071
DFT	DGEBA	164,688403	291,7799	352,094321
	TGTEP	212,959691	393,309345	456,291958
	HGTEP	205,910121	388,677367	454,216139
	HGCP	249,271785	344,793388	373,697582

The Fig (6, 7, 8 and 9), show the variation of temperatures in experimental and theoretical degradation of resins studied (DGEBA, TGTEP, HGTEP and HGCP). They are obvious that there is a strong relationship between experimental and theoretical values, indicating that these models can be used to predict the thermal flame-retardant properties of news precursors which are structurally related to epoxy resins studied.

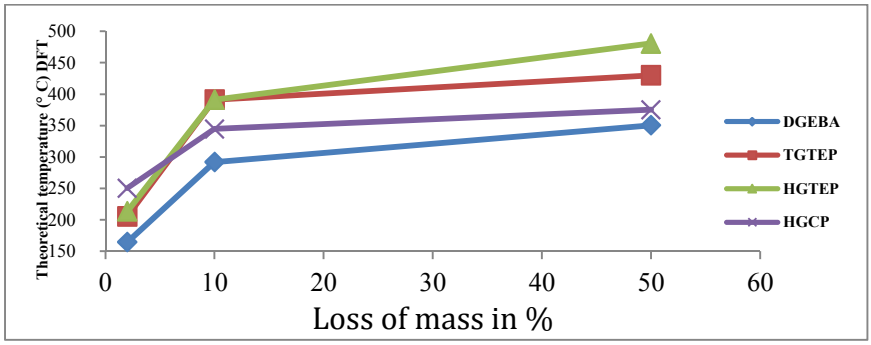


Fig 6 : Variation of Theoretical temperature DFT based on% loss

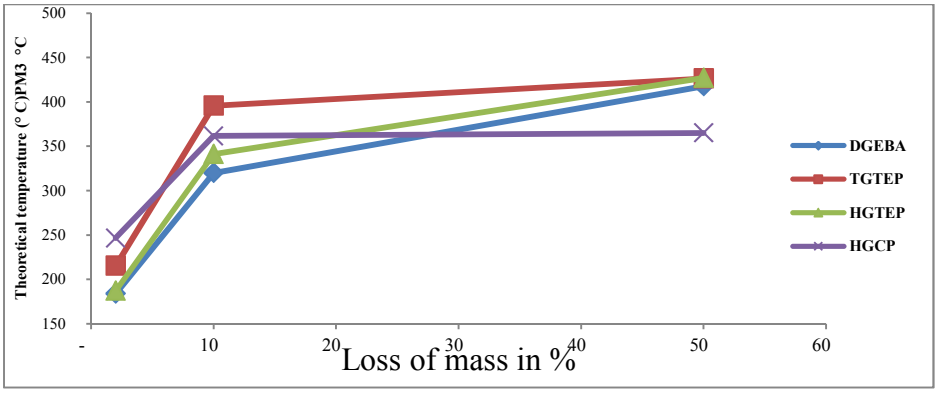


Fig 7: Change in Theoretical temperature PM3 depending % loss

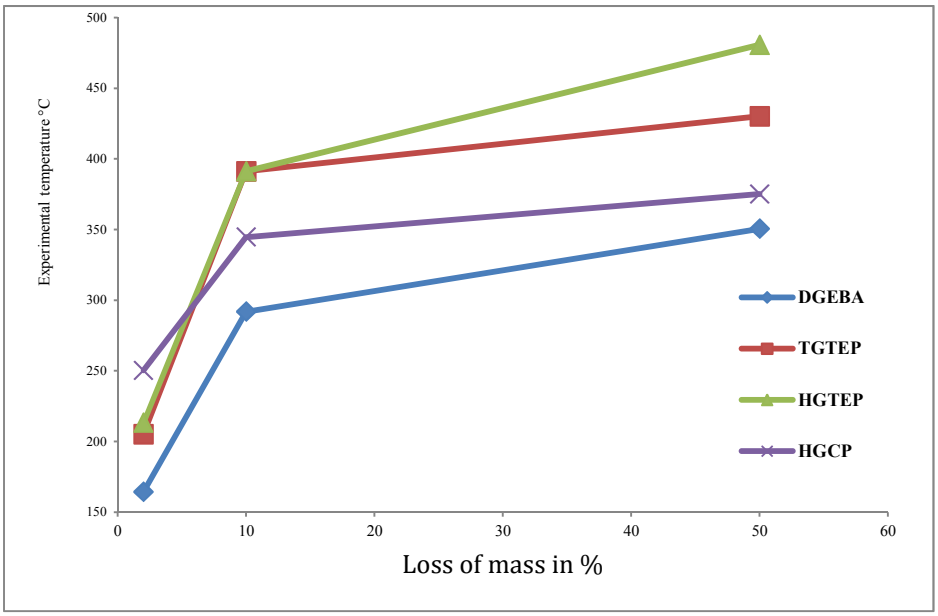


Fig 8: Change in Temperature Experimental based mass loss in %

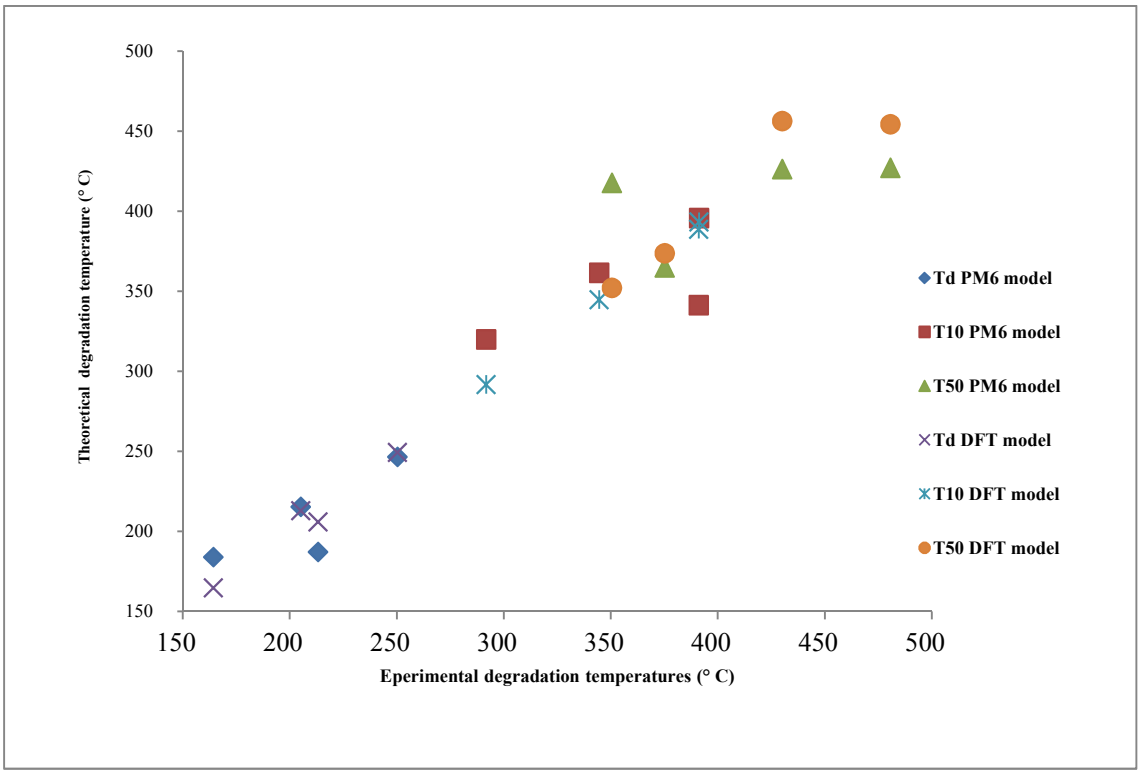


Fig 9: Variation of temperature versus theoretical, experimental temperature

The HOMO and LUMO orbitals of resins organophosphorus derivatives are presented in fig (10-13). This shows clearly that the effect of the electronic regulating the thermal phenomenon on the epoxy-dimmine systems studied.

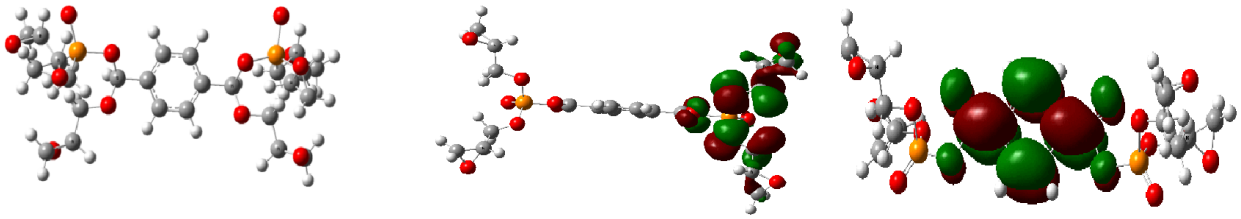


Fig 10: HGTEP

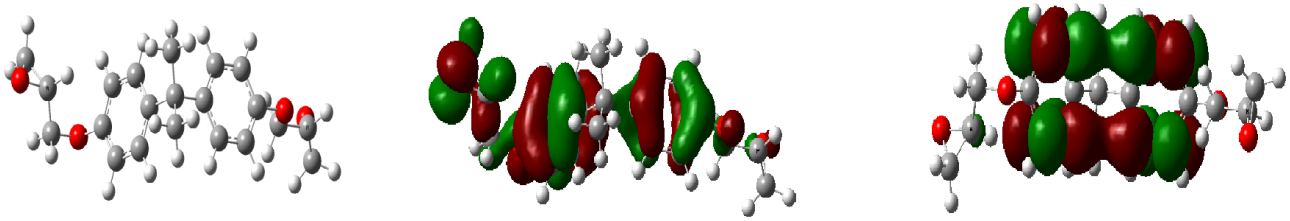


Fig 11 : DGEPA

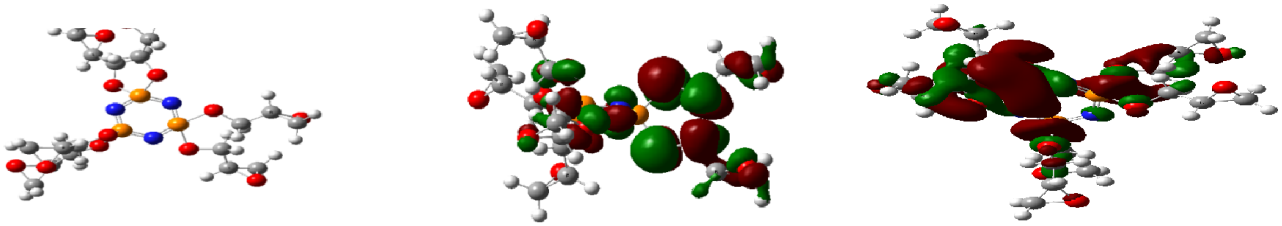


Fig 12 : HGCP

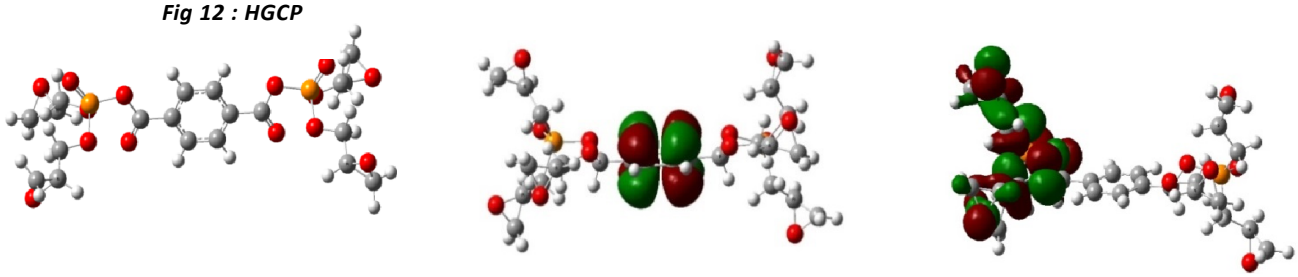


Fig 13 : TGTEP

4 CONCLUSION

In this work, we have studied the impact effect of electronics on the retardant behavior property heat a classy variety of epoxy resins organophosphorous. This calculation allows QSPR models to calculate the values of certain characteristical temperatures of the retardant behavior of thermal degradation involving a number of quantum parameters (descriptors). All theoretical results obtained coincide with the experimental results The distribution of electron density of the influence on properties of the behavior retardant epoxy resins range studied where the strong correlation between the phenomenon and the electronic effect of thermal degradation are linked.

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Chemo-prophylactic and Hemato-serological effect of anti-diarrheal drugs against Neonatal Calf Diarrhea

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ABSTRACT: A very important disease of younger age that usually appears and leads to death of neonate in case of improper diagnosis and treatment is Neonatal calf diarrhea. Disease has its own economic importance as livestock has a major role in gross domestic production (GDP) of Pakistan. A trail was conducted to check chemo-prophylactic effects of different anti-diarrheal drugs. Thirty neonates were selected and divided into six equal groups treated respectively with Colimune Ora, Cosumix Plus, Streptomegma, NMK Powder and Biovet by keeping last group as control. Blood sample were collected to check any untoward change in blood just after birth, on 3rd and 28th day of experiment. Mixed results were found in hematology on 28th day with overall increasing pattern in Total leukocyte count (TLC) and Packed cell volume (PCV). IN contras Total erythrocyte count (TEC) shows increase of 16.57%, 96% and 93.47% respectively in case of Colimune Ora, NMK and Cosumix Plus whereas decrease in case of Streptomegma and Bio Vet up-to 5.06%. Mixed results concerning DLC, serum sodium and potassium level were witnessed. Inclusively there was no annoying change was noticed with increase in (TLC) eventually providing protection to animal to avoid the disease. Henceforward use of above listed drugs prophylactically especially Cosumix Plus, strongly suggested against neonatal calf diarrhea to lessen the mortality due to neonatal calf diarrhea.

KEYWORDS: Ruminants, Collibacillosis, Neonatal calf diarrhea, anti-diarrheal drugs.

1 INTRODUCTION

Neonatal calf diarrhea, usually caused by Collibacillosis and Salmonellosis, is an acute and fatal disease of calves of 1-4 weeks of age. Calves of less then 7 days of age are more affected. Outbreaks of calf diarrhea are more common during fall winter and early spring in the large heads [1]. In mild case faces become loose than the normal but in severe cases common symptom are depression, lack of appetite, severe yellowish foul smelling diarrhea which may be watery or foamy. Affected calves may have rough hair coat, sunken eyes due to dehydration and emaciated. In very acute or septicemic cases death may occur before the onset of diarrhea; however death usually occurs after 2-3 days of commencing of diarrhea [2]. Common pathophysiological conditions are dehydration, emaciation, and fluid filled intestinal tract. Field and laboratory investigation revealed that there are many etiological agents of calf diarrhea e.g. bacteria (enterotoxigenic E.coli, Salmonella spp, Clostridial spp etc) viruses (Rota virus, Corona virus, Astro virus) and other pathogens such as babesia, coccidia, fasciola

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and cryptosporidium species [1], [2]. Calf diarrhea is mostly treated by alteration of diet, electrolyte and fluid therapy, immunoglobulin therapy and antimicrobial therapy along with some supportive treatment [2]. In the present study chemo-prophylactic effect of some antidiarrheal drugs like colimune ora, cosumix plus, streptomegma, n.m.k. powder and bio vet were studied which reveled that all the drugs worked well and their hematological and serological studies did not show any untoward change/reaction when used as prophylactically against neonatal calf diarrhea.

2 MATERIAL AND METHODS

Thirty neonates were selected by systemic random from Animal Nutrition Center, Rakh Dera Chahl, Lahore, which were divided into six different groups, each consisting of five calves. Keeping one group as control, five other were medicated by a single therapeutic agent amongst, Colimune Ora, Cosumix Plus, Streptomegma, NMK Powder and Biovet (Table 1). The composition of these drugs was as under:

Colimune Ora

E Coli antiserum minimum K99- Antibody titer of 1:512	
Thimerisal 10%	0.03ml
Oxytetracycline HCL	0.003ml
Phenol 5%	1ml

Cosumix Plus

100 gm sachte contains	
Sulphachloropyridazine Sodium Salt	10grams
Trimethoprim	2 grams

Streptomegma

Kaoline USP	486 mg
Pectin USP	43.3 mg
Auminium Hydroxide gel USP	63.3mg

NMK Powder

Neoterea	6gm
Magnesium Carbonate	5gm
Kaolin	10gm

Bio Vet

EM basic solution	1 liter
Molasses	1 kg
Water	20 liter

Table 1. Schedule of using anti-diarrheal drugs as a prophylactic agent in different animal groups

Group no.	Drugs	Dose rate	Route of administration	Manufacturer
1	Colimune Ora	10ml/calf within 12 hours	Orally	AZM Pharmaceuticals Karachi
2	Cosumix Plus	10gm/50kg body weight	Orally	Ciba Geigy Ltd Karachi
3	Streptomegma	25gm/calf	Orally	Wyeth Lederic Division Cyanamid Lahore
4	NMK Powder	1gm/8kg body weight	Orally	Self Prepared
5	Bio Vet	10ml/day	Orally	Nature Farming Faisalabad

Supportive therapy was given to prevent dehydration and acidosis including Normal saline, Dextrose 5% and Sodium Bicarbonate depending upon dehydration and acidosis. Calves were kept separate from their dams. Cleaning of the barn and environment was according to the season. For hematology and serology the samples were collected:

- just after parturition
- 36 hours after parturition
- 28th day of experiment

3 RESULTS

The present study showed an increase in Packed Cell Volume (PCV) but in case of Total Erythrocyte Count (TEC) the results were variable (Table 2). In case of Colimune Ora and Cosumix Plus an increase of 16.57% and 93.47% observed after 36 hours. Streptomegma decreased TEC after 36 hours. NMK increased up to 96% and Bio Vet decreased TEC by 5.06%. An over all increase in Total Leukocyte Count (TLC) was observed with slight decrease in case of Colimune Ora and Streptomegma. Variable results were observed in Differential Leukocyte Count (DLC). Lymphocytes were decreasing 0.3 to 11.07% which showed that every therapeutic agent regress the production of lymphocyte. Same was the case in monocytes. Basophils decreased in case of Colimune Ora. Cosumix Plus and Streptomagma regressed neutrophils by 1.8 to 4.4%.

Table 2. Effects of anti-diarrheal agents on different blood parameters

Group no.	Drugs	PCV (%)	TEC m/mm^3	TLC thousand/mm^3	DLC				
					M	E	L	B	N
1	**Colimune Ora**	34-35	5.9-7.1	5.4-7.3	5-11	7-0	50-51	1-2	30-34
2	**Cosumix Plus**	27-37	5.8-6.3	6.0-7.9	7-11	7-10	50-53	1-2	27-34
3	**Streptomegma**	31-34	5.4-6.4	7.3-8.0	5-7	7-10	50-55	1-2	28-34
4	**NMK powder**	28-34	5.2-6.0	6.0-8.0	7-9	7-8	50-53	1-2	30-34
5	**Bio Vet**	29-35	5.7-6.7	6.9-7.3	5-8	7-10	50-53	1-2	28-35

Mixed results of Serum Sodium concentration were obtained. The Serum Potassium concentration tended to decrease for all therapeutic agents except NMK powder. Total Serum Protein was decreased in all cases except an increase in case of NMK and Bio Vet. The pH of the bodies was fluctuating throughout experiment. Microbiology of fecal samples was done for detection of E coli and Salmonella species as the major cause of diarrhea but after 36 hours and 28 days no fragment was observed in the media of such samples.

4 DISCUSSION

Neonatal calf diarrhea is one of the most important disease in which a veterinarian might face difficulties in the laboratory diagnosis prior to treatment. It is a significant cause of economic losses in cattle herds. One of the calves died during whole of the project of the group treated with Climune Ora. Thus mortality rate was 20%. The fact does not match the observations of [3]. The PCV significantly decreased, thus results were not in agreement with [1]. It also disgraced the observation of [4]. TEC showed non significant difference along with TLC. These results were in agreement with [5]. Significant Neutrophilia was observed as was found by [1]. The results found in this experiment differ from previous findings most probably due to the reason that these calves were consuming precautionary medication which cause the increase in lymphocyte population.

Therapeutic agents when introduced initially increased the values of Serum Protein significantly but as the time passed the values tend towards a non significant change. These observations were not matched with [5], [6]. The probable reason was these neonates were under medication right from birth. Serum albumin increased significantly when we introduced the drugs but as the time passed non significant results were obtained. Serum globulin concentration showed significant difference. None of the bacteria was found in the fecal culture obtained from neonates of each group. The results were the same found by [7], who described that normal healthy calves did not showed any bacteria.

5 CONCLUSION

All the drugs worked well against neonatal calf diarrhea but critically Cosumix Plus was found best because it is in the combination of two best groups of antibiotics i.e. Sulphanomide and Trimethoprim. These observations were same as described by [2] and [8], who reported that antibiotics are good treatment of diarrhea particularly the Slphanomides, Tetracyclines, Trmethoprim and Chlorophenicol.

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Can Workplace Accidents Classification and Compensation in Kenya be used to Predicts Level of Victims Satisfaction?

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ABSTRACT: The main objective of this study was to examine the effectiveness and adequacy of the work injury compensation and whether there is adequate compensation to those who get injured in the cause of duty. Exploratory study design was adopted for this study on a targeted population of compensation claims filled between the year 2007 – 2011 in Nakuru County Occupational Safety and Health Offices and the Law Courts. Purposive sampling procedure was used to come up with a sample of all cases filed and compensated between 2007 and 2011 that were directly related to occupational safety and health problems. Questionnaires were sent to all the people who have been compensated to determine their satisfaction levels. Descriptive statistics and referential statistics were used to analyze the relationships between accidents classification, compensation and victims' satisfaction level. The study established that the accidents occurred in agriculture and manufacturing based companies. Second, the study established that the compensation awarded to the victims were not adequate to take care of their medical bills and truly compensate the losses they had incurred yet the process of what they termed as an inadequate compensation was very slow. Last, the study established that the victims were not satisfied with the compensations they were given and that they did not even know how to calculate the compensation on their own.

KEYWORDS: Occupation Safety, Accidents Classification, Accidents Compensation, Accidents Victims Satisfaction.

1 INTRODUCTION

Occupational health and safety issues are concerned with ensuring and improving the working conditions of employees so that they can remain health and safe .The United States congress while enacting the occupational safety and health act of 1970 defined "Occupational safety and health standards", as "Standards which requires conditions, or the adoption or use of one or more practices, means, methods, operations or processes, reasonably necessary or appropriate to provide safe or healthful employment in places of employment. The primary objectives of occupational safety and health issues is to uphold the employees well being. All hazards that affect the employees in their workplaces are identified and appropriate measures to minimize the hazards are put in place. Occupational safety therefore ensures an accident free work environment. Risks and hazards are identified, investigated, controlled and eliminated. Occupational health on the other hand refers to the general state of the physical, mental and emotional well being of employees or the work place.

Whilst industries and factories in Kenya have tried to employ the modern safety and health practices, work place accidents and related incidences are on the increase (Ministry of labour)

About 1000 work injury claims have been reported in the Nakuru district occupational safety and health offices in Nakuru in a spun of five years between the years 2007 and 2011. Claims are solved through the legal proceedings in court while others are either solved between mutual agreement between employer and employee and some are never reported by the injured employees at all, most are compensated through the district occupational safety and health offices. Once an accident relating to the issues of occupational safety and health arises, most victims are not aware of their rights through the law that protects them against such hazards.

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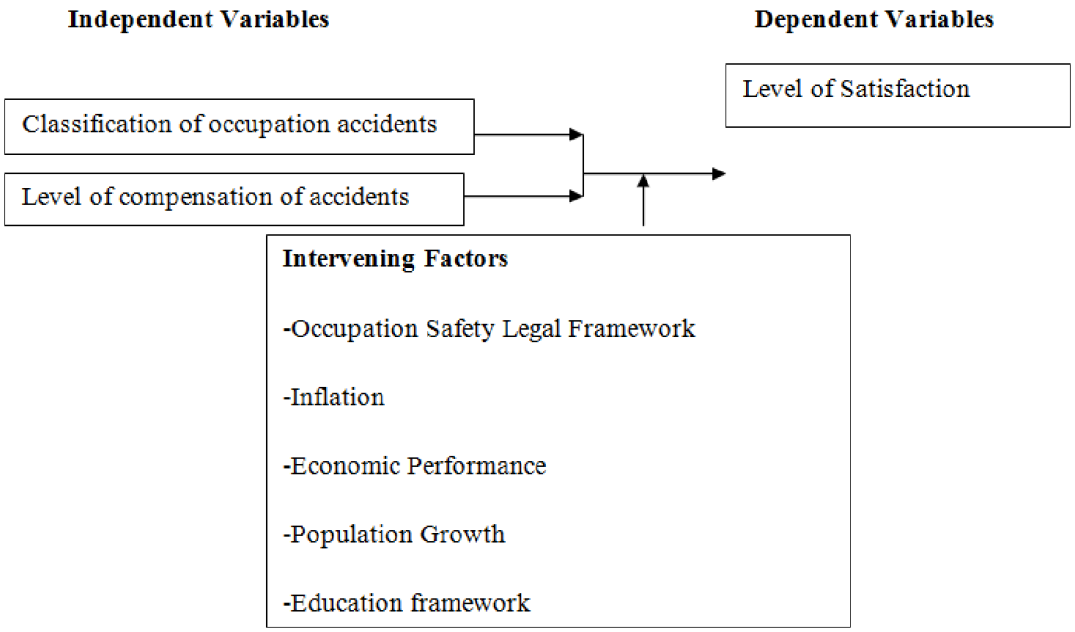
When the victims get compensated through the labor offices or court, where compensation is guided by the work injury benefit act, the compensation is quite unsatisfactory. Most of the victims lose their claims due to the adversarial nature of our system and the fact that relationship between an employee and the employer changes immediately a claim is filled. Most victims are dismissed from work, making it quite difficult to prove their claims for lack of witnesses. In recent years serious questions have been raised (ILO) concerning the fairness and adequacy of present work injury compensation framework in the light of the growth of the economy, the changing nature of the labor force, increase in medical knowledge, changes in the hazards associated with various types of employment, new technology creating new risks to health and safety and increase in general level of wages and cost of living.

The wellbeing and safety of employees is of paramount importance in any industry to ensure maximum productivity, increases morale and lowers risk of liability. No studies have been conducted in Nakuru county concerning occupational accident compensation hence this study will provide empirical data on accident compensation and gaps in occupational accidents compensation systems hence improve the occupational accidents compensation framework. The evaluation of the existing work injury compensation framework will help the victims of the occupational safety and health accidents to follow up their compensation from the employer, the findings of the study will guide the employer in safeguarding the rights of employee when they fall victim of occupational accidents. The costs, litigation period and court procedures in Kenya have posed a challenge to the process of accident compensation to both the victim and the employer. In the light of the above, many victims of occupational safety and health have questions on the amount of compensation awarded. This study is therefore aimed to fill the knowledge gap that exists in the work injury compensation framework and its implementation in dealing with occupational safety and health accidents in Nakuru County. The key questioned to be answered by this study were; What are the classifications of the occupational accidents which have happened within five years as per international labor organization economic activities in Nakuru County?; What are the occupational accidents compensation levels among victims?; What are the occupational accident compensation satisfaction levels?

2 CONCEPTUALIZATION

Table 1: Factors Affecting Occupation Accidents Compensation Satisfaction



The independent variables of the study include; the classification of occupation accidents and level of compensation by the companies. The dependent variable is the level of satisfaction by the workers on the compensation. The intervening variables are; the existing occupation safety framework in Kenya, the inflation, economic performance which gauges the level of possibility of companies employing, the population growth from which the companies draw the workers and education framework which imparts the required skills to the workers needed by the companies. When the classification of occupation accidents is well followed and the accidents cases are determined within the required time to enhance the level of compensation under well controlled occupation safety legal framework, inflation, economic performance, population growth and education framework, then the level of satisfaction by the workers will rise.

2.1 OPERATIONALIZATION OF THE CONCEPTUAL FRAMEWORK

Table 2: Operationalizations of the Variables of the Study in Occupational Safety and Health Setup

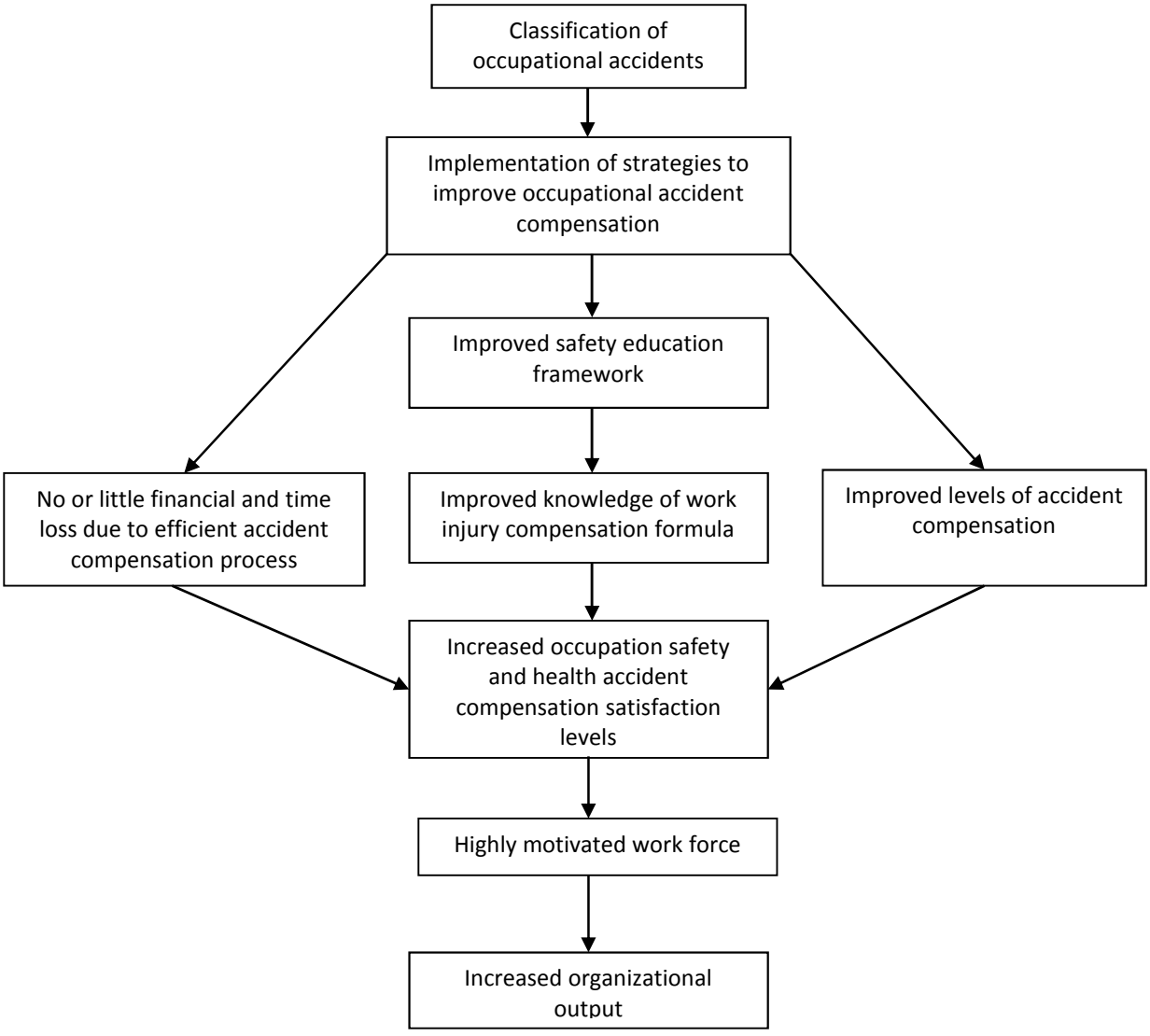


Figure 2 above was used by the study to operationalize the variable of the study into real life occupational safety work place setup. In every work place setup, all possible occupation accidents should be classified as per the ILO Classification Scheme which is the first independent variable of the study. Each workplace should implement strategies which should reduce the occupation accidents in order to reduce on the financial compensation arising from occurrence of occupation accidents. In case the accidents occur, the work place should improve on the compensation amount and process (which was the second independent variable of the study) as a means of motivating the staff leading to increased level of staff satisfaction with the occupation compensation system in place which was the dependent variable in the study.

3 LITERATURE

Occupational safety and health is an area that has continued to remain outside the mainstream of management research (Barling, Loughlin, & Kelloway, 2002). In fact, less than 1% of organizational research focuses on issues concerning occupational safety and health (Barling & Zacharatos, 2000). This statistic is very low considering the significant social and economic costs associated with occupational safety such as occupational fatalities, work related injuries, and lost productivity. In light of these social and economic costs resulting from workplace accidents, it is critical that researchers better understand the events preceding work-related injuries, as well as the organizational factors that may affect an individual's safety behavior at work.

Barling, Loughlin, and Kelloway (2002) found that safety specific transformational leadership directly affected perceived safety climate, which significantly influenced safety performance. In other words, management's actions will directly affect an individual's perceived safety climate such that if management is committed to safety then it is more likely that the workers will exhibit commitment to safety.

Perceived risk in the workplace is an area that has also received much attention from researchers. For example, Cree and Kelloway (1997) found that both perceived accident exposure and perceived safety attitudes of others predicted risk perceptions in the workplace. Furthermore, the perceived risks associated with the job tend to be heightened when an individual experiences or learns about an injury or accident in the workplace. This is consistent with the findings of a study conducted by Nelkin and Brown (1984) in which the individual's accident history (witness to or hearing about an accident) influenced risk appraisals. Researchers have also found that perceived risk is associated with employees' willingness to adopt safe working practices. Other factors such as perceived susceptibility to risk, perceived seriousness of a threat, and perceived cost of adopting an action have also been examined with respect to their relationship with adopting precautionary behavior. Workers who compare the negative aspects (risk of being injured) to positive aspects (good wages, benefits, etc.) tend to be more likely to adopt unsafe practices if the costs are perceived to be less than the beneficial outcomes. Furthermore, researchers have shown that individuals are likely to have greater judgments of risk if the negative effects of the actions are immediate as opposed to delayed. Quite often, work-related injuries are not immediate and progress over repeated exposure to the harmful agent. Thus, workers who tend not to experience visible or immediate harm are in fact more likely to have a lower judgment of associated risks, thus engage in unsafe work behavior. Finally, consistent with previous research, optimistic bias, or the belief that one is less susceptible to risks (Vaughn, 1993) is associated with engaging in risky or unsafe behavior.

Managers must recognize the significant role that early socialization influences play in teaching and reinforcing safety attitudes and behavior. Although organizational socialization has received some attention from researchers (e.g., Blau, 1988; Jones, 1983) few have yet to specifically investigate safety socialization. When individuals become members of an organization they generally receive some degree of training in terms of specific job tasks and skills that are required as well as organizational policies and practices. Experienced workers often adopt the role as the socializing agent or mentor to assist the new employee with becoming part of the organization. Research has shown that the nature of this socialization process will affect the degree to which the new employee accepts organizational values and polices. With regard to safety, the socialization process and agent provides new employees with a model for the development of safety attitudes and behavior. If the experience between the employee and socializing agent is one that reinforces positive safety attitudes and behavior, then the employee is most likely to adopt similar attitudes and become a worker who follows safe work practices. Thus, the results of this study suggest that early safety socialization processes and the socializing agent may have a significant impact on employee safety attitudes and behavior. Managers must ensure that new employees receive proper training that reinforces the desired safety attitudes and training that is delivered by a competent and positive socializing agent.

Managers must also recognize the power of subjective norms within the workplace as well as the need for maintaining a positive image. These factors clearly achieved greater importance for individuals over safety as was found in previous research (e.g., Wagenaar & Groenweg, 1987; Wright, 1986). Employees experienced strong social pressure within the organization to perform work using normal work methods (e.g., what everyone else does) rather than following formalized

safety procedures. Resisting social pressure to perform work using 'normal methods' seriously compromises one's desired image (e.g., competent, tough). This suggests that management at all organizational levels needs to address how they can change existing subjective norms to better support safety as well as mitigate any social pressures that compromise an employee's image. Management must reassess incentive programs that may inadvertently reward unsafe behavior. If employees perceive that performing unsafe work practices (e.g., violating safety procedures to increase productivity) will enable them to obtain rewards (e.g., wage increase for being productive) they will unintentionally be reinforced to continue such unsafe behavior. Several researchers have also discussed the influence of performance pressure on safety behavior. Performance pressure has been found to increase the likelihood that employees will violate safety rules by taking short cuts (e.g., Hofmann et al., 1995; Wright, 1986), and lead employees to perceive that there isn't adequate time or resources to follow safety guidelines (Dawson, 1991). Thus, the value of safety over performance remains to be an important message that must be communicated by managers. Furthermore, the results of this study provide support for the notion that the influence of performance pressure on safety behavior may be reduced by ensuring employees the necessary time, resources, and training to perform their jobs.

Management typically requires workers to work both safely and productively. However, ever-increasing work demands strain the worker's ability to safely meet management's production expectations. One possible influence on the workers' decisions regarding their safety and production behaviors is the perceived compatibility of these two demands. If this is so, managers' ability to manage safety might be facilitated by understanding how workers' perceptions of safety-production compatibility influence behaviors that threaten safety or weaken production. High production demands may cause workers to sacrifice safety. Wright (1986) noted that organizations often emphasize working as quickly as possible. This can result in work overload, which leads to stress and strain. Stress has, in several studies, been identified as a predisposing factor in workplace accidents. Task pressures associated with overload are, therefore, likely to be associated with increased accidents. Baron and Pate-Cornell (1999) suggest that resource constraints make this effect more prevalent in the short-than the long-term. A mechanism for the influence of production pressure on accidents is found in the mediating influence of attention, a limited resource that rations effort among multiple demands. When work load strains attention, and the worker reduces the effort to work safely, injuries are more likely to result.

An empirical study by Freudenburg (1993) revealed that beliefs about the competence of an institution to effectively and safely manage a hazardous waste site explained about 25% of responses among individuals most concerned about site risks. The source of risk information, more specifically the competencies of science and technology and of federal government agencies, was an important predictor of local residents' attitudes toward locating the facility. In a field study of firefighters, McLain (1995) found that trust in the department's handling of safety explained significant variance in several measures of perceived safety risk. Trust appears to reduce perceived risk when the trusted party has influence over the situation (McLain, 1995). This reflects real confidence that the trusted party will reduce risk; in this case reduce the worker's exposure to harm from hazards. It also reflects the increased information sharing about safety that accompanies trust building (Zacharatos et al., 2005).

According to systems theory**,** an injury is one of several abnormal or unwanted effects of a system. An injury is a consequence of a dysfunctioning in the system which does not work as planned. Various methods of systems safety analysis (e.g. fault tree analysis and failure mode and effect analysis) support the identification of deviations and the analysis of the conditions and consequences of these deviations (Recht, 1965). A subset of systems models of accidents are based on an industrial engineering systems view. Accidents are analyzed in terms of failures of the management system for the control of production (Adams, 1976).

The Roben's report after a review of the existing legal framework in Britain and a careful study of the industry discovered that, The law on health and safety was often obscured, haphazard and outdate, that there were too many enforcing agencies involved which caused confusion, that the main reason of continuing of this unsatisfactory state of affairs was apathy, this committee proposed that, a system should be advised to enable all employers and employees to become aware of their personal responsibility for safety and health. There was need to set up a unified framework of legislation to cover all work activity i.e. not just factories. A unified enforcement agency should be set up and should be given stronger powers of sanction. These recommendations led to the passing of the occupational safety and health Act 1974. In the United States of America, the United States occupational safety and health Act of 1970 is the main act that is effective in this area. In the United States, upon the enactment of occupational safety and health act of 1970 a national commission was established to revaluate the state of workmen compensation laws. The congress found out that:

"The vast majority of American workers and their families are dependent on the workmen compensation for their basic economic security in the event such workers suffer disabling injury or death in the cause of their employment and the full protection of American workers from job related injury or death requires an adequate prompt and equitable system of

workmen's compensations as well as an effective program of occupational safety and health regulations (US department of labor, occupational safety and health).

The congress in establishing the commission observed thus: "In recent years serious questions have been raised concerning the fairness and adequacy of present workmen compensation laws in the light of the growth of the economy, the changing nature of the labor force, the increases in medical knowledge, changes in the hazards associated with new technology creating new risks to safety and health and increasing in the general level of wages and the cost of living.

By 1970 the United States congress was realizing that there existed a problem with its own workmen compensation laws. It therefore authorized an effective study and objective evaluation of state workmen compensation laws to determine if such laws provide an adequate, prompt and equitable system of compensation for injury or death arising out of or in the cause of employment. It is this same challenge that this paper wishes to address in relation to the Kenyan situation. Is the work injury compensation framework in line with the changing times and technological advancement. The review of the related literature has a bearing with the purpose of this study. The relationship is that even in Britain and America they have not been able to consolidate their entire framework dealing with occupational safety and health. In Kenya, serious amendment are lacking in work injury compensation framework and hence the study. A study limited to Nakuru County will endeavor to answer these questions.

Accidents are classified into seven major categories Economic activities, Occupations, Employment situation, Injury type, Injury location, Accident type and Material agent. The following are international labor organization economic activities,

A - Agriculture, hunting and forestry are,

Agriculture, hunting and related service activities, Forestry, logging and related service activities

B – Fishing activities are,

Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing

C - Mining and quarrying activities are,

Mining of coal and lignite; extraction of peat, extraction of crude petroleum and natural gas, service activities incidental to oil and gas extraction excluding surveying, Mining of uranium and thorium ores, Mining of metal ores and other mining and quarrying activities.

D – Manufacturing includes,

Manufacture of food products and beverages, Manufacture of tobacco products, Manufacture of textiles, Manufacture of wearing apparel; dressing and dyeing of fur, Tanning and dressing of leather; manufacture of luggage, handbags, saddler, harness and footwear, Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials, Manufacture of paper and paper products, Publishing, printing and reproduction of recorded media, Manufacture of coke, refined petroleum products and nuclear fuel, Manufacture of chemicals and chemical products, Manufacture of rubber and plastics products, Manufacture of other non-metallic mineral products, Manufacture of basic metals, Manufacture of fabricated metal products, except machinery and equipment, Manufacture of machinery and equipment ,Manufacture of office, accounting and computing machinery, Manufacture of electrical machinery and apparatus ,Manufacture of radio, television and communication equipment and apparatus, Manufacture of medical, precision and optical instruments, watches and clocks, Manufacture of motor vehicles, trailers and semi-trailers, Manufacture of other transport equipment, Manufacture of furniture; manufacturing and Recycling

E - Electricity, gas and water supply activities are,

Electricity, gas, steam, hot water supply and Collection, purification and distribution of water.

F – Construction.

G - Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods includes,

Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel, Wholesale trade and commission trade, except of motor vehicles and motorcycles, Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods

H - Hotels and restaurants.

I - Transport, storage and communications activities are,

Land transport; transport via pipelines, Water transport, Air transport, Supporting and auxiliary transport activities; activities of travel agencies and Post and telecommunications

J - Financial intermediation activities are,

Financial intermediation, except insurance and pension funding, Insurance and pension funding, except compulsory social security and Activities auxiliary to financial intermediation

K - Real estate, renting and business activities includes,

Real estate activities, renting of machinery and equipment without operator and of personal and household goods, Computer and related activities, Research and development and other business activities

L - Public administration and defense; compulsory social security.

M – Education.

N - Health and social work activities

O - Other community, social and personal service activities are,

Sewage and refuse disposal, sanitation and similar activities, Activities of membership organizations, Recreational, cultural and sporting activities and other service activities

P - Private households with employed persons.

Q - Extra-territorial organizations and bodies.

The main industries in Kenya are plastic, furniture, batteries, textiles, clothing, soap, cigarettes, flour, agricultural products, horticulture, oil refining; aluminum, steel, lead, tourism, telecommunications, transport, and construction.

4 METHOD

The study adopted exploratory research design with target population of the 200 cases which were compensated within this period 2007-2011. Secondary data was collected from case files in the District Occupational Safety and Health Offices in Nakuru, Kenya. The secondary data collected in these files include the following areas, data relating to the time of filing of the claim, how much time had lapsed after happening of the accident causing the disabling, injury or death to the time of filing the claim, whether the employer is covered by an insurance company data on the amount awarded in compensation will also be collected.

Primary data was also collected for this study. The owners of these case files were traced back to where they work for the purposes of obtaining primary data especially their satisfaction on the compensation awarded by the Courts of Law. The questionnaires were sent to the Human resource manager for the selected sample of manufacturing concerns targeted. The data collected aimed at determining the number of incidences and accidents that occurred between the year 2007 and the year 2011, how they were processed, the outcome thereof and the time they took for the injured worker to receive compensation. Descriptive and inferential statistics were used to analyze the data. Specifically, Pearson Correlation was used to test the relationship between accidents classifications, compensation and levels of victims' classifications.

5 RESULTS, INTERPRETATION AND DISCUSSION

5.1 OCCUPATION ACCIDENTS CLASSIFICATION

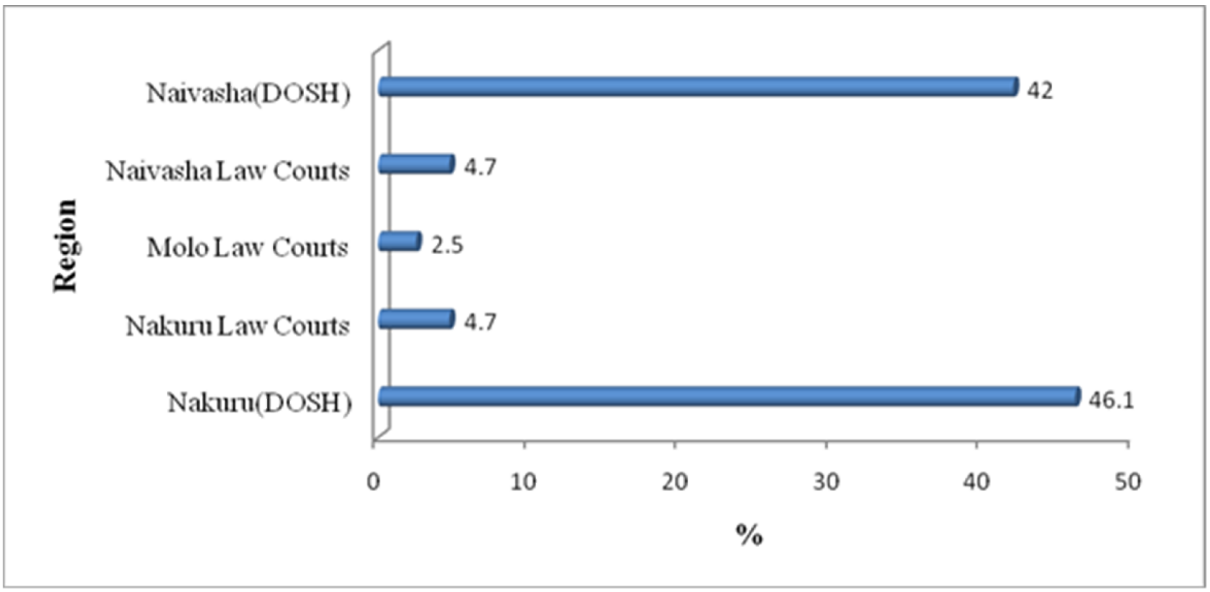


Figure 1: Regions where the Research Data was collected

The study established that the majority of the workplace related data 42.0% were collected from Companies in Naivasha, 46.1% were collected from Companies in Nakuru and 11.9% were collected from Nakuru, Naivasha and Molo law Courts where workplace compensation cases were filled and compensated.

Table 3: Workplace Accidents Classification by Sector

Classification	Frequency	Percent
Agricultural	168.0	60.4
Manufacturing	53.0	19.0
Electrical	15.0	5.2
Wholesales, Retails, Motor repair	13.0	4.6
Public Administration	8.0	2.8
Education	6.0	2.1
Transport	8.0	2.8
Construction	5.0	1.7
Other community service	4.0	1.4
Total	278.0	100.0

Source: Field Data (2014)

The study established that the majority of the respondents 60.4% of the accidents occurred in agriculture based companies, 19.0% occurred in manufacturing based companies, 4.6% occurred in wholesale, retails and motor repair based companies, 2.8% occurred in public administration and education based companies respectively. 2.8% occurred in transport related companies and 5.2% occurred in electrical based companies. This finding indicated that the majority of the work place accidents occurred in agricultural and manufacturing based companies.

Table 4: Workplace Accidents Classification by Age Variance

Sector	<20 Yrs	%	21-30 yrs	%	31-30 yrs)	%	41-50 yrs	%	> 50 yrs	%	Total	Total %
Agricultural	3	1	55	20	63	23	40	14	7	3	168	60
Manufacturing	4	1	18	6	18	6	10	4	3	1	53	19
Electricals	0	0	5	2	5	2	3	1	2	1	15	5
Construction	0	0	2	1	2	1	0	0	1	0	5	2
Wholesale/Ret.	0	0	3	1	6	2	1	0	3	1	13	5
Transportation	0	0	4	1	2	1	0	0	0	0	6	2
Public Admin.	0	0	3	1	1	0	4	1	0	0	8	3
Education	0	0	0	0	2	1	4	1	0	0	6	2
Others	0	0	2	1	0	0	0	0	2	1	4	1
Total	7	3	92	33	99	36	62	22	18	6	278	100

Source: Field Data (2014)

Majority of the accidents reported in Nakuru County 23% were from the age bracket of 31-40 years and came from agricultural sectors, 20% of the accident cases were in the age bracket of 21-30 years and were also from agricultural sector, and 14% of the cases came from 41-50 years and were from Agriculture sector. Manufacturing sector had the highest cases of 7% from 21-30 years and 31-40 years age bracket. Generally, 36% of the accidents occurred in the age bracket of 31-40 years, 33% occurred among 21-30 years age group, 22% occurred among 41-50 years age group, 6% occurred among employees above 50 years and 3% those below 20 years. This finding indicated that cases of accidents were common in 31-40 and 21-30 years age bracket in both the agricultural and manufacturing sectors.

Table 5: Workplace Accidents Classification by Length of Service

Sector	< 1 Year	%	1-5 years	%	>5 Years	%	Total	%
Agricultural	61	22	64	23	43	15	168	60
Manufacturing	16	6	20	7	17	6	53	19
Electricals	-	-	7	3	8	3	15	5
Construction	2	1	3	1	-	-	5	2
Wholesale/Retail	5	2	3	1	5	2	13	5
Transportation	-	-	5	2	1	0	6	2
Public Admin.	7	3	1	0	-	-	8	3
Education	1	0	2	1	3	1	6	2
Others	-	-	2	1	2	1	4	1
Total	92	33	107	38	79	28	278	100

Source: Field Data (2014)

Majority of the accidents 23% occurred among employees who had worked for 1-5 years, 22% in less than 1 year, 15% in more than 5 years and all these occurred in agricultural sector. 20% of the accidents were recorded among employees who had worked for 1-5 years in the manufacturing sector. Generally, 38% of the accidents occurred within 1-5 years of the employees' service, 33% occurred within less than 1 year while in services and 28% occurred within more than 5 years while in service. This finding indicated that the majority of the work place accidents occurred within 1-5 years of employees service life followed by less than 1 year and lastly greater than 5 years.

Table 6: Workplace Accidents Classification by Body Parts Affected

Sector	HD	%	LG	%	HN	%	CA	%	EY	%	O	%	T	%
Agricultural	20	7	51	18	64	23	3	1	15	5	15	5	168	60
Manufacturing	3	1	4	1	35	13	1	0	5	2	5	2	53	19
Electricals	5	2	3	1	7	3	-	-	-	-	-	-	15	5
Construction	-	-	2	1	2	1	-	-	1	0	-	-	5	2
Wholesale/Retail	3	1	3	1	4	1	-	-	-	-	3	1	13	5
Transportation	-	-	2	1	2	1	-	-	-	-	2	1	6	2
Public Admin.	2	1	-	-	4	1	-	-	-	-	2	1	8	3
Education	-	-	4	1	2	1	-	-	-	-	-	-	6	2
Others	2	1	-	-	2	1	-	-	-	-	-	-	4	1
Total	35	13	69	25	122	44	4	1	21	8	27	10	278	100

Source: Field Data (2014)

Table was used to analyze Workplace Accidents Classification by body parts affected. HD – Head, LG – Leg, HN - Hand, CA – Chest/Abdomen, EY – Eye, O – Other Parts and T - Total

The majority of the accidents that occurred in Nakuru County in the agricultural sector 23% affected employees hands, 18% affected leg. Generally, 44% of the accidents affected the hands, 25% affected the leg, 13% affected the head, 10% affected other parts of the body, 8% affected eyes and 1% affected chest/abdomen. This finding indicated that much of the accidents affecting employees' body parts also occurred in agricultural and manufacturing sector affecting hand, legs, head, eyes and other parts of the body respectively.

Table 7: Workplace Accidents Classification by Severity of Occurrence

Sector	Minor	%	Sever	%	Very Sever	%	Total	%
Agricultural	137	49	18	6	13	5	168	60
Manufacturing	45	16	5	2	3	1	53	19
Electricals	11	4	1	0	3	1	15	5
Construction	3	1	2	1	-	-	5	2
Wholesale/Retail	10	4	3	1	-	-	13	5
Transportation	4	1	2	1	-	-	6	2
Public Admin.	4	1	3	1	1	-	8	3
Education	5	2	1	0	-	-	6	2
Others	3	1	1	0	-	-	4	1
Total	222	80	36	13	20	7	278	100

Source: Field Data (2014)

Majority of the occupation accidents 49% were minor in the agricultural sector and 16% which were equally minor but in manufacturing sector. Generally, 80% of the occupation accidents that occurred were minor, 13% were sever and 7% were very sever. This finding indicated that the occupation accidents in the county were minor with early indications of potential gratuity to sever cases.

5.2 OCCUPATIONAL ACCIDENTS CLASSIFICATIONS

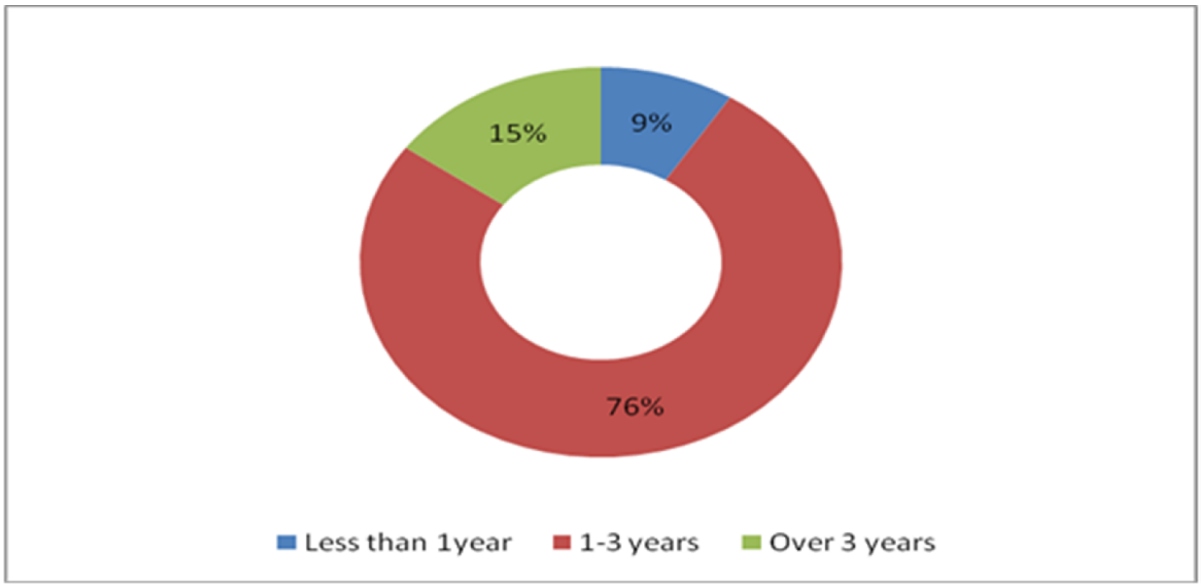


Fig 8: Period it took to Effect Compensation

The study established that the majority of the work place accidents victims 76% observed that compensation took between 1-3 years to be effected when the compensation were first filled, 15.0% observed that it took over 3 years whereas 9.0% observed that it took less than 1 year to effect the compensation. The average duration taken from filing to receiving compensation was calculated to be 30 months which is in line with responses. This finding showed that the process was slow and took unnecessarily long for a victim to receive compensation. The occupational safety and health compensation framework in kenya should reduce the compensation period in order to benefit the workers given that the majority of the workers are quite in need of money when these accidents occur.

Table 9: Workers Compensation (Kshs)

Compensation (Kshs)	Frequency	Percent
Less than 200,000	169.0	84.5
200,000-400,000	8.0	4.0
400,000-600,000	6.0	3.0
600,000-800,000	4.0	2.0
800,000-1,000,000	9.0	4.5
Over 1,000,000	4.0	2.0
Total	200.0	100.0

Source: Field Data (2014)

The study established that the majority of the workers involved in work place accidents 84.5% were compensated less than Kshs. 200,000 and the rest 15.5% were compensated between Kshs. 200,000 to over Kshs. 1,000,000. This finding showed that the majority of the workers who suffered workplace accidents were compensated little money which could not handle their medical bills leave alone the required compensation. The total amount of money paid in 5 years to occupational accidents totaled up to 50 million Kenyan shillings in Nakuru County.

5.3 VICTIMS SATISFACTION WITH OCCUPATIONAL ACCIDENTS COMPENSATION

Table 10: Employees Satisfaction Level

	Respondents	Percentage (%)
Very satisfied	0	0
Satisfied	51	30.8
Dissatisfied	72	43.6
Very dissatisfied	30	17.9
Undecided	13	7.7
Total	**166**	**100%**

Source: Field Data (2014)

The study established that the majority of the respondents 68.2% were dissatisfied with the compensation, 30.8% were satisfied and 7.7% were undecided on their level of satisfaction.

Table 11: Satisfaction on Process and Relationship

Response	SA	A	U	D	SD	Total
Efficient compensation process	1.8	37.3	0	48.2	12.7	100
Accidents affected relationships	6.6	63.3	2.4	21.1	6.6	100

Source: Field Data (2014)

Key: SA-Strongly Agree, A-Agree, U-Undecided, D-Disagree and SD-Strongly Disagree

The study established that the majority of the respondents 60.9% disagreed that the compensation process was efficient compared to 39.1% who agreed it was efficient. The majority of the respondents 69.9% agreed that the accidents affected their relationships with friends and families, 27.7% disagreed and 2.4% were undecided. This finding showed that the accidents victims were unsatisfied with the process and that the accidents affected their relationships with their families and friends.

5.4 RELATIONSHIP BETWEEN OCCUPATION SAFETY CLASSIFICATION COMPENSATION AND EMPLOYEES LEVELS OF SATISFACTION

The main objective of the study was to evaluate the occupational accidents compensation among workers in Nakuru County. The study used Pearson Correlation to establish whether there was relationship between classification occupation compensation with employees' level of satisfaction with compensation.

Table : Occupation Compensation and Employees Level of Satisfaction

Correlations	compensation	classification
Satisfaction	0.125	0.017
Level of Significance	0.108	0.829

Source: Field Data (2014)

The study established a week positive correlation of 0.125 and 0.017 between classification, compensation level with employees satisfaction level indicating that occupational accidents classification and compensation are positively correlated.

6 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Work place accidents compensation laws are enforced by the Ministry of Labour and Manpower Development. Companies are under law to observe the guidelines and protect the employees from occurrence of accidents by installing the relevant equipments. Unfortunately, accidents have continued to increase in many companies and the compensation process

has remained slow and inefficient. The main objective of this study was to evaluate occupational accidents compensation among victims in Nakuru County.

The study came up with a number of very important findings in relationship with classification of occupational accidents which have happened within five years as per international labor organization economic activities, evaluation of the occupational accidents compensation levels among victims and determination of the occupational accidents compensation satisfaction levels. Each finding is hereby summarized under the corresponding objective.

6.1 SUMMARY

6.1.1 CLASSIFICATION OF OCCUPATIONAL ACCIDENTS

First, the study established that the majority of the workplace related data were collected from Companies in Naivasha, and Nakuru. This finding is in coincidence with the fact that the majority of the workers were employed in agriculture based companies where Naivasha Town is the leading in many farms followed by manufacturing companies' majority of which are in Nakuru Town. Second, the study established that the majority of the respondents observed that the accidents occurred in agriculture and manufacturing based companies. These findings indicated that the majority of the work place accidents occurred in agricultural and manufacturing based companies. Third, cases of accidents were common in 31-40 and 21-30 years age bracket in both the agricultural and manufacturing sectors. Four, the majority of the work place accidents occurred within 1-5 years of employees service life followed by less than 1 year and lastly greater than 5 years. Five, much of the accidents affecting employees' body parts also occurred in agricultural and manufacturing sector affecting hand, legs, head, eyes and other parts of the body respectively. Six, the occupation accidents in the county were minor with early indications of potential gratuity to sever cases.

6.1.2 EVALUATION OF OCCUPATIONAL ACCIDENTS COMPENSATION

First, the study established that the majority of the workers earned less than Kshs. 10,000. This finding indicated that the workers who were more pre-disposed to work related accidents earn much less money which in turn affects their compensation since compensation is calculated based on salaries. Second, the study established that the majority of the respondents of the accidents occurred in agriculture based and manufacturing based companies. These findings indicated that the majority of the work place accidents occurred in agricultural and manufacturing based companies. Third, the study established that the majority of the compensation took between 1 to 3 years to effect when the compensation cases were determined. This finding showed that the process of compensation is slow, a situation which should be improved to benefit the workers given that the majority of the workers are quite in need of the money after accidents have occurred. Four, the study established that the majority of the workers awarded compensation had less than 10% percentage injury. Five, the study established that 81.7% of the workers involved in work place accidents were compensated less than Kshs. 200,000. This finding showed that the majority of the workers who suffered workplace accidents were compensated little money which could not handle their medical bills leave alone the required compensation.

6.1.3 OCCUPATIONAL ACCIDENTS COMPENSATION SATISFACTION

First, the study established that the majority of the respondent had knowledge of occupational safety and health hazards at the work place. They equally had knowledge on occupational safety and health laws of the Republic of Kenya. Whereas the respondents had knowledge on occupational safety and health hazards and also the occupational safety and health laws of the Republic of Kenya, the majority of the respondents did not have knowledge of occupational safety and health Act 2007 and work injury benefit Act. This finding showed that the knowledge the workers had on issues of occupation safety was not sufficient enough for them to completely know their rights, the process of pursuing such rights and even ensuring that they were compensated as per law. This was evident because the workers did not know the content of the Acts. Second, the study established that the majority of the respondents did not know how to calculate the work injury compensation payments. This finding indicated that since the workers did not know how to calculate their compensation, some of the work place accidents ended up in the Court of Law and therefore exposed victims to a lot of manipulations by the advocates and other Court agencies making them loose a big portion of what ought to be their compensations. Third, the study established that the majority of the accidents victims suffered from burns and also lost their limbs. Third, the study indicated that the work place accidents victims were not compensated adequately. Four, the study established that the majority of the respondents were dissatisfied with the compensation they were given. Five, the study established that the majority of the respondents disagreed that the compensation process was efficient although they agreed that the accidents affected their relationships

with friends and families. This finding showed that the accident victims were unsatisfied with the process and that the accidents affected their relationships with their families and friends.

6.2 CONCLUSION

Occupational safety and health accident compensation framework is a crucial interest area of research because of massive complaints and many workers suffering loss some of which are fatal. This study attempted to evaluate occupational accidents compensation among victims in Nakuru County. The conclusion of this study was linked closely with the questions that this study had raised beforehand. The first question was; what are the classifications of the occupational accidents which have happened within five years? The study established that the accidents occurred in agriculture and manufacturing based companies. The second question was; what are the occupational accidents compensation levels among victims? The study established that the compensation awarded to the victims were not adequate to take care of their medical bills and truly compensate the losses they had incurred yet the process of what they termed as an inadequate compensation was very slow. The third question was; what are the occupational accident compensation satisfaction levels? The study established that the victims were not satisfied with the compensations they were given and that they did not even know how to calculate the compensation on their own. The study established positive correlation between occupation accidents classification and compensation with employees' level of satisfaction.

6.3 RECOMMENDATIONS

The Ministry of labor should rework the compensation policies to improve on these percentages so that workers can get money that can be equivalent to the accidents they suffered to enhance the true meaning of compensation. Third, the Ministry of labor must re-look into this matter seriously in order to first separate compensation from medical bills so that the workers be given by their employers compulsory medical cover plus compensation to cover the suffering they incur at the work place. Four, the ministry should make sure that the human resource departments of the companies where the victims work are compliant in terms of training the workers on how to calculate their compensation benefits. This information is important to work place occupation training intervention in knowing the service length to target in executing work place occupation accident trainings. Six, the Ministry of labor through legislations should make the compensation process simple and efficient in order to make the process less burdensome to the victims. Seven, the compensation satisfaction also can be improved by extending the compensation benefits to mend the broken relationships between victims and their friends and relatives. In designing interventions to mitigate workplace accidents like training, production of safety equipment by third party manufactures, providing directive information in the work place, developing protective legislations, this finding would be important in knowing that the providers should target 21-40 years age bracket where such accidents occur more frequently. It is also important to note that while planning for compensation, the compensation agencies should prepare more compensation to this age bracket. In planning for stocking of safety equipment, the study recommends that the factories should stock all types of hand protective gloves, machines with laser beams that can detect body limbs, factory designed shoes and gumboots, protective helmets and protective eye glasses. The interventions should also target employees in training them how to use laser beam machines in order to reduce work place accidents.

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Effect of Carburization on the Mechanical Properties of the Mild Steel

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ABSTRACT: The properties of metals and alloys can be changed by heating followed by cooling under definite conditions to make them suitable for specific applications. Carburization is a method of producing mild steel having tough inner core and hard outer surface. Three Heat Treatment process namely Quenching, Carburizing and Tempering were done. The mild steels are carburized at temperature range of 850 to 950 ^{o}C and then it is tempered at 200 ^{o}C for thirty minutes after that it subjected for different kind of tests such as hardness, tensile and toughness. The results indicated that the process of carburization greatly improves the mechanical properties like hardness and tensile strength and these properties increases with increase in the carburization temperature but apart from this, the toughness property decreases and it is further decreases with increase in carburization temperature. The mild steels carburized at the temperature of 950 ^{o}C gives the best results for the mechanical properties because at this temperature it gives the highest tensile strength and hardness, so it must be preferred for the required applications.

KEYWORDS: Carburization, hardness, tensile strength, toughness and impact test.

1 INTRODUCTION

Engineers usually require a material with a blend of high yield strength and good elongation, but these properties are often mutually exclusive. It has been shown that the yield strength of normalized low carbon mild steel can be increased by inducing strain ageing effects in the steel, until the yield stress attains values up to and beyond the ultimate tensile strength, but unfortunately, the elongation is correspondingly reduced [1]. Steels are alloys of iron and carbon together with any other alloying elements. The steel is being separated as low carbon steel, high carbon steel and medium carbon steel. The controlled heating and cooling processes used to change the structure of a material and alter its physical and mechanical properties [2, 3]. Heat treatment is generally employed for the purpose such as to improve mechanical properties like tensile strength, hardness, ductility, yield strength and so on. The heat treatment and carburization increases the mechanical and wear resistance. The heating of a metal at a constant temperature for a suitable duration of time is called soaking time. Mechanical properties of mild steels were found to be strongly influenced by the carburizing temperature and soaking time at carburizing temperature. The mechanical properties of mild steel were found to be strongly influenced by the process of carburization, carburizing temperature and soaking time at carburizing temperature [4-7].

Carburizing is a metal treatment process that adds carbon to the surface of metal that has a low carbon content to increase the hardness of the metal. The metal is heated at an elevated temperature in an atmosphere rich with carbon. Heat will cause carbon atoms to diffuse into the metal surface. The process is done below the melting point of the metal being carburized. There are five carburizing methods—pack, gas, liquid bath, vacuum, and plasma. Pack carburizing uses a furnace to heat the metal parts to be carburized that are packed inside a container with a sufficient amount of carbon powder. The heating process will last for 12 to 72 hours at a high temperature. This method is noted to be slow compared to the other methods and has heating inefficiencies because of the difficulty in maintaining an even temperature. Gas carburizing follows the same procedure applied in pack carburizing. It, however, feeds carbon monoxide (CO) to the furnace to improve diffusion, which is not done in the pack method. The process has safety issues because CO is a poisoning gas that is odorless and colorless and could be inhaled by persons working inside the plant. The gas method is preferred in carburizing large

volumes of metal [8–14]. Hardening is accomplished when the high-carbon surface layer is quenched to form martensite so that a high-carbon martensitic case with good wear and fatigue resistance is superimposed on a tough, low-carbon steel core. Carburizing steels for case hardening usually have base-carbon contents of about 0.2%, with the carbon content of the carburized layer generally being controlled at between 0.8 and 1% C. However, surface carbon is often limited to 0.9% because too high a carbon content can result in retained austenite and brittle martensite. Carburizing steel is widely used as a material of automobiles, form implements, machines, gears, springs and high strength wires etc. which are required to have the excellent strength, toughness, hardness and wear resistance, etc. because these parts are generally subjected to high load and impact. Such mechanical properties and wear resistance can be obtained from the carburization and quenching processes. This manufacturing process can be characterized by the key points such as: it is applied to low carbon work pieces, work pieces are in contact with high carbon gas, liquid or solid, it produces hard work piece surface, work piece cores retain soft [15].

Hardness is the property of a material to resist permanent indentation. Because there are several methods of measuring hardness, the hardness of a material is always specified in terms of the particular test that was used to measure this property. Although hardness testing does not give a direct measurement of any performance properties, hardness correlates with strength, wear resistance, and other properties. Hardness testing is widely used for material evaluation due to its simplicity and low cost relative to direct measurement of many properties.

Tensile strength, hardness, toughness, elasticity, plasticity, brittleness, and ductility and malleability are mechanical properties used as measurements of how metals behave under a load. These properties are described in terms of the types of force or stress that the metal must withstand and how these are resisted. The ability of material to absorbed energy and deform plastically before fracture is called “toughness”. It is usually measured by the energy absorbed in a notched impact test like charpy or izod tests. In present work for each of the sample, test was conducted for 3 times and the average of all the samples was taken as the observed values in each case.

2 MATERIALS AND METHODS

2.1 MATERIALS SELECTION

Mild steels test specimens of the required dimensions were prepared. The chemical composition of mild steel is C-0.16%, Si-0.03%, Mn-0.32%, S-0.05%, P-0.2%, Ni- 0.01%, Cu-0.01%, Cr-0.01% and Fe-balance.

2.2 PREPARATION OF TEST SPECIMENS

Carburization of mild steel samples

The prepared test samples were embedded in the activated carbon inside a steel pot which was then tightly sealed with clay cover to prevent the CO from escaping and prevent unwanted furnace gas from entering the steel pot during heating. The furnace temperature was adjusted to the required temperature range and the loaded steel pot was charged into the furnace. When the furnace temperature reaches the required carburizing temperature, it was then held/soaked for thirty minutes. After that, the steel pot was removed from the furnace and the material was quenched in industrial engine oil (which was initially at the ambient atmospheric temperature).

The hardness of all the samples has been done using a Vickers hardness testing machine. The applied load during the testing was 100 N, with a dwell time of 10 s. It has a square-base diamond pyramid indenter. Ten hardness readings are taken at different location to circumvent the possible effects of particle segregation. The impact tests were performed on various sample determine the impact strengths by using the Impact Testing Machine. Tensile properties of the alloys were analyzed by carrying out test on the universal testing machine. The test specimen for analysis of different mechanical properties (tensile strength, toughness and hardness test results) was prepared as per ASTM standard as below:

1. **Specimen for hardness test** is prepared having the dimensions (4cm x 2.5cm x 0.5cm).
2. **Specimen for tensile strength test** is prepared based on the following equation: $L_o = 5.65\sqrt{A_o}$

   Where, L_o = Gauge length and A_o = Cross sectional area
3. **Specimen for toughness test** is prepared having the dimensions; Length – 5.5 cm, Width – 1 cm, Thickness – 1 cm and Notch depth – 0.5 cm

3 RESULTS AND DISCUSSION

3.1 HARDNESS

The hardness values varied in the range of 551 Hv – 694 Hv as shown in figure (1). With increase of carburization temperature the hardness values increases. The hardness value is higher for the mild steel carburized at temperature of 950 ^{o}C and is lower for the mild steels carburized at 850 ^{o}C, so with increase of carburization temperature the hardness values increases as shown in figure (1). I.e., the carburized mild steel at 950 ^{o}C is giving the best results for the mechanical properties like tensile strength and hardness except the case of toughness test.

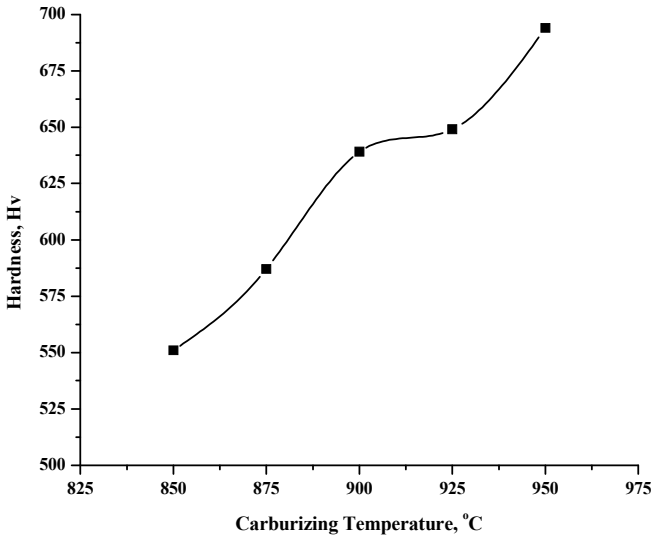

Figure (1): Variation of hardness with the carburization temperature

3.2 MECHANICAL PROPERTIES RESULTS (TENSILE STRENGTH, IMPACT AND TOUGHNESS TEST RESULTS)

The results of different mechanical characteristics like tensile strength, toughness and hardness under different carburization temperatures are shown in figures (2–8) and summarized in the following:

3.2.1 TENSILE STRENGTH

The tensile strength is varied between the ranges of 441MPa – 1960 MPa and is higher for the mild steel carburized at temperature of 950 ^{o}C and lower for the uncarburized simple mild steel. This shows that the carburization greatly improved the tensile strength of mild steels. That's leads to the increase in the carburization temperature, the tensile strength of carburized mild steels increases, as shown in the figure (2).

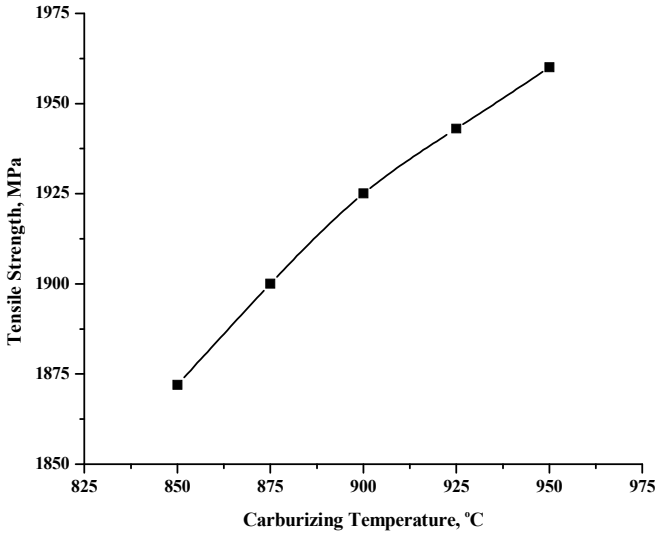

Figure (2): Variation of tensile strength with carburization temperature.

In figure (3), it is observed that, the ultimate tensile strength (UTS) initially decreased from 751.81 Nmm^{-2} (at the carburizing temperature of 850°C) to 655.97 Nmm^{-2} when the carburizing temperature increased to 900°C. It then increased to its maximum value of 789.76 Nmm^{-2} as the carburizing temperature increased to 950°C. This shows that the UTS of the samples soaked for 30 minutes was reduced by the carburization process. Similarly, for both series the carburization process reduced the UTS of the treated samples at carburizing temperature of 850°C when compared with the UTS of the untreated as received sample which has a UTS of 800.07 Nmm^{-2} and impact energy of 61.25 J. This relationship of the UTS with the carburizing temperature is similar to its relationship with the percentage carbon content of steel in both annealed and tempered conditions [16, 17]; it can be reliably assumed that the amount of carbon that diffused into the samples increases with the carburizing temperature. The behavior of the samples in figure (6), is similar to the discoveries of Ward, (1981) [17] where he found that the UTS of carburized samples of some steel grades were some reduced.

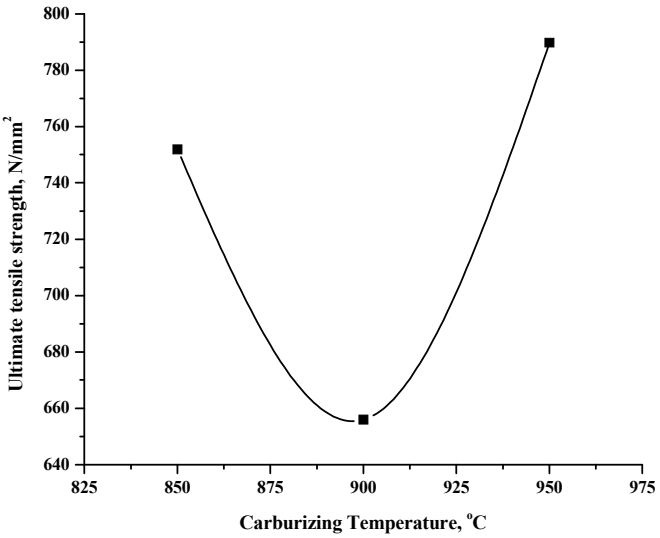

Figure (3): The effect of carburizing temperature on the ultimate tensile strength of the samples

In figure (4), the strain for the samples initially increased from its minimum level of 0.02421 (i.e. 2.421 % elongation) at 850°C, to its maximum of 0.15987 (i.e. 15.987 % elongation) as the carburizing temperature is increased to 900°C which then reduced to 0.10977 (i.e. 10.977 % elongation) with further increase in the carburizing temperature to 950°C. This is due to an increased interface area produced by the carbide formation at grain boundaries which lead to the impurities (cavities and cracks) being redistributed, because their concentration is low the problem of embrittlement is negligible [18].

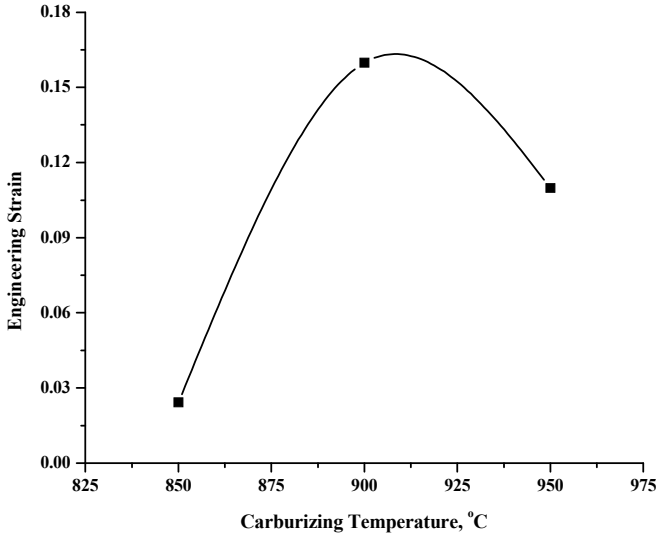

Figure (4): The effect of carburizing temperature on the engineering strain of the samples

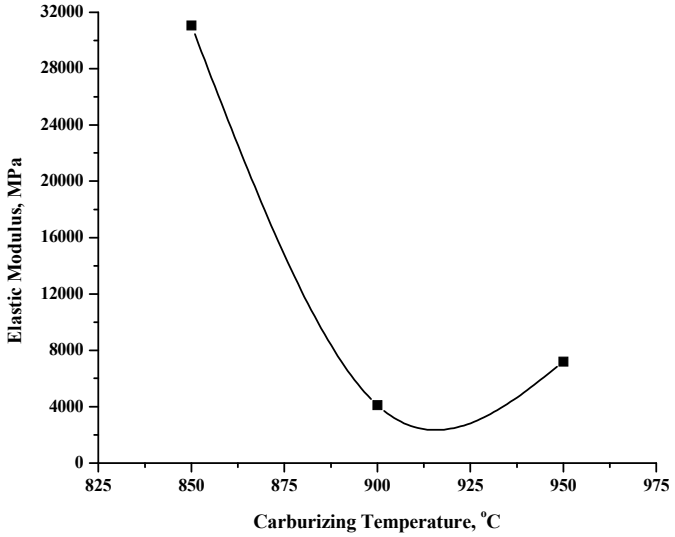

Figure (5): The effect of carburizing temperature on the Young's modulus of elasticity of the samples

From figure (5) it is clearly seen that for the samples, the Young's' modulus at carburizing temperature of 850°C reduced from its maximum value of 31,053.7 Nmm^{-2} to the minimum value of 4,103.15 Nmm^{-2} as the carburizing temperature is increased to 900°C and then increased to 7,194.68 Nmm^{-2} as the carburizing temperature is increased to 950°C. Comparing these with the Young's' modulus of the as received sample which has a value of 12,973.86 Nmm^{-2} show that the stiffness of the carburized samples were initially higher than the as received samples. This shows that the samples lost their stiffness with increase in the carburizing temperature.

3.2.2 IMPACT TEST AND TOUGHNESS

From figure (6), it is observed that the absorbed (impact) energy increases with increase in the carburizing temperature.

The toughness is varied in the range of 54 J – 32 J. It is higher for the uncarburized mild steels and lower for the carburized mild steel at temperature of 950 ^{o}C, so the carburization process decreases the toughness of the mild steels, as shown in figure (7). This is expected and supported from the literature [14].

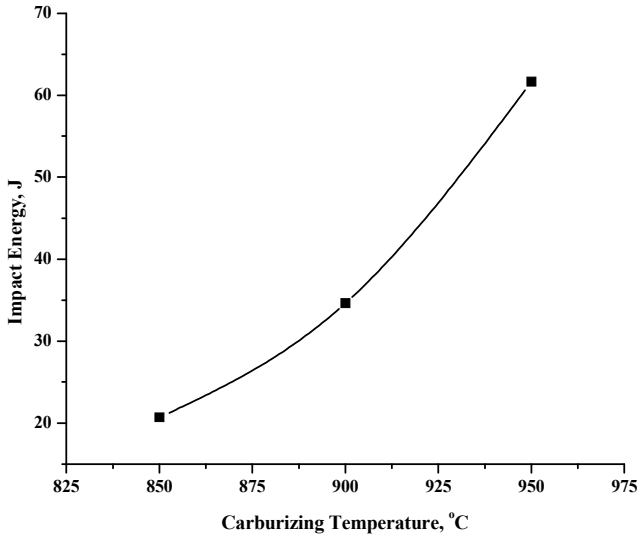

Figure (6): The effect of carburizing temperature on the impact energy of the samples.

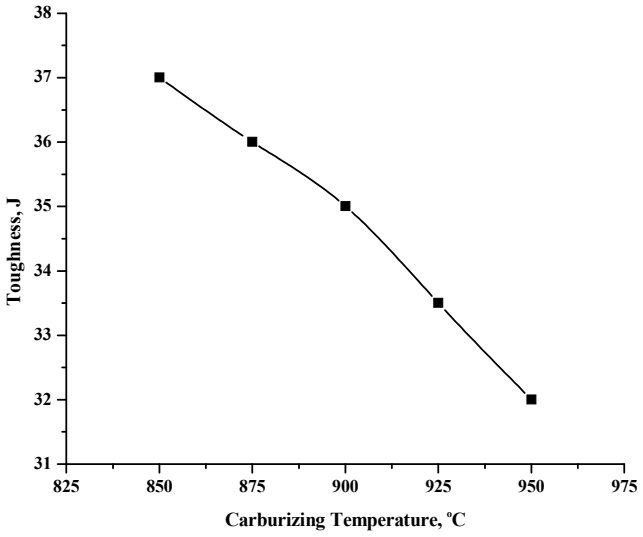

Figure (7): Variation of toughness with carburization temperature

3.3 EFFECT OF HARDNESS ON THE TENSILE STRENGTH OF CARBURIZED MILD STEELS

The variation between hardness and tensile strength is represented in the figure (8). The tensile strength is highly affected by the hardness and it varies directly with the hardness.

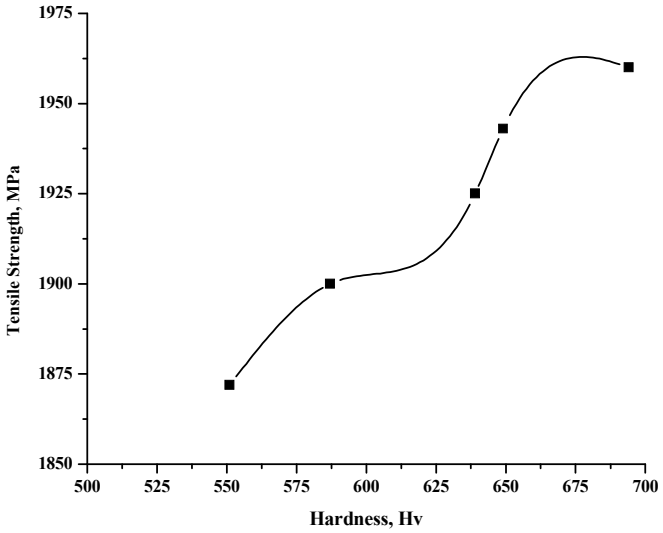

Figure (8): Variation of tensile strength with hardness for carburization temperature.

4 CONCLUSIONS

1. The mechanical properties of mild steels were found to be strongly influenced by the process of carburization and carburizing temperature.
2. Hardness and tensile strength increase, while toughness (impact energy) of the mild steels decreases as increase in the carburization temperature.
3. Carburization process reduced the impact toughness of mild steels, but contrary to the trend observed where activated carbon is the carburizer the impact toughness increases with the carburizing temperature where pulverized bone is used as the carburizer.
4. The stiffness of the mild steel is increased by the carburization process, but it decreases with increasing carburizing temperature.
5. As comparing for different carburization temperature. The mild steels carburized at the temperature of 950 ^{o}C shows the best combination of higher hardness and higher tensile strength.
6. Finally the net conclusion is that the mild steel carburized under the different temperature range of 850 to 950 ^{o}C in which the mild steel carburized at the temperature of 950 ^{o}C is giving the best results.

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THE EFFECT OF CARBURIZATION ON HARDNESS AND WEAR PROPERTIES OF THE MILD STEEL SAMPLES

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ABSTRACT: The properties of metals and alloys can be changed by heating followed by cooling under definite conditions to make them suitable for specific applications. Carburization is a method of producing mild steel having tough inner core and hard outer surface. Three Heat Treatment process namely Quenching, Carburizing and Tempering were done. The mild steels are carburized at temperature range of 850 to 950 ^{o}C and then it is tempered at 200 ^{o}C for thirty minutes after that it subjected for different kind of tests such as abrasive wear, hardness, tensile and toughness. The results indicated that the process of carburization greatly improves the mechanical and wear properties like hardness, tensile strength and wear resistance and these properties increases with increase in the carburization temperature but apart from this, the toughness property decreases and it is further decreases with increase in carburization temperature. The mild steels carburized at the temperature of 950 ^{o}C gives the best results for the mechanical and wear properties because at this temperature it gives the highest tensile strength, hardness and wear resistance, so it must be preferred for the required applications.

KEYWORDS: Carburization, abrasive wear, weight loss, wear resistance and hardness.

1 INTRODUCTION

Engineers usually require a material with a blend of high yield strength and good elongation, but these properties are often mutually exclusive. It has been shown that the yield strength of normalized low carbon mild steel can be increased by inducing strain ageing effects in the steel, until the yield stress attains values up to and beyond the ultimate tensile strength, but unfortunately, the elongation is correspondingly reduced [1]. Steels are alloys of iron and carbon together with any other alloying elements. The steel is being separated as low carbon steel, high carbon steel and medium carbon steel. The controlled heating and cooling processes used to change the structure of a material and alter its physical and mechanical properties [2, 3]. Heat treatment is generally employed for the purpose such as to improve mechanical properties like tensile strength, hardness, ductility, yield strength and so on. The heat treatment and carburization increases the mechanical and wear resistance. The heating of a metal at a constant temperature for a suitable duration of time is called soaking time. Mechanical properties of mild steels were found to be strongly influenced by the carburizing temperature and soaking time at carburizing temperature. The mechanical properties of mild steel were found to be strongly influenced by the process of carburization, carburizing temperature and soaking time at carburizing temperature [4-7].

Carburizing is a metal treatment process that adds carbon to the surface of metal that has a low carbon content to increase the hardness of the metal. The metal is heated at an elevated temperature in an atmosphere rich with carbon. Heat will cause carbon atoms to diffuse into the metal surface. The process is done below the melting point of the metal being carburized. There are five carburizing methods — pack, gas, liquid bath, vacuum, and plasma. Pack carburizing uses a furnace to heat the metal parts to be carburized that are packed inside a container with a sufficient amount of carbon powder. The heating process will last for 12 to 72 hours at a high temperature. This method is noted to be slow compared to the other methods and has heating inefficiencies because of the difficulty in maintaining an even temperature. Gas carburizing follows the same procedure applied in pack carburizing. It, however, feeds carbon monoxide (CO) to the furnace to improve

diffusion, which is not done in the pack method. The process has safety issues because CO is a poisoning gas that is odorless and colorless and could be inhaled by persons working inside the plant. The gas method is preferred in carburizing large volumes of metal [8–14].

Hardening is accomplished when the high-carbon surface layer is quenched to form martensite so that a high-carbon martensitic case with good wear and fatigue resistance is superimposed on a tough, low-carbon steel core. Carburizing steels for case hardening usually have base-carbon contents of about 0.2%, with the carbon content of the carburized layer generally being controlled at between 0.8 and 1% C. However, surface carbon is often limited to 0.9% because too high a carbon content can result in retained austenite and brittle martensite. Carburizing steel is widely used as a material of automobiles, form implements, machines, gears, springs and high strength wires etc. which are required to have the excellent strength, toughness, hardness and wear resistance, etc. because these parts are generally subjected to high load and impact. Such mechanical properties and wear resistance can be obtained from the carburization and quenching processes. This manufacturing process can be characterized by the key points such as: it is applied to low carbon work pieces, work pieces are in contact with high carbon gas, liquid or solid, it produces hard work piece surface, work piece cores retain soft [15].

Hardness is the property of a material to resist permanent indentation. Because there are several methods of measuring hardness, the hardness of a material is always specified interms of the particular test that was used to measure this property. Although hardness testing doesn't give a direct measurement of any performance properties, hardness correlates with strength, wear resistance, and other properties. Hardness testing is widely used for material evaluation due to its simplicity and low cost relative to direct measurement of many properties. Wear is commonly defined as the undesirable deterioration of a component by the removal of material from its surface. In laboratory tests, wear are usually determined by weight loss in a material and wear resistance is characterized by the loss in weight per unit area per unit time.

2 MATERIALS AND METHODS

2.1 MATERIALS SELECTION

Mild steels test specimens of the required dimensions were prepared. The chemical composition of mild steel is C-0.16%, Si-0.03%, Mn-0.32%, S-0.05%, P-0.2%, Ni- 0.01%, Cu-0.01%, Cr-0.01% and Fe-balance.

2.2 PREPARATION OF TEST SPECIMENS

Carburization of mild steel samples

The prepared test samples were embedded in the activated carbon inside a steel pot which was then tightly sealed with clay cover to prevent the CO from escaping and prevent unwanted furnace gas from entering the steel pot during heating. The furnace temperature was adjusted to the required temperature range and the loaded steel pot was charged into the furnace. When the furnace temperature reaches the required carburizing temperature, it was then held/soaked for thirty minutes. After that, the steel pot was removed from the furnace and the material was quenched in industrial engine oil (which was initially at the ambient atmospheric temperature).

The hardness of all the samples has been done using a Vickers hardness testing machine. The applied load during the testing was 100 N, with a dwell time of 10 s. It has a square-base diamond pyramid indenter. Ten hardness readings are taken at different location to circumvent the possible effects of particle segregation.

Computerized pin on disc wear test machine was used for the wear and friction tests of alloy samples under different loads from 10 N to 100 N and linear speed of 0.65 m s^{-1} for one hour. The rotating disc was made of carbon steel of diameter 50 mm and hardness of 64 HRC. The alloys samples were held stationary and a required normal load was applied through a lever mechanism. Wear resistances are measured by a weight loss using a four digital microbalance. Each wear sample is ultrasonically cleaned and weighed before the wear test using a balance with an accuracy of 0.01 mg. Three samples for each condition are tested and the average of the weight loss measurements is used for calculation of the wear property. The test specimen for abrasive wear and hardness test is prepared having the dimensions (4cm x 2.5cm x 0.5cm).

3 RESULTS AND DISCUSSION

3.1 ABRASIVE WEAR TEST

The results of abrasive wear test of the samples are shown in figures (1–3). The wear resistance is higher for the carburized mild steel and it is lowest for the uncarburized mild steel. The weight loss during abrasion is higher for uncarburized simple mild steel and is lower for the carburized mild steel at temperature of 950 ^{o}C because of comparatively low carbon content at lower carburization temperature. So it is concluded that, as the carburization temperature increases the weight loss during abrasion is decreases. The weight loss is higher for the load of 49 N and it is lower for the load of 14.7 N, this is because of the increase in the force, the friction increases which causes the weight loss, as shown in the figure (1).

For taking only the case of carburized mild steels, the wear resistance is higher for the mild steel carburized at the temperature of 950 ^{o}C and is lower for mild steels carburized at temperature of 850 ^{o}C as shown in figure (2). Hence the abrasion results explain that the wear resistance is directly proportional to the carburization temperature, as the carburization temperature increases the wear resistance increases. I.e. The mild steel carburized at temperature of 950 ^{o}C is giving the best results, as it has having the highest wear resistance, lowest weight loss due to abrasion and lowest wear rate.

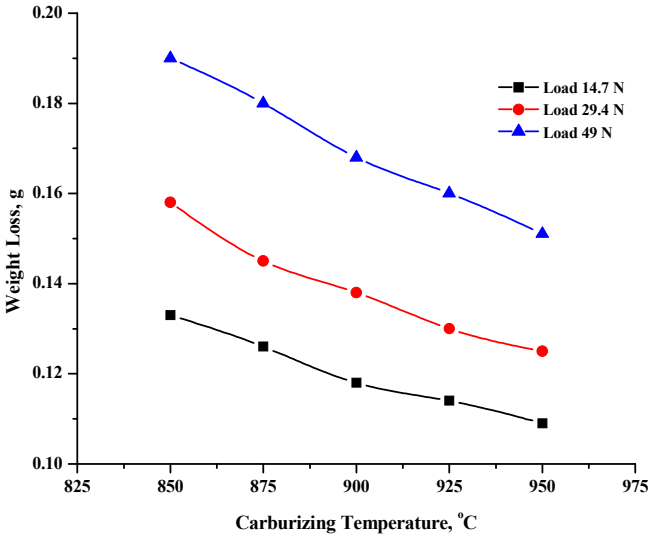

Fig. (1): A comparison of weight loss vs. carburization temperature at different loads.

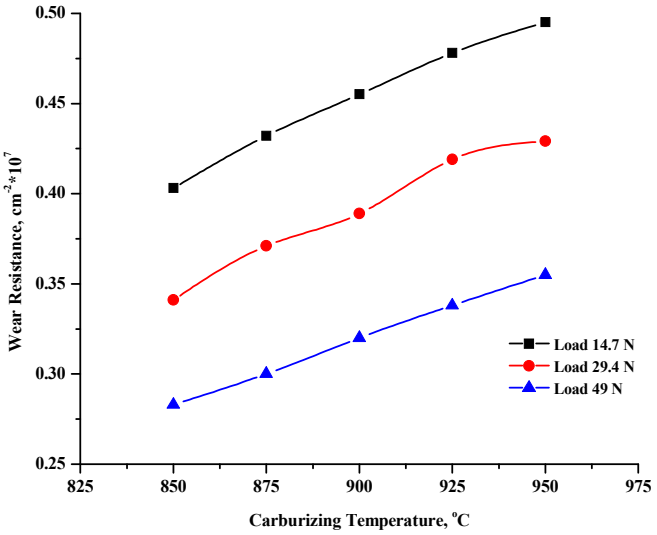

Fig. (2): A comparison of wear resistance vs. carburization temperature at different loads.

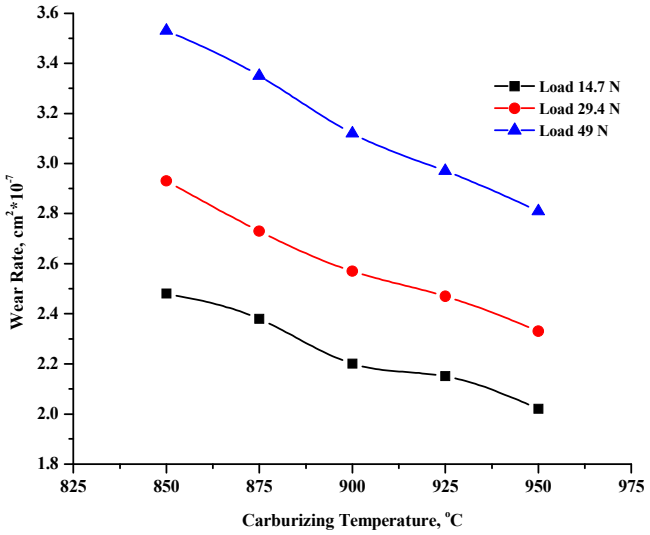

Fig. (3): A comparison of wear rate vs. carburization temperature at different loads.

3.2 HARDNESS

The hardness values varied in the range of 551 Hv – 694 Hv as shown in figure (4). With increase of carburization temperature the hardness values increases. The hardness value is higher for the mild steel carburized at temperature of 950 ^{o}C and is lower for the mild steels carburized at 850 ^{o}C, so with increase of carburization temperature the hardness values increases as shown in figure (4). I.e., the carburized mild steel at 950 ^{o}C is giving the best results for the mechanical properties like tensile strength and hardness except the case of toughness test.

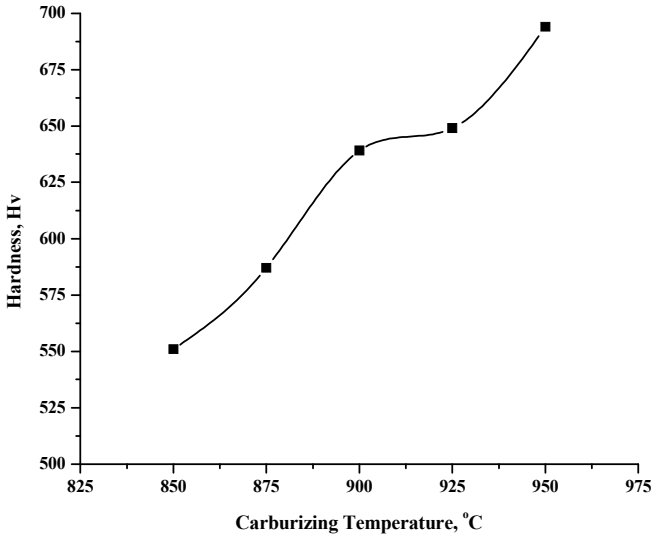

Fig. (4): Variation of hardness with the carburization temperature.

3.3 EFFECT OF HARDNESS ON THE WEIGHT LOSS AND WEAR RESISTANCE OF CARBURIZED MILD STEELS:

The variation between hardness and weight loss due to abrasion is represented in the figure (5). The weight loss due to abrasion is highly affected by the hardness and it varies inversely with the hardness. That is because of the hard material having the greater abrasive wear resistance, so the less wear occurs in the carburized mild steels and the weight loss decreases.

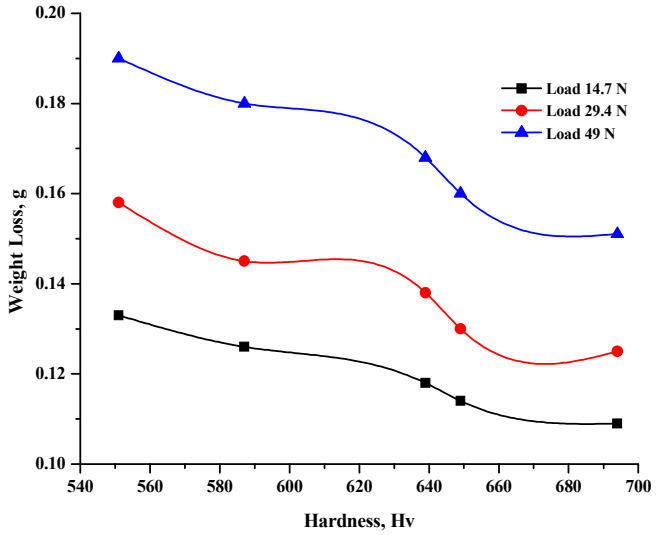

Fig. (5): A comparison of weight loss due to abrasion vs. hardness at different loads.

The wear resistance is affected by the hardness as represented in figures (6). The wear resistance increases as the hardness increases.

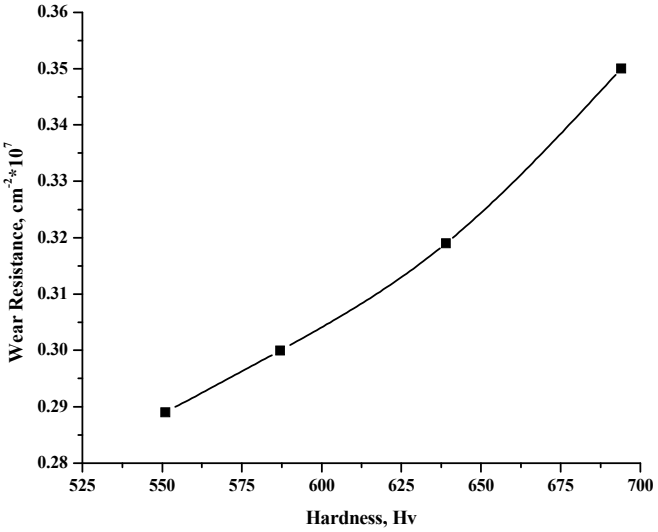

Fig. (6): Variation of wear resistance with hardness for the carburization temperature.

4 CONCLUSIONS

From the above discussions so far it can be concluded that:

1. The mechanical and wear properties of mild steels were found to be strongly influenced by the process of carburization and carburizing temperature.
2. Hardness and wear resistance increase with increase in the carburization temperature, while the wear rate decreases.
3. The weight loss due abrasion, wear volume and wear rate increases with the increase in the applied load.
4. With increase in the hardness the wear resistance increases, but there is decrease in weight loss due to abrasion and wear rate.
5. As comparing for different carburization temperature, the mild steels carburized at the temperature of 950 ^{o}C shows the best combination of higher hardness and less wear rate.
6. Finally the net conclusion is that the mild steel carburized under the different temperature range of 850 to 950 ^{o}C in which the mild steel carburized at the temperature of 950 ^{o}C is giving the best results for the wear properties and hardness.

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La responsabilité sociale de la PME artisanale au Maroc: - Une étude empirique de la région Fès Boulemane -

[Social responsibility of craft SMEs in Morocco: - An empirical study of the Fez region -]

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ABSTRACT: The concept of corporate social responsibility (CSR) was born in the United States and spread to Europe for decades. We focus in this article on CSR practices in Morocco. We study the craft sector SMEs, it is considered one of the pillars of the Moroccan. The fundamental questions we ask about are: How to craft SMEs perceive themselves their social roles and / or societal? What is the status of their current practices in terms of CSR? Extent craft SMEs in the region of Fez are socially responsible?
To answer these questions, we conducted a survey of SMEs in the craft sector in the region of Fez. We structure our article as follows: in the first part we present the conceptual framework of CSR in general and Morocco in particular. Then we will present our research methodology. The third part is devoted to the presentation and discussion of the results obtained from the data collected from the survey.

KEYWORDS: Corporate Social Responsibility, artisanal sector, sustainable Development.

RESUME: Le concept de la responsabilité sociale de l'entreprise (RSE) est né aux États-Unis et s'est répandu en Europe depuis des décennies. Nous nous intéressons dans cet article aux pratiques de RSE au Maroc. Nous étudions des PME du secteur artisanal, ce dernier est considéré comme l'un des piliers de l'économie marocaine.
Nous nous intéressons dans cet article à explorer les pratiques de la RSE dans le secteur de l'artisanat, considéré comme un secteur fondamental de l'économie nationale et l'un des meilleurs atouts de développement (Emploi : 381.568 artisans, Chiffre D'Affaires : 17,7 Milliards Dhs, Exportations : 340 Millions Dhs, Valeur ajoutée : 10,7 Milliards Dhs).
Les questions fondamentales que nous nous posons à ce sujet sont les suivantes :
Comment les PME artisanales perçoivent-elles leurs rôles sociaux et/ou sociétaux? Quel est l'état de leurs pratiques actuelles en termes de RSE ? Dans quelle mesure les PME artisanales dans la région de Fès sont socialement responsable ?
Pour répondre à ces interrogations, nous avons mené une enquête auprès des PME du secteur artisanal de la région de Fès. Nous structurons notre article comme suit : nous présenterons en première partie le cadre conceptuel de la RSE rn général et au Maroc en particulier. Ensuite, nous exposerons notre méthodologie de recherche. La troisième partie sera consacrée à la présentation et la discussion des résultats obtenus à partir des données recueillis de l'enquête réalisée.

MOTS-CLEFS: Responsabilité Sociale des Entreprises, Secteur Artisanal, Développement Durable.

1 INTRODUCTION

La responsabilité sociale des entreprises a été développée dans les grandes entreprises dans les années 1950 avec les travaux de H. Bowen sur la responsabilité du dirigeant, cet économiste protestant américain souligne pour la première fois la responsabilité sociale d'un dirigeant comme un facteur de performance. C'est au milieu des années 1990 que le concept de

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RSE s'est largement diffusé notamment avec la libéralisation des économies dans le monde et le recul des rôles social et économique de l'Etat. Depuis les années 1990, le concept de développement durable est le nouvel objectif à atteindre : Efficacité économique, éthique sociale et respect de l'environnement. Au niveau de l'entreprise, cette notion est liée à la responsabilité sociale.

L'intérêt pour le concept de responsabilité sociale de l'entreprise (RSE) s'est accru au cours des dernières années, tant d'un point de vue théorique, pour expliquer ce constat, qu'opérationnel, dans les efforts soutenus des différentes parties prenantes dans l'entreprise, pour se doter d'indicateurs de performance à long terme (Tchankam et Estay, 2004) [2].

En effet, La Responsabilité sociale des entreprises –RSE- est née dans la grande entreprise pour faire face à des problèmes qui lui sont spécifiques (réduction des coûts de production, motivation du personnel, amélioration de la qualité, etc.), mais malgré ce grand intérêt accordé à cette notion, les travaux en RSE n'apportent jusqu'à présent que peu d'éclairage sur la responsabilité sociale des PME. En effet, la notion a été conçue pour les grandes entreprises (GE) et la recherche s'est principalement focalisée sur le comportement des grandes firmes multinationales, négligeant ainsi la population des PME.

Partant du postulat que toute entreprise quelle que soit sa taille sur le plan social, est insérée dans un environnement social donné, institutionnellement structuré, à partir duquel elle tire ses ressources et crée des marchés, ou sur le plan économique, l'entreprise doit pour être performante réduire ses coûts, d'où la RSE est une réalité incontestable que ce soit pour les grandes entreprises que pour les PME.

Afin de pouvoir répondre à la question : L'entreprise a-t-elle vraiment un rôle social ?, nous chercherons à mieux expliciter le sens que le concept de RSE a pris depuis les années trente du siècle dernier jusqu'à nos jours, et ce, en passant en revue les principales définitions qui lui ont été attribués, les principales théories sur lesquelles se fonde ce concept, ainsi que les concepts connexes et leurs relations avec ce concept de base qu'est celui de la RSE.

Si la RSE est une innovation qui est née dans la grande entreprise, l'entreprise artisanale ne peut cependant pas l'ignorer car c'est en faisant l'addition des individualités que le secteur de l'artisanat existe.

Quelle est la position des PME artisanales sur ce sujet ? Nous avons cherché à y apporter une réponse à partir d'une enquête sur le terrain réalisée dans des PME artisanales de la région Fès Boulemane.

2 CADRE CONCEPTUEL DE LA RECHERCHE ET CONCEPTS OPÉRATOIRES

2.1 LA RSE, EMERGENCE ET DÉVELOPPEMENT DU CONCEPT

Plusieurs courants de pensée se sont affrontés autour de la problématique de la responsabilité sociale, plusieurs chercheurs se sont penchés sur la question mais il n'ya pas vraiment un consensus sur la définition de le RSE.

Selon Tchankam et Estay, étymologiquement, le terme « responsabilité » trouve son origine dans le droit. Du latin **spontio**, lui-même décalqué du grec **spondé**, signifie promesse solennelle génératrice d'engagement (Tchankam et Estay, 2004) [2].

Au-delà de la question sémantique, la multiplicité des définitions-même illustre la difficulté à encadrer le concept.

Ainsi, traduite directement de l'anglo-américain « Corporate Social Responsability », la formule française la plus couramment employée « Responsabilité Sociale de l'Entreprise », suggère une conception restreinte à ce qui relève des relations entre les personnes, ou ce qui est favorable au bien-être des individus, selon la définition du terme "social" considérée. C'est la raison pour laquelle certains militent pour le recours au terme « sociétal », afin d'exprimer une dimension plus large et éviter ainsi toute confusion.

La Commission européenne a donné la définition suivante : *« C'est un concept qui désigne l'intégration volontaire par les entreprises de préoccupations sociales et environnementales à leurs activités commerciales et leurs relations avec leurs parties prenantes. »* (Commission européenne, 2001).

Dans le même contexte, Boutillier et Fournier définissent la RSE comme une tentative de réponse à une triple problématique : économique (augmentation du chiffre d'affaires de l'entreprise), sociale (bonnes conditions de travail et de vie des salariés) et environnementale (respect de l'environnement physique, qualité des produits et des matières premières, recyclage des déchets, etc.). Elle est ainsi la transcription à l'échelle de l'entreprise du développement durable qui depuis la fin des années 1980 (rapport Brundtland en 1987) a été défini comme un idéal à atteindre [3].

A partir de ces définitions , Être socialement responsable signifie non seulement satisfaire pleinement aux obligations juridiques applicables, mais aussi aller au-delà et investir «davantage» dans le capital humain, l'environnement et les

relations avec les parties prenantes surtout que l'entreprise est soumise de nos jours à de grandes pressions de la part de la société : les actionnaires, les employés, les clients, les fournisseurs, les lois et les réglementations, les groupements de la société civile, etc. Selon Joras, Igalens. Et Mancy, En intégrant à ses objectifs le développement durable (DD), l'entreprise finit par avoir une responsabilité illimitée de par les innombrables responsabilités économique, sociale, et environnementale auxquelles elle est confrontée [4].

Dans le même ordre d'idées, le WBCSD (World Business Council for Sustainable Development) parle de « contribution des entreprises au développement économique durable, travaillant avec les employés, leurs familles, la communauté locale et la société au sens large pour améliorer leur qualité de vie ».

L'expression « la responsabilité sociale de l'entreprise » couvre les responsabilités qu'ont les entreprises envers les sociétés au sein desquelles elles sont basées et elles opèrent. Il est certain que la RSE ne veut pas dire la même chose, tout le temps et pour tout le monde. Pour certains, la RSE rejoint la responsabilité juridique ; pour d'autres, elle se rapporte à l'éthique ou au comportement social responsable ; d'autres encore l'associent aux actions de charité ; alors certains autres y voient une action de conscience sociale. En nous penchant sur le sens direct de l'expression RSE, il s'avère que le terme de « responsabilité » n'est pas pris ici au sens d'« obligation » puisque l'action est présumée « volontaire ». En plus, cette responsabilité sous-tend un engagement de la part de l'entreprise, ce qui implique des conséquences sur elle-même et sur autrui.

Archie B. Carroll (1979) considère que la RSE correspond aux attentes qu'à un moment donné la société a de l'entreprise aux niveaux économique, juridique, éthique et discrétionnaire. En 1979, A. Carroll considère que la RSE est l'ensemble des obligations que l'entreprise a vis-à-vis de la société en englobant l'économie, mais aussi les catégories légales, éthiques et discrétionnaires. La responsabilité économique détermine en quelque sorte les autres types de responsabilité. La responsabilité économique consiste à produire des biens et des services que les consommateurs demandent et d'en obtenir un profit. La responsabilité légale s'attache à la conformité aux lois en vigueur. La responsabilité éthique concerne les actions non codifiées juridiquement mais attendues par la société [3].

Diouri F, évoque les principes sur lesquelles fondées La RSE, ce sont des valeurs éthiques de respect vis-à-vis de toutes les parties prenantes de l'activité de l'entreprise (employés, fournisseurs, clients, actionnaires, concurrents…), de la communauté (collectivités locales, associations de consommateurs, ONG…) et de l'environnement [5]. C'est une démarche de progrès qui va être intégrée dans la réflexion stratégique de l'entreprise et qui se décline de manière transversale dans toutes ses fonctions (RH, achat, marketing, logistique…). L'Objectif recherché est d'assurer une performance économique (rentabilité financière, bonne gouvernance, saine concurrence…), sociale (bien-être des salariés, non-discrimination), sociétale (développement des communautés) et environnementale (analyse des impacts, optimisation des consommations de ressources, maîtrise des déchets et des émissions polluantes…).

Cependant, ces approches divergent quant à la structure de la RSE, et les axes privilégiés par les entreprises qui ne sont pas toujours les mêmes mais nous constatons qu'il existe un noyau commun à toutes les définitions recensées : celui-ci inclut la participation de l'ensemble des parties prenantes, la dimension sociale, économique, volontaire et environnementale.

2.2 VERS UNE NOUVELLE APPROCHE DE LA RSE

Hormis le fait de créer des emplois, la mission d'une coopérative consiste à satisfaire les besoins économiques, sociaux et culturels de ses membres (RISQ, 2003, p18).

Toujours dans le même contexte et en se basant sur la définition de l'alliance coopérative internationale *« la coopérative est une association autonome de personnes volontairement réunis pour satisfaire leurs aspirations et besoins économiques, sociaux et culturels communs au moyen d'une entreprise dont la propriété est collective et où le pouvoir est exercé démocratiquement (ACI, 1995).*

Nous remarquons, à partir de cette définition, que la coopérative associe l'économique et le social, donc d'une nature associative et entrepreneuriale.

Dans la mesure où elles poursuivent à la fois des objectifs commerciaux et des objectifs sociaux, les coopératives se dotent de mécanismes efficients qui assurent la promotion des objectifs sociaux à l'échelon de leurs membres et au niveau des communautés d'une manière générale, notamment les objectifs relatifs à la promotion d'un emploi décent. Par ailleurs, la responsabilité sociale, à laquelle les entreprises ont récemment commencé à prêter attention, en mettant l'accent sur la responsabilité sociale de l'entreprise, constitue depuis longtemps le socle sur lequel sont bâties les coopératives.

S'associant au concept de la RSE, un concept est étroitement lié c'est la performance sociale, qui montre clairement que les entreprises font partie d'un réseau des parties prenantes au centre d'une toile de droits et de devoirs et non pas seulement d'intérêts. Cette théorie doit en effet tenir compte du rôle des relations de parties prenantes, de l'importance des valeurs au sein et en dehors de l'entreprise, ainsi que la nature des pouvoirs entre acteurs sociaux. (Wood, 2004, p 75).

Nous avons retenu, à partir de la littérature, trois approches de la RSE [6]:

L'approche moraliste : elle repose sur l'idée que l'entreprise et ses activités sont assujetties à un comportement moral, la notion de l'éthique apparait à ce niveau, mais Giasson et DePaula stipule que cette approche est intrinsèque dans les coopératives, en effet, elle agit conséquemment à la morale de ses gestionnaires et ses dirigeants elle doit agir d'une manière socialement responsable sous peine de ne plus avoir de raison d'être.

L'approche contractuelle qui s'appuie sur le principe qu'entreprise et société sont interreliées, susceptibles de se renforcer mutuellement et quelles sont liées par un contrat social. Dans cette perspective Donaldson affirme que le contrat social est conclu entre un agrégat d'individus « la société »et une organisation productive « la corporation ».

Mais nous avançons que le contrat social entre la société et les coopératives seront totalement différents puisque leur mission est basée sur des valeurs et des principes totalement différents de celui du système libre du marché.

L'approche utilitaire avance que ce qui est bon pour l'entreprise est bon pour la société et inversement. Elle voit la RSE comme une stratégie marketing pour développer de nouveaux marchés plus sensibles aux préoccupations sociales, elle devient un outil pour soutenir la finalité de l'entreprise.

La notion de la RSE interpelle une autre notion s'avérant cruciale qui est la rentabilité sociale, à prime d'abord, c'est la création d'une richesse sociale, mais cette notion nous semble différente selon qu'il s'agit dune entreprise capitaliste, collective ou bien de l'économie sociale.

Selon Molina 2006, la rentabilité sociale ne se réfère pas exclusivement à l'entraide, à l'insertion sociale, à l'aide aux démunis, ces dernières sont incluses mais le social est plus large, c'est un avantage qui a comme résultat l'amélioration du mieux être collectif, une approche citoyenne et une vision des membres d'une collectivité : la qualité de vie, l'emploi, la citoyenneté active, la cohésion sociale, l'environnement, la culture.

D'autre part, Neamtam définit « *la rentabilité sociale comme la contribution d'une entreprise au développement économique et social, elle se mesure en fonction des activités déployés pour réaliser les objectifs visés, des résultats et des effets attendus des parties prenantes et des effets indirects positifs ou négatif des activités* » [6].

En économie sociale, Patenaude affirme que les résultats et les impacts sont mesurés en termes de rentabilité sociale ou de bénéfices collectifs, elles visent le dépassement de l'évaluation des simples retombées économiques, dans le même sujet, Gadrey nous présente une typologie des bénéfices collectifs :

- Le moindre cout collectif direct de certains services.
- La contribution indirecte à la réduction des couts économiques divers, publics et privés.
- La contribution indirecte à la progression du taux d'activité et de formation professionnelle de certains usagers.
- La contribution au dynamisme économique et social des territoires, à leur attractivité et à leur qualité de vie collective
- La contribution à la réduction d'inégalités diverses jugées excessives
- La contribution du capital social, à la démocratie de proximité et aux solidarités locales et relationnelles.

2.3 LES LEVIERS DE LA RSE AU MAROC

Au Maroc, le concept de la RSE est devenu un sujet de débat tant dans la sphère économique que celle académique. En effet, La mondialisation de l'économie impose un nouvel ordre aux entreprises marocaines marqué par l'ouverture des marchés et l'apparition de nouveaux concurrents internationaux. Un des facteurs de différenciation est l'innovation technologique et organisationnelle. Dans ce cadre, de nombreuses opportunités s'ouvrent pour encourager l'intégration de la RSE dans les pratiques managériales au Maroc

2.3.1 LE CONTEXTE ÉCONOMIQUE

La RSE au Maroc a été connue par les filiales des entreprises multinationales qui sont engagées dans de tels processus et par leurs partenaires locaux» [7]. Son développement est favorisé par un contexte global propice porté par des réformes juridiques et institutionnelles parmi lesquelles on cite :

L'Initiative nationale pour le développement humain (INDH), la réforme du cadre législatif du code de travail et le mouvement de normalisation.

L'Initiative nationale pour le développement humain, lancée par le Roi Mohammed VI en mai 2005, vise à concevoir les fondations d'un programme national pluriannuel pour l'intégration des objectifs sociaux dans les décisions d'investissement. Dans ce cadre, le discours royal constitue un signal politique fort et positif et un vecteur d'incitation et d'encouragement aux initiatives privées : « *La responsabilité sociale des investisseurs a pour pendant et pour condition la responsabilité sociale des entreprises. À cet égard, Nous suivons avec intérêt et satisfaction l'action des entreprises marocaines qui se sont volontairement engagées dans cette voie* » (Extrait du Message de S.M. le Roi à la troisième édition des « Intégrales de l'Investissement », 2005) [8]. Plus concrètement, l'INDH offre aux acteurs économiques un cadre de référence et des ressources financières.

Par ailleurs, le cadre législatif marocain Mis en vigueur depuis juin 2004, (Bulletin officiel n°5210, 2004) se caractérise par sa conformité avec les principes de bases fixés par la Constitution marocaine et avec les normes internationales telles que prévues dans les conventions des Nations unies ses organisations spécialisées en relation avec le domaine du travail.

Par ailleurs, le nouveau code du travail propose des instruments pour l'adaptation de certaines mesures aux spécificités sectorielles et organisationnelles. Il s'agit principalement des outils internes comme le comité d'entreprise, le comité d'hygiène et de sécurité, l'accord d'entreprise et la convention collective de branche. Les entreprises attachées à la RSE trouvent dans ce code d'abord les normes obligatoires dont le respect s'impose à tous et en tête desquelles on trouve les droits et les principes fondamentaux au travail ainsi que les mesures relatives à la santé au travail, au licenciement, à la durée du travail et aux salaires; mais aussi, les instruments destinés à adapter ces dispositions à leurs propres pratiques et à les promouvoir dans des secteurs voisins, tels que celui de l'environnement, des droits humains et de la transparence: règlement intérieur, comité d'entreprise, comité d'hygiène et de sécurité, accord d'entreprise, convention collective de branche… etc.

D'un autre côté, le Maroc vit un mouvement de normalisation en pleine émergence, il est membre de la commission francophone de la préparation de la norme ISO 26000 sur la responsabilité sociale. Ce mouvement de normalisation reflète une dynamique orientée vers l'intégration des enjeux sociaux dans les systèmes de management et une volonté d'établir les bases normatives pour aller au-delà des obligations légales et contribuer à un climat de confiance entre les différents acteurs socio-économiques.

2.3.2 LES OBSTACLES À LA RSE AU MAROC

Nul ne pourra ignorer les efforts fournis pour promouvoir la RSE au Maroc, mais ceci n'empêche que plusieurs obstacles compromettent sa mise en application dans les systèmes de management. Selon Filali Maknassi (2009), ces facteurs sont principalement la qualification du personnel, le manque d'information et de ressources financières. Ces facteurs [7] et [8] trouvent leurs sources dans :

- L'arrière-plan culturel du Maroc basé sur des valeurs paternalistes traditionnelles (Mezuar, 2002). Cette culture d'« entrepreneuriat paternaliste » réduit la performance économique à la diminution des coûts et place l'autorité au centre des relations entre le patronat et les employés. Elle freine la prolifération des pressions des parties prenantes, notamment les syndicats, et donc réduit les opportunités de concertation sociale (Ettahiri, 2009). D'ailleurs, le mouvement syndical au Maroc a été pendant plusieurs années affaibli et dominé par des logiques d'affrontement et de combat (Hamoumi, 2005), d'où la difficulté de mettre en place les bases d'un dialogue social tourné vers la négociation et la concertation.
- La prédominance des petites et moyennes entreprises (PME) dans le tissu économique au Maroc met en avant une fragilité financière, structurelle et humaine qui handicape la mise en place d'une RSE formelle, contrôlée voire même certifiée, car ceci implique la mise en place de modes de management qui substituent le formel à l'informel, la procédure au processus, la planification à l'intuition et l'écrit à l'oral (Torres, 1997). Ces changements poussent à un phénomène de « *dénaturation de la PME marocaine* » (El Moujadidi et Karim, 2009) puisqu'ils s'avèrent difficilement opérationnels dans un contexte économique où la priorité est accordée à la survie et à la pérennité de la PME.
- La qualification des employés et des cadres dirigeants ne suit pas encore l'enthousiasme accordé à la RSE par les autorités marocaines. La formation universitaire ou professionnelle reste en large partie dominée par les disciplines qui encouragent principalement la compétitivité et qui mettent l'intégration des aspects sociaux en second plan (Ettahiri, 2009) [8].

Après ce panorama contextuel de la RSE au Maroc, nous nous focaliserons ci-après sur l'exploration des pratiques dans le secteur artisanal pour découvrir leur adéquation avec les initiatives gouvernementales et privées en la matière.

3 CADRE METHODOLOGIQUE ET RÉSULTAS

3.1 MÉTHODOLOGIE

La méthodologie préconisée a été réalisée à partir d'un questionnaire visant à cerner les pratiques (ou les non pratiques) des dirigeants interviewés en matière de RSE1. Notre objectif a été de cerner les pratiques des entreprises artisanales en matière de RSE et adaptant les questions à leur situation particulière (faible hiérarchie, un éventail de compétences moins diversifié, faiblesse des moyens financiers disponibles, importance des relations familiales, méconnaissance du sujet, etc.).

Le questionnaire a été le moyen retenu pour obtenir les informations voulues auprès des PME artisanales dans la région de Fès-Boulemane. Il permet de rejoindre un nombre important d'entreprises. Le questionnaire comporte cinq grandes thématiques :

- **La première sert à identifier les caractéristiques de l'entreprise et de l'entrepreneur** : localisation dans la région, effectif, secteur d'activité, âge et diplôme de l'entrepreneur, entreprise / lieu d'habitation). Trois questions étaient particulièrement importantes, d'une part, l'âge du chef d'entreprise, d'autre part le niveau d'étude et enfin si l'entreprise est située sur le lieu d'habitation.

  Expliquons-nous le choix de ces variables:

  - L'âge constitue un facteur très important en matière de RSE, car théoriquement un individu jeune est plus sensibilisé aux grandes questions du l'actualité (notamment sur l'environnement et le développement)
  - Le niveau d'étude : les chefs d'entreprise interrogés se définissent tous d'abord en fonction du métier exercé validé, plus ce métier est validé par un diplôme, plus la communication a un niveau d'excellence donné.
  - Entreprise / lieu d'habitation : l'entreprise se trouve-t-elle sur le lieu Cette imbrication plus ou moins étroite peut-elle influer sur la sensibilité de l'entrepreneur en matière de RSE, tout particulièrement si les salariés de l'entreprise artisanale manipulent des produits dangereux (peintures, solvants, produits de forte odeur, etc.).
- **La seconde a pour objet de mettre le point sur la perception et la connaissance de la RSE pour l'entreprise marocaine, les moteurs et les freins.**
- **La troisième thématique met l'accent sur les aspects liés à la dimension interne de la RSE :(** Recrutement, formation, conditions de travail, …) **:**
- **Quant à la quatrième, elle a pour objectif d'identifier es aspects liés aux relations avec les partenaires extérieures : (les** clients, les fournisseurs et la communauté locale).
- **La dernière partie du questionnaire permet de mettre le point sur l'aspect environnemental de la RSE** : hygiène, respect de l'environnement, etc.

Le total des entreprises artisanales est de 113 entreprises [9], sont réparties spécialement entre la filière vêtement et accessoires, bâtiment et décoration.

En ce qui concerne le déroulement de notre étude, au départ, nous avons pu contacter 70 entreprises par appels téléphoniques ou via des recommandations, ceci nous a permis d'éviter des déplacements inutiles et de nous assurer des réponses. Nous avons retenu l'accord de 52 entreprises.

Les questionnaires ont été déposés auprès de cet échantillon, nous avons obtenu un taux de réponse de 62%, ce qui nous apparaît très correct, compte tenu de la réticence et du non implication des répondants.

Le traitement de ce questionnaire a été élaboré via le logiciel SPHINX[1].

[1] ***Le sphinx*** *est un éditeur de logiciels d'enquêtes et d'analyse statistique de données.*

3.2 RÉSULTATS DE L'ÉTUDE

3.2.1 CONNAISSANCE ET PERCEPTION DE LA RSE

La question centrale de notre recherche porte sur la manière dont les dirigeants de PME artisanales perçoivent le concept de RSE. Dans ce sens, nous avons demandé aux dirigeants des PME artisanales s'ils connaissent ou non la RSE.

Le choix des dirigeants se justifie par plusieurs raisons. L'acteur le plus prisé pour la recherche en PME est incontestablement le dirigeant, souvent dirigeant-propriétaire voire entrepreneur. L'importance accordée en littérature au dirigeant dans le cadre de la recherche en PME (Julien et Marchesnay, 1992). Le dirigeant de PME est un acteur central dans la firme. Il est à la source des croyances dominantes de l'entreprise ce qui le distingue fondamentalement de tous les autres acteurs.

Plus de 50% des dirigeants interrogées n'avaient jamais entendu parler de la RSE, pourtant il s'est avéré que presque la plupart connaissent plus le concept du développement durable .après leur avoir expliqué le concept, Certains se sont ainsi rendus compte qu'ils avaient un comportement conforme aux principes de la RSE, sans le savoir.

Cette question est développée en fonction de l'âge et du niveau d'étude de l'entrepreneur, les deux variables que nous avons évoqués précédemment,

Mais les réponses sont similaires pour toutes les catégories d'âge ainsi que pour les diplômés et les non diplômés, Les réponses que nous avons rassemblées tendent à montrer que ni l'âge ni le niveau le diplôme ne constitue un facteur déterminant.

3.2.2 ASPECTS LIÉS À LA GESTION DES RESSOURCES HUMAINES

Les pratiques RH qui sont concernées par notre enquête sont : le recrutement, la formation, couverture sociale des employés.

En ce qui concerne l'aspect recrutement, l'enquête montre que la plupart des PME artisanales sont de type familial(le propriétaire, sa conjointe ou des dirigeants affirme avoir une démarche de recrutement. Néanmoins, ils réclament ne pas disposer d'une politique de recrutement des jeunes sans expérience ou des handicapés.

Pour le recrutement externe, les entreprises, quelque soit leur taille et quelque soit leur secteur, recourent aux demandes d'emploi recommandées par des intermédiaires (proches, amis, connaissance …).

En outre, selon le type d'acticité , il existe une certaine préférence en ce qui concerne le recrutement par genre , des PME tels que la vannerie , le tapis , broderie ont une préférence pour le recrutement des femmes tandis que pour certains métiers tels que la menuiserie, dinanderie, le choix est dirigé vers le recrutement des hommes , les dirigeants expliquent qu'il y a des métiers qui sont dédiés spécialement aux femmes et d'autres aux hommes depuis de longues années , une minorité affirment qu'il n'existe pas une disparité par genre , tous les métiers artisanaux pourront être exercé par les hommes et femmes . Nous assistons également à un autre type de recrutement celui des enfants qui quittent l'école.

En matière de formation, la quasi-totalité des entreprises soit 80%, déclare soutenir l'initiative à la formation de leur personnel. Ces entreprises établissent un plan de formation qu'elles réalisent en collaboration avec l'OFPPT[2] ou avec d'autres organismes de formation publics et privés type CFQMA[3], ANAPEC[4]. Toutes les entreprises artisanales affirment préférer la formation sur le tas.

En ce qui concerne la couverture sociale de ses employés, les PME déclarent ne pas faire bénéficier tous leur employés vu le caractère saisonnier de certaines activités, les cadres bénéficient de l'assurance mais seulement 58% de l'échantillon assure une couverture maladie à l'ensemble de son personnel. Mais Depuis l'entrée en vigueur de l'AMO (assurance maladie obligatoire) en 2005, davantage de PME artisanales disposent de cette couverture.

[2] Office de la formation professionnelle et de la promotion du travail
[3] Centre de formation et de qualification dans les métiers de l'artisanat
[4] Agence nationale de promotion de l'emploi et des compétences

De même, beaucoup d'entreprises (90%) ne déclarent pas la totalité de leurs effectifs. Ceci s'explique par le caractère informel que revêt le secteur de l'artisanat au Maroc. Or, pour dire qu'une PME artisanale est socialement responsable il faut au moins respecter le salaire minimal payer les impôts et assurances sociales et déclarer son personnel.

Au Maroc, les salariés peuvent être représentés soit par les délégués du personnel soit par les syndicats. Les premiers sont obligatoires dans les établissements employant au moins dix salariés permanents. Sur les entreprises étudiées plus que la moitié ne connaissent aucune présence syndicale déclarée. La raison s'explique par l'importance du sexe féminin qui, selon les dirigeants sont « rigoureuses » et ne s'intéressent pas au syndicalisme et par l'ignorance des employés dans l'artisanat.

Dans ces conditions, la responsabilité sociale des PME artisanales sur le plan social se résume simplement à appliquer le code du travail. Rares sont les entreprises qui vont au-delà.

3.2.3 RELATIONS AVEC LES PARTIES PRENANTES

Notre enquête concernant cet aspect se base sur la question suivante : devant qui l'entreprise artisanale est-elle responsable ? d'après la littérature Il semble aussi que le facteur susceptible d'influer sur le comportement des entrepreneurs est extérieur à l'entreprise. Nous pouvons mettre l'accent sur le rôle joué par les collectivités locales, les fournisseurs et la clientèle.

La clientèle du secteur de l'artisanat est principalement, en effet c'est la principale destination des exportations de la production artisanale avec 60% des ventes. Par pays de destination, la France accueille 18% des exportations totales, elle est suivie de l'Allemagne (14%), de l'Espagne (6%). Ainsi les PME s'engagent dans la RSE envers sa clientèle en améliorant la qualité de leurs produits en matière de finition, de matière première, de design, d'emballage…, s'engager également dans une politique marketing développée visant à promouvoir le produit artisanal à travers labellisation, organisation des foires pour exposition des produits etc.

Les fournisseurs des entreprises artisanales sont régionaux (91%), nationaux (54,5%) et internationaux (45,5%). La France est le premier fournisseur étranger avec 86,7 % pour l'agroalimentaire et 71,4 % pour l'artisanat.

Au niveau de la relation avec la communauté locale, l'enquête révèle que 20% seulement entretiennent des relations avec la communauté locale, Ces relations prennent la forme d'aides aux associations et aux coopératives, de financement de certaines manifestations (expositions, foires...), ce faible taux s'explique par le manque de moyens financiers leur permettant de s'engager dans ces actions.

3.2.4 LA RSE DE TYPE ENVIRONNEMENTAL

Nous avons interrogé les dirigeants sur leur engagement en faveur de l'environnement sur les points suivants : développement de produits / services respectueux de l'environnement, politique de recyclage des déchets, réduction de la consommation énergétique, Exploitation d'énergies renouvelables, mesures pour un emploi réduit des ressources naturelles (eau, sachets, etc.), mesures pour la réduction d'émissions polluantes, évaluation de l'impact écologique lors des décisions d'investissement.

L'enquête révèle que la majorité des artisans interrogés sont très impliqués dans ce genre d'opérations concernant la préservation de l'environnement. En effet, 59 ,6% des PME du secteur ont engagé des actions pour réduire leur impact sur l'environnement. Ces entreprises éliminent par elles mêmes leurs déchets et procèdent au prétraitement des émissions de vapeurs dangereuses.

En effet, nous avons remarqué que les points qui sont le plus souvent cités concernent soit les questions relatives au domaine de la loi (exemple : recyclage des déchets) ou encore ce qui peut avoir un impact direct sur la rentabilité de l'entreprise (exemple : réduction de la consommation d'énergie ou encore de la consommation de certaines matières naturelles comme l'eau pour nettoyer des instruments de travail).

Le programme de développement régional de l'artisanat

L'artisanat qui a un impact nuisible sur l'environnement. Il s'agit notamment des branches de dinanderies, de la tannerie et de la poterie. Des actions ont été menées par les organismes étatiques en partenariat avec les artisans. Ces dernières sont:

- La réalisation d'une station collective de récupération et de recyclage du chrome des tanneries;
- Des opérations de sensibilisation et de démonstration aux méthodes de réduction de la pollution causées par le chrome dans les tanneries;
- Le transfert des dinanderies de la Médina à l'extérieur de la ville de Fès, valorisation de la zone Ain Nokbi …

- Des efforts ont été également déplorés pour soutenir et moderniser la production de la poterie céramique à Fès à travers l'acquisition des fours à gaz, ces fours sont de faible impact environnemental.

Dans le cadre du bilan du PDRA[5], le nombre des fours à gaz à Fès est de 43 fours [10]. Parmi les entreprises artisanales enquêtées, 80% des PME dans la poterie céramique réclament leur volonté d'éliminer définitivement les fours traditionnels.

4 DISCUSSION ET CONCLUSION

Les PME artisanales marocaines sont de plus en plus conscientes que la responsabilité sociale est un concept primordial pour le développement territorial et local. En effet, Bien que leur responsabilité première soit de générer des profits, elles peuvent en même temps contribuer à des objectifs sociaux et à la protection de l'environnement, en intégrant la responsabilité sociale comme investissement stratégique au cœur de leur stratégie commerciale

Les résultats de l'enquête fournissent, dans un premier temps, une vision globale sur les pratiques des PME artisanales dans les domaines du travail et de l'environnement et, dans un deuxième temps, nous avons remarqué que La RSE est n'est pas un effet de mode qui passera. Les chefs d'entreprise interviewés sont convaincus que ce ces pratiques vont se renforcer dans les années à venir (droit de l'environnement surtout) va aller en se renforçant.

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TALENT MANAGEMENT AND HUMAN RESOURCE PRACTICES

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ABSTRACT: In a competitive marketplace, talent management is a primary driver for organizational success. Broadly defined, talent management is the implementation of integrated strategies or systems designed to increase workplace productivity by developing improved processes for attracting, developing, retaining and utilizing people with the required skills and aptitude to meet current and future business needs (Collings & Mellahi, 2009). The purpose of this essay is to link talent management intervention in contributing to HR practice of recruiting, training and development at the organisational level. In other words, the essay examines the effect of talent management on the HR practice of employee training and selection in the organisation. This essay therefore, provides a comprehensive account of the correlates, contexts, theoretical frameworks, talent pool development, examining the role of HR in finding the right people, employee engagement practices, while measuring business impact of talent management, challenges of talent management and outcomes of talent management from recent literatures and research findings in the field of HR Management practice in recruitment and training. Despite the growing popularity of talent management and over a decade of debate and hype, the concept of talent management remains indistinct. A recent paper concluded that there is "a disturbing lack of clarity regarding the definition, scope and overall goals of talent management". This paper thus proposes the explanation in the area of talent management as it concerns recruitment and training of employees. While there have been some useful theoretical contributions to date (Boudreau & Ramstad, 2007; Cappelli, 2008), heretofore the theoretical foundations of talent management have been relatively sparse. If talent management is to gain more mainstream acceptance then the theoretical foundations which underpin it must be advanced.

KEYWORDS: Talent management, Human Resources, Employee Engagement, Employee Training.

INTRODUCTION

"Talent Management" has become one of the most important catchphrases in corporate Human Resource Management (HR) and training today (Bersin, 2006). To understand why talent management has become so important, with is imperative to look at the evolution of corporate HR.

In the 1970s and 1980s the business function which was responsible for people was called "The Personnel Department." The role of this group was to hire people, pay them, and make sure they had the necessary benefits. The systems which grew up to support this function were batch payroll systems. In this role, the personnel department was a well understood business function (Bersin, 2006).

In the 1980s and 1990s organizations realized that the HR function was in fact more important and the concepts of "Strategic HR" emerged. During this period organizations realized that the HR managers had a much larger role: recruiting the right people, training them, helping the business design job roles and organization structures (organization design), develop "total compensation" packages which include benefits, stock options and bonuses, and serving as a central point of communication for employee health and happiness (Bersin, 2006).

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In 1997, a groundbreaking McKinsey study exposed the “war for talent” as a strategic business challenge and a critical driver of corporate performance (Micheals, Handfield-Jones & Axelrod, 2001). However, the emergence of "Talent Management" in the “new age” continues to be a major focus, HR organizations are now focused on a new set of strategic inquiries like, how can we make our recruiting process more efficient and effective by using "competency based" recruiting instead of sorting through resumes, one at a time? As well as how can HR organisations better develop managers and leaders to reinforce culture, instill values, and create a sustainable "leadership pipeline?" and so on (Bersin, 2006).

These new, more challenging problems require new processes and systems developed to confront this problem. They require firm integration between the different HR departments and direct incorporation into line of business management processes. Today organizations are starting to buy, build, and stitch together performance management systems, succession planning systems, and competency management systems (Lawler, 2005).

In a competitive marketplace, talent management is a primary driver for organizational success. Broadly defined, talent management is the implementation of integrated strategies or systems designed to increase workplace productivity by developing improved processes for attracting, developing, retaining and utilizing people with the required skills and aptitude to meet current and future business needs (Collings & Mellahi, 2009). The purpose of this essay is to link talent management intervention in contributing to HR practice of recruiting, training and development at the organisational level. In other words, the essay examines the effect of talent management on the HR practice of employee training and selection in the organisation.

This essay therefore, provides a comprehensive account of the correlates, contexts, theoretical frameworks, talent pool development, examining the role of HR in finding the right people, employee engagement practices, while measuring business impact of talent management, challenges of talent management and outcomes of talent management from recent literatures and research findings in the field of HR Management practice in recruitment and training.

New conceptual frameworks, research methods, and findings continue to advance our understanding of talent management (SHRM, 2006). However, this knowledge base is compromised by the frequently atheoretical, unsystematic, and fragmented fashion in which research findings in talent management have accrued, and by the conceptual and research complexities inherent in the study of such a rapidly changing and corporately embedded HR practice of talent management (Collings & Mellahi, 2009).

LITERATURE REVIEW

Despite the growing popularity of talent management and over a decade of debate and hype, the concept of talent management remains indistinct. A recent paper concluded that there is “a disturbing lack of clarity regarding the definition, scope and overall goals of talent management” (Lewis & Heckman, 2006: 139), a view which also prevails in the practitioner literature.

In this regard, a UK survey found that 51 per cent of HR professionals surveyed undertook talent management activities, however only 20 per cent of them operated with a formal definition of talent management (CIPD, 2006). Thus, the field would benefit from a clear and comprehensive definition of the concept. Second, the current state of talent management literature is exacerbated by the fact that, in addition to ambiguities around the definition of the concept, there has also been an alarming lack of theoretical development in the area (Lewis and Heckman, 2006).

Talent management is regarded as the implementation of integrated strategies or systems designed to increase workplace productivity by developing improved processes for attracting, developing, retaining and utilizing people with the required skills and aptitude to meet current and future business needs (SHRM, 2006). Talent management is also broadly defined as activities and processes that involve the systematic identification of key positions which differentially contribute to the organization’s sustainable competitive advantage, the development of a talent pool of high potential and high performing appointees to fill these roles, and the development of a differentiated human resource architecture to facilitate filling these positions with competent incumbents and to ensure their continued commitment to the organization (Collings & Mellahi, 2009).

To gain competitive advantage, the demand for human capital drives talent management. Talent management strategies focus on five primary areas: attracting, selecting, engaging, developing and retaining employees. Although pay and benefits initially attract employees, top-tier leadership organizations focus on retaining and developing talent (Perrin, 2003).

Due to demographic changes, the workforce is also increasingly diverse in age, gender and ethnicity comprising lifestyles, migration patterns and cultural norms (SHRM, 2006). Organizations are already taking advantage of these workplace trends.

For example, The Home Depot, Inc., the home improvement giant, focuses its staffing initiatives on older workers (SHRM, 2006).

Talent management strategies also provide the context for diversity and inclusion. Proctor and Gamble, for example, feels that getting the right mix of people is a major part of talent management and hires many of its leaders as university recruits (Morton, 2005).

Moving talent management initiatives forward, however, requires organizational total commitment. That is, all levels of management must be on board with applying the importance of talent management strategies for the benefit of the overall organisation (Becker and Huselid, 2006). When the board is involved, the value of talent management is apparent and has high visibility (Morton, 2005). Yet to be successful, the value must be understood throughout the organization, with strong links between leadership and talent to translate into specific organizational value-based behaviors (Morton, 2005).

Moreover, it is important that HR educate top management on the link between the talent management cycle and the cost of turnover (SHRM, 2006). For example, an employee's decision to stay or leave is related to career possibilities in the company as well as how he or she can become better prepared to move to other opportunities.

To keep a valued employee, the easy answer is not merely compensation (Tucker, Kao & Verma, 2005). Employee loyalty tends to be more directed to his or her professional skills rather than to the organization (Dell & Hickey, 2002). Hence, to best attract, engage, develop and retain talent, those who have responsibility for talent management must understand what is essential to employees.

A THEORETICAL MODEL OF STRATEGIC TALENT MANAGEMENT

The theoretical model of strategic talent management is based on the definition of talent management identified. The identification of pivotal talent positions should be the first stage in any strategic talent management system. As noted above, while an influential stream of talent management literature emphasizes the identification of 'A performers' and focuses on their retention and development (Axelrod, Handfield-Jones & Michaels, 2002; Frank, Finnegan &Taylor, 2004; Michaels et al., 2001) an emerging literature base advocates a focus on the identification of key positions (Boudreau & Ramstad, 2007) or "A positions" (Huselid, Beatty & Becker, 2005) which have the potential to differentially impact on sustainable competitive advantage.

Some strategic HRM (SHRM) scholars (Lepak & Snell, 2008), adopt a bottom up focus in their theory development emphasizing the idea that employees can contribute to the firm's strategic objective simply because of their value and uniqueness (Becker and Huselid, 2006).

In contrast, Becker & Huselid (2006: 904) advocate a top-down focus arguing that "When employees are able to contribute to a firm's strategic objectives they have (strategic) value" and that "not all strategic processes will be highly dependent on human capital". Thus, they recognise that the locus of differentiation, in terms of fit, should be the job not the individual employee.

Human capital is of little economic value unless it is deployed in the implementation of the organization's strategic intent (Becker & Huselid, 2006; Boxall & Purcell, 2008).

Traditionally, jobs were differentiated in terms of inputs, such as skills, efforts and abilities and working conditions (Huselid et al, 2005). The approach advocated here emphasises evaluation in terms of potential outputs or the potential for roles to contribute to the organisational strategic intent. However, the extent to which a variation in performance between employees in strategic roles is also a significant consideration (Huselid et al, 2005).

While some roles are strategically important, regulation and standardised training or professional qualification, mean that performance in the role may be relatively standardised and the potential for differentiation is limited. Thus strategically important roles which allow for potential differentiation between performances in the role should be particularly central in organization's strategic talent management systems (Axelrod, Handfield-Jones & Michaels, 2002).

DEVELOPING A TALENT POOL

The term talent pool refers to the pool of high potential and high performing incumbents that the organisation can draw upon to fill pivotal talent positions. While differing with Boudreau and Ramstad's (2007) use of the term pivotal talent pools, to refer to the key roles within organisations which differentiate performance, the definition is consistent with authors such as Smilansky (2006); Sparrow, (2007).

The framework proposes that having identified the pivotal talent positions within an organisation, the key for strategic talent management system is the development of a talent pool to fill these pivotal positions. In simple terms, this entails a shift from vacancy led recruitment toward 'recruiting ahead of the curve' (Sparrow, 2007). This clearly resonates with earlier contributions as it involves the proactive identification of incumbents with the potential to fill key positions which may become available.

However, it is important to introduce a note of caution here. Those employees who are likely to compose this talent pool are high achievers and may easily become disillusioned if they are appointed to roles with limited scope for the application of their skills or development of their talent. In this regard, Hackman, Oldham, Janson & Purdy, (1975) research demonstrates that where jobs are more complex employees tend to be more motivated, more satisfied and even more productive. Given that those included in the organization's talent pool will be high achievers to begin with, the impact of working in menial roles are likely to be magnified and likely to result in a reduction in employee's perceived person organization which we return to below.

Thus without wishing to be overly prescriptive, it is suggested that in developing talent pools the following factors would facilitate their effective development. Firstly, organisations should combine internal development and external recruitment in filling talent pools (Cappelli, 2008). This facilitates the management of quantitative risks associated with ensuring there is sufficient talent to meet organisational needs and not an oversupply which represents a waste in resources. Secondly, it is clear that for organisations, it is more effective to develop talent within the broader context of the organisation, rather than with a particular succession role in mind. This prevents developing employees to fit narrow, specialized roles but rather, once developed employees can be developed with broader competencies which would fit a range of roles (Cappelli, 2008).

THE ROLE OF HUMAN RESOURCE

As a primary owner of talent management, HR has many roles one of the most important is that of facilitator of the talent mindset. HR leads the way for the organization to own, as an entity, the role of talent management for organizational success. In the role of business partner, HR works closely with the board, the CEO and senior management to ensure that they are committed to talent management work (SHRM, 2006).

As talent management facilitator, HR also pays close attention to how the organization's culture supports talent. Broadly speaking, HR's role encompasses communicating the talent management philosophy companywide and knowing the industry competition. To integrate talent management into all areas of the company, HR also plays a role of change management agent. To drive this change, HR addresses four diverse talent management activities: recruitment, performance management, leadership development and organizational strategy. In this role, HR manages four major risks to the business: 1) vacancy risk (to safeguard key business capabilities, focus on scarce skills and fit to position); 2) readiness risk (to accelerate leadership development, provide full business exposure to rising stars); 3) transition risk (to avoid loss of key talent, select successors with leadership ability and hire for organization capability); and 4) portfolio risk (to maximize strategic talent leverage, focus on senior management's commitment to development and performance standards) (Corporate Leadership Council, 2003).

Finally, proactive HR leaders take a holistic approach to talent management. It is important to establish clear expectations and communicate openly about the talent management process. By HR explaining to management and employees why talent management is important, how it works and what the benefits are to the organization and participants, talent management strategies are more likely to be seen as a fair process (Walker & LaRocco, 2002).

EMPLOYEE ENGAGEMENT AND ITS RELATIONSHIP TO TALENT MANAGEMENT

According to SHRM, (2006) effective talent management policies and practices that demonstrate commitment to human capital result in more engaged employees and lower turnover. Consequently, employee engagement has a substantial impact on employee productivity and talent retention. Employee engagement, in fact, can make or break the bottom line.

Employees who are most committed perform 20% better and are 87% less likely to resign. In addition, the foundation for an engaged workforce is established by the quality, depth and authenticity of communication by HR and senior management to employees, as well as the quality of supervision. The role of the manager as the most important enabler of employee commitment to the job, organization and teams cannot be overemphasized (SHRM, 2006). Furthermore, when done well, practices that support talent management also support employee engagement (e.g., work-life balance programs—flex time, telecommuting, compressed workweeks, reward programs, performance management systems). Rewards and recognition also help both to retain talent and to improve performance. A Carlson/Gallup study on employee engagement and business

success showed that employees who were extremely satisfied at work were four times more likely than dissatisfied employees to have a formal measurement process in place as well as receive regular recognition. Also, 82% said recognition motivated them to improve job performance (The Gallup Organization, 1998).

Increasingly, organizations are putting formal and informal reward programs in place. For example, according to SHRM's 2005 Reward Programs and Incentive Compensation Survey Report, 84% of companies offer some form of monetary and/or nonmonetary reward programs to employees. The process of building employee engagement is ongoing. Beyond compensation and benefits, employee engagement is best fostered through a meaningful and emotionally enriching work experience. Effective employee engagement a mixture\of tangible and intangible factors fosters an environment of stimulation, development, learning/support, contribution and recognition. However, a recent study found that less than one-fifth of employees were highly engaged, one-fifth of the\workforce was disengaged and about two-thirds were moderately engaged. The impact of employee dissatisfaction varies, depending on work experience (e.g., overwhelming workloads, distant and non-communicative senior leadership, and few developmental opportunities). The risk is that moderately engaged employees may move toward being disengaged (Deloitte, 2005).

The opportunity and challenge for HR, working with senior management, is to increase the strength of employee engagement. Focus on engagement demands strong leadership, a sense of shared destiny, autonomy, accountability and opportunities for development and advancement. To better engage workers, companies must work harder to inspire people and provide a sense of passion, pride and mission (Perrin, 2003). Ultimately, it is organizational culture that determines employee engagement and retention of talent.

FINDING THE RIGHT PEOPLE

In the war for talent, organizational success depends on effective recruitment and retention. To accomplish this goal, HR can provide value by focusing on five key areas: ensuring organizational stability, emphasizing employer brand and reputation, developing integrated talent strategies, supporting multilevel accountability, getting involved in talent management initiatives and offering opportunities for career and personal development (Dell & Hickey, 2002).

Regarding recruitment and retention, HR has a number of challenges to address. According to SHRM's 2006 Talent Management Survey Report, the top areas in need of improvement regarding talent management practices and strategies are 1) building a deeper reservoir of successors at every level; 2) creating a culture that makes employees want to stay with the organization; 3) identifying gaps in current employee and candidate competency levels; and 4) creating policies that encourage career growth and development opportunities (Fegley, 2006).

To attract and retain talent, hiring for compatibility the "fit" between employer and employee is critical. In addition, companies with excellent reputations and strong brands are well positioned to attract top talent. Yahoo! Inc. exemplifies the organization that effectively links organizational culture and company values in its recruiting initiatives to determine the best candidates. This process, however, takes time. For example, in the first six months of 2004, Yahoo spent 6,000 hours interviewing candidates to fill 500 positions an average of 12 hours per new hire (Throop, 2005).

MEASURING BUSINESS IMPACT OF TALENT MANAGEMENT

Talent management metrics link human capital investment to financial performance. According to management gurus Huselid, Becker and Beatty, there are three critical challenges to successful workforce measurement and management. First, there is "the perspective challenge" meaning; do all managers really understand how workforce behaviors and capabilities drive strategy execution? Second, there is "the metrics challenge" that is, are the right measures of workforce success identified (e.g., workforce culture, mindset, leadership, competencies and behaviors)? The third challenge is "the execution challenge" specifically, in order to monitor progress and communicate the strategic intent of talent management initiatives, are managers motivated to use these data and do they have access and capability to do so? Talent management metrics are evolving (Huselid, Becker & Beatty, 2005). As organizations increasingly focus on talent management strategies, they seek ways to validate these initiatives and measure their business impact.

Companies also create their own measurements to fit their organizational cultures. Pfizer, for example, developed three primary talent management objectives strength of leadership team and pipeline, robustness of talent management processes, and development of talent mindset and values with corresponding drivers and metrics. One metric used to evaluate the robustness of talent management processes is the percentage of key position holders with individual development plans. To be able to identify where talent in the organization is located, a database now houses employee

profiles, which can be routinely updated. As a result, the organization can make more data-driven decisions regarding talent (Accenture, 2004)

CHALLENGES OF GLOBAL TALENT MANAGEMENT

Global competition for skilled workers is keen; worldwide, many employers are experiencing a talent shortage. A survey of nearly 33,000 employers in 23 countries reveals that 40% are struggling to locate qualified candidates (Manpower, 2006). With the liberation of trade policies, transnational companies moving production to low-cost areas and the corresponding growth of global supply chains, increased globalization has resulted in socio-economic and cultural challenges.

Consequently, the demand for skills has countries working hard to develop policies that will attract talent with human and technological skills to support economic growth, retain talent and even reverse talent migration. In a "reverse brain drain" effect, China and India, for example, encourage their educated nationals to return and fill jobs at home (Kuptsch, & Pang, 2006). Thus, the need for talent creates movement between countries. The United States relies on foreign talent, particularly in certain fields. U.S. universities, for example, are not graduating enough U.S. students in science and engineering, and by 2010, 25% of the nation's scientists and engineers will reach retirement age. Reflecting this shift, in 2000, 22% of all U.S. science and engineering positions were held by foreign-born professionals, up from 14% in 1990 (Morton, 2005).

In contrast, countries such as China and India have a wealth of talent in science, engineering and technology. Research shows organizations value having global frameworks, specifically around a common language and structure in areas such as performance management, leadership development for high potentials and professional development. There is less agreement, however, about developing common frameworks for recruitment (Morton, 2005).

RECENT STUDIES ON TALENT MANAGEMENT

Studies on talent management reveal a number of common themes. First, the focus on talent management forces companies to become aware of and assess their workforce talent and current and future talent needs. Second, organizations that understand the business case for talent management successfully link talent management and organizational strategy, reaping benefits in increased workplace performance. Third, organizations are seeking effective ways to measure talent and determine bottom line impact (Deloitte, 2005). According to this study, 43% of companies see retention of key talent as the issue that will have the most impact on their business.

HOW LEADING ORGANIZATIONS MANAGE TALENT

From in-depth interviews with HR leaders of large employers in a variety of industries, this study reveals that leading companies make attracting, engaging and retaining employees a strategic business priority. Senior leadership focuses on clearly communicating the business strategy to the workforce as well as defining the role people play to execute that strategy. Effective leaders have a clear understanding of what drives value in their organizations, what motivates their customers and how to achieve growth in the future.

Many companies have developed talent management metrics to support business and financial measures, with metrics built into the balanced scorecard. Through the performance management system, managers are held accountable for employee retention and creating opportunities for high-potential employees (SHRM, 2006).

RECOMMENDATION FOR THE FUTURE

To benefit from the knowledge, skills and corporate memory of mature workers, phased retirement will become prevalent. Keeping workers engaged particularly the next generations may call for HR to redesign the workweek, benefits packages and reward programs (Tucker, Kao & Verma, 2005). Effective talent management calls for strong participatory leadership, organizational full participation, employee engagement and workplace scorecards with talent management metrics. Companies that master talent management will be well-positioned for long-term growth in workforce performance for years to come.

CONCLUSION

Given the high level of interest in the concept of talent management over the past decade, it is somewhat paradoxical that it remains relatively poorly defined and lacking in theoretical underpinning (Tucker, Kao & Verma, 2005). This review of the current body of literature suggests that from a theoretical point of view, the area of talent management is in its infancy and a significant degree of theoretical advancement is required. The contribution of this essay is two-fold; to develop a clear and concise working definition of talent management and propose a theoretical model of talent management in recruitment and training.

In doing, insights are drawn from a number of discreet literature bases. The essay aims to aid future research in the area of talent management though (1) helping to clarify the conceptual boundaries of talent management and (2) providing a theoretical framework which can help in framing their research efforts in the area.

Additionally, it should aid HR managers in engaging with some of the issues they face with regard to talent management. This paper thus proposes the explanation in the area of talent management as it concerns recruitment and training of employees. While there have been some useful theoretical contributions to date (Boudreau, and Ramstad, 2007; Cappelli, 2008), heretofore the theoretical foundations of talent management have been relatively sparse. If talent management is to gain more mainstream acceptance then the theoretical foundations which underpin it must be advanced.

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Marketing management des organisations

[Marketing management of organizations]

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ABSTRACT: Marketing communications are becoming more and more the form of a dialogue between the company and its customers. Brands are no longer just asking how to contact their customers, but also how customers can contact and even how they can contact each other. The techniques used for this purpose are numerous, with Internet, fax, mobile and wireless applications. These technologies allow to move from mass communication to more targeted communication and two-way, in which consumers play an increasing role.

KEYWORDS: brand image, direct marketing, interactive marketing, viral marketing.

RESUME: Les communications marketing prennent de plus en plus la forme d'un dialogue entre l'entreprise et ses clients. Les marques ne se demandent plus seulement comment contacter leurs clients, mais aussi comment les clients peuvent les contacter et même comment ils peuvent se contacter les uns les autres. Les techniques utilisables dans ce but sont nombreuses, avec Internet, le fax, le téléphone mobile et les applications sans fil. Ces technologies permettent de passer d'une communication de masse à une communication plus ciblée et à double sens, dans laquelle les consommateurs jouent un rôle croissant.

MOTS-CLEFS: marketing management, image de marque, marketing direct, marketing interactif, marketing viral.

1 INTRODUCTION

L'étude des perceptions des marques a acquis une place de choix, au cours des dernières années, dans la littérature marketing. Des mobiles théoriques et managériaux sont à l'origine des ces recherches. En plus, des évolutions que connaissent les différentes dimensions de l'environnement et leurs répercussions sur les exigences des consommateurs, les nouvelles règles de la concurrence ainsi que la rapidité des changements technologiques. Désormais, les stratégies de marque ont pour vocation le développement de valeurs solides et pérennes, tenant compte des vicissitudes du marché. Le succès nécessite une meilleure connaissance des perceptions détenues par les consommateurs à l'égard des marques, et surtout l'image de marque qu'elles véhiculent. Une fois ces données collectées et analysées, elles alimenteront une stratégie de marketing-mix efficace qui contribue à la fidélisation de la clientèle (Aaker D., 1992).

La valeur des marques est établie sur la base de l'image que les producteurs désirent véhiculer, comte tenu du capital affectif détenu par le consommateur à l'égard de la marque. Dans cette perspective, l'image de marque est définie comme l'ensemble des représentations mentales affectives et rationnelles (Décaudin, 1996), voir même cognitive qu'associe un individu à une marque (Kapferer et Thoening, 1994).Il s'agit donc d'un élément à part entière de la valeur ajoutée d'une marque, combinant des valeurs réelles, des idées reçues, des sentiments affectifs, des impressions objectives et/ou subjectives, conscientes et/ou inconscientes (Lehu, 1996).

2 DEFINITION DES CONCEPTS

2.1 LE MARKETING MANAGEMENT

Par définition, le marketing englobe toutes les techniques utilisées dans le dessein de connaître les besoins et d'évaluer les intentions des consommateurs. Suivant les données qui sont obtenues, l'entreprise pourra mettre en place les meilleures stratégies qui lui permettront d'inciter les consommateurs à acheter.

Afin que toutes les opérations puissent être menées à bien, les actions doivent être entreprises dans un ordre bien précis et un programme doit être scrupuleusement respecté. C'est ici qu'intervient la notion de gestion du marketing ou encore marketing management.

Le marketing management comporte des étapes bien précises. Il s'agit de la planification, de l'organisation, de la direction et enfin du contrôle de la prise de décision. Ce dernier a principalement trait aux différentes gammes de produits à commercialiser, à la détermination du prix et à la promotion proprement dite.

Il est bon de savoir qu'il est possible de faire la distinction entre deux cas. Dans le premier, le marketing dirige toutes les opérations et dans le second (comme c'est le cas de la création des différentes gammes de produits), le marketing joue un rôle de consultant, de conseiller.

L'ÉTUDE DE MARCHÉ:ETAPE PRIMORDIALE DE MARKETING MANAGEMENT

Dans le dessein d'optimiser les ventes et d'obtenir un maximum de rendement, l'étude de marché est une étape importante du marketing management.

Très souvent, l'étude de marché implique le recours à des enquêtes, des tests ou encore des études statistiques. Quel que soit le cas, l'objectif est d'analyser les tendances de la consommation et de planifier les différentes quantités à produire ainsi que les lieux de lancement du produit. Dans tous les cas, le but est de rentabiliser.

Actuellement, il est possible de faire appel à des méthodes de mesure utilisant des moyens à la pointe de la technologie. L'outil informatique est désormais incontournable et le marketing Internet se révèle être un allié de taille.

CERNER LES CONSOMMATEURS

Actuellement, les besoins des consommateurs sont en constante évolution. Les entreprises commerciales doivent impérativement en prendre compte dans l'établissement de leur marketing management.

Les consommateurs sont de plus en plus exigeants dans la mesure où les informations sont à la portée de tous (supports papier tels que les journaux et les magazines, support visuel mais aussi et surtout Internet).En plus d'en demander plus, les penchants de tous sont particulièrement divergents, ce qui donne encore plus de fil à retordre aux spécialistes du marketing.

En définitive, il ne faut surtout pas oublier que les marchés sont de plus en plus segmentés et les besoins et les attentes de chaque catégorie sont bien spécifiques et très différents des autres groupes. Ainsi, il est primordial de porter une attention particulière au positionnement du produit c'est-à-dire à la détermination de la segmentation des consommateurs qui sont susceptibles d'acheter tel ou tel produit.

Avant l'étude académique de marketing, divers penseurs datant des anciens philosophes grecs Socrate, Platon et Aristote, ont discuté des questions de macro marketing, comme la façon dont le marché a été intégré dans la société (Shaw, 1995).

Tout au long du Moyen Age, les scolastiques médiévaux, de St Auguste d'Hippone au St Thomas de d'Aquin, a écrit à propos de micro marketing préoccupations, telles que comment les gens pouvaient pratiquer le marketing éthique et sans péché (Jones et Shaw, 2002). La plupart des historiens s'accordent à dire, cependant, que le marketing en tant que discipline académique a émergé comme une branche de l'économie appliquée. Diverses écoles d'économie prévus l'eau au moulin de marketing à l'époque, en particulier les écoles classiques et néoclassiques (Bartels, 1988), ainsi que les historiques et américains allemands écoles institutionnels (Jones et Monieson, 1990).

En plus de l'économie en tant que discipline de parent, la direction a également développé comme une discipline sœur au début du 20e siècle. Innovations pratiques, comme des pièces interchangeables et des lignes d'assemblage ont été combinées à la pensée novatrice dans les pratiques de gestion plus efficaces. Mis au point par Taylor (1903, 1911) et Gilbreth

(1911), «gestion scientifique» a étudié les tâches et les coûts et le temps et le mouvement ouvrier, pour produire l'efficacité sur le plancher de l'usine.

Dans la seconde période, les approches traditionnelles de la compréhension du marketing pensée développés. Au tournant de l'entreprise du 20ème siècle a été animé aux États-Unis. Il a été l'augmentation des migrations vers les villes, l'émergence de marques nationales et les chaînes de magasins, de courrier libre et livraison de colis en milieu rural, et de plus en plus les journaux et les magazines.

2.2 PILOTER LE MARKTING DIRECT, LE MARKETING INTERACTIF, LE MARKETING VIRAL ET LA FORCE DE VENTE

Il est aujourd'hui essentiel pour les entreprises d'adopter un dialogue avec les consommateurs et de s'adresser à chacun de manière personnalisée au moment adéquat. Dans ce chapitre, nous analysons les différents outils de la communication individualisée : le marketing direct et interactif, le marketing viral fondé sur le bouche-à-oreille, et enfin la force de vente.

2.2.1 LE MARKETING DIRECT

Le marketing direct est une communication directe aux consommateurs en vue d'obtenir une réponse et/ou une transaction.

Ses caractéristiques spécifiques sont l'absence d'intermédiaire entre l'entreprise et le client, une double fonction de communication et/ou de vente, et l'attente d'une réaction rapide du client (souvent une commande ou une demande d'information). Les canaux utilisés incluent le mailing par courrier, fax, e-mail ou SMS, l'envoi de catalogues, le télémarketing (téléphone), ou encore la télévision.

L'importance du marketing direct dans les plans de communication s'explique par de multiples raisons : la fragmentation des marchés et la recherche d'une approche personnalisée du client ; le développement du marketing relationnel, d'information, des invitations et d'autres messages pour construire une relation suivie avec les clients les plus fidèles et les plus rentables (Kivetz et Itamar Simonso, p. 454-67) ; et la richesse croissante des bases de données permettant un marketing direct réellement personnalisé.

Dans les activités business-to-business, le coût croissant des visites commerciales incite à les réserver aux prospects les plus importants et à les préparer par du télémarketing, de l'e-mailing et l'envoi de courrier.

Dans la mesure où le marketing direct intègre des outils assez divers, nous les présentons successivement dans les paragraphes suivants.

- ***Le mailing***

Les mailings sont préparés à partir de fichiers internes ou achetés (ou loués) à l'extérieur. On peut trouver une liste de n'importe quel groupe : les gauchers, les futurs mariés, les parents d'enfants de 4 à 5 ans, les grands voyageurs, les adeptes de musique classique, les fans de body-building… En général, un fichier est d'abord loué « à l'essai », puis testé pour vérifier le taux de réponse.

Le mailing représente près de la moitié des investissements de marketing direct. Il permet une grande sélectivité, une personnalisation et une flexibilité maximales en même temps qu'il se prête bien aux opérations de test. Pour des produits tels que les livres ou les abonnements aux magazines, il constitue un outil marketing de première importance. Le mailing peut se faire sur différents supports.

- *Le courrier*, bien sûr. Le contenu de l'envoi peut prendre des formes très diverses: lettre, prospectus, échantillon, magazine, coupon, etc. Avec la montée en puissance des autres supports et notamment de l'e-mailing, le courrier papier a dû redéfinir ses spécificités. Il présente l'avantage d'offrir des possibilités créatives importantes et de jouer sur l'émotionnel. Pour renforcer cette dimension, les agences travaillent aujourd'hui sur de nouvelles textures et de nouvelles matières de courrier. (CBNews, 2007)
- *L'e-mailing* permet un envoi simultané à une multiplicité de destinataires assorti d'un lien avec le site Internet de l'offreur, ce qui facilite la prise de commande. Cet outil est beaucoup moins cher que le courrier classique : le routage

d'un message électronique coûte environ 2 centimes contre 45 pour une lettre.[1] Un troisième avantage porte sur la facilité de mesure du nombre de destinataires ayant lu le message, à travers le taux d'ouverture et le taux de clic. (Anne-Sophie Cases, Christophe Fournier et Pierre-Louis Dubois, 2006)

- *L'envoi de SMS* sur téléphone mobile répond au même principe, mais exige une grande brièveté du message (pas plus de 160 caractères). Tout comme pour l'e-mailing, un lien peut être établi avec le site Internet de la marque. Parfois, un dialogue peut s'instaurer, le destinataire répondant par SMS pour indiquer son produit préféré ou son âge. Un frein réside toutefois dans l'obtention des numéros de téléphones portables. Les entreprises peuvent demander cette information à leurs clients ou louer des fichiers auprès de sociétés spécialisées, mais celles-ci sont limitées par la réglementation stricte sur l'autorisation à divulguer ces données[2].
- *Le mailing par télécopie*, enfin, est réservé aux offres destinées aux entreprises, mais en déclin.

L'élaboration d'une campagne de mailing suppose successivement de définir ses objectifs, cibler les destinataires, choisir les supports, tester la campagne et en mesurer les résultats.

- ***Le marketing par catalogue***

Ancêtre du marketing direct, le catalogue s'intègre à la fois dans la vente à distance et dans la communication des distributeurs. Par exemple, Ikea édite chaque année un catalogue qui stimule la vente en ligne, mais surtout donne des informations aux clients avant qu'ils ne se rendent dans un magasin.

Dans certaines catégories de produits business-to-business comme les fournitures de bureau (Office Depot), des sociétés de vente par catalogue obtiennent de très bons résultats. Certaines entreprises se distinguent par les cadeaux qu'elles offrent, leur politique de service (remboursement, garantie) ou leur rapidité de livraison (48 heures chrono).

La plupart des entreprises mettent leur catalogue sur Internet, ce qui leur permet de toucher plus de clients potentiels à moindre coût. Mais cela exige de trouver des manières de les inciter à se connecter au site web de la marque : tandis que le catalogue va vers le client (approche *push*), c'est au client de se connecter sur Internet (approche *pull*).

- ***Le télémarketing (ou marketing téléphonique)***

Le télémarketing est à la fois utilisé dans les secteurs de la grande consommation et du business-to-business. Il consiste à utiliser le téléphone afin d'atteindre différents objectifs : prendre des commandes, par exemple après l'envoi d'un catalogue ; contacter ou qualifier des prospects ; préparer une visite de la force de vente ; entretenir les relations avec les clients à travers des entretiens téléphoniques ; répondre aux questions des clients ou leur fournir une assistance. Epson dispose ainsi de trois hotlines différentes : la ligne Epson information, la ligne b-to-b / b-to-c et la ligne service après-vente. Globalement, le télémarketing permet aux entreprises d'accroître leur chiffre d'affaires, de réduire leurs coûts commerciaux et d'améliorer la satisfaction de la clientèle.

Les centres d'appel peuvent être utilisés à la fois pour recevoir des appels ou en émettre. Ils associent de plus en plus le téléphone avec les autres canaux de communication avec le client.

2.2.2 LE MARKETING INTERACTIF

L'internet offre aux entreprises et aux consommateurs une approche *interactive et individualisée*[3]. Le marketing interactif constitue une forme récente et en ligne du marketing direct, mais le dépasse dans la mesure où il intègre la publicité sur Internet (les bannières), le parrainage de sites, les liens sponsorisés sur les moteurs de recherche, et les sites Internet eux-mêmes.

Pour ce faire, le site prodigue des conseils pratiques pour la vie quotidienne et propose aux visiteurs de discuter sur des forums. Mais auparavant, il faut s'inscrire et divulguer des informations personnelles (adresse, composition de la famille,

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[1] *Les coûts marketing », Décision micro et réseau, 18 février 2002, p. 36-37*

[2] *Capital, « Les promesses de la pub sur mobile », juin 2008, p. 104-106, et Décisions Marketing, « Entretien avec Bérangère Brial de M6 Web : Le push SMS, un nouvel outil marketing », n° 45, janvier-mars 2007*

[3] *Sur les nouvelles formes de communication liées à Internet et au buzz, voir le numéro spécial de Recherche et Applications en Marketing coordonné par Marie-Laure Gavard-Perret, vol. 22, n° 3, septembre 2007.*

goûts, talents particuliers, etc.). En fonction de leur profil, les internautes ne verront pas les mêmes pages apparaître sur leur écran ni ne recevront les mêmes *newsletters*[4].

Les spécificités d'Internet permettent, en outre, de privilégier des communications moins conventionnelles que sur les autres médias en les destinant à une clientèle ciblée.

- ***Les différents outils du marketing interactif***

Le marketing interactif relève d'outils très divers. (Philippe Jourdan, 2002)

♦ *Les sites Internet*. Une entreprise doit avoir un site Internet qui incarne ou exprime sa mission, son histoire, ses produits et sa vision. Le site doit être attrayant à la première visite et suffisamment intéressant pour stimuler les visites futures. Sept éléments doivent être pris en compte lors de sa conception. Pour inciter les internautes à revenir régulièrement sur le site, il faut particulièrement travailler sur les éléments de contexte et de contenu, tout en les changeant en permanence.

Les internautes jugent un site en fonction de deux critères : (1) la facilité d'utilisation, qui dépend elle-même de la rapidité de téléchargement, de la facilité à comprendre la page d'accueil et à naviguer d'une page à l'autre ; (2) l'attrait du site, données, à la lisibilité du texte et des caractères, et au bon usage du son et de la couleur. Il convient également de tenir compte des préoccupations de sécurité et de respect de la vie privée de nombreux internautes. (Jan-Benedict Steenkamp et Inge Geyskens, 2003)

♦ Les *microsites* sont des zones limitées, gérées et achetées par une entreprise externe au site. Il s'agit, par exemple, de quelques pages web qui fonctionnent comme supplément au site d'origine. Cet outil est particulièrement utile pour les entreprises qui vendent des produits qui intéressent peu les gens. Ainsi, peu de gens visitent spontanément les sites Internet des compagnies d'assurance, mais un assureur peut créer un microsite sur un site de voitures d'occasion qui donne des conseils à l'achat et… suggère de bons contrats d'assurance.

♦ Les *bannières publicitaires* (20 %) sont de petits aplats rectangulaires présentant du texte et parfois des images, qui s'affichent à l'insu de l'internaute pour attirer son attention sur un produit ou une marque distincts du site qu'il consulte. L'image peut être fixe, animée, en flash… Plus l'audience est large, plus le prix est élevé. L'efficacité des bannières est évaluée par deux indicateurs distincts : le nombre de personnes voyant la page (l'audience) et le taux de clic visant à consulter le site de l'annonceur. Aux débuts d'Internet, les internautes cliquaient sur 2 à 3 % des bannières, mais la forte baisse survenue depuis incite aujourd'hui de nombreux publicitaires à privilégier d'autres formes de communication. (Puneet Manchanda, Jean-Pierre Dubé, Khim Yong Goh, et Pradeep K. Chintagunta, 2005)

Pourtant, les bannières restent un outil privilégié de communication sur le web : lorsque l'on sait que les internautes passent seulement 5 % de leur temps à réellement chercher de l'information, on voit qu'il est possible d'attirer l'attention des gens qui surfent sans objectif précis. Cela suppose d'élaborer des bannières ciblées qui éveillent la curiosité[5].

L'émergence du *ciblage comportemental* permet aux entreprises de suivre le comportement en ligne des consommateurs afin d'ajuster au mieux la publicité au prospect. Par exemple, si une personne consulte trois sites web liés à l'assurance automobile, puis regarde un site consacré aux loisirs ou au sport, des bannières pour l'assurance automobile peuvent apparaître. Microsoft souligne que le ciblage comportemental augmente la probabilité de clic jusqu'à 76 %, tandis que des voix s'élèvent pour dénoncer l'immersion dans la vie privée des consommateurs[6].

♦ Les *interstitiels* sont des écrans publicitaires de transition, souvent animés ou avec vidéo, qui apparaissent lors du passage d'une page web à une autre.

♦ *Les vidéos sur Internet*. Grâce aux sites de contenu vidéo comme Dailymotion, YouTube, MySpace Video ou Google Video, les consommateurs et les publicitaires peuvent mettre en ligne des vidéos et des publicités visionnées par des millions de gens dans le monde.

♦ Le *marketing mobile* est en pleine croissance : La plupart des opérations correspondent à l'envoi de SMS commerciaux et promotionnels, mais pas seulement : Darty utilise le mobile pour informer de l'envoi d'un article commandé en ligne ; en

[4] *« Ne laissez pas tomber le web, ça marche ! », Management,septembre 2002, p. 34-38.*
[5] *Business 2.0 « The Quest for the Perfect Online Ad », mars 2007, p. 88-93; BusinessWeek, « The Promise of Online Display Ads », 1er mai 2007.*
[6] *« Microsoft Adds Behavioral Targeting », Associated Press, 28 décembre 2006.*

cas de rupture de stock, Ikea propose d'envoyer un SMS dès que l'article sera à nouveau en rayon ; certains constructeurs automobiles préviennent leurs clients de la prochaine date limite pour leur contrôle technique.

Cependant, pour que le consommateur perçoive bien ces initiatives, il faut qu'elles ne soient pas trop nombreuses (ne dépassant pas un message par mois d'une même marque) et répondent à un réel besoin[7].

2.2.3 LE MARKETING FONDÉ SUR LA BOUCHE-À-OREILLE ET LE MARKETING VIRAL

De plus en plus conscientes de l'importance du bouche-à-oreille, notamment sur Internet, les entreprises essaient désormais de le contrôler, parfois de le stimuler. (Delphine Manceau, 2003)

Pour cela, elles peuvent recourir à différentes techniques comme l'organisation d'événements exceptionnels qui feront parler d'eux, la stimulation du bouche-àoreille électronique ou l'identification de consommateurs complaisants.

- ***Le buzz et le marketing viral***

Le *buzz* consiste à organiser des opérations ou des événements originaux qui génèrent un fort intérêt du public et des médias et stimulent le bouche-à-oreille.

Le buzz présente souvent l'avantage d'être peu coûteux, car il s'appuie sur une couverture médiatique gratuite. En effet, les médias, en particulier locaux, relaient volontiers les événements originaux et amusants, *a fortiori* si on les informe discrètement quelques jours avant.

Une autre approche pour stimuler le bouche-à-oreille consiste à envoyer des messages par e-mail ou sur Internet en incitant les consommateurs à les diffuser à leur entourage. (Gilles Bernard et Frédéric Jallat, 2001)

Cette approche est appelée marketing viral en référence aux phénomènes de contagion des virus qui se propagent très rapidement. Le marketing viral consiste à favoriser le bouche-à-oreille électronique en incitant les consommateurs diffusé par Internet des informations sur l'entreprise. Lors du lancement d'un nouveau produit ou service, certaines entreprises contactent directement certains clients potentiels identifiés comme des leaders d'opinion, afin de les informer sur la nouveauté en lancement ou la leur prêter. Ces personnes transmettent le message à leurs collègues et amis en se l'appropriant, ce qui lui confère de la crédibilité.

Le marketing viral peut provoquer des succès commerciaux inespérés avec des budgets très réduits. Il est particulièrement adapté aux petites marques qui ne disposent pas de budgets importants. Il convient également aux marques qui génèrent une relation particulière avec leurs clients, car ceux-ci ont envie de les soutenir. Il doit s'appuyer sur le plaisir et l'amusement davantage que sur les techniques classiques de la communication et du marketing direct. La diffusion de l'information ne repose plus sur des règles liées à la proximité géographique des individus (comme dans le cas du bouche-à-oreille classique), mais sur des centres d'intérêt partagés. Les lois mathématiques spécifiques auxquelles correspond le bouche-à-oreille sur Internet, modélisées par Steyer, Garcia-Bardidia et Quester, en font un outil relativement imprévisible avec une diffusion extrêmement rapide de l'information et un arrêt brutal. (Alexandre Steyer, Renaud Garcia-Bardidia et Pascale Quester, 2007)

Les caractéristiques spécifiques du buzz et du marketing viral résident dans leur fort taux d'échec, lorsque le bouche-à-oreille ne se transmet pas. Mais de nombreuses entreprises prennent ce risque compte tenu du coût limité des opérations.

Plus grave, il existe un risque de dénaturation du message qui peut se retourner contre son instigateur. Il convient également de noter que ce type de marketing est parfois à la limite de l'éthique.

- ***Les blogs***

Les blogs sont devenus un élément important du bouche-à-oreille. Ils sont de nature très diverse : certains blogs sont essentiellement destinés aux proches, à la famille et aux amis, tandis que d'autres sont conçus pour s'adresser à une large audience. Selon le moteur de recherche de blogs Technocrati, chaque jour plus de 175 000 nouveaux blogs sont créés et 1,6 million de pages sont mises en ligne. Dans ce contexte, les entreprises créent leurs propres blogs et suivent ce qui est écrit

[7] *Capital, « Les promesses de la pub sur mobile », juin 2008, p. 104-106.*

sur ceux des autres. Les moteurs de recherche de blogs permettent de savoir ce que disent les gens sur n'importe quel sujet à travers l'analyse instantanée de millions de blogs.[8]

Outre le nombre de blogs évoquant la marque, ils peuvent classer chaque blog selon sa réactivité à l'information, son impact dans la blogosphère, le caractère plus ou moins positif des commentaires et leur degré de pertinence.

Certains consommateurs utilisent les blogs pour remercier certaines marques ou, au contraire, dénoncer celles qu'ils jugent déficientes.

Les défauts du service clientèle de Dell furent dénoncés sur le web par une série de commentaires d'utilisateurs. (Judith Chevalier et Dina Mayzlin, 2006)

Aujourd'hui, les responsables marketings explorent toutes sortes de mesures pour évaluer et quantifier les effets du bouche-à-oreille. Bien que 80 % du bouche- à-oreille ait lieu en dehors d'Internet, la plupart se focalisent sur le on-lineparce qu'il est facile à suivre. Certains modèles permettent même de prévoir le succès d'un produit à partir de ces éléments. Ainsi, on peut anticiper la fréquentation d'un film à partir du nombre et du caractère plus ou moins positif des commentaires des internautes lors de la première semaine de diffusion sur les sites spécialisés. (Fabrice Larceneux, 2007)

2.2.4 LA MISE EN PLACE DE LA FORCE DE VENTE

La forme la plus ancienne du marketing personnalisé est la force de vente. De nombreuses entreprises industrielles sont confrontées à des problématiques complexes face auxquelles les représentants constituent le meilleur outil marketing. De même, de nombreuses entreprises de grande consommation confient des missions essentielles à leurs équipes commerciales.

Même si aucune entreprise ne conteste l'importance de la force de vente, nombre d'entre elles sont sensibles à son coût élevé et croissant. En conséquence, elles cherchent à faire prendre en charge une partie des activités commerciales par des unités de vente opérant par courrier postal, par e-mail et par téléphone.

Les entreprises essaient également d'accroître la productivité de la force de vente par la sélection des vendeurs, leur formation, leur supervision, leur motivation et leur évaluation. (René Darmon, 2001)

En réalité, la place des représentants varie énormément d'une entreprise à l'autre (Alain d'Astous, 1997) et l'on peut identifier différentes catégories où la créativité joue un rôle croissant :

♦ Le représentant livreur, dont le rôle consiste avant tout à livrer un produit, du fuel domestique par exemple.

♦ Le preneur de commandes, comme le vendeur dans une boulangerie.

♦ Le missionnaire, qui doit surtout créer un climat favorable au produit ou informer un client actuel ou potentiel, tel le visiteur médical employé par un laboratoire pharmaceutique.

♦ Le technicien, qui dispose de fortes connaissances techniques, comme l'ingénieur technico-commercial qui joue un rôle de conseil auprès des clients.

♦ Le créateur de demande, qui doit faire un effort créatif pour vendre des produits (aspirateur, encyclopédie) ou des services (assurance, services publicitaires).

♦ Le vendeur de solutions, dont le rôle consiste à résoudre un problème du client, souvent en intégrant différents produits et services proposés par l'entreprise.

[8] *« Looking for a Blog in a Haystack », BusinessWeek, 25 juillet 2006, p. 38.*

3 MARKETING MANAGEMENT EN TUNISIE

QUELS SONT LES DOMAINES D'APPLICATION DU MARKETING ?

C'est d'abord dans le secteur des produits de grande consommation que le marketing a été appliqué. Les entreprises fabriquant des produits d'entretien ou détergents, des produits alimentaires ou cosmétiques, ont été les premières à pratiquer le marketing.

Cette discipline s'est étendue par la suite aux entreprises produisant des biens semi-durables (les constructeurs automobiles, les entreprises d'électro-ménager…).

Le marketing s'est ensuite développé dans l'industrie (marketing pharmaceutique, marketing industriel,…) et les services (tourisme, banques, assurance,…).

Désormais, le marketing s'applique de plus en plus à des secteurs non-marchand.

C'est le cas du marketing politique, le marketing culturel (augmenter la fréquentation des musées, développer la lecture,…), le marketing social (lutte contre le tabagisme, prévention en matière de sécurité routière,…). Dans ces domaines, on ne parle plus d'entreprise mais d'organisation. Le produit est remplacé par la notion de comportement souhaité. On ne cherche plus à vendre un produit mais on cherche à promouvoir des comportements (d'achat ou de consommation ou politiques ou sociaux) souhaités. La notion de public se substitue à celle de marché et la notion d'objectifs à celle de rentabilité.

- EXISTE-T-IL AUTANT DE MARKETINGS QUE DE DOMAINES D'APPLICATION

Quel que soit le domaine d'application, le marketing s'appuie sur une même démarche de base pour aborder les problèmes de toute organisation qui désire faire adopter certains comportements par les publics qui l'intéressent. Cette démarche comprend toujours deux phases essentielles : la connaissance des publics visés et la réponse de l'organisation avec le choix de stratégies et de politiques visant à modifier le comportement de ces publics dans un sens favorable à la réalisation des objectifs de l'organisation. Des différences et des adaptations de la démarche peuvent être nécessaires mais elles ne sont que de degré et non de nature.

4 CONCLUSION

Le marketing direct est un marketing individualisé et interactif qui utilise un ou plusieurs outils en vue d'obtenir une réponse et/ou une transaction. Il connaît aujourd'hui une croissance considérable dans ses formes traditionnelles mais aussi électroniques.

Le marketing interactif permet une interaction et une individualisation accrues de la communication à travers des sites Internet bien conçus, des microsites, des liens sponsorisés, des bannières, des interstitiels, des vidéos sur Internet, des communautés virtuelles et d'autres approches.

Le marketing fondé sur le bouche-à-oreille et le marketing viral consistent à trouver des manières d'inciter les consommateurs à parler des produits, des services et des marques. Le marketing fondé sur le buzz repose sur des opérations ou des événements originaux qui génèrent un fort intérêt du public et des médias et stimulent le bouche-à oreille.

Le marketing viral, pour sa part, favorise le bouche-à-oreille électronique en incitant les consommateurs à diffuser par Internet des informations sur l'entreprise ou ses produits.

La force de vente assure le lien entre l'entreprise et ses clients. Dans bien des cas, le vendeur incarne l'entreprise auprès d'eux. Il l'alimente en informations sur le marché.

Alors, le marketing management est bien pratiqué au pays développés mais en Tunisie la revue de littérature est un peu abondante.

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[12] Sur les nouvelles formes de communication liées à Internet et au buzz, voir le numéro spécial de *Recherche et Applications en Marketing* coordonné par Marie-Laure Gavard-Perret, vol. 22, n° 3, septembre 2007.

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La frontière entre un système de gestion des connaissances et un système d'information

[The boundary between a system of knowledge management and information system]

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ABSTRACT: Nowadays information systems play a very important role in improving an organization's performance and its increased competitive capacity. Therefore, it is essential for organizations to decide what are the most important business processes and core competencies that have to be supported by an information system. However, recent trends in organizational development have demonstrated the importance of knowledge management, in this context; we are interested to this question: what is the boundary between information systems and knowledge management systems?

KEYWORDS: information, knowledge, information system, knowledge Management, Knowledge Management System.

RESUME: Aujourd'hui, les systèmes d'information jouent un rôle très important dans l'amélioration de la performance et la capacité concurrentielle d'une organisation. Par conséquent, il est essentiel pour les organisations de décider quels sont les processus d'affaires les plus importants et les compétences de base qui doivent être pris en charge par son système d'information. Or, les dernières tendances en matière de développement organisationnel ont démontré l'importance de la gestion des connaissances, dans ce cadre nous posons la question suivante : quelle est la frontière entre les systèmes d'information et les systèmes de gestion des connaissances?

MOTS-CLEFS: information, connaissance, systèmes d'information, gestion des connaissances, système de gestion des connaissances.

1 INTRODUCTION

Les deux systèmes d'information et les systèmes de gestion des connaissances sont importants dans une organisation et remplissent souvent la même tâche. Le but de cet article est d'identifier la frontière entre ces deux systèmes. L'approche de la recherche est d'analyser les deux systèmes afin d'identifier leur rôle dans une organisation, de déterminer les problèmes, les avantages et les possibilités, et de découvrir des points communs et rares entre eux pour savoir quand un système d'information devient un système de gestion des connaissances et quand il est utile de mettre en œuvre ce dernier. Mots-clés : connaissance, information, gestion des connaissances, systèmes de gestion des connaissances, systèmes d'information

1.1 DEFINITION DES CONCEPTS

Il est très important de bien clarifier ces concepts : données, informations et connaissances puisqu'ils jouent un rôle essentiel à la fois dans le système d'information et le système de gestion de connaissances. Dans la pratique, les conditions données, informations et connaissances sont souvent utilisés de manière interchangeable. Ainsi, la différenciation est

généralement difficile parce que les données et les informations se trouvent dans un système de gestion de l'information et les utilisateurs ne peuvent pas les interpréter que lorsqu'ils les utilisent.

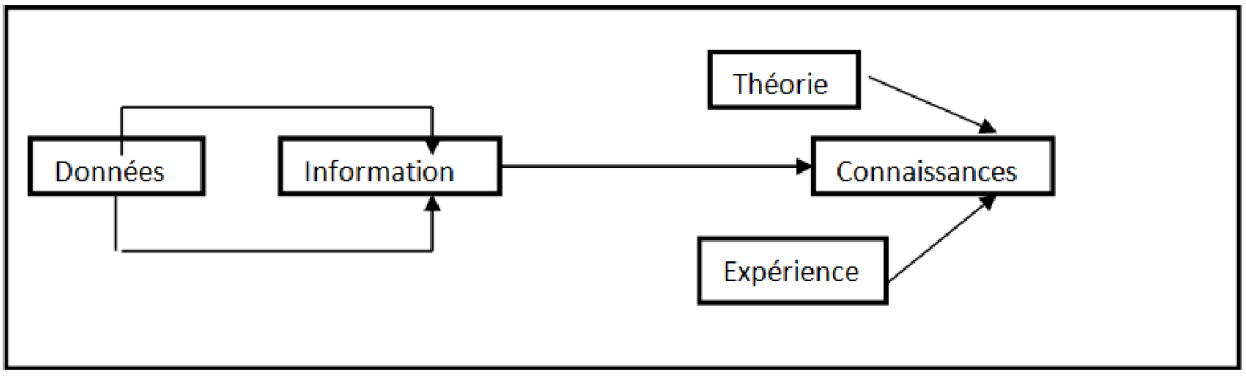
QU'EST-CE QUE LA CONNAISSANCE ?

Selon le Knowledge Management Research Center (Santosus, M. et Surmacz, J., 2001), il n'y a pas de consensus pour offrir une définition à la connaissance. Cependant, les termes comme donnée, information et connaissance, sont souvent utilisés comme synonymes, mais leur nature permet de les discriminer. Les définitions suivantes essayent d'offrir une perspective sur ces trois éléments, elles seront présentées en suivant cette chaîne : donnée → information → connaissance.

LA RELATION INFORMATION – CONNAISSANCE

La distinction entre information et connaissance est essentielle, puisque la connaissance requiert un niveau d'articulation et d'abstraction qui ne pourrait être démystifié facilement par les non-initiés dont la capacité d'absorption des connaissances est relativement limitée au départ (Cohen et Levinthal, 1990, p. 128). Nonaka et Takeuchi (1995) ont montré que la distinction entre l'information et la connaissance est importante, car l'information n'est pas la connaissance. Une connaissance est toutefois constituée d'informations qui sont interprétées, consciemment et inconsciemment, par un individu au terme d'un processus d'apprentissage. Également, la connaissance est évolutive : les données alimentent l'information qu'alimente à son tour la production de la connaissance. Les données et les informations occupent les deux premiers paliers du spectre du savoir (Miller et Morris, 1999)[1], vient ensuite la connaissance et plus loin sur ce spectre, la sagesse et la vérité qui apparaissent comme des aboutissements du spectre (Kaipa, 2000 et Scharmer, 2001)[2].

Fig. Information versus connaissances: spectre de savoir



Source : Lamari, (2010)

Selon Gray P. [GRA 00], il y a une progression naturelle qui mène à la connaissance. Cette chaîne commence avec un ensemble de données et se termine avec la « création » de la connaissance.

Donnée ↔ Information ↔ Connaissance

- Une ***donnée***, est un élément discret, un résultat comme des nombres, des symboles, des figures, des schémas, sans contexte ni interprétation.
- L'***information*** est produite par l'application d'un modèle d'interprétation sur un ensemble de données. Elle facilite la compréhension d'un sujet quelconque dans un contexte précis et elle est la base pour acquérir la connaissance (Comité Européenne de Normalisation, 2004). Donc l'information (élément stocké dans un système

[1] *Cité par ;* ***Lamari, M. (2010)****, «Le transfert intergénérationnel des connaissances tacites : les concepts utilisés et les évidences empiriques démontrées », Télescope, vol. 16, nº 1, pp. 39-65.*

[2] *Op.cit* ***Lamari, M. (2010)***

de connaissances) est le facteur, l'élément ou le moyen permettant de découvrir et de produire la connaissance. C'est-à-dire l'information qui permet de réactiver, de stimuler ou de recréer la connaissance.

Selon Nonaka et Takeuchi(1997), la **connaissance** se différencie de l'information car « …l'information est un flux de messages alors que la connaissance est créée par ce flux d'information et est ancrée dans les croyances et adhésions de celui qui la détient. » [19].

LA GESTION DES CONNAISSANCES

Le management des connaissances ou gestion des connaissances, issu de l'anglais Knowledge Management (KM en abrégé), est depuis plusieurs années au cœur des préoccupations des dirigeants d'entreprises qui ressentent de plus en plus le besoin de créer, partager et capitaliser les connaissances au sein de leur organisation. Comme tout concept nouveau, le management des connaissances a fait l'objet de nombreuses définitions plus ou moins claires et précises (Davenport, Prusak, Quintas, Earl, ...).
Le management des connaissances, peut être défini comme l'ensemble des actions systématiques et organisées qu'une entreprise réalise pour obtenir une plus grande valeur des connaissances dont elle dispose (Davenport et Prusak, 1998). Pour certains, le management des connaissances est un « processus organisationnel permettant l'acquisition, la structuration, l'intégration et la diffusion de la connaissance des individus à travers l'organisation, en vue d'offrir une aide au travail et d'accroître l'efficacité organisationnelle » [21]. Il s'agit donc, suivant cette vision d'utiliser aux mieux les connaissances déjà existantes chez les individus de l'organisation, en s'assurant que ces connaissances soient partagées par les bonnes personnes au bon moment et au bon endroit afin qu'elles puissent prendre les bonnes décisions dans un but d'accroissement de l'efficacité organisationnelle. Autrement dit, c'est l'ensemble des actions systématiques et organisées qu'une entreprise réalise pour obtenir une plus grande valeur des connaissances dont elle dispose (Davenport et Prusak, 1998). Suivant cette optique, le management des connaissances apparait donc comme un processus de création de nouvelles connaissances à travers l'innovation continue (ce qu'on qualifie d'apprentissage organisationnel), qui est présentée dans la littérature comme une source importante d'influence de la performance organisationnelle (Nonaka, 1991 ; Nonaka et Takeuchi, 1995 ; Davenport et Prusak, 1998). Il apparait donc clairement que la gestion des connaissances ne peut se réduire à une seule réalité, mais présente plutôt un caractère multidimensionnel.

SYSTÈME DE GESTION DES CONNAISSANCES (KMS)

Le KMS est un concept très large et englobe toute une gamme de systèmes qui diffèrent à bien des égards (Alavi et al. 2001, Gallupe 2000). Ils diffèrent dans l'objet de la connaissance qu'ils contiennent; les installations qu'ils fournissent ; les technologies qu'ils utilisent, et le processus de la connaissance particulière qu'ils soutiennent (un certain soutien à la création de connaissances, par exemple, d'autres se concentrent sur les partages des connaissances existantes). Il est devenu évident au début du projet de recherche que le champ était trop large pour couvrir adéquatement dans un seul projet. Il était donc nécessaire de restreindre le domaine de recherche en se concentrant sur un type particulier de KMS. Pour restreindre le champ, les chercheurs ont consulté un certain nombre de schémas de catégorisation KMS (Alaviet al. 2001, Gallupe 2000, Maier 2002), un certain soutien à la création de connaissances en se concentrant sur les partages des connaissances existantes. Quelques auteurs l'ont classé selon les types de connaissance que le système traite, d'autres selon la fonction de processus de connaissance que le système tente de soutenir. Pour Zack (1999) et Maier (2002), le KMS est un système utilisé pour faciliter l'échange des connaissances: ce système ne se base pas principalement sur des documents stockés dans certains types de référentiel. Alors, faut-il fournir des installations par lesquelles les parties respectives peuvent rencontrer (même si virtuellement) et échanger des connaissances dans un temps réel, ou semi-réel? « Les applications intégrative du KM se concentrent sur un référentiel et connaissances explicites comme le moyen principal d'échange de connaissances.» [15].

QU'EST-CE QU'UN SYSTÈME D'INFORMATION ?

Plusieurs auteurs ont défini le concept de Système d'Information (SI), par exemple : "Un système d'information est un ensemble organisé de ressources : matériels, logiciels, personnel, données, procédures permettant d'acquérir, traiter, stocker, communiquer des informations dans les organisations." [22]. "Un système d'information est un ensemble d'éléments qui contribuent au traitement et à la circulation des informations au sein de l'organisation (base de données, logiciels, procédures et document) y compris les Technologies de l'Information." [6].

"Techniquement, nous définissons un Système d'Information comme un ensemble de composantes inters reliées qui recueillent de l'information, la traitent, la stockent et la diffusent afin de soutenir la prise de décision, la coordination, le contrôle, l'analyse et la visualisation au sein d'une organisation." [13] [14]. « Le système d'information est un ensemble organisé de ressources technologiques et humaines visant à aider la réalisation des activités de l'organisation » [20].

Un système d'information peut être définie techniquement comme un ensemble de composantes interdépendantes qui collectent (ou récupèrent), traitent, stockent et diffusent de l'information pour appuyer la prise de décision, de coordination et de contrôle = dans une organisation. En plus d'appuyer la prise de décision, de coordination et de contrôle, les systèmes d'information peuvent également aider les gestionnaires et les travailleurs d'analyser les problèmes, de visualiser des sujets complexes, et créer de nouveaux produits.

Les systèmes d'information contiennent des informations sur les personnes importantes, les lieux et les choses au sein de l'organisation ou de l'environnement qui l'entoure. Par information, on entend les données qui ont été façonnées en une forme qui est significative et utile pour les êtres humains. En revanche, les données sont des flux de données brutes représentant les événements survenus dans les organisations ou l'environnement physique avant qu'ils ont été organisés et disposés dans une forme que les gens peuvent comprendre et utiliser. Le système d'information est un ensemble qui repose sur un tissu sociotechnique (individus en interaction : entre eux, avec des machines, et avec le système lui-même). Il comprend:

• Un système d'information, constitué d'individus qui, dans un contexte donné, sont des processeurs de données auxquelles ils donnent un sens sous forme d'informations. Ces informations, selon les cas, sont transmises, mémorisées, traitées, et diffusées par eux-mêmes ou par le Système d'Information Numérique (SIN).

• Un système de connaissance (SCO), constitué de connaissances tacites incarnées par les individus et de connaissances explicites formalisées et codifiées sur toute forme de supports (documents, vidéo, photo, numérisés ou non). Les connaissances numérisées, sous certaines conditions, sont susceptibles d'être transmises, mémorisées, traitées, et diffusées par le SIN. Dans ce cas, elles sont assimilables à des informations. Nous les désignons par l'expression : « Information source de connaissance pour quelqu'un » Les systèmes d'informations et les systèmes de connaissances reposent sur des systèmes d'information numériques (SIN). Ces derniers constituent d'une part, la source et le support des processus de décision et de pilotage de l'entreprise, et d'autre part, le socle structurant des entreprises au sein desquelles ils sont conçus et déployés. Le SIN est le système artificiel (artefact) conçu à partir des technologies de l'information et de la communication (TICs).

GÉRER LE PROCESSUS D'INFORMATION

La gestion de l'information exige le même niveau de discipline comme la gestion d'autres processus d'organisation (achat, location, etc), en prenant soin adéquatement de chacun des processus nécessaires pour gérer les informations du projet peut avoir un contrôle sur les résultats du processus et être confiant sur la qualité de l'information produite.

Nous devons traiter l'information comme une ressource stratégique et gérer en conséquence, de la même façon dont nous gérons les gens, les ressources financières et matérielles. Un projet doit avoir les ressources et les compétences nécessaires pour apporter la bonne information, aux bonnes personnes au bon moment. C'est grâce à la gestion de l'information que le projet peut améliorer son processus de prise de décision, d'apprendre et de créer de nouvelles connaissances.

La gestion de l'information est le processus de création, l'identification, la collecte, l'organisation, le partage, l'adaptation et l'utilisation de l'information sur les pratiques qui ont produit des résultats exceptionnels dans d'autres situations et qui pourraient être adaptés à une autre situation. Si nous avons défini la connaissance que les informations en action alors que lorsque l'information est utilisée et appliquée dans le contexte du projet, c'est quand de nouvelles connaissances est créé. Les connaissances résident dans les expériences des gens, ce «capital intellectuel» est l'une des missions des actifs critiques de soins. Les informations sur les pratiques, les informations sur les méthodes actuelles, les solutions et les approches ont besoin d'atteindre un public toujours plus large qui peut dépasser parfois les limites organisationnelles. (Rodolfo Siles, 2004)

1.2 TECHNOLOGIE DE L'INFORMATION POUR LA GESTION DES CONNAISSANCES

Il y a un débat animé en cours sur le rôle que la technologie de l'information peut jouer pour la gestion des connaissances. D'une part, la technologie de l'information est utilisée de façon omniprésente dans les organisations, et se qualifie donc comme un moyen naturel pour la circulation des connaissances. Une étude récente du Centre de productivité

et la qualité américaine montrent que les organisations qui se lancent dans les efforts de gestion des connaissances reposent généralement, pour atteindre leurs objectifs, sur la mise en place d'une infrastructure informatique adaptée (AP & QC 1997). À l'autre extrémité du spectre, les principaux théoriciens de la gestion des connaissances ont mis en garde contre l'attitude qui conduit vers la gestion d'importants investissements dans l'informatique, peut-être au détriment des investissements dans le capital humain. Sveiby (1997a).

D'après ce point de vue, les stratégies de gestion des connaissances IT peuvent finir par objectiver et calcifier les connaissances en statique, informations inertes, en négligeant ainsi le rôle de la connaissance tacite. Les stratégies de gestion des connaissances de ce type seraient de ramener le fantôme de l'infâme, et pas trop loin dans le temps, les jours de re-engineering, lorsque la devise de l'entreprise était «plus TI, moins de gens!", ils évoquent des scénarios sombres des organisations avec suffisamment de mémoire se souvenir de tout et pas assez d'intelligence pour faire quelque chose avec elle.

Une partie du problème ici provient d'une ambiguïté linguistique: de nos jours, les technologies d'information ont autant de créer des liens directs entre les personnes par le biais des applications telles que le courrier électronique, chat-rooms , la vidéo conférence et d'autres types de groupware comme ils sont sur le stockage d'informations dans des bases de données et d'autres types de référentiels . En ce qui concerne les bases de données, ils peuvent également être fructueux repensés, dans un point de vue de la gestion des connaissances, en tant que ressources pour le partage des meilleures pratiques et pour préserver le capital intellectuel des organisations.

D'une manière générale, l'investissement en TI semble être inévitable pour élargir les projets de gestion des connaissances. La meilleure façon d'appliquer la technologie de l'information pour la gestion des connaissances est probablement une combinaison de deux facteurs : d'une part, la prise de conscience des limites de la technologie de l'information, et du fait que le déploiement de l'informatique n'atteindra pas beaucoup, si elle n'est pas accompagnée par un changement culturel global vers des valeurs de la connaissance, de l'autre coté, la disponibilité des technologies de l'information qui ont été expressément conçues avec la gestion des connaissances en vue. Ce dernier sujet, la conception et l'application des technologies de l'information axée sur le savoir, à condition que la mise au point pour la conférence sur les applications pratiques de gestion des connaissances qui s'est tenue en Octobre 1996 à Bâle, en Suisse (Wolf et Reimer, 1996). Pour ce numéro spécial de J.UCS sur technologies de l'information pour la gestion des connaissances, nous avons sélectionné plusieurs contributions à la conférence de PAKM et demandé aux auteurs pour des versions longues de leurs papiers. Les contributions retenues portent sur les technologies de soutien les différents types de connaissances organisationnelles au cours des différentes phases de son cycle de vie.

La recherche en gestion des connaissances met l'accent sur le développement des concepts, des méthodes et des outils de soutien à la gestion de la connaissance humaine. La gestion des connaissances est préoccupée par la représentation, l'organisation, l'acquisition, la création, l'utilisation et l'évolution des connaissances dans toutes ses formes. Pour construire des technologies efficaces pour la gestion des connaissances, nous devons approfondir notre compréhension de la façon dont les individus, les groupes et les organisations utilisent les connaissances.

2 EXPLOITATION EN SENS DES SYSTEMES D'INFORMATION

Dans le domaine de la science informatique, il a en effet été un mouvement progressif vers ce qu'on pourrait appeler « l'orientation de la connaissance ». Cela a eu lieu au cours des 15 à 20 dernières années, bien avant que le terme ou le concept de « gestion des connaissances » est devenu à la mode. Bien qu'il n'y ait pas de consensus sur une notion de connaissance ou de la transformation de la connaissance en sciences de l'informatique, les termes sont utilisés habituellement pour l'opposer à des données ou de traitement de données - de mettre en évidence les besoins de clarifier la relation entre les symboles stockés dans les ordinateurs et ce qu'ils représentent dans le monde extérieur, de dissocier la manipulation de ces représentations symboliques de traitement informatique interne, pour traiter explicitement et formellement, la sémantique de ces représentations et les manipulations, et à faire un usage efficace de méta-descriptions dans l'exploitation de ces symboles et structures.

Un assortiment de techniques de représentation de gestion des connaissances codifiées a émergé d'un certain nombre de domaines dans l'informatique, l'intelligence artificielle, notamment, les bases de données, génie logiciel et des systèmes d'information. Ce mouvement vers l'orientation de la connaissance n'a pas été organisé comme un mouvement cohérent ou même vu en tant que tel, comme il est venu sur une variété de raisons. D'un point de vue pratique, la complexité croissante des domaines d'application, de développement de logiciels, et l'imbrication croissante des processus humains sur machine ont contribué à la reconnaissance de ces besoins et le développement de techniques pour y remédier. Cependant, le

mouvement a également été motivé par la recherche de bases plus solides dans les différentes disciplines d'informatique (Bubenko, 1980 ; Newell, 1982 ; Ullman, 1988).

La zone de l'intelligence artificielle a développé des techniques pour représenter les connaissances sous des formes qui peuvent être exploitées par des procédures et des heuristiques de calcul. La recherche en systèmes de gestion de bases de données produit de techniques qui prennent en charge la représentation et la gestion de grandes quantités de connaissances relativement simple. Des véhicules sous-jacents comprennent des bases de données relationnelles et des technologies connexes. L'ingénierie logicielle a développé des techniques élaborées pour la capture des connaissances qui concerne les exigences, les décisions de conception et de justification d'un système logiciel. Le domaine des systèmes d'information a bénéficié directement ou indirectement de ces développements.

Dans les systèmes d'information sur ordinateur, la signification de l'information est généralement capturée en termes de modèles conceptuels d'information qui offrent des conditions sémantiques pour les applications de modélisation et de structurer l'information (Mylopoulos , 1998) . Ces modèles s'appuient sur des concepts primitifs tels que l'entité, l'activité, l'agent et le but. En outre, les modèles prennent en charge des mécanismes pour organiser l'information sur les dimensions d'abstraction génériques, telles que la généralisation, l'agrégation et la classification (Mylopoulos, Jurisica et Yu, 1998) . En outre, les modèles prennent en charge des mécanismes pour organiser l'information sur les dimensions d'abstraction génériques, telles que la généralisation, l'agrégation et la classification (Mylopoulos , Jurisica et Yu , 1998) . Par exemple , si nous supposons que nos demandes seront constituées d'entités interdépendantes , il est logique de construire des termes tels que l'entité et la relation dans notre modèle conceptuel , et pour permettre le calcul basé sur la sémantique de ces termes , par exemple , de navigation, de recherche , récupération , mise à jour , et l'inférence basée sur la sémantique de ces relations . L'identification des bons concepts pour la modélisation du monde pour lequel on voudrait faire des calculs (ou des opérations de gestion des connaissances) sur est venu à être connu comme «ontologie» dans l'informatique.

3 ÉTAT DE L'ART CONCERNANT LES SYSTEMES DE GESTION DES CONNAISSANCES ET LES SYSTEMES D'INFORMATION POUR LA GESTION DES CONNAISSANCES

On va se concentrer sur la relation entre les systèmes de gestion des connaissances et des systèmes d'information et le débat sur la contribution de la technologie et des systèmes d'information pour la gestion des connaissances.

Même s'il y désaccord considérable dans la pratique de la littérature et des entreprises sur ce qui est la direction exactement de la connaissance est, certains chercheurs et praticiens soulignent l'importance et l'utilité des technologies de l'information et de la communication comme facilitateurs ou des véhicules pour la mise en œuvre de ces approches. Les ystèmes de gestion des connaissances devraient notamment aider à surmonter les lacunes des pratiques actuelles de l'ingénierie d'affaires en ce qui concerne la performance organisationnelle (Maier, 2002).

La technologie seule ne constitue pas un programme de gestion des connaissances facilite plutôt, en particulier dans les grandes organisations, géographiquement dispersées. La gestion des connaissances est l'occasion de tirer des avantages supplémentaires de l'investissement existant dans la technologie de l'organisation, bases de données et des réseaux en les intégrant à soutenir la gestion des connaissances à de nombreux égards (Zaharova et Galandere Zile, 2002). Le rôle le plus précieux de la technologie dans la gestion des connaissances est d'élargir la portée et l'amélioration de la vitesse de transfert des connaissances (Tiwana 2000).

Aujourd'hui, il y a un besoin pour de nouveaux types de systèmes qui mettraient l'accent sur la découverte de connaissances qui répond à l'environnement changeant. En augmentant les capacités des décideurs, des systèmes d'information qui soutiennent les initiatives de gestion des connaissances aident une organisation à atteindre ses objectifs. Les systèmes d'information qui favorisent une diffusion de l'information sont une composante essentielle dans un système de gestion des connaissances. Les systèmes d'information aident à créer un bon environnement virtuel pour la gestion des connaissances (Galandere-Zile 2004).

Des exemples de technologies de l'information et de la communication liées à la gestion des connaissances sont (Maier, 2002):

- L'infrastructure Intranet qui fournit des fonctionnalités de base pour la communication (e-mail, téléconférence), ainsi que le stockage, l'échange, la recherche et la récupération de données et de documents. Les systèmes de gestion de contenu gèrent des documents électroniques contenants de documents Web.
- les systèmes de gestion de flux de travail qui prennent en charge les processus organisationnels bien structurés et gèrent l'exécution des flux de travail.
- Les technologies de l'intelligence artificielle qui soutiennent, par exemple, la recherche et la récupération.

- des outils d'intelligence d'affaires qui soutiennent le processus analytique qui transforme les données organisationnelles et concurrentielles fragmentées en «connaissance» axée sur les buts et nécessitent une base de données intégrée quil est généralement fourni par un entrepôt de données.
- Les outils de visualisation qui aident à organiser les relations entre les connaissances, personnes et les processus.
- Groupware qui prend en charge, par exemple, la gestion du temps, des discussions, des réunions ou des ateliers de création de groupes de travail et équipes.
- les systèmes d'e-learning qui offrent un contenu d'apprentissage spécifié aux employés d'une manière interactive et soutiennent ainsi l'enseignement et / ou d'apprentissage.

Les systèmes de gestion des connaissances promettent d'améliorer considérablement la fonctionnalité grâce à une combinaison intégrée des systèmes d'information mentionnés ci-dessus du point de vue de la gestion des connaissances. Un système de gestion des connaissances ne doit pas être considéré comme une base de données centralisée volumineux. Il peut plutôt être imaginé comme une grande collection en réseau des données et des documents contextualisés liées aux annuaires des personnes de compétences et de fournir des renseignements pour analyser ces documents, des liens, des intérêts et le comportement des employés, ainsi que des fonctions avancées de partage des connaissances et de la collaboration (Maier 2002).

Le système de gestion des connaissances à long terme est devenu une métaphore forte ou une vision pour le développement d'une nouvelle génération de systèmes d'information et des technologies de la communication. Dans cette vision, le système de gestion des connaissances d'entreprise crée un environnement de technologies de l'information et de la communication, une base conceptualisée, une infrastructure qui prend en compte la nature complexe de la connaissance et donc prend en charge la gestion des connaissances dans les organisations. Pour atteindre cet objectif, un certain nombre de technologies de l'information et de la communication hétérogènes doivent être intégrées, l'amélioration, recombinée, et reconditionnée. Le développement d'un système de gestion des connaissances est une entreprise complexe (Maier, 2002).

La gestion des connaissances doit gérer et améliorer les relations et les réseaux complexes plutôt que des éléments de connaissance individuels ou un seul endroit, pour une base de connaissances. Dans le processus d'un système de gestion des connaissances, la mise en œuvre du contenu à gérer est très importante. Les entreprises qui mettent la connaissance organisationnelle au centre de l'étude mettent en œuvre la gestion des connaissances. En règle générale, la structure de la connaissance de l'organisation est déterminée à des ateliers ou reflète des sources qui existent déjà dans l'organisation, mais sont gérées par un certain nombre de systèmes d'information et des technologies de communication incompatibles. Dans de nombreux cas, la connaissance explicite est prédominante. Il est également beaucoup plus difficile de décrire les connaissances implicites qui est une partie aussi importante de la teneur en mémoire organisationnelle (Maier, 2002), mais un facteur important de la mise en œuvre de systèmes de gestion de la connaissance est la capacité du personnel de l'organisation de partager des connaissances par un certain type de forum en ligne.

Les principaux composants des systèmes de gestion des connaissances sont considérés comme les meilleures pratiques, facilitateurs de la communication, et les cartes routières du système. Le but principal de ces composants est de fournir aux utilisateurs la bonne information au bon moment. L'expérience a montré que les développeurs de systèmes de gestion des connaissances de succès sont ceux qui ont une collaboration bien établie entre tous ces outils (Maier, 2002). Les systèmes de gestion des connaissances peuvent aussi être considérés comme des actifs organisationnels importants qui fournissent des compétences de base pour l'organisation. En particulier, des organisations très fortes intensité de connaissances pourraient voir le traitement systématique de la connaissance en général, et en particulier leurs systèmes d'information et de technologie de communication supportant la gestion des connaissances, que leurs compétences de base et la peur qu'ils pourraient perdre un avantage stratégique s'ils mettent en œuvre une solution de logiciel standard disponible sur le marché (Thierauf 1999).

4 D'UN SYSTEME D'INFORMATION VERS UN SYSTEME DE GESTION DE CONNAISSANCES

La tâche est de mettre en œuvre un système de gestion des connaissances réussi peut sembler insurmontable. Mais en réalité, il y a différents points de vue et approches de mise en œuvre d'un système de gestion des connaissances. Certains experts ont indiqué que jusqu'à 90 pour-cent de l'infrastructure nécessaire à la gestion des connaissances est déjà en place. Dans la plupart des organisations cela se réfère à la structure existante des réseaux informatiques et des serveurs. Par conséquent, seul un petit changement dans le budget de la technologie informatique total est nécessaire pour faire le passage à un système de gestion des connaissances (Lasker et Norton, 1996). Le succès d'une organisation dépend davantage de sa capacité à créer un environnement efficace pour la production et l'application des connaissances, et sur les connaissances et les talents dont elle peut recruter, développer et retenir afin d'assurer l'innovation (Kim et Mauborgne,

1999). Ces nouveaux systèmes aident les décideurs à prendre de meilleures décisions en termes de leurs activités professionnelles. La technologie est accessoire à cette question cruciale.

La refonte peut être nécessaire de modifier les méthodes de travail de la connaissance (Thierauf 1999) :

- Le contenu de la connaissance doit être modifié en augmentant ou en ce qu'il englobe, afin de mieux atteindre les objectifs souhaitables.
- La composition de travail devrait être réorganisée (afin que le personnel de l'entreprise puisse changer l'orientation de leurs emplois de l'information à connaissances) .
- Le changement peut être porté sur l'emploi d'une nouvelle technologie de mise en réseau qui se prête à groupware . Thierauf (1999) propose un résumé de ces facteurs critiques qui détermine le logiciel approprié pour fournir des connaissances utile aux décideurs et à la gestion du logiciel.

Les systèmes de gestion des connaissances d'aujourd'hui intègrent souvent une variété de produits de logiciels tels que le groupware , les systèmes de gestion de documents , e-mail , bases de données relationnelles , et flux de travail , avec des outils d'extraction de connaissances , les moteurs de recherche intranet de gestion des connaissances , et la découverte de connaissances ou le logiciels d'extraction de données . En outre, un système de gestion des connaissances peut utiliser un logiciel d'analyse statistique pour aider les décideurs à faire la connaissance à portée de main. Selon la nature et le but d'un système de gestion des connaissances, il peut y avoir encore d'autres produits de logiciels et matériels nécessaires pour former un ensemble de système de gestion de la connaissance complète, de recueillir, d'organiser, de collaborer, d'affiner et diffuser les connaissances (Thierauf 1999) . La plupart des organisations qui avaient fait œuvre de solutions de systèmes de gestion des connaissances ont combiné plusieurs outils et mis en œuvre des fonctions supplémentaires sur leur propre plutôt que d'acheter simplement un logiciel de système de gestion des connaissances spécialisées sur le marché. Une classification des systèmes de gestion des connaissances ne peut être considérée comme préliminaire en raison de la dynamique considérable du marché pour la gestion des connaissances.

5 CONCLUSION

La frontière entre un système d'information et un système de gestion des connaissances est diffusée et dépend de l'existence de facteurs tels que la stratégie et les objectifs concernant les processus d'affaires et de la connaissance de l'organisation, les technologies de la culture, des initiatives, de l'information et de la communication, etc. Une gestion efficace de la connaissance ne dépend pas seulement sur les plateformes de technologie de l'information, mais surtout sur la structure sociale d'une organisation. Le système de gestion des connaissances se concentre sur la découverte de connaissances qui répond à l'évolution du contexte et tient compte d'une connaissance implicite qui joue un rôle essentiel dans l'avantage concurrentiel d'une organisation. Les recherches futures visent à affiner l'architecture des systèmes de gestion des connaissances et des systèmes d'information organisationnels, et de fournir une analyse plus approfondie des relations de dépendance entre les deux systèmes.

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Au Seigneur, qui nous accorde santé et protection, et nous comble de ses bénédictions tous les jours de notre vie. A feu mon père, ma mère et ma sœur, mes frères et mon amie Soumaya qui ont toujours été présent pour moi, qui ont su m'offrir le support moral indispensable à la réalisation de ce travail et à qui je dédie ce travail.

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Performance of a magnetic fluid based infinitely long rough parallel surface bearing: A comparison of forms of magnitude of the magnetic field

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ABSTRACT: An attempt has been made to study and analyze the performance of a magnetic fluid based infinitely long parallel rough surface bearing. A comparison has been made with two different forms of the magnitude of the magnetic field. The stochastic model of Christensen and Tonder has been used to account for the effect of surface roughness, considering a different type of probability distribution function. The concerned stochastically averaged Reynolds type equation is solved with suitable boundary conditions to obtain the pressure distribution leading to the calculation of the load carrying capacity. Further, the expressions for volume flow rate and response time are derived. The graphical representations make it clear that the adverse effect of porosity and roughness can be minimized by the positive effect of magnetization particularly, in the case of negatively skewed roughness. However, this compensation is found to be more when the magnitude of the magnetic field is described by a trigonometric function. This investigation establishes that the bearing system sustains certain amount of load even in the absence of flow which does not happen in the case of conventional fluid based bearing system. It is found that the volume flow rate is comparatively augmented in the case of trigonometrical form as compared to the algebraic form of the magnitude of the magnetic field. It is appealing to note that the response time does not change for both the forms of magnitude of the magnetic field.

KEYWORDS: Long bearing, porosity, roughness, magnetic fluid, load carrying capacity.

1 INTRODUCTION

In fact, the infinite long slider bearing is the idealization of a single sector shaped pad of a hydrodynamic thrust bearing. Such a bearing consists of a fixed or pivoted pad and a moving pad which may be plane, stepped, curved or composite shaped (such bearings are widely used in hydrodynamic generators and turbines).

Reference [1] analyzed the performance of magneto-hydro-dynamic squeeze film, by considering infinitely long rectangular plates. It was observed that the squeeze action got altered significantly when the electric field was symmetrical about the centre of the bearing. Reference [2] derived the load carrying capacity and time-height relations for squeeze films between porous plates of various shapes. The geometries considered were circular, annular, elliptical, rectangular and conical. The circular shape recorded the highest load carrying capacity as compared to the other shapes. Reference [3] considered ferro fluid based porous squeeze films in bearings of various geometrical shapes including infinitely long rectangular plates. The bearing working with magnetic fluid as a lubricant was found to be better than that of an identical bearing working with a conventional lubricant. Reference [4] analyzed the effects of surface roughness by using Christensen stochastic theory in infinitely long porous journal bearing. The surface roughness considerably affected the bearing performance, the direction of the influence depending on the type of roughness. Reference [5] made a comparison of squeeze film behavior in an infinitely long journal bearing using the ferrofluid flow models of Neuringer- Rosensweig, Jenkin and Shliomis with uniform and non-uniform magnetic fields. An uniform magnetic field failed to produce magnetic pressure

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in the Neuringer- Rosensweig model, but it could affect the bearing characteristics in the Shliomis model owing to the rotational viscosity.

Reference [6] conducted a study of ferrofluid based squeeze film between infinitely long rough rectangular plates. For this type of bearing system it was established that magnetic fluid failed to deliver in reducing the adverse effect of surface roughness. Reference [7] observed the squeeze film performance between rough porous infinitely long parallel plates with porous matrix of variable film thickness under the presence of a ferrofluid. This investigation suggested that considerable increase in the load carrying capacity was possible with a suitable choice of film thickness ratio in the case of negatively skewed roughness. Reference [8] also discussed the magnetic fluid lubrication of a squeeze film in infinitely long bearing. Here, it was shown that the magnetization failed to respond favourably because the form of the magnitude of the magnetic fluid was quit unusual. Reference [9] investigated the squeeze film performance between rough porous infinitely long parallel plates with porous matrix of non uniform thickness. This study revealed that the thickness ratio played a crucial role for improving the bearing performance besides providing an additional degree of freedom, from design point of view. Further, the magnetic fluid lubrication compensated the adverse effect of porosity and roughness up to certain extent with a suitable choice of thickness ratio parameter. Reference [10] considered the lubrication performance of rough short journal bearings under the presence of a magnetic fluid. It was shown that the longitudinal roughness enhanced the load capacity and reduced the modified friction coefficient.

Reference [11] made a comparison of various porous structures on the performance of a magnetic fluid based transversely rough short bearing. The Kozeny-Carman model was found to be superior to Irmay's model. Reference [12] discussed the combined effect of couple stress and magneto-hydro-dynamic lubrication on squeeze film between two parallel plates. It was shown that the load carrying capacity increased with increased couple stress parameter and Hartmann number as compared to the classical Newtonian case. Reference [13] made an attempt to discuss the squeeze film performance between infinitely long rough porous rectangular plates in the presence of a ferrofluid. The negatively skewed roughness increased the already increased load carrying capacity owing to magnetization. This load further advanced with a suitable range of thickness ratio parameter. Reference [14] evaluated the effect of surface roughness on the performance of ferrofluid based parallel plate porous slider bearing considering the effect of slip velocity. It was established that the friction remained unchanged. However, for an enhanced performance the slip parameter was required to be kept at minimum. Reference [15] studied combined effect of magnetic fluid and surface roughness on the performance of a long journal bearing. It was noted that under a higher power-law index and induced magnetic force the transverse roughness could enhance the load capacity while reducing the attitude angle and modified friction coefficient.

Here it has been proposed to compare the effects of various forms of the magnitude of the magnetic field on the performance of a magnetic fluid based infinitely long rough parallel surface bearing.

2 ANALYSIS

The geometry and configuration of the bearing system is given in Figure-1.

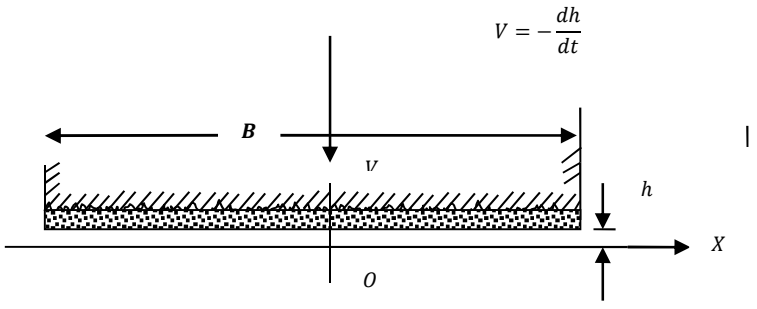

Fig. 1. Parallel Surface Bearing

It is well-known that for an isoviscous incompressible fluid the Reynolds equation can be written as

$$\frac{\partial}{\partial x}\left(h^3\frac{\partial p}{\partial x}\right)+\frac{\partial}{\partial z}\left(h^3\frac{\partial p}{\partial z}\right)=-12\,\eta V \tag{1}$$

where V is the squeeze velocity $V=-\frac{dh}{dt}$, η is the viscosity of the lubricant.

Assuming that the length in the z-direction is infinitely long, this differential equation for the bearing reduces to

$$\frac{\partial^2 p}{\partial x^2}=\frac{-12\eta V}{h^3} \tag{2}$$

It is assumed that the porous region is homogeneous and isotropic. The flow in the porous region is governed by Darcy's law. In corporation of porosity transforms the equation(2) into

$$\frac{\partial^2 p}{\partial x^2}=\frac{-12\eta V}{h^3+12\varphi H} \tag{3}$$

where φ is the permeability and H is a thickness of the porous facing.

Reference [16] proposed a mathematical model to describe the steady flow of magnetic fluids, in the presence of slowly changing external magnetic fields. This model and related aspects has also been discussed in [17]. Following the model outlined in [17], equation(3) takes the following form when a magnetic fluid is considered as a lubricant.

$$\frac{\partial^2}{\partial x^2}\left(p-\frac{\bar{\mu}\mu_0}{2}H^2\right)=\frac{-12\eta V}{h^3+12\varphi H} \tag{4}$$

where μ_0 is the magnetic permeability, $\bar{\mu}$ is the magnetic susceptibility of the magnetic particles and H is the magnitude of the applied external magnetic field.

Christensen and Tonder recognized the random character of roughness and characterized the surface roughness by a random variable with non zero mean, variance and skewness. In view of the deliberations of [18], [19], [20], [21] the roughness of the bearing surfaces is governed by a beta density function of the form

$$f(h_s)=\frac{15}{16c}\left(1-\frac{{h_s}^2}{c^2}\right)^2;\quad -c<h_s\le c$$
$$=0;\quad \text{elsewhere}$$

where c is optimum value of h_s. This form has been considered in [21].

In view of the stochastic model of Christensen and Tonder , stochastically averaging equation(4) one arrives at

$$\frac{\partial^2}{\partial x^2}\left(p-\frac{\bar{\mu}\mu_0}{2}H^2\right)=\frac{-12\eta V}{g(h)} \tag{5}$$

where

$$g(h)=h^3+4(\sigma^2+\alpha^2)h+2\alpha^2 h+2\alpha^3+3\sigma^2\alpha+\varepsilon+12\varphi H$$

where σ is the standard deviation, α is the variance and ε is the measure of symmetric of the random roughness.

The associated boundary conditions are

$$p=0 \text{ at } x=\pm\frac{B}{2} \tag{6}$$

Considering

$$H^2=k(x^2-\frac{B^2}{4}) \tag{7}$$

and solving equation(5) in view of the boundary conditions(6), the governing equation for the pressure distribution in dimensionless form is obtained as

$$P=\left(\frac{\mu^*}{8}+\frac{3}{2g(\bar{h})}\right)(1-4\bar{x}^2) \tag{8}$$

where

$g(\bar{h}) = 1 + 4(\bar{\sigma}^2 + \bar{\alpha}^2) + 2\bar{\alpha} + 3\bar{\sigma}^2\bar{\alpha} + 2\bar{\alpha}^3 + \bar{\varepsilon} + 12\bar{\psi}$

while the dimensionless quantities are

$P = \frac{ph_2{}^3}{\eta V B^2}, \bar{x} = \frac{x}{B}, \bar{\sigma} = \frac{\sigma}{h_2}, \bar{\alpha} = \frac{\alpha}{h_2}, \bar{\varepsilon} = \frac{\varepsilon}{h_2{}^3}, \bar{\psi} = \frac{\varphi H}{h_2{}^3}, \mu^* = \frac{-k\bar{\mu}\mu_0 h^3}{\eta V}$

wherein k is a suitably choosen constant for preparing a required magnetic strength.([17])

One can see that the expression for maximum value of the non dimensional pressure distribution turns out to be

$$P = \frac{\mu^*}{8} + \frac{3}{2g(\bar{h})} \tag{9}$$

Then, the load carrying capacity of the bearing given by

$$w = L\int_{-B/2}^{B/2} p\, dx$$

in dimensionless form is obtained as

$$W = \frac{\mu^*}{12} + \frac{1}{g(\bar{h})} \tag{10}$$

where $W = \frac{h_2{}^3 w}{\eta V L B^3}$

The volume flow rate in dimensionless form is derived as

$$\bar{Q} = \left(\frac{\mu^*}{12} + \frac{1}{g(\bar{h})}\right)\bar{x} \tag{11}$$

The dimensionless time of approach starting from a initial film thickness h1 at t1 to final film thickness h2 at t2 is calculated in dimensionless form as

$$\Delta\bar{t} = \frac{1}{Wg(\bar{h})}(1 - \overline{h_1}) \tag{12}$$

Wherein $\overline{h_1} = \frac{h_1}{h_2}$ and $\Delta\bar{t} = \frac{-h_2{}^3}{\eta L B^3}\Delta t$

For the comparison a trigonometric function has also been choosen to describe the magnitude of the magnetic field, namely

$$H^2 = kB^2\cos\frac{\pi x}{B} \tag{13}$$

This form has been discussed and used in [21] and [22].

For this case the non-dimensional pressure distribution is obtained as

$$P = \frac{\mu^*}{2}\cos\pi\bar{x} + \frac{3}{2g(\bar{h})}(1 - 4\bar{x}^2) \tag{14}$$

Further, the maximum value of non-dimensional pressure distribution is

$$\frac{1}{2}\left[\mu^* + \frac{3}{g(\bar{h})}\right]$$

The non dimensional load carrying capacity associated with this form comes out to be

$$w = \frac{\mu^*}{\pi} + \frac{1}{g(\bar{h})} \tag{15}$$

The dimensionless flow rate is described by

$$\bar{Q} = \frac{\mu^*}{24}\pi\sin\pi\bar{x} + \frac{\bar{x}}{g(\bar{h})} \tag{16}$$

A little computation shows that the maximum value of $\bar{Q}$ is

$$\frac{1}{2}\left[\frac{\pi\mu^*}{12}+\frac{1}{g(\bar{h})}\right]$$

Lastly, the non dimensional response time is found to be

$$\Delta\bar{t}=\frac{1}{Wg(\bar{h})}(1-\overline{h_1}) \tag{17}$$

It is interesting to note from equations(12) and (17)that the dimensionless time of approach remains same for both the forms of magnitude.

3 RESULTS AND DISCUSSION

It is easily seen that, the non dimensional load carrying capacity for both the forms can be determined from equations(10) and (15).One can observe that the expressions involved in both the equations are linear with respect to the magnetization parameter. Accordingly, an increase in the magnetization parameter would lead to increased load carrying capacity. Probably, this may be due to the fact that the magnetization increases the viscosity of the lubricants. Further, it is noticed that the load carrying capacity enhances by $\frac{\mu^*}{12}$ in the algebraic form of the magnitude of the magnetic field and $\frac{\mu^*}{\pi}$ for the trigonometric form as compared to the case of conventional lubricant. It is clearly seen that the load carrying capacity is comparatively more in the case of the trigonometrical form of the magnitude of the magnetic field. It is established from equations (12) and (17) that the squeeze time remains same for both the forms of the magnitude. From equations (11) and (15) it is found that the volume flow rate increases by $\frac{\mu^*}{\pi}\bar{x}$ for the algebraic form of the magnitude, while the increase in the flow rate with respect to the trigonometrical form is $\frac{\mu^*}{24}\pi\sin\pi\bar{x}$ as compared to the case of conventional lubricant.

When the bearing surfaces are smooth this study reduces to the performance of a magnetic fluid based squeeze film in infinitely long porous plates. Further, taking $\mu^*=0$ one gets the behavior of a squeeze film in infinitely long porous plates. This study reduces to the performance of a squeeze film in infinitely long parallel plates in the absence of porosity([23]).

Fig. 2-7 are concerned with algebraic form of the magnitude of the magnetic field, while the fig. 8-13 are associated with the trigonometric form of the magnitude. It can be easily seen that the effect of porosity on the distribution of load carrying capacity with respect to the roughness parameters $\bar{\alpha}$ and $\bar{\varepsilon}$ is negligible for the value of porosity less than or equal to 0.001. Further, increasing value of standard deviation causes severe reduction in the load carrying capacity. Likewise, the load carrying capacity decreases when variance [+ve] and skewness[+ve] increase. Besides, the combined effect of variance (-ve) and negatively skewed roughness is to increase the load carrying capacity, significantly. Also, the combined effect of porosity and standard deviation is relatively adverse.

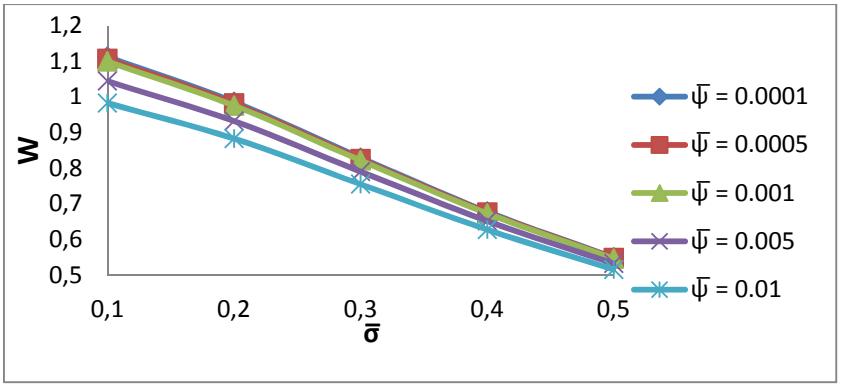

Fig. 2. Variation of Load Carrying capacity with respect to $\bar{\sigma}$ and $\bar{\psi}$

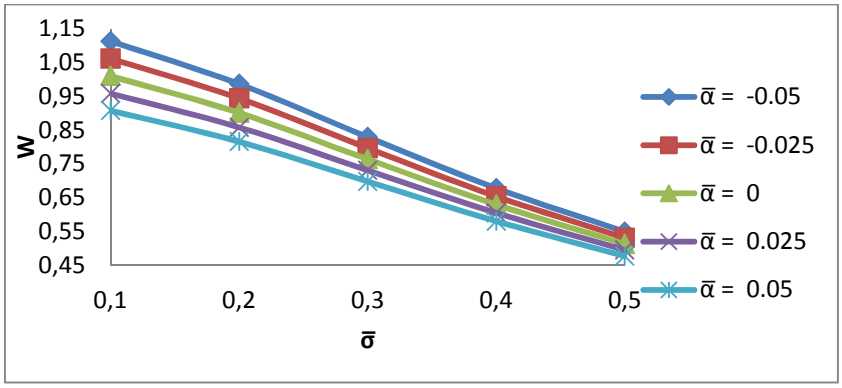

Fig. 3. Variation of Load Carrying capacity with respect to $\bar{\sigma}$ and $\bar{\alpha}$

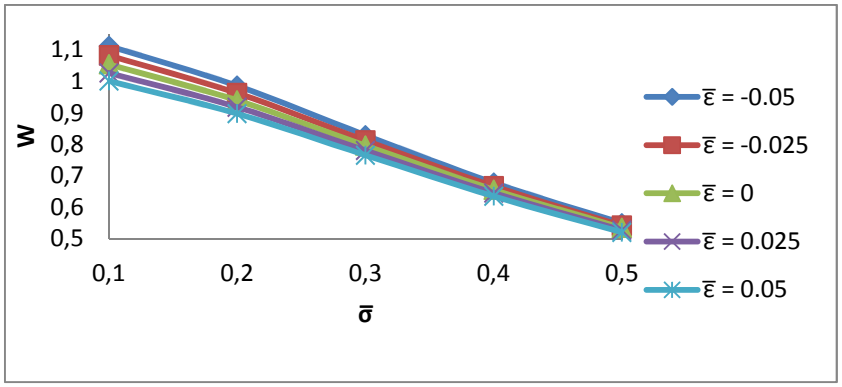

Fig. 4. Variation of Load Carrying capacity with respect to $\bar{\sigma}$ and $\bar{\varepsilon}$

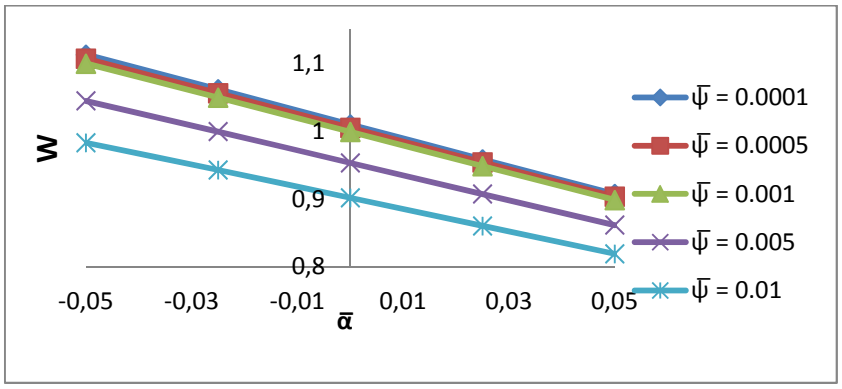

Fig. 5. Variation of Load Carrying capacity with respect to $\bar{\alpha}$ and $\bar{\psi}$

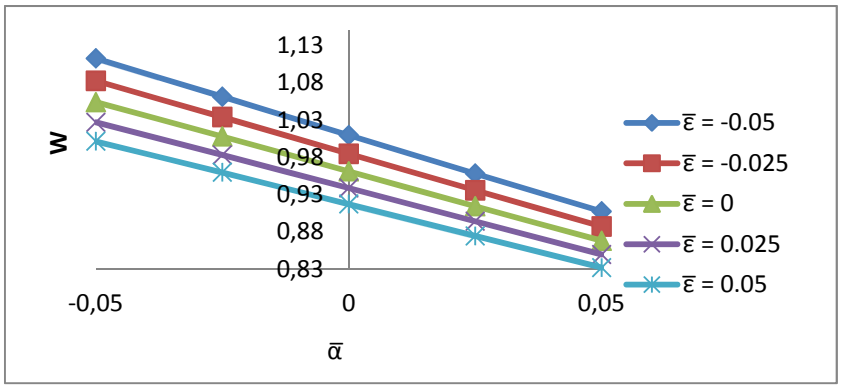

Fig. 6. Variation of Load Carrying capacity with respect to $\bar{\alpha}$ and $\bar{\varepsilon}$

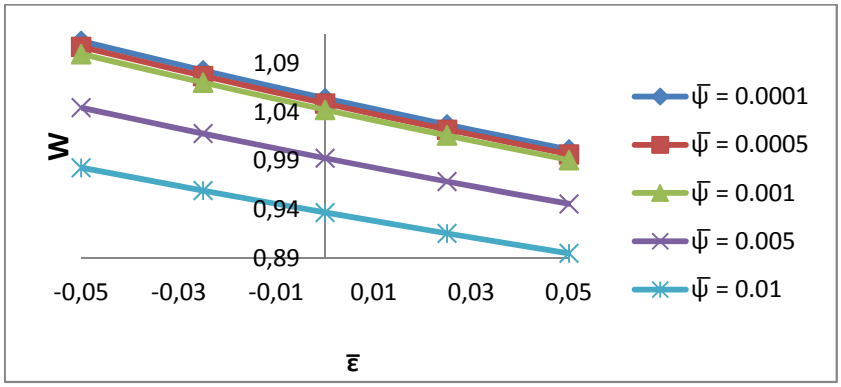

Fig. 7. Variation of Load Carrying capacity with respect to $\bar{\varepsilon}$ and $\bar{\psi}$

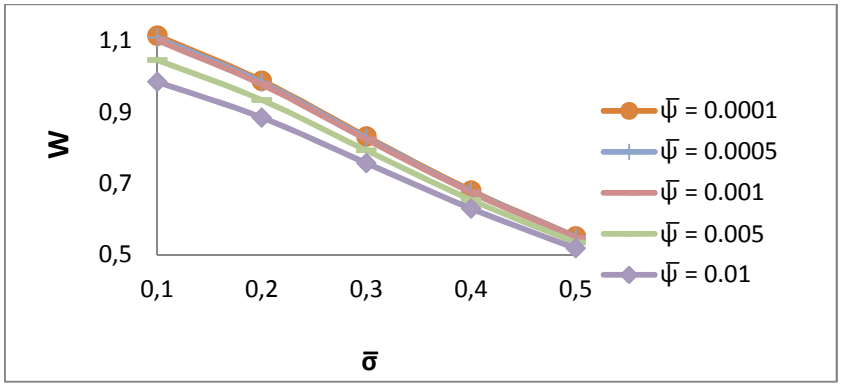

Fig. 8. Variation of Load Carrying capacity with respect to $\bar{\sigma}$ and $\bar{\psi}$

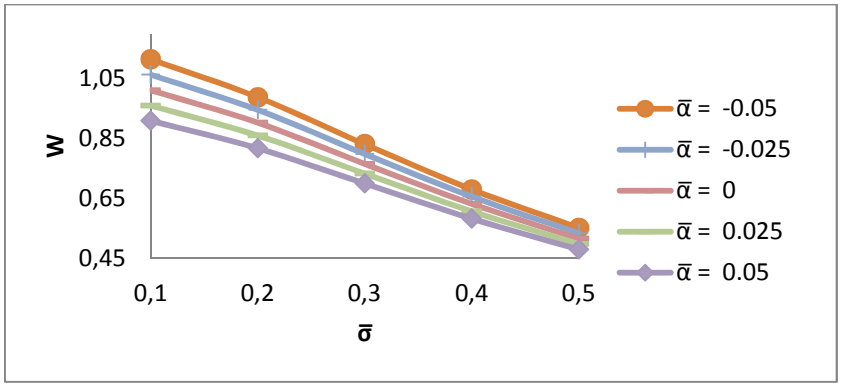

Fig. 9. Variation of Load Carrying capacity with respect to $\bar{\sigma}$ and $\bar{\alpha}$

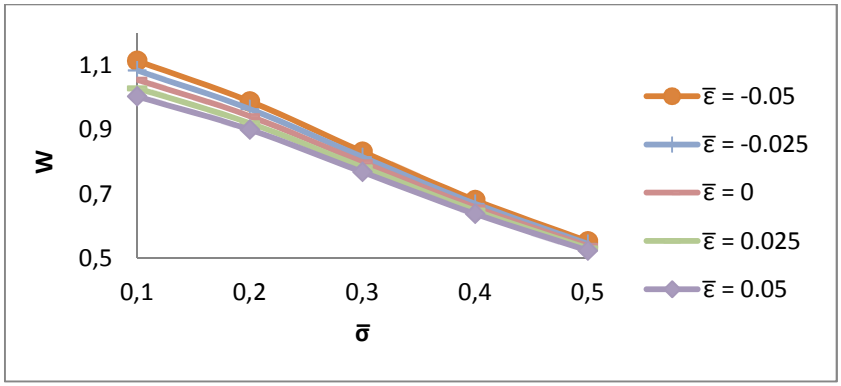

Fig. 10. Variation of Load Carrying capacity with respect to $\bar{\sigma}$ and $\bar{\varepsilon}$

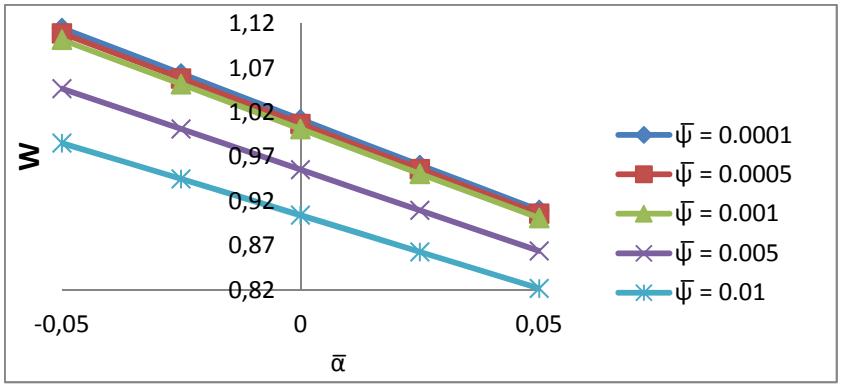

Fig. 11. Variation of Load Carrying capacity with respect to $\bar{\alpha}$ and $\bar{\psi}$

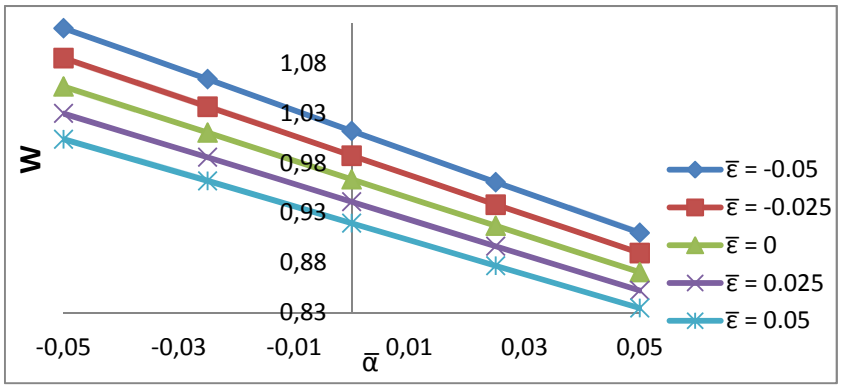

Fig. 12. Variation of Load Carrying capacity with respect to $\bar{\alpha}$ and $\bar{\varepsilon}$

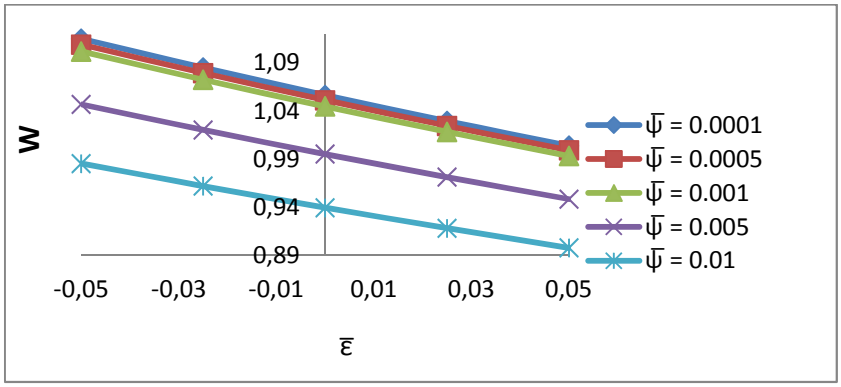

Fig. 13. Variation of Load Carrying capacity with respect to $\bar{\varepsilon}$ and $\bar{\psi}$

The effect of magnetization is presented in fig. 14 - 17 for algebraic form and 18 - 21 for the trigonometrical form of the magnitude of the magnetic field. It is seen from these figures that san increase in the magnetization parameter gives rise to sharply increased load carrying capacity. It is clear that the increase in the load carrying capacity is more in the case of trigonometrical forms of the magnitude. This can also be visualized from equations(10) and (15).

Some of these graphs tend to reveal that the effect of magnetization can go a long way in reducing the adverse effect of porosity and standard deviation in the case of negatively skewed roughness at least when variance [-ve] occurs and this compensation is a little more in the case of the trigonometrical form.

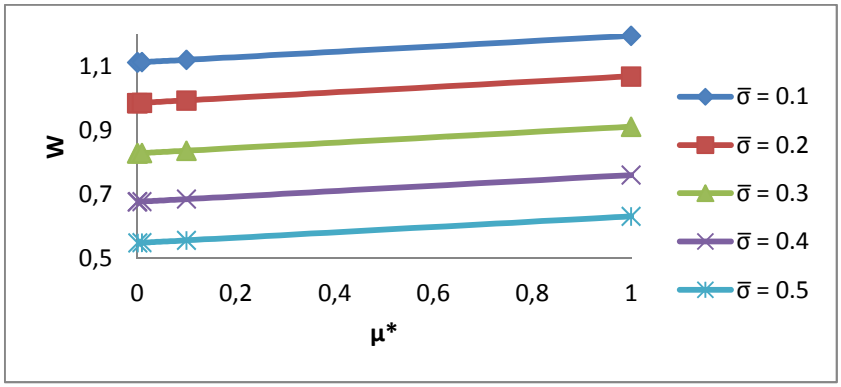

Fig. 14. Variation of Load Carrying capacity with respect to μ^* and $\bar{\sigma}$

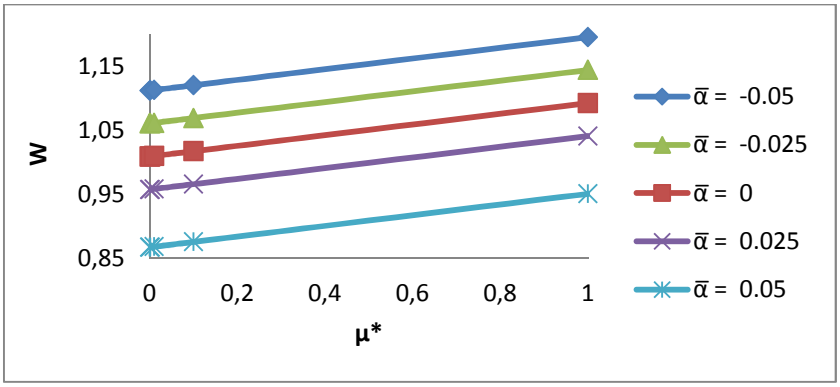

Fig. 15. Variation of Load Carrying capacity with respect to μ and $\bar{\alpha}$*

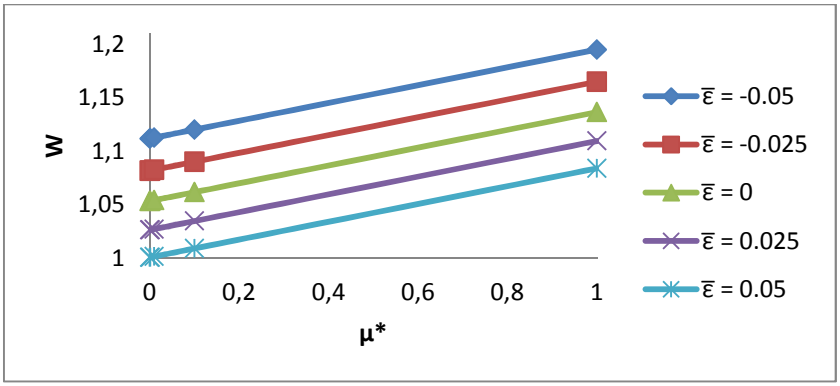

Fig. 16. Variation of Load Carrying capacity with respect to μ and $\bar{\varepsilon}$*

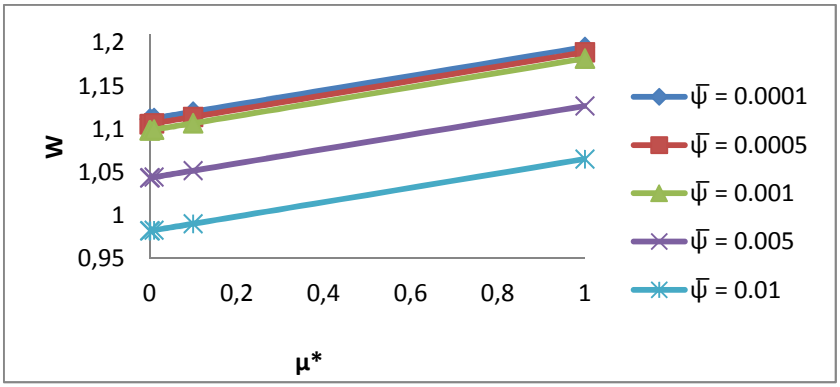

Fig. 17. Variation of Load Carrying capacity with respect to μ and $\bar{\psi}$*

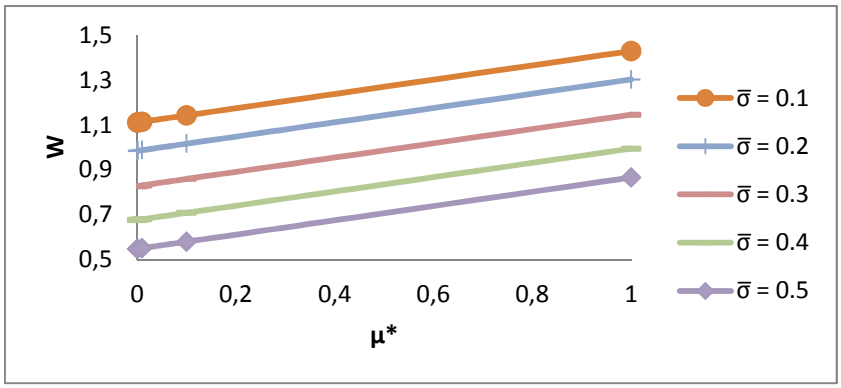

Fig. 18. Variation of Load Carrying capacity with respect to μ and $\bar{\sigma}$*

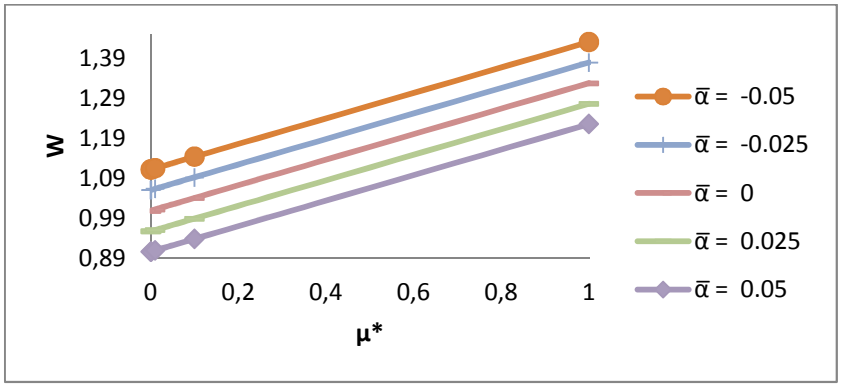

*Fig. 19. Variation of Load Carrying capacity with respect to μ*and $\bar{\alpha}$*

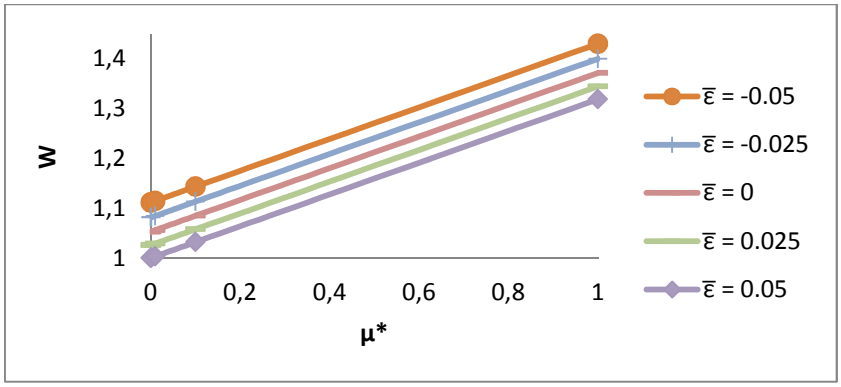

Fig. 20. Variation of Load Carrying capacity with respect to μ and $\bar{\varepsilon}$*

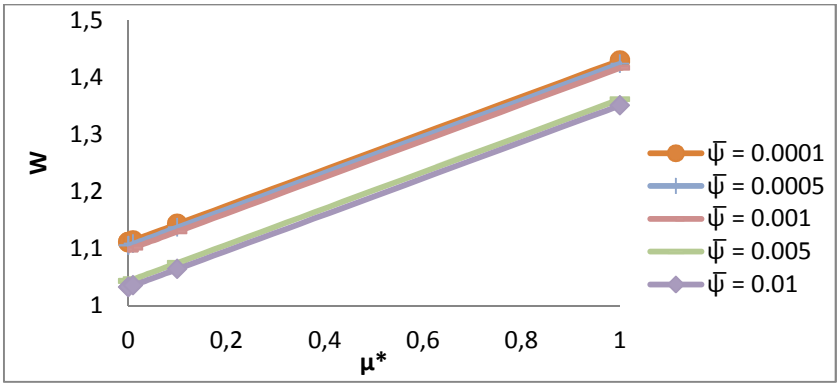

Fig. 21. Variation of Load Carrying capacity with respect to μ* and $\bar{\psi}$

It can be noticed from equations (11) and (16) that the effect of magnetization on the volume flow rate is comparatively more in the case of trigonometrical form of magnitude. This can also be seen from the graphical representations [Fig. 22-25 for algebraic form, Fig. 26-29 for trigonometric form]. It is also found that in the case of trigonometric form the rate of increase in the volume flow rate is more. Further, it is observed from Fig. 25-29 that the effect of porosity on the volume flow rate with respect to magnetization remains insignificant up to the porosity value of 0.001.

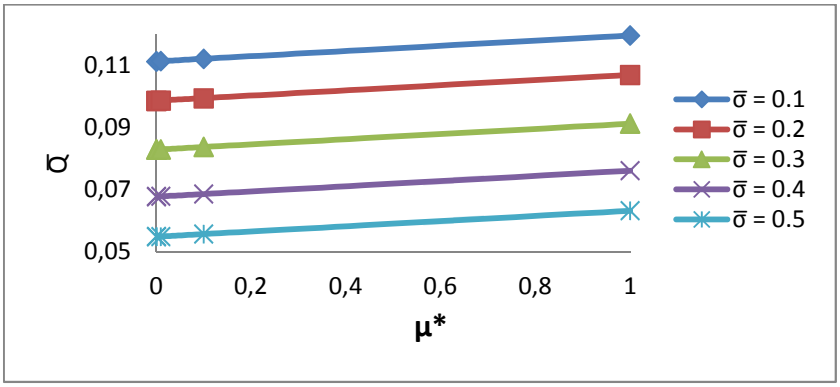

Fig. 22. Variation of Volume flow rate with respect to μ* and $\bar{\sigma}$

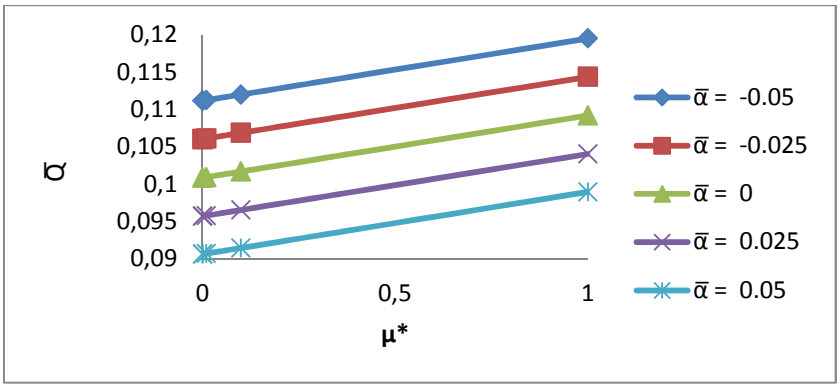

Fig. 23. Variation of Volume flow rate with respect to μ*and $\bar{\alpha}$

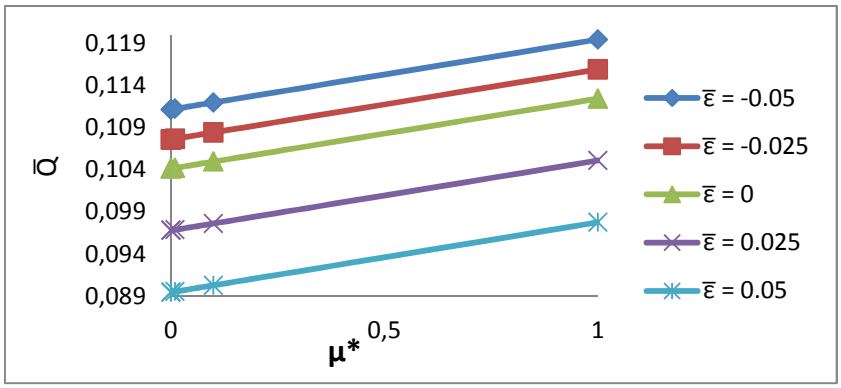

Fig. 24. Variation of Volume flow rate with respect to μ and $\bar{\varepsilon}$*

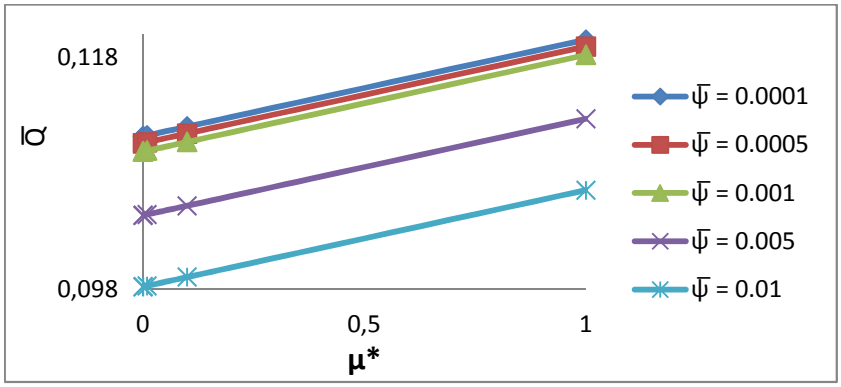

Fig. 25. Variation of Volume flow rate with respect to μ and $\bar{\psi}$*

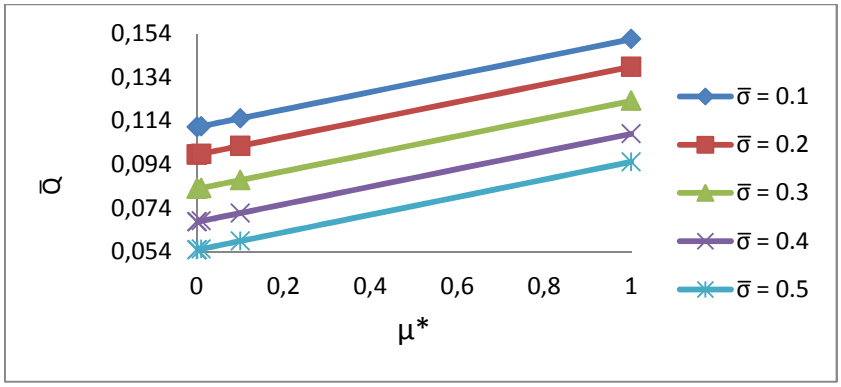

Fig. 26. Variation of Volume flow rate with respect to μ and $\bar{\sigma}$*

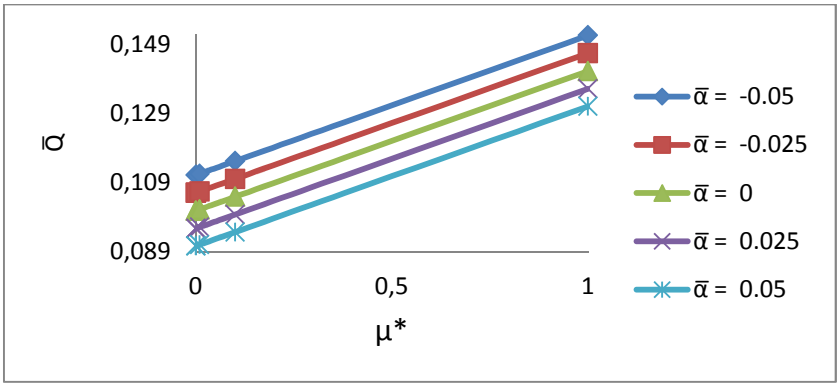

*Fig. 27. Variation of Volume flow rate with respect to μ*and $\bar{\alpha}$*

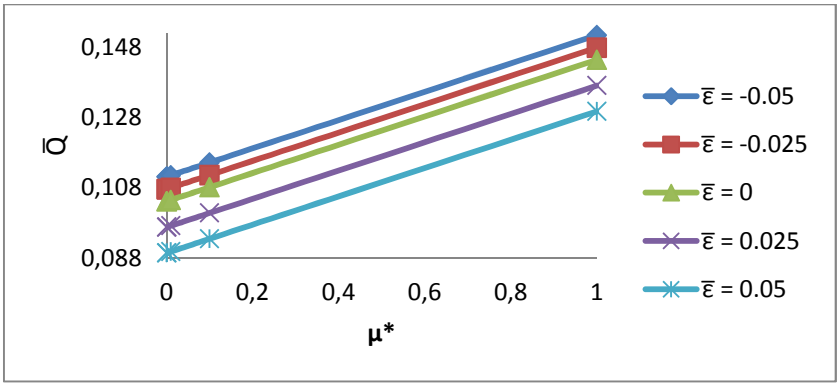

Fig. 28. Variation of Volume flow rate with respect to μ and $\bar{\varepsilon}$*

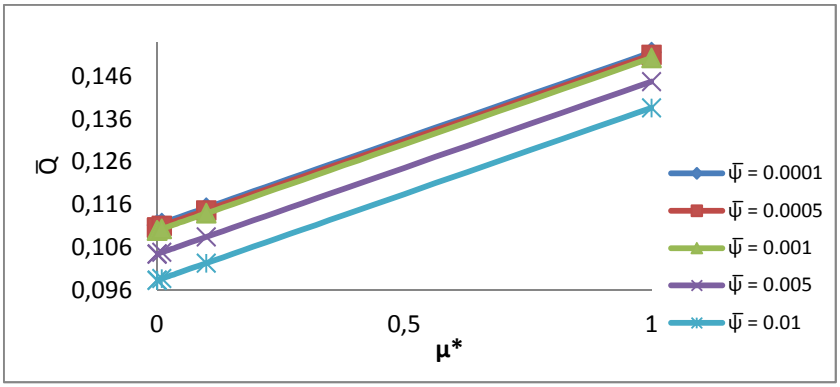

Fig. 29. Variation of Volume flow rate with respect to μ and $\bar{\psi}$*

4 CONCLUSION

This analysis confirms that the form of the magnitude of the magnetic field provides an additional degree of freedom from design point of view. This investigation makes it clear that the roughness aspects must be considered duly while designing the bearing system, even if the magnetic strength is suitably choosen. It is observed that this type of bearing system supports certain amount of load even when there is no flow unlike the case of conventional lubricants. A close glance at the results reveals that for this type of probability density function the effect of standard deviation is more as compared to the results of some other published works. Lastly, it is noticed that exclusively from roughness point of view, the trigonometric form of the magnitude of the magnetization may be adopted.

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L'entrepreneuriat: Importance de ses facteurs socioculturels

[Entrepreneurship: Importance of its socio-cultural factors]

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ABSTRACT: Researchers studying entrepreneurship have lent great value by exploring the factors that explain how entrepreneurs create new businesses and therefore, how societies and economies grow and prosper.
Although there is considerable research based on psychological and economic approaches to entrepreneurship, the influence of cultural factors on the development of the company remains under study. However, the purpose of this article is to integrate, from a theoretical point of view, the socio-cultural factors and entrepreneurial activity.

KEYWORDS: entrepreneurial activity, cultural factors, social factors, social networks, social capital.

RESUME: Les chercheurs qui étudient l'esprit d'entreprise ont prêté une grande valeur en explorant les facteurs qui expliquent comment les entrepreneurs créent de nouvelles entreprises et donc, comment les sociétés et les économies se développent et prospèrent.
Bien qu'il y ait des recherches considérables fondées sur des approches psychologiques et économiques à l'esprit d'entreprise, l'influence des facteurs socioculturels sur le développement de l'entreprise reste sous étudiés. Cependant, le but de cet article est d'intégrer, à partir d'un point de vue théorique, les facteurs socio-culturels et l'activité entrepreneuriale.

MOTS-CLEFS: activité entrepreneuriale, facteurs culturels, facteurs sociaux, réseaux sociaux, capital social.

1 INTRODUCTION

L'activité entrepreneuriale est une source vitale de l'innovation, l'emploi et la croissance économique [6][12][44]. Les chercheurs qui étudient l'esprit d'entreprise ont prêté une grande valeur par en continuant à explorer les facteurs qui expliquent comment les entrepreneurs meilleur créent de nouvelles entreprises et ainsi, comment les sociétés et les économies croître et à prospérer. Avec le tournant entrepreneurial des années 1990, les gouvernements de plus en plus ont consulté l'entrepreneuriat comme une solution à de nombreux problèmes économiques, a connu une croissance considérable dans de nouvelles recherches à partir psychologique et point de vue économique. En dépit de cette croissance dans la littérature et la prégnance de l'esprit d'entreprise dans les politiques publiques, l'influence des facteurs sociaux et culturels sur le développement de l'entreprise reste peu étudiée.

Néanmoins, les chercheurs continuent de faire valoir que les variations d'entreprise sont mieux comprises par compte tenu de l'environnement social dans lequel l'entreprise est créée, parce que, en plus de l'activité économique, l'entrepreneuriat est un phénomène social [5][53]. Alors que les conditions économiques peuvent expliquer une partie de la variation, tout convaincant que l'explication doit tenir compte des aspects sociaux et culturels de l'esprit d'entreprise.

Les praticiens de l'esprit d'entreprise et les décideurs publics ont montré un intérêt croissant pour les facteurs contextuels dans lesquels les activités entrepreneuriales ont lieu. Par exemple, internationale des organisations telles que

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l'Organisation de coopération et de développement économiques (OCDE) et Union européenne (UE) se concentrent sur les facteurs environnementaux de l'esprit d'entreprise, en particulier les facteurs sociaux et culturels qui influent sur le choix de la carrière d'individu pour 'être un entrepreneur et pour créer une nouvelle entreprise [41][42].

Plus généralement, les individus et les organisations affectent et sont affectés par le contexte de leur environnement social. C'est un argument séminal dans la sociologie classique et contemporaine, et l'argument a été appliqué à l'étude de l'esprit d'entreprise à différents niveaux d'analyse [55]. N'oublions pas que la thèse classique de Weber (1930) était multi-niveaux, la culture légitimée l'individualisme, qui a conduit au développement économique. Depuis qu'il a été déclaré, l'argument de Weber continue d'être testé, en utilisant diverses opérationnalisations de la culture, par des psychologues, les sociologues [16] et, plus récemment, par les économistes [4].

Par conséquent, le but de cet article est d'intégrer, à partir d'un point de vue théorique, les facteurs socio-culturels et l'activité entrepreneuriale.

2 QU'ENTEND-ON PAR L'ENTREPRENEURIAT?

Le concept de l'entrepreneuriat a été créé dans les années 1700, et le sens a évolué depuis. Beaucoup assimilent simplement avec le démarrage de sa propre entreprise. La plupart des économistes estiment qu'il est plus que cela.

Pour certains économistes, l'entrepreneur est celui qui est prêt à assumer le risque d'une nouvelle entreprise s'il ya une chance significative pour le profit. D'autres mettent l'accent sur le rôle de l'entrepreneur comme un innovateur qui commercialise son innovation. D'autres économistes disent que les entrepreneurs développent de nouveaux produits ou procédés que les demandes du marché et ne sont pas actuellement fournis.

Au 20e siècle, l'économiste Joseph Schumpeter (1883-1950) a porté sur la façon dont le lecteur de l'entrepreneur pour l'innovation et l'amélioration crée de bouleversements et de changements. Schumpeter a vu l'entrepreneuriat comme une force de «destruction créatrice». L'entrepreneur réalise de «nouvelles combinaisons», contribuant ainsi à rendre de vieilles industries obsolètes. Façons de faire établies, les entreprises sont détruites par la création de nouveaux et de meilleurs moyens de les faire.

L'expert d'affaires Peter Drucker (1909-2005) a eu cette idée plus loin, décrivant l'entrepreneur comme quelqu'un qui cherche effectivement pour le changement, y répond, et exploite le changement comme une opportunité. Un rapide regard sur les changements dans les communications de machines à écrire à-ordinateurs personnels à l'Internet illustre ces idées.

La plupart des économistes conviennent aujourd'hui que l'entrepreneuriat est un ingrédient nécessaire pour stimuler la croissance économique et des possibilités d'emploi dans toutes les sociétés. Dans le monde en développement, les petites entreprises prospères sont les principaux moteurs de la création d'emplois, la croissance des revenus et la réduction de la pauvreté. Par conséquent, le soutien du gouvernement pour l'entrepreneuriat est une stratégie cruciale pour le développement économique.

Comme le Comité consultatif économique et industriel auprès de l'Organisation de coopération et de développement économiques (OCDE) a déclaré en 2003 que "Les politiques visant à encourager l'entrepreneuriat sont essentiels à la création d'emplois et la croissance économique." Les fonctionnaires peuvent fournir des incitations qui encouragent les entrepreneurs à risque de tenter de nouvelles entreprises. Parmi ceux-ci des lois pour faire respecter les droits de propriété et d'encourager un système de marché concurrentiel.

La culture d'une communauté peut également influencer combien l'entrepreneuriat, il est en elle. Différents niveaux de l'entrepreneuriat peuvent provenir de différences culturelles qui font l'entrepreneuriat plus ou moins gratifiant personnellement. Une communauté qui accorde le statut le plus élevé pour ceux qui sont au sommet des organisations hiérarchiques ou ceux qui ont l'expertise professionnelle peut décourager l'entrepreneuriat. Une culture ou une politique qui accorde un statut élevé pour l'individu "self-made" est plus susceptible d'encourager l'entrepreneuriat.

3 LES FACTEURS SOCIAUX ET L'ACTIVITE ENTREPRENEURIALE : ENRACINEMENT ET RESEAUX RELATIONNELS

Comprendre l'entrepreneuriat comme un phénomène social nous permet de tirer sur la littérature bien développée, plus générale, sur le capital social et les réseaux sociaux. Le concept de capital social est sans doute l'un des «exportations» les plus réussis de la sociologie aux autres sciences sociales [46]. L'origine du terme «capital social», est créditée de Jacobs (1962) et Loury (1977) qui ont développé la conception individualiste et économique. Le capital social est défini comme les ressources matérielles et virtuelles qui facilitent la réalisation des objectifs des acteurs et qui reviennent à des acteurs à travers la structure sociale [45]. Compte tenu de la proposition centrale que les réseaux de relations constituent une

ressource précieuse [37], un bon nombre des idées de la théorie du capital social par rapport à l'activité entrepreneuriale peut être trouvé dans la littérature de réseau social [13].

En termes généraux, les réseaux sociaux sont définis par un ensemble d'acteurs individus et organisations) et un ensemble de liens entre ces acteurs [9]. Les réseaux sociaux sont les relations à travers lequel on reçoit la possibilité d'utiliser le capital financier et humain - relations dans lesquelles la propriété n'est pas uniquement la propriété d'un individu, mais est détenue conjointement entre les membres d'un réseau [10]. Les réseaux sociaux sont également un ensemble de relations qui peuvent définir la perception d'une communauté, que ce soit une communauté d'affaires ou une notion plus générale de la communauté dans la société [2]. Ainsi, la société, dans le sens abstrait, est une série de nœuds connectés ou «liée» [38].

Cette conception large des réseaux sociaux et du capital social implique que la dynamique des échanges économiques sont socialement intégrés [21][47]. À la différence du point de vue du choix rationnel, la perspective d'intégration sociale souligne que, dans des contextes intégrés, l'agence d'entreprise, c'est la capacité de recueillir des idées d'entrepreneuriat et les ressources nécessaires pour développer, est façonnée par les normes implicites et les mœurs sociales. Ainsi, le capital social est conçu comme un ensemble de ressources incorporées dans les relations [10]. Cette idée soulève d'intéressantes questions tournant autour des applications d'entreprise de capital social, en particulier, par rapport à des conséquences moins souhaitables.

Dans le domaine de l'entrepreneuriat de nombreuses études ont établi sur l'analyse de réseau social pour illustrer l'accès des entrepreneurs aux ressources qui ne sont pas possédés interne [8]. L'idée sous-jacente est que, bien que les entrepreneurs ont habituellement une partie des ressources nécessaires pour créer une entreprise (par exemple, les idées , les connaissances et les compétences pour diriger l'entreprise) , en général, ils ont également besoin de ressources complémentaires qu'ils obtiennent grâce à leurs contacts (par exemple, de l'information , le capital financier , travail) pour produire et livrer leurs produits ou services [1][54].

Dans la littérature du réseau de l'esprit d'entreprise, trois éléments des relations de réseau apparaissent comme critique à la recherche théorique et empirique sur le processus entrepreneurial [28][29]: la nature du contenu qui est échangée entre les acteurs (par exemple, le capital social et incorporels ressources, telles que le soutien affectif) [3], les mécanismes de gouvernance dans les relations de réseau (par exemple la confiance entre les entrepreneurs et les partenaires qui s'aventurent) [32], et la structure du réseau créé par les relations transversales entre les acteurs (par exemple la possibilité d'utiliser la cohésion et trous structuraux pour découvrir et développer des rendements d'entreprise) [10].

4 LES FACTEURS CULTURELS ET L'ACTIVITE ENTREPRENEURIALE

Parce que les sociétés sont dotées par la nature avec différents environnements physiques, les membres de la société doivent adopter des modes de comportement dans l'environnement pour réussir. Ces tendances dans l'environnement de comportement conduisent à la formation de différentes valeurs culturelles dans les différentes sociétés, dont certaines influent sur la décision de créer de nouvelles entreprises. Ainsi, la culture, à la différence de contextes politiques, sociaux, technologiques ou économiques, présente un intérêt pour le comportement économique et l'entrepreneuriat [51].

Une des difficultés dans l'examen de la culture affects et effets par rapport à l'activité entrepreneuriale est l'absence d'une définition précise et communément compris de la culture [35]. Les anthropologues suggèrent que la culture est liée à la façon dont les sociétés» organisent le comportement social et la connaissance [23]. Les valeurs culturelles sont définies comme la programmation collective de l'esprit qui distingue les membres d'un groupe humain d'un autre et leurs réponses respectives à leurs environnements [25].

Plusieurs études ont souligné l'influence des facteurs culturels sur l'esprit d'entreprise à partir de différents points de vue. Hayton et al. (2002), dans leur revue de la littérature, de la culture de l'esprit d'entreprise et lien à trois grands courants de recherche. Le premier porte sur l'impact de la culture nationale sur les mesures globales de l'esprit d'entreprise telles que la production nationale d'innovation ou de nouvelles entreprises créées. Le deuxième courant traite de la relation entre la culture nationale et les caractéristiques des entrepreneurs individuels. La troisième examine l'impact de la culture nationale sur l'entrepreneuriat social.

Une grande partie de la recherche en entrepreneuriat qui considère les variables culturelles a suivi le travail séminal de Hofstede (1980, 2001) montrant comment la culture se manifeste sous diverses formes, et comment les valeurs culturelles au niveau individuel ou de la société sont influencés par la culture nationale. Selon ce point de vue, les différences culturelles entre les sociétés peuvent être réduites à quatre dimensions quantifiables: l'incertitude, l'individualisme, la masculinité et la distance de puissance. La dimension de contrôle de l'incertitude représente la préférence pour la sécurité et l'inconfort des situations non structurées ou ambiguës. L'individualisme signifie une préférence pour agir dans l'intérêt de soi-même et sa

famille immédiate, par opposition à la dimension du collectivisme, qui se tient pour agir dans l'intérêt d'un grand groupe en échange de leur loyauté et leur soutien. La distance de puissance représente l'acceptation de l'inégalité dans la position et l'autorité entre les gens. La masculinité représente une croyance dans le matérialisme et de décision plutôt que le service et l'intuition. L'utilisation du concept de la culture de Hofstede (1980), les chercheurs ont en général l'hypothèse que l'esprit d'entreprise est facilité par les cultures qui sont riches en individualisme, faible contrôle de l'incertitude, de faible puissance-distance et de grande masculinité [24].

En somme, les approches centrales à la compréhension du rôle des facteurs sociaux et culturels s'articulent autour des concepts de «réseaux » et « encastrement » [21] [22], et le flux de recherche basés sur cadre culturel dimensions de Hofstede (1980, 2001). Bien que, en général, la recherche a montré variables culturelles à avoir une influence sur l'esprit d'entreprise, les variables culturelles dans de nombreux cas ont été théorisé et modélisé comme modérateur des résultats d'entreprise [24]. Cela suggère qu'une plus grande attention devrait être accordée aux interactions entre les dimensions culturelles et la conception de la culture qui permet une plus grande complexité par rapport à d'autres caractéristiques de l'environnement.

Les effets d'une telle complexité culturelle sont à l'étude par un groupe éclectique d'économistes et de sociologues autour de l'idée de la façon dont la culture fournit des justifications pour les actions et les résultats des individus dans les économies de la peine à nous tous collectivement [5]. Contrairement à la conception parsonienne de la culture comme force relativement monolithique sein d'une nation et les dimensions de Hofstede développé à partir des données dans le cadre d'une entreprise, ces chercheurs considèrent la culture comme fragmenté par des ordres institutionnels qui peuvent ou peuvent ne pas s'aligner sur la culture nationale [11].

Selon ce point de vue, les principaux domaines de la vie et comment ils affectent le comportement entrepreneurial conceptualiser et mesurer dans le cadre de commandes institutionnelles distinctes - par exemple la famille, les religions, le marché, les professions, l'état et la société [56]. Ces ordres institutionnels incarnent concurrents et contradictoires sources de normes, de valeurs, de la légitimité et des justifications de valeur qui ont des conséquences pour le support ou le comportement entrepreneurial décourageant.

Les éléments de ces ordres institutionnels sont potentiellement décomposables et transposable dans de nouveaux contextes. Cette modularité implique que la culture, plutôt que d'être conformes aux valeurs, peut être tout à fait incompatible, si ce n'est pas gênant dans la manifestation de conflits de valeurs et les ambiguïtés de rôle qui deviennent particulièrement visibles lorsque des éléments sont transposables d'un ordre institutionnel à l'autre. Par exemple, la famille et le marché comme des ordres institutionnels incarnent des valeurs qui organisent le comportement et les connaissances de manières très différentes.

5 INTEGRER LES FACTEURS SOCIAUX ET CULTURELS ET L'ACTIVITE ENTREPRENEURIALE : UNE PERSPECTIVE INSTITUTIONNELLE

Cette revue de la littérature renforce l'idée que le problème de l'intégration des analyses des facteurs sociaux et culturels qui influent sur l'esprit d'entreprise est difficile. Un nombre croissant de chercheurs mettent au point des approches institutionnelles pour expliquer divers sujets de l'entrepreneuriat et PME [2][11][52][60]. Parce que les institutions sont constituées par la culture et les relations sociales, et parce humain, social et le capital culturel sont souvent des antécédents à l'acquisition du capital financier et autres ressources nécessaires pour démarrer une entreprise, une approche institutionnelle avec sa large méta- théorie tient la promesse de développement futur la recherche de l'esprit d'entreprise.

Diverses théories et méthodes d'analyse institutionnelle sont utilisés dans les différentes branches des sciences sociales par exemple, en sociologie, la science politique et de l'économie (Scott, 2008). Il existe un écart considérable dans la définition d'une institution, et dans les méthodes d'analyse utilisées par les chercheurs pour étudier les institutions et leurs effets. A la base, nous définissons institutions en place une structure stable pour l'interaction humaine. Scott (2008) suggère que les institutions se composent de structures et d'activités cognitives, normatives et réglementaires qui assurent la stabilité et la signification du comportement social. Les institutions sont les règles du jeu dans une société qui fonctionnent comme des contraintes et des possibilités de mise en forme d'interaction humaine [39]. Appliqué au domaine de l'entrepreneuriat, les institutions représentent l'ensemble des règles qui articulent et organisent les interactions économiques, sociales et politiques entre les individus et les groupes sociaux, avec des conséquences pour l'activité des entreprises et le développement économique [57].

Selon North (1990) , les institutions peuvent être formelles , telles que les règles et les contrats politiques et économiques, ou non, tels que les codes de conduite, des conventions , des attitudes , des valeurs et des normes de comportement . Les institutions formelles sont subordonnées aux institutions informelles dans le sens où ils sont les moyens délibérés utilisés pour structurer les interactions d'une société en ligne avec les normes et les valeurs qui composent ses

institutions informelles. La définition de North implique que l'élaboration de politiques qui vise à changer les institutions formelles de la société sans mesures pour ajuster les institutions informelles de manière compatible aura un succès marginal. Par exemple, des difficultés surgissent quand un organe de direction peut influer sur l'évolution des institutions formelles de la société d'une manière directe, mais les institutions informelles moins tangibles restent inchangées en dehors de l'influence directe de la politique publique. Alors que les institutions informelles peuvent être formées, ils sont susceptibles de résister au changement et prendre le temps d'évoluer vers de nouvelles normes sociales. Par exemple, la performance « radicalement différent » des économies peut exister sur de longues périodes de temps en raison du caractère intégré des institutions informelles [39][40].

Les sociologues Scott et Thornton étendent cette vue économique de la distinction entre les institutions formelles et informelles, faisant valoir que l'écart ou décalage entre les institutions formelles et informelles, potentiellement généré par les décideurs publics et privés, peuvent donner atteindre une conséquence involontaire [50][55]. Dans le langage du sociologue [55], il s'agit d'un effet «couplage lâche» causé lorsque des individus et des organisations découpler éléments de la culture ou des couches de la structure organisationnelle pour éviter le conflit que cette incompatibilité peut présenter. Tel découplage, pour le « entrepreneur institutionnel», peut être la genèse de nouvelles combinaisons de parties institutionnelles et organisationnelles du paysage entrepreneurial [36]. Par conséquent, les institutions formelles et informelles peuvent légitimer et délégitimer activité comme une activité socialement valorisée ou attrayant - et de promouvoir et de contraindre l'esprit d'entreprise [57][60].

En résumé, les différentes variétés d'approches institutionnelles offrent un cadre de méta- théorique globale pour l'intégration d'une compréhension de la contribution des facteurs socio- culturels dans la recherche de l'esprit d'entreprise, ainsi que des pistes suggérant pour la recherche future.

6 LES OBSTACLES A L'ENTREPRENEURIAT

Au lieu de diviser le monde en entrepreneurs et non entrepreneurs, nous pourrions commencer en tenant compte de la distribution du potentiel pour devenir un entrepreneur. Je dirais que cette distribution prend la forme suivante : certaines personnes vont devenir des entrepreneurs peu importe ce que ; d'autres ne seront pas devenir des entrepreneurs en aucun cas ; mais l' grande majorité se compose de personnes qui deviendront entrepreneurs dans certaines circonstances et pas dans d'autres. En d'autres termes, si nous ignorons les deux -né (ou) groupes d'entrepreneurs et non entrepreneurs à base de traits (en supposant une telle existe à tous), notre univers contient toujours une grande population de personnes qui ne sont ni des entrepreneurs ni non entrepreneurs.

En commençant par l'hypothèse qu'il existe des circonstances dans lesquelles l'ensemble de ce population va devenir entrepreneurs, nous pouvons reformuler nos questions de recherche en termes de '' Quels sont les obstacles à l'entrepreneuriat exister ? '' Plutôt que ce qui induit les gens à devenir entrepreneurs. Parfois, la suppression des barrières peut favoriser de plus en plus l'esprit d'entreprise que des mesures incitatives. Une liste des obstacles à l'entrepreneuriat pourrait comprendre les éléments suivants, dont certains au moins ont été proposées et étudiées par des chercheurs en dehors du courant de recherche en entrepreneuriat :

6.1 LES DROITS DE PROPRIETE ET LE TITRAGE DES ACTIFS SANS TITRE

Hernando De Soto (2000), dans son étude sur les pays en développement en Asie, en Afrique, au Moyen Orient et en Amérique latine, en évidence le fait que les actifs sans titre qui ne pouvaient pas être utilisés comme capital a été un principal obstacle à la nature de l'esprit d'entreprise qui mène à l'accumulation du capital et la prospérité économique nationale. Grâce à un cumul surprenant de données détaillées, il démontre que la soi-disant pauvres de ces pays sont très bons à l'épargne et déjà avoir les atouts nécessaires pour les lancer dans la prospérité. Ce qui leur manque, cependant, est un droit système de propriété qui leur permet de coopérer avec imagination dans la création de nouveaux usages pour les actifs qu'ils possèdent déjà. Ce genre de déclenchement du potentiel d'innovation dans les gens et actifs nécessite titres négociables et l'infrastructure institutionnelle qui permet les échanges de fluide dans ces titres. Comme De Soto (2000, p. 65) le dit, '' Si le capitalisme avait un esprit, il serait situé dans le système de la propriété juridique. '' [17]

6.2 LES GOUVERNEMENTS QUI NE SONT PAS SUR LE MARCHE AUGMENTANT

Prenant le même défi pratique que De Soto a pris, mais d'une profonde position théorie du développement, Olson (2000) a fait valoir que ce n'est pas le manque de l'esprit d'entreprise qui a gardé les pays sous-développés économiquement en retard, mais le manque des gouvernements en augmentant le marché. Il a fourni un cadre utile pour la façon dont un

gouvernement pourrait fonctionner dans un augmentant de marché, plutôt que d'une manière entraver le marché. A gouvernement qui n'est pas assez forte pour faire respecter les contrats privés et protéger la propriété droits ou qui est trop fort et les piétine peuvent à la fois créer insurmontable obstacles à l'entrepreneuriat.

6.3 LE MANQUE DE VARIETE DANS LES TYPES DE CAPITAL-RISQUE

Venkataraman (2000) a souligné l'existence d'une variété de types de risque capital dans une économie entrepreneuriale comme les États- Unis et interrogé les raisons pour le phénomène qui va à l'encontre des théories néoclassiques de l'économie et des finances.

Un ensemble de questions intéressantes de recherche découle de son exposition '', des différences dans les niveaux de l'esprit d'entreprise dans une économie ou d'une région liée à la diversité des sources de capital de risque en elle ?

Si oui, pourquoi ? '' Bien que les chercheurs ont examiné la présence ou l'absence de capital-risque comme une explication de l'activité entrepreneuriale dans une zone géographique donnée, la question de la diversité et diversité des sources est presque toujours négligé.

6.4 LES FAIBLES NIVEAUX DE CHOMAGE

Outre l'accès au capital-risque, il existe des preuves empiriques qu'il existe une relation entre le démarrage d'entreprise et le niveau de chômage dans l'économie (par exemple, voir Blanchflower et Oswald, 1998, p. 37). En outre, au cours de la bulle Internet, journaux ont plusieurs rapports de petites entreprises étant fermées par leurs propriétaires qui décidé de chercher un emploi dans l'économie de main-d'œuvre hautement lucrative. Pour le groupe particulier des entrepreneurs qui ne perçoivent et agissent sur des compromis entre les possibilités du marché du travail et les possibilités d'entrepreneuriat , nous avons besoin de comprendre comment le taux de chômage peut agir comme une barrière ou un animateur de la décision de devenir ou de cesser d'être un entrepreneur .

6.5 ATTITUDES A L'EGARD DE L'ARGENT ET LE PROFIT

McCraw (1997, p. 1) montre que, avant le 18 e siècle, la plupart des économies, y compris pays qui ont depuis adopté avec succès le capitalisme, sont restés stables à un taux annuel. La croissance du PIB d'environ 1,1 %. Il attribue cette stagnation en grande partie à la perception avant ce moment de profit comme un mal à éviter, et les commerçants / entrepreneurs comme une classe inférieure des citoyens à être méprisés, voire moqué ou condamné d'emblée. Plus récemment, Dana (1995) relate la façon dont le système de croyance basée sur les fonctions Theraveda bouddhisme contre l'esprit d'entreprise chez les hommes lao et concerne à la pauvreté de la nation. D'autre part, Gerschenkron (2000) apporte des preuves historiques à porter sur la façon dont les sociétés ont surmonté cette désapprobation par trouver des substituts ingénieux pour ceux qui aideraient à stimuler l'esprit d'entreprise.

6.6 PROCESSUS DE DECISION BIEN ANCREE DANS LES GRANDES ENTREPRISES

Christensen et Bower (1996) ont identifié le « dilemme » innovateurs qui aboutit à l'échec des principales sociétés face au changement technologique perturbateur, en particulier dans le diskdrive industrie. Leurs points de travail à l'existence d'obstacles à l'entrepreneuriat en grand entreprises axées sur la technologie sous la forme de processus de décision axés sur la clientèle. Une façon d'atténuer ces obstacles a été suggérée par de rosée et Sarasvathy (2002). Cependant, d'autres obstacles possibles à l'esprit d'entreprise dans les bureaucraties et les moyens de les surmonter doivent être explorés par la recherche future.

7 CONCLUSION

En résumé, les entreprises entrepreneuriales font deux contributions indispensables à la l'économie de marché. D'abord, ils font partie intégrante du processus de renouvellement qui imprègne et définit l'économie de marché. Les entreprises entrepreneuriales jouent un rôle crucial dans les innovations qui conduisent au changement technologique et croissance de la productivité. En bref, ils sont sur le changer et la concurrence parce qu'ils changent la structure du marché. Les économies de marché sont des entités organiques dynamiques toujours dans le processus de «devenir », plutôt que d'un établis un qui est déjà arrivé. Ils sont sur les perspectives pour l'avenir, pas sur le héritage de la (Kuratko et Hodgetts, 2004) passé.

Deuxièmement, les entreprises entrepreneuriales sont le mécanisme essentiel par lequel des millions entrer la vie économique. Entreprises entrepreneuriales permettent des millions de personnes, y compris les femmes, les minorités et les immigrés, pour accéder à la poursuite de la réussite économique. Dans ce processus d'évolution, l'esprit d'entreprise joue un rôle crucial et indispensable de fournir la «colle sociale» qui lie ensemble les deux high-tech et les activités " Main Street " (de la Small Business Administration [ASB], 1998).

L'entrepreneuriat est un processus dynamique de la vision, le changement, et la création. Il nécessite une application de l'énergie et de la passion pour la création et la mise en œuvre de la nouvelle des idées et des solutions créatives. (Kuratko et Hodgetts , 2004, p . 30).

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Scientific Progress, Technology and the Population Explosion

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ABSTRACT: Scientific progress, technology and the population explosion have led to the knowledge, accumulation, fast transferee of it and the increase of individual educational ambitions. This formed many pressures on the educational institutions to provide education with high efficiency for the increasing numbers of students with low possible costs. It has become for the educational process new prospects and fields that are because of the stunning challenges derived from the needs of the epoch and the development necessities, which target the education and its style. All these are for meeting its excessive increase in preparing the students and education demanders, which require educational institutions with specification that receives these huge numbers of students. Furthermore, the knowledge is in excessive increase where the available time in classes will not be able to absorb that increase. This increase requires using the technology in the educational process, especially in the English language.

KEYWORDS: Scientific Progress, Technology, Population Explosion.

1 INTRODUCTION

The educational technology is considered as one of the important pillars of developing the education because it supports and increases its efficiency. The perfect usage of educational technology requires a special kind of teachers who have the sufficient knowledge, skill and the capacity of the effective functional utilization of these technologies in the context of modern teaching systems, as well as using technology in teaching the English language. It makes this subject take a distinguished place among other subjects. The English language is considered to be an international language, and consequently the learning of it has become a necessity in the modern era wherein it interests are interlinking with each other. Moreover, the communication of people is increasing so that the learning of national language alone is not enough to address the development challenges at all levels.

The importance of learning the English language at secondary schools stage stems as it is from one of the subjects that qualify for admittance of university education. The question of the extent and the provision of educational technology and its role in teaching the English language in the secondary schools stage in Saudi Arabia, and about the extent of effectiveness and harmony with other elements which combine the educational functions was at the concern of the researcher, which made the feeling this problem went deep on him. So he gave it his concern and adopted it with research so as this study must reach to results for those who are concerned with the technology, may find it helpful to them in understanding the education and developing evaluation and development of educational technology, as well as the media used in teaching the English

language in the context of the work on and efforts exerted to enable the students to understand this subject which may help achieve the educational objectives.

The world pays great attention to the trends of teachers which is very essential in the educational process since it has great effects on the motivations of students towards the subject and consequently, on their performance. The preparation and training of the teacher is an ever-continuing process concerning the entire world, learning organizations and international institutions. There is increasing attention to improve the trends of teachers toward the process of education and its technology. This improvement is an essential target for those who work in this field. In addition, to the technical, economic, cultural and political education technology and different media or improving the output of education process, the world has become a small village. Due to the technology in the recent time that a normal person can move easily from one place to another virtually the English language is the medium of communication of people all over the world. It is the language of sciences, media, economy, and policy that is to say it is the dominant language and internationally agreed upon as a complimentary element of development of different fields. This unique position of the English language has drawn attention to acquire it, and students have been encouraged to acquire it so as to know what is going on all over the world.

To follow up this situation in Saudi Arabia, notice the decline of the standard of the English language and the obvious retardations of the students' standards at all stages. Many factors have critical contributions to these problems, which leads to the situation. Insufficient attention to using educational technology is one of those factors. Since the trends of teachers towards using educational technology is a central point to improve the ways of technology of the English language, the researcher has bound himself to work on this issue and that is through research and study as an essential step on the way to improving the situation of the English language as the secondary stage in the AlJouf Province.

As a matter of fact, we can say that the technology of learning is mainly connected to:

1. Human resources,
2. Teaching and technology, and
3. Materials as a whole printed.

2 METHODS AND MATERIALS

The suitable methodology for this study is the descriptive methodology. Sample One (1) includes 60 teachers of governmental secondary schools of English of the AlJouf Province who participated in the English language. This sample represented 60 of the total number of AlJouf Province teachers. Sample Two (2) includes thirty directors of the English language of the governmental secondary schools of the AlJouf Province.

The data of this study has been directed from the respondents of the two samples to a questionnaire and an interview.

2.1 THE QUESTIONNAIRE

The researcher has derived the questionnaire and consulted with the supervisor to change some topics according to his feedback. After that step, the questionnaire has been evaluated by the scholar specialized in education and curriculum development. According to their feedback, the researcher has changed the questionnaire by adding some topics and deleting some others. This leads to the validity of the questionnaire.

The reliability of the questionnaire has been calculated by a small sample of the questionnaire, and by using SPSS we find Alfa Cronbach according to the equation

$$a = \frac{K}{K-1}\left(1 - \frac{\sum s_1^2}{S_1^2}\right)$$ were 5

is standard deviation (Lyle F. Bachman, 2004, p. 64), which reached 0.80 in higher percentage. According to the educational opinions, 60 copies of the questionnaire were distributed to the teachers who have been teaching the English language at AlJouf Province.

2.2 DISCUSSIONS

The first issue is the role of educational technology in teaching the English language at the secondary school level.

Table 1. This table shows the result to identify the opinions of the sample on the issue.

No	*Clause*	*Mean*	*S.D.*
1	It includes performance in the educational process in the secondary schools.	4.34	0.741
2	It assists in communicating information through a pleasing way to the students.	4.66	0.591
3	It provides solutions for class crowds.	4.06	1.056
4	It observes the individual differences among the students.	3.83	1.317
5	It provides live expertise for the students.	4.54	0.852
6	It induces the concern of students and renews their activities, contributions and satisfies their desires in education.	4.83	0.568
7	It contributes to reduction of failure rates of the students.	4.03	1.043
8	It reduces the time used in transferring information, skills, and expertise to the students.	4.71	0.458
9	It reduces explaining the naked terms by live media, which enables visual images in the learners' brains.	4.74	0.561
10	It assists in simplifying and explaining the information and thoughts.	4.69	0.530
11	It assists the students in performing the required skills with activity and desire.	4.46	0.886

This table indicates that the study community individuals agreed with a very high degree, on all clauses of this issue, which proves the significance of the educational technology in teaching the English language in the secondary schools because it:

1. Improves performance in the educational process in the secondary schools,
2. Assists in communicating information through an attractive way to the students,
3. Assists in providing live expertise to the students,
4. Stimulates actively the concerns and renews their activities and participation,
5. Minimizes the time used in transferring the information, skills and attractiveness to the students, and
6. Assists in simplifying and explaining the information and thought.

The second issue is the role of the educational technology in the academic learning of the English language at secondary schools.

Table 2. This table explains the results to identify the opinions of the sample on the issue.

No.	*Clause*	*Mean*	*S.D.*
1	Enhancing the relationship between the teacher and students, if it is used effectively and efficiently, may contribute to the increase of academic learning.	4.66	0.684
2	The teacher uses keenness in communicating in English with students during display of educational means will contribute to increasing students' academic learning.	4.63	0.547
3	Training of the teachers of the English language on operating and maintaining the educational technology will increase academic learning of the students.	4.60	0.604
4	It avails the teacher and students a chance to know the immediate results their work through feedback, which may contribute to the academic learning of the students.	4.69	0.530

Table 2 shows that of the study sample individuals agreed on all clauses of the issue with a very high degree that media in educational technology has a very big role in the increase of the academic learning of the English language. This comes through:

1. Enhancing the relationship between the teacher and the student if it is used efficiently, which may contribute to the increase of the academic learning,
2. The teacher's keenness in communicating in English with students while displaying the educational means which contribute to increasing their academic learning,
3. Training of the teachers of the English language on operating and increasing the educational technology will increase in academic learning of the students, and

4. It avails to the teacher and the student a chance to know the immediate results of his or her work through feedback, which may contribute to the academic learning for the students.

The third issue is the characteristics and conditions of the educational technology used in English language teaching at the secondary schools.

Table 3. This table represents the result to identify the opinions of the sample on the issue.

No.	*Clause*	*Mean*	*S.D.*
1	Of concern and attention for students.	4.69	0.867
2	In its preparation, designing and production psychological basis and general principles should be observed.	4.60	0.847
3	It should be in connection with the syllabus and checking its objectives.	4.83	0.453
4	Proportional with the time and effort required for its usage.	4.51	0.658
5	Proportional with the environment in which it is displayed from its tradition and its industrial resources.	4.26	1.010
6	It complies with the number of students in the class.	4.57	0.655
7	It is well designed for the sequence of thought, implements and transfers from one educational objective to another.	4.69	0.583
8	Within its design and production, the right content from the aspects of academic, technical and structure should be observed.	4.66	0.591
9	It must contain the elements of the motivation, attraction and stimulation of attention.	4.66	0.802
10	It must be creative and distant, away as much as possible from the traditional production.	4.57	
11	It must be made from the raw materials found in the local environment to minimize the cost.	4.46	

Table 3 confirms that the study sample individuals agreed on all clauses of this issue with a very high degree, where these individuals asserted that these characteristics and conditions, which the educational technology used, must enjoy English language teaching:

1. It may be of concern and attention for the students,
2. It should observe in its preparation, designing and production, physiological basis and general principles in connection with the syllabus and checking its objectives,
3. It should be proportional with the time and effort required for its usage,
4. It should be proportional with the environment in which it is displayed, in terms of its traditions and its industrial natural aspects,
5. It complies with the number of students in the class,
6. It should be well designed as for the sequence of thoughts, elements and transfer from one educational objective to another,
7. It should be observed within its design and production, the right content from the academic, technical and structural aspects,
8. It must contain the elements of the motivation, attraction and stimulation of attention,
9. It must be creative and distant away as much as possible from the traditional production, and
10. It must be made from the raw materials found in the local environment to minimize the cost.

The fourth issue is the role and contribution of the teacher in the academic learning of the students at the secondary schools using educational technology.

Table 4. This table introduces the result to identify the opinions of the sample on the issue.

No.	*Clause*	*Mean*	*S.D.*
1	The English language teacher using educational technology shall contribute in the increase of the academic learning of the students.	4.54	0.74
2	The English language teacher's keenness in monthly tests upgrades the academic learning levels.	4.54	0.70
3	The understanding of the English language teacher may assist in the performance of the students.	4.66	0.684
4	The teach burden weight may affect directly on the performance of the teacher and hence on the academic learning level of the students.	4.63	0.770

The above table confirms that the study sample individuals agreed on all clauses of this issue with a very high degree, which media that the role and contribution of the teacher in the students academic learning of the English language at the secondary schools through using educational technology. This role is represented in:

1. English language teacher using educational technology shall contribute to the increase of the academic learning of the students,
2. The English language teacher's keenness in monthly testing upgrades the academic learning levels of the students,
3. The accurate follow-up and correction of the English language teacher may rise in the performance of the students,
4. Appreciation of the teacher of the English language may improve the performance of the students, and
5. The heavy teaching burden may directly affect the performance of the teacher and hence the academic learning level of the students.

The fifth issue is the difficulties and problems, which face the teacher of the English language at the secondary schools in the AlJouf Province by using educational technology in teaching the material.

Table 5. This table expresses the result in identifying the opinions of the sample on the issue.

No.	Clause	Mean	S.D.
1	Discouragement of the school management to the teachers of the English language in using educational technology.	4.20	1.08
2	Non-existence of the material used in producing educational technology.	4.20	1.02
3	Carelessness of the school management in the participation of the teachers in the training courses in the field of using educational technology.	4.26	1.172
4	Non-existence of the specialized technical staff in producing operating and maintaining educational technology.	4.06	1.282
5	The increase of teaching burden in the timetable of the teacher may constitute constraint in using educational technology.	4.34	1.027

Table 5 explains that the study sample individuals agreed on all clauses of this issue with a high degree on all the problems indicated in this issue, with which media that these problems can be represented in:

1. Discouragement of the school management to the teachers of the English language to use educational technology,
2. Carelessness of the school management in the participation of teachers in the training courses in the field of using educational technology,
3. Non-existence of the material used in producing educational technology,
4. Non-existence of specialized technical staff in producing, operating and maintaining educational technology, and
5. The increase of the teaching burden in the timetable of the teacher may constitute constraint in using educational technology.

3 CONCLUSION AND RECOMMENDATIONS

In light of the objectives of this study, as well as the issues presented in this study and discussion and through the analysis of the information stated in the previous chapter, it is obvious that there was a severe lack of concern about the educational technology and their use in the teaching process, as one of the assisting elements that makes the educational process a

success. Therefore, to avoid these shortcomings, it would be better to reconsider and intensify the educational effort to investigate the importance and necessity of the use of the educational technology by the teachers, as they were considered to be active factors in increasing the academic learning of the student.

3.1 CONCLUSIONS

1. The secondary schools in the AlJouf Province are lacking in educational technology and consequently there was no physical training for the teachers of the English language in using the educational technology in these schools.
2. The Ministry of Education was not keen enough to direct the teachers of the English language at the secondary schools to use the educational technology in teaching this subject.
3. In spite of the directives stipulated in the National Comprehensive Strategy of Education to use the educational technology, lack of funds, however, constituted a major obstacle in implementing these directives and, at the same time, transforming them into a tangible reality.
4. Heavy teaching burdens related to the teachers besides the critical economic situation they are experiencing left its negative impact on their concerns of the educational technology in the teaching process.
5. No appropriate school environment was established, e.g. provision of instrument and teaching aids, as well as building spacious theaters.

3.2 RECOMMENDATIONS

From the previous chapters of this study and the results that have been reached, the researcher is recommending the following:

1. The competent bodies should give more concern to the importance and necessity of using the educational technology,
2. The study also recommends the establishment of specialized theaters in English language at the secondary schools in the province, and
3. The researcher recommends the importance of recruiting specialized technical cadres in the field of producing, operating and maintaining the educational technology at the secondary schools.

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The New York Times Coverage of Islam in the Arab Spring

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ABSTRACT: This paper is intended to discuss the image of Islam and Muslims in the representational discourse of the New York Times during the Arab Spring. It is predicated on the premise that news reports in the media are both biased and less objective. Certainly, the wave of demonstrations in Muslim majority countries like Tunisia, Egypt, Libya and even Syria were a raw material for the New York Times' writers to report if not rethink their views and perceptions of Islam and Muslims. In this journalistic discourse, Muslim women are delineated as being both alien and different; they do not cherish a good representation, given the bad images that turn linked to them many decades ago. As for the Arab leaderships, they are in turn not safe from the propagandistic tendencies of this print media form as they become equated with and synonymous to evil, despotism and dictatorship. While it adopts the content analysis method, this paper aims at casting some light on the way the New York Times render Islam and Muslims in its columns. It, therefore, makes no distinction between news reports, be they articles, Op-Eds or Editorials.

KEYWORDS: New York Times, Islam, Arab Spring, misrepresentation, bias.

INTRODUCTION

Along history the media has played an important role in shaping the beliefs and the opinions of people. It has been so influential in determining the course of human history, hence affecting faiths and beliefs negatively. The result was serious battles over images, stereotypes and wrong ideas. Alan Gitelson informs us that

> The media influence foreign and defense policymaking in several way. In their search for stories that will stir the interest of their readers and listeners…, news reporters constantly monitor American involvement in world affairs. News reports from Vietnam, for example, greatly affected public attitudes toward that war.[1]

The same view was reiterated by Barbara A. Bardes et Al, who believed that

> The media...serve as information sifters, deciding which stories are discussed and which are ignored. Some Americans even argue that the growth of media monopolies in recent years has created a collusive environment in which corporate interests dictate which information will be disseminated to Americans.[2]

In his notable book, *Covering Islam*, Edward Said has already captured public attention on how the media, journalists and experts determine how the world sees Islam, questioning the objectivity of the media, and discussing the relations between

[1] *Gitelson, Alan, et al. American Government. USA: Wadswarth, 2009. 447.*
[2] *Bardes, Barbara A, et al. American Government and Politics Today: The Essentials. USA: Wadswarth, 2008, 195.*

knowledge, power and the media. The Runnymede Trust in the United Kingdom echoed the same idea in which "Islamophobia" is defined as an "Unfounded hostility towards Muslims."[3]

After the 9/11, the Americans have started to study Islam and all the Islamic groups. Such interest is due mainly to the handfuls of stereotypes and misconceptions about Islam that the Mass Media is propagating. People, then, would question the role of the media in [mis]representing Islam and whether the former was able to provide a just and balanced reporting of Islam.[4] In many cases, the image of Islam is distorted and proven incorrect as Islam is often looked at as an "extremist," or "fundamental" religion wherein terrorism and radicalism are at issue.

> Pope Benedict XVI delivered a speech in September 2006 at the University of Regensburg in Germany in which he made references to Islam and "holy war." In his speech entitled, "Faith, Reason and the University-Memories and Reflections," he quoted the Byzantine emperor Manuel II Paleolgus as saying, "Show me just what Muhammed brought that was new and there you will find things only evil and inhuman such as his command to spread by the sword the faith he preached" (Libreiria Edifice Vaticana, 2006).[5]

Angry reactions went on throughout the Muslim populations of the world. The Organization of the Islamic Conference released a statement in reference to the Pope's speech that stated, "The Attribution of the spread of Islam around the world to the shedding of blood and violence…is a complete distortion of facts" ("Press Release," 2006)[6]. The Pope, however, would issue an apology to the Muslim world and explain that "The Byzantine emperor's quote did not reflect his personal opinion and it in fact it was an invitation for interfaith dialogue."[7]

Adding to this, the recent declaration of a Florida Pastor Terry Jones for burning the Holy Qur'an on the anniversary of the 11th of September and the bad mainstream reaction of Americans against Barack Obama's authorization for Muslims to set up a mosque few meters far away from the Manhattan site, are all factors that show how the state of Islam is conceived and perceived in the U.S media.

With all these pieces of information in mind, this paper seeks to explore the actual image of Islam in *The New York Times* (NYT) daily newspaper during the Arab Spring. I shall meanwhile contend that all misconceptions and all forms of misrepresentation lie in the perception of the Muslim-other who is reduced to a mere object and commodity that must be controlled as E. Said has already advocated in his ground-breaking books *Orientalism* and *Culture and Imperialism*. The theoretical framework for this enquiry is articulated within the multidisciplinary scholarship of discourse analysis, a field of study that fascinated theorists of media and cultural studies for so many years.

1 ISLAM, A THREAT OR NOT?

Islam is represented as a threat to America and to the Christian West. Some people claim that it is the new threat to replace the communist fears from the Cold War. Human history bears witness that military conflicts and the bloody confrontations between Islam and the Christian West hark back to the advent of Islam in the Seventh century and continues with the Byzantine empire, the crusades, the fall of the Muslim Spain and Constantinople, the colonial eras, the cold war and the post cold war and, and above all, the tragic events of 9/11.

Because of this, Islam becomes a widely misunderstood religion. America has many stereotypically-based views about Islam owing to the bad intervention of the U.S. print media, whose reports about Islam are inaccurate, incorrect and they lack much credibility in terms of facts. The American audience is invariably misinformed about Muslims through the wrong images they read about in newspaper articles and watch in Hollywood movies. This palpable reality urged some to call for a new invasion into the land of Muslims and, henceforth, bring all Muslim subjects under America's sway. "We should invade their countries, kill their leaders and convert them to Christianity."[8] Reporters on Islam often contend that Muslims are sub-

[3] *Shryock, Andwrew. Islamophobia: Beyond the politics of Enemy and Friend. USA: Indiana University, 2010. 4.*
[4] *Koubali, Jamal. "Islam in the US press." Middle Ground. Issue N° 1. Morocco: Manibel, 2007. 68.*
[5] *Samovar, Larry, et al. Intercultural Communication: A Reader. USA: Wadswarth, 2006. 165.*
[6] *Ibid.*
[7] *Ibid.*
[8] *O'Shaughnessy, Nicholas J. Politics and Propaganda: Weapons of Mass Seduction. UK: Manchester University Press, 2004. 126.*

humans almost like animals or even worse, and that the Arab world is a world of contradictions wherein only the fittest can survive.

> The Arab World is where innocent people are kidnapped, blindfolded, tied up, tortured and beheaded, and then videotape of all of this is released to the world as though they're somehow proud of their barbarism.[9]

Even Muslim's God is mysteriously depicted, exoticized and viewed as different. "The God of Islam is not the same God. He's not the son of God of the Christian or Judeo-Christian Faith. It's a different God, and I believe it is a very evil and wicked religion." [10] According to Yvonne Haddad, a specialist on Islam in the West, Muslims have an image problem:

> For Muslims…discrimination has been aggravated as a consequence of growing hostility towards Islam in the West, sometimes called 'Islamophobia.' Recently, the religion factor has been especially significant. The stereotyping that has come from media responses to international events usually has repercussions on Muslims living in minority communities in the West. They [Muslims] become the focus of attention and scapegoating.[11]

In his Op-Ed column headlined "Is Islam the Problem?" published on March 5, 2011, Nicholas D. Kristof delves into the Muslim world's backwardness; he criticizes the assumption that Western colonialism could be the reason for the state of chaos pervading in the lands of Muslims, and sides with Professor Kuran, who persuasively contends that

> What held the Middle East back wasn't Islam as such, or colonialism, but rather various secondary Islamic legal practices that are no longer relevant today.[12]

Apologists of this claim assume that Islam is a traditional religion and it cannot fulfill the demands of the progressive modern-day world. Many years ago, the Muslim culture put Europe in the shade thanks to many great achievements in astronomony, mathematics, and medicine, but such glory has boiled down due to many reasons which Islam is not accountable for. Consider the following abstract taken from the same Op-Ed.

> Many Arabs blame outsiders for their backwardness, and cope by rejecting modernity and the outside world. It's a disgrace that an area that once produced outstanding science and culture (giving us worlds like algebra) now is an educational underachiever, especially for girls."[13]

Nicholas Kristof presumes that the Prophet Muhammed was a successful merchant, much more sympathetic to the wealthy than Jesus was. He believes that the revolts of the Arab Spring called for a democracy, and strongly confutes the idea that the Arab world's backwardness can be traced up to Islam. This is clearly manifest in the following excerpt.

> Yet after 1200, the Middle East took a long break: it stagnated economically, and today it is marked by high levels of illiteracy and autocracy. So as the region erupts in protests seeking democracy, a basic question arises: What took so long? And, a politically incorrect question: Could the reason for the Middle East's backwardness be Islam?[14]

Nicholas Kristof, who exposed the chaos in Darfur and Egypt and led a call to action for the world community to take steps to end several outbursts in many areas boiling with military conflicts, admits that in his career, he attempted to remain impartial while reporting news, but the story of the student democracy movement in China and its subsequent suppression, forced him to take sides,

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[9] *Jack Cafferty, host of CNN's American Morning show, 17 Nov. 2004.*
[10] *Mark, Allman J. Who Would Jesus Kill? USA: The Confraternity of Christian Doctrine, 2008. 150.*
[11] *Margret, Nydell K. Understanding Arabs: A Guide for Modern Times. USA: Intercultural Press, 2006. 137.*
[12] *Nicholas, Kristof D. "Is Islam the Problem?" The New York Times on the Web. 5 Mar. 2011. 27 Feb. 2012 <http://www.nytimes.com/2011/03/06/opinion/06kristof.html>.*
[13] *Ibid.*
[14] *Ibid.*

> How could I not stand with the students in the face of government troops that were murdering these young people simply for expressing their opinions.[15]

Among all Muslim countries, Iran is reported every now and then as having conflicts with America. Lots of sanctions and inducements could not persuade her from giving up its nuclear ambitions. America, on behalf of the international community, demanded that Iran stop enriching uranium, but Iran alleged that it only wanted access to nuclear technology for electricity and peaceful purposes. An editorial appearing on January 13, 2012 of the NYT sheds light on this problem:

> With tensions rising over Iran's nuclear program, the Obama administration has no warned the country's supreme leader, Ayatollah Ali Khamenei, that Iran's threat to close the strait of Hurmuz would provoke an American response.[16]

According to the latest report from the UN inspectors, Iran was able to conduct experiments on nuclear triggers, has created computer models of nuclear explosions, and completed advanced research on a warhead that could be delivered by a medium-range missile. America and Europe have been imposing their own penalties on Iran, yet the latter's recent threat to shut the Strait of Hermuz, gateway to one-fifth of the world's oil trade, is, according to the editorial, "an obvious sign of its growing economic desperation."[17]

Though subjected to an accelerating campaign of assassinations, bombings, cyber-attacks and defections, Iran is held guilty for plotting to kill foreign diplomats and bomb a Saudi embassy on American soil.

> Abdullah Alshamri, a Saudi official in Riyadh...said the plot that the Justice Department said it had broken up was only the latest Iranian attempt to attack Saudi diplomats. "This is their hobby," he said. "Iran has no respect for international law."[18]

In another column featuring on September 2, 2011, Eliyahu Stern assures the NYT readers worldwide not to fear Shariah and the Islamic law. He believes that the crusade against Shariah law undermines American democracy, ignores America's rich history of religious tolerance and assimilation, and worse, creates a large gap between America and its fastest-growing Muslim minority.

> The suggestion that Shariah threatens American security is disturbingly reminiscent of the accusation, in 19th-century Europe, that Jewish religious law was seditious. In 1807, Napoleon convened an assembly of rabbinic authorities to address the question of whether Jewish law prevented Jews from being loyal citizens of the republic. (They said that it did not)[19]

Like all religious minorities, American Muslims feel obliged to adjust their legal and theological traditions to conform to the American values. A recent Pew Research Center Poll found that

> Muslim Americans exhibit the highest level of integration among major American religious groups, expressing greater degrees of tolerance toward people of other faiths than do Protestants, Catholics or Jews. [20]

Yet, those who assume that "Shariah is a mortal threat to the survival of freedom in the United States and in the world,"[21] are totally wrong. They forget to remember in this respect that America, once the dreamland, was a shelter for many people of different races and faiths. This was possible because America itself was capable of transforming itself culturally and even religiously. An Abrahamic ethic embracing Islam is now needed into the religious tapestry of American life. The

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[15] *Melissa, Steffan. "Nicholas Kristof: How a New York Times columnist rewrote opinion Rewrote Opinion Journalism." The Washington Post on the Web. 29 Nov. 2011. 25 Feb. 2012 <.http://www.washingtonpost.com/national/on leadership/nicholas-kristof-how-a-new-york-times-columnist-rewrote-opinion journalism/2010/11/28/gIQA 7PHY8N_story.html>.*

[16] *Editorial. "Dangerous Tension With Iran." The New York Times on the Web. 12 Jan. 2012. 25 Feb. 2012 <http://www.nytimes.com/2012/01/13/opinion/dangerous-tension-with-iran.html>.*

[17] *Ibid.*

[18] *Ibid.*

[19] *Eliyahu, Stern. "Don't Fear Islamic Law in America." The New York Times on the Web. 2 Sep. 2011. 24 Feb. 2012 <http://www.nytimes.com/2011/09/03/opinion/dont-fear-islamic-law-in-america.html>.*

[20] *Ibid.*

[21] *Shane, Scott. "In Islamic Law, Gingrich Sees a Mortal Threat to U.S." The New York Times on the Web. 21 Dec. 2011. 24 Feb. 2012 <http://www.nytimes.com/2011/12/22/us/politics/in-shariah-gingrich-sees-mortal-threat-tous.html>.*

commonalities among Muslims, Jews and Christians must be accentuated to allow peace to take its course and American laws should protect the rights of Muslims and other religious minorities.

2 THE BURQA AND THE BIKINI?

Many columnists in the NYT papers have negatively portrayed Muslim women, insisting that Islam oppresses them, deprive them of their freedoms.

> The burqa worn by Afghan women was widely viewed in the West as symbolic of Muslim's subjugation and oppression and Islam's inability to co-exist alongside Western concepts of modernity and democracy. [22]

In a pre-9/11 diatribe against Islam and Muslims, Julie Birchill, a reporter in *The Guardian,* described Islam as "shit" and "burqa" as "mobile prisons"[23]. Muslim scholars agree that the 9/11 has given US journalists and commentators an opportunity to ridicule Islam and Muslim women. The NYT continues to show typical images of Muslim women wearing black clothes and looking both oppressed and different.

Veiled in black from head to toe, Muslim women are represented as a strong threat to American liberal values. These females rendered in black are underscored at the expense of others. On January 23, 2012, Neil MacFarquhar wrote a column about an Iranian teen girl aged 14 called Zahra Noorbakhsh who would defy the family ban on mingling with boys. Misunderstanding within the Muslim family, and between the daughter and her Iranian immigrant mother is highlighted:

> 'Zahra, you have a hole,' her mother started. 'For the rest of your life, men will want to put their penis in your hole. It doesn't matter who you are, what you like, who is your friend'. Young Zahra staggered from the car thinking: 'I have a what?! A hole? Where? Was that what I had missed in sex ed the one day I had the flu?[24]

The following exchange, recounted in a new anthology of essays about flirting, dating and sex published under the title "Love, InshaAllah: The Secret Love Lives of American Muslim Women," sought to dispel the stereotype of Muslim women as mute and oppressed. "InshAllah", the Arabic word for "God willing," was included in the title to proffer the book an exotic dimension. The pitfalls of converts are rendered to justify whatever contradiction that is more likely to inhere in Islam.

Angela Collins Telles, a convert, aged 36, described the almost unbelievable twists of fate that she overcame in finding her Brazilian husband, including all manner of un-Islamic behavior, starting with their first chance encounter in a bar and proceeding through a platonic night in a hotel room.

> 'I know my story will be looked on with a frown by people who know me, but that is O.K.,' said Ms. Collins Telles, a former elementary school principal, particularly since her husband also converted, and they now have two small sons. [25]

In a sarcastic tone, some issues are raised in the NYT, as what to do when a Muslim girl's date surprises her with a bottle of Champagne and how Muslim families would react to the question of premarital sex.

> It is doubly hard for Muslim women, because we want to complain about our men without everyone turning around to say, ' See, I knew they were all crazy terrorists,' said Ms. Noorbakhsh, a 31-year-old comedian, who after describing her sex education talk goes on to detail losing her virginity in college. "'You leave yourself vulnerable to people using your voice to attack your community, so we kind of censor our voices."[26]

Women, especially in Saudi Arabia are brought into focus. They are denied some rights: the right to vote in elections, to drive a car and to practise their daily tasks more freely. They are sometimes perceived as an object that is voiceless and

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[22] *Shirazi, Faegheh. Muslim Women in War and Crisis: Representation and Reality. USA: The University of Texas Press, 2010. 255.*
[23] *Ibid.*
[24] *MacFarquhar, Neil. "Lifting Veil on Love and Islam." The New York Times on the Web. 23 Jan. 2012. 19 Feb. 2012 <http://www.nytimes.com/2012/01/24/books/in-love-inshallah-american-muslim-women-reveal-lives. html>.*
[25] *Ibid.*
[26] *Ibid.*

unable to have a say in family affairs, and at other times depicted as rebels against their patriarchal regimes. Neil MacFarquhar and Dina Salah Amer reported on June 12, 2011 the following:

> Several dozen women drive in defiance of the law in major cities of Saudi Arabia on Friday, according to reports on social media and by an informal network of activists in the country. There appeared to be few confrontations reported with the traffic or morals police, and at least half a dozen women who were stopped were escorted home and admonished not to drive, said activists reached by telephone.[27]

Some pertinent questions need to be asked such as: what are the sources from which the NYT columnists get their news? Do these columnists know the Arabic language and its complex varieties to write upon issues of this kind? Or do they simply rely on local freelance translators to get at the news dish?

> "Women in Saudi Arabia see other women in the Middle East making revolutions, women in Yemen and Egypt at the forefront of revolutions, being so bold, toppling entire governments," said Waleed Abu Alkhair, whose wife drove around Jidda. "The women of Saudi Arabia looked at themselves and they realized, "Wow! We can't even drive!'"[28]

The choice of themes is not gratuitous in the NYT daily; it backs up the claim that the US media is concerned mainly and only with some exotic and bizarre aspects of the Muslim culture. Dwight Garner has examined the lives of what he called two "warriors" of militant Islam. He, not much different from other reporters, would introduce his column with a hypothesis to trigger off suspense on the NYT readership. Consider the if-clause below as well as the third personal pronoun "you," implicitly involving the reader to take a stance somewhere in the column:

> If you were the Franklin mint and wanted to issue a set of four collectible dinner plates devoted to "The Women of the War on Terror," whose faces would appear on them? Condoleeza Rice, George W. Bush's national security adviser during 9/11, would surely smile up from one. As would Lynndie England, "The lady with the leash," as Mick Jagger sang on the 2005 Rolling Stones song "Dangerous Beauty." Plates 3 and 4? They would almost certainly depict Ayaan Hirsi Ali and Aafia Siddiqui, the subjects of Deborah Scroggins's sober provocative new book, "Wanted Women."[29]

The stories of these dissimilar Muslim women have been intricately composed by Ms. Scroggins in a dual biography. Seen as veritable opposites, the author memorably notes, these Muslim women are like

> The bikini and the burka or the virgin and the whore, you couldn't quite understand one without understanding the other. [30]

If one is wondering who is the bikini (and consequently the whore) in that quote, Ms. Scroggins leaves little suspicion that it is Ms. Hirsi Ali, whom her book relentlessly attacks, sometimes persuasively and tendentiously. Ms. Hirsi Ali is a Somalian-born former member of the Dutch Parliament. She wrote the best-selling memoir "Infidel" (2007).

> Raised as a devout Muslim, Hirsi Ali, renounced her faith after arriving in Holland and now calls herself a "Muslim" atheist." She says she fled to Holland to escape a forced marriage to a distant relative in Canada…As a youth, she says, she supported calls by Iran's Ayatoallah Khomeini for the murder of Salmane Rushdie, author of *The Satanic Verses*. [31]

In the words of the British journalist, Andrew Anthony, a news reporter for *The Guardian* and *The Observer*, Hirsi Ali looks almost "Like a fashion model and [she] talks like a public intellectual.[32]" She was brought up as a Muslim fundamentalist in Kenya, where she was subjected to genital cutting, yet she would escape to the West and emerge as an inflammatory critic of Islam, notably on issues related to women.

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[27]MacFarquhar, Neil. "In a Scattered Protest, Saudi Women Take the Wheel." The New York Times on the Web. 17 June 2011. 19 Feb. 2012 <http://www.nytimes.com/2011/06/18/world/middleeast/18saudi.html>.

[28]Ibid.

[29]Dwight, Garner. "Warriors on 2 Sides of Militant Islam." The New York Times on the Web. 15 Jan. 2012. 19 Feb. 2012 <.http://www.nytimes.com/2012/01/16/books/wanted-women-faith-lies-the-war-on-terror-review .html>.

[30]Ibid.

[31]Israeli, Raphael. The Islamic Challenge in Europe. USA: Transaction Publishers, New Brunswick, New Jersey, 2008: 81-82.

[32]Garner, Dwight. "Warriors on 2 Sides of Militant Islam." The New York Times on the Web. 15 Jan. 2012. 19 Feb.2012<http://www.nytimes.com/2012/01/16/books/wanted-women-faith-lies-the-war-on-terror review.html>.

A 2008 NYT article comparing Hirsi Ali and Manji concludes that, despite their stark differences, these two women share many points. Whereas Hirsi Ali seeks to change Islam from outside, Manji tries that from inside. Yet, both women could be seen as staunch feminists:

> No element more thoroughly informs the work of both women than feminism; its influence on their thinking can hardly be overstated, and in this sense they might be considered crown jewels in the history of the modern women's movements. …As feminists, Ms. Hirsi Ali and Ms. Manji are demanding more than equality; they are very self-consciously challenging the foundations of an entire way of life.[33]

Aayan Hirsi Ali and Irshad Manji are the most known authors who would regularly appear in such widely circulated outlets as *The New York Times*, *Newsweek*, *USA today*, and *The Washington Post*. Much has been written about them and the significant congruence between them, more precisely their "escape" experiences from the house of Islam to that of Christians. While Manji fled an Islamic school in a Vancouver suburb that suppressed her ability to ask critical questions, Hirsi fled a forced marriage to the Netherlands.

The other woman who embodies the burqa, again Ms. Scroggins leaves no doubt, is Ms. Siddiqi. She is a Pakistani-born Muslim woman, who left for America to study neuroscience and earned degrees from the Massachusetts Institute of Technology and Brandeis University. Married to a Pakistani doctor who was accepted to study for a master's degree at Harvard, and with whom she had three children, Ms. Siddiqui had indeed been in the U.S. news. *The Philadelphia Inquirer* hit the street with an alarming story, announcing with a four-column banner headline across the front page:

> "U.S. Seeks 7 in Terror Alert." Above the headline the paper displayed small mug shots of seven Middle Easterners, six men and a woman, collectively described as "armed and dangerous"-a characterization taken from comments made by Attorney General John Ashcroft. Siddiqui was one of the seven. [34]

Stephan Salisbury gave the following portrait of her,

> She is a Pakistani woman with an MIT doctoral degree with large, round eyes, wide mouth, and curving, Picasso-esque lips. [35]

According to Dwight Garner, Ms. Siddiqui became a nearly psychotic anti-Semite, and began dabbling in pro-jihad organizations in America. In 2003 the F.B.A. named her the only known female operative of Al Qaeda. Laura Sjoberg and Caron E. Gentry spoke of her arrest:

> In 2008, she was arrested in Afghanistan with bomb-making materials, instructions, and a list of New York landmarks in her possessions. At the scene of the arrest, she managed to shoot at the agents before being shot herself. In February 2010, she was found guilty of attempted murder. [36]

Ms. Scroggins, a veteran reporter, whose very first book, "Emma's War" (2002), was about a young British aid worker and tarnished idealism in the Sudan, drew an analogy between Ms. Ali Hirsi and Ms. Aafia Siddiqui. She concluded:

> They were both in their early 30s…They were both fiercely intelligent. They both came from politically ambitious families. They had both been tossed about among Africa, Asia, Europe and the United States ever since childhood…They shared a kind of warrior mentality. Both prized fearlessness. They were both rebels.[37]

Interestingly enough, one can note that each woman epitomized a complicated intellectual Muslim background; this evinces clearly in the different directions they have gone, one becoming a Westernized feminist and the other a militant Islamist. Dwight Garner argues for the very beguiling aspect of Hirsi's personality:

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[33] *Butler, Judith & Weed, Elisabeth. The Question of Gender: Joan W. Scott's Critical Feminism. USA: Indiana University press, 2011. 121.*
[34] *Salisbury, Stephan. Mohammed Ghosts: An American Story of Love and Fear in the Homeland. New York: Nation Books, 2010. 7.*
[35] *Ibid.*
[36] *Sjoberg, Laura & Gentry, Caron E. Women, Gender, and Terrorism . USA: The University of Georgia Press. 2011, 181.*
[37] *Garner, Dwight. "Warriors on 2 Sides of Militant Islam." The New York Times on the Web. 15 Jan. 2012. 19 Feb. 2012 < http://www. nytimes.com /2012/01/16/books /wanted-women-faith-lies-the-war-on-terror-review .html>.*

> It is possible to appreciate both burkas and bikinis and still wonder why [Scroggins] book's sympathies seem to be with the woman who hoped to speak through the most destructive weaponry available.[38]

While some Muslim women were severely criticized in The NYT publication, few of them had been positively portrayed. In his report launched on December 27, 2010, Brian Knowlton opted for an unprecedented headline, "Muslim Women Gain Higher profile in U.S," perhaps to deracinate the monotonous Hollywood images about Muslim women from the American intellect:

> These women have achieved a level of success and visibility unmatched elsewhere. They say they are molded by the freedoms of the United States-indeed, many unabashedly sing its praises-and by the intellectual ferment stirred when American-born and immigrant Muslims mix. [39]

Though they had been the object of abusive letters, racist e-mails and humiliating blog posts, Muslim women tried to get integrated into the American society by breaking some outmoded stereotypes and correcting American people's views regarding Islam and Muslim women. According to a Gallup survey in March 2009, Muslim women are better educated than their counterparts in Western Europe, and also than the Average American. The Gallup also found that Muslim American women are entrepreneurial, coming so closer than women of other faith to earning what their menfolk do.

Historically speaking, Muslim women have wielded power and worked from behind the scenes. Another survey conducted in 2009 by Georgetown University and the Royal Islamic Strategic Center of the world's most influential Muslims, listed just 2 women in the top of 50: a Syrian religious leader and Queen Rania, wife to the Jordanian king. Mr. Knowlton mentions three successful Muslim female figures who managed to outperform their American peers: Ms. Soumaya Khalifa, Ms. Mattson and Ms. Taylor.

The first was born in Egypt and raised in Texas. She is heading a consultancy working with students, executives, soldiers and even the F.B.I. Her sole aim is to do away with all stereotypes and prejudices that target Muslims in America and elsewhere.

> Ms. Khalifa, who has degrees in chemistry and human resources, began wearing a headscarf in her mid-30s, about 15 years ago. At first, she said, people looked at her "like I was different, Muslim, un-American, stupid."[40]

This Muslim woman was delineated as being defiant, persistent and strongly determined to reach her professional purposes. So, when a small-town newspaper declined her idea to run ad listing the hours of a nearby mosque, Ms. Khalifa was capable of organizing a successful boycott by local churchmen.

The second Muslim woman who caught Knowlton's attention is the American Ms. Ingrid Mattson. She is seen as being a fabulous and a highly noticed figure among American Muslim women probably thanks to her religious and political charisma.

> In a bright-red jumper and multicolored head scarf, she stood out among the gray-haired clerics in black who gathered in Washington in September to try and defuse the anger over the planned mosque near the World Trade Center site in New York. [41]

Ms. Mattson was the first woman to head the Islamic Society of North America, one of the largest Muslim associations on the continent. She is 47 years old and lectures at the Hartford Seminary in Connecticut. Knowlton lists Ms. Mattson achievements and, meanwhile, focuses on the limitations that encircle Muslim women practices:

> "The only area where there is a limitation is religious leadership-the imam," she added, predicting that "we will have some communities in the future that have female imams."[42]

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[38] *Ibid.*
[39] *Knowlton, Brian. "Muslim Women Gain Higher Profile in U.S." The New York Times on the Web. 27 Dec. 2010. 19 Feb. 2012 <http://www.nytimes.com/2010/12/28/world/middleeast/28iht-muslim28.html>.*
[40] *Ibid.*
[41] *Ibid.*
[42] *Ibid.*

The news report, presented in the form of interviews, stresses that Muslim women in the United States reflect the country's diversity: white converts like Ms. Mattson , women from the Middle East like Ms. Khalifa, or Tayyibah Taylor, a convert of Caribbean background in Atlanta, have all struggled for an Islamic identity in America.

> "I did not see Islam as taking my freedoms as a woman," said Ms. Taylor, who is 57 and studied the Koran in Jidda for six years." It really opened up worlds for me."[43]

Gender separation at prayer times is also at issue, an issue that is imposed to reflect what Knowlton has named notions of "modesty," bringing to the fore the very antiquated slogan "The best rows for women are the back rows and the worst are the front rows." While deeply concerned to consolidate some negative and discriminatory images about Muslim women, the NYT often repeatedly fails to remind the American public that in Islam many women have had the opportunity to serve as chairs to political parties, advisors to kings, MPs and that they managed to climb the summit of the whole pyramid in their societies.

3 THE ARAB SPRING LEADERSHIP

Some years ago, Ron Carlson (1973), the president of Christian Ministries International, wrote the following words:

> Muhammed took the political laws which governed seventeeth century Arabian tribes and literally made the laws of Allah, their God. In such tribes, the sheikh or chief of the nomadic tribes had absolute authority. There were no concepts of civil or personal rights in seventh-century Arabia. This is why Islamic countries are inevitably ruled by dictators or strong men who rule as despots. There are 21 Arab nations today, and not one of them is a democracy. Democracy cannot flourish in Islam.[44]

This Islamphobic attitude has been negated by Jean-Marie Guéhenno, a former United Nations under-secretary general for peacekeeping operations and a professor of professional practice at the Saltzman Institute of Columbia University, who saw public social media networks as the motor of change in the Arab world. He pointed up,

> The Arab revolutions are beginning to destroy the cliché of an Arab world incapable of democratic transformation. But another caricature is replacing it: according to the new narrative, the crowds in Cairo, Benghazi or Damascus, mobilized by Facebook and Twitter, are the latest illustration of the spread of Western democratic ideals; and while the "rise of the rest" may challenge the economic dominance of Western nations, the West will continue to define the political agenda of the world."[45]

The columnist argues that the movements that destabilized the Arab world are profoundly different from the revolutions that toppled down the Soviet empire. 1989 and 2011 could be seen as two facets of the same coin, connecting in a self-congratulatory way the political appeal of democracy, the transformative power of new technologies in media and social networking.

> The Arab Spring is about justice and equity as much as it is about democracy, because societies in which millions of young men and women have no jobs-and millions live with less than two dollars a day-crave justice as much as democracy.

Vali Nasr, the author of *The Shia Revival: How Conflicts Within Islam Will Shape the Future*, preferred to tackle the same issue from another angle. His column, "If the Arab Spring Turns Ugly," appearing on August 27, 2011 grapples with sectarian divisions in the Middle East between Shiite and Sunnis, conflicts and instability in the region, is worthwhile mentioning.

> The Arab Spring is a hopeful chapter in Middle Eastern politics, but the region's history points to darker outcomes. There are no recent examples of extended power-sharing or peaceful transitions to democracy in the Arab world. When dictatorships crack, budding democracies are more than likely to be

[43] *Ibid.*
[44] *Carlson, Ron & Decker, Ed. Fast Facts on False Teachings. USA: Harvest House Publishers, 1994. 104.*
[45] *Guéhenno, Jean-Marie. "The Arab Spring is 2011, Not 1989." The New York Times on the Web. 21 Apr. 2011. 19 Feb. 2012 <http://www.nytimes.com/2011/04/22/opinion/22iht-edguehenno22.html>.*

> greeted by violence and paralysis. Sectarian divisions-the bane of many Middle Eastern societies-will then emerge, as competing groups settle old scores and vie for power.[46]

Nasr reminds us of the brutality of Bashar al-Assad's regime, which, in his view, had opened a hazardous fissure between the Alawite minority, which rules the country, and the majority Sunni population.

> After Mr. Assad's butchery in the largely Sunni city of Hama on July 31, on the eve of the holy month of Ramadan, the Muslim Brotherhood, a Sunni group, accused the regime of conducting "a war of sectarian cleansing." It is now clear that Mr. Assad's strategy is to divide the opposition by stoking sectarian conflict.[47]

In a thoughtful op-ed, Nicholas Noe makes the case for negotiating with Bashar al-Assad-for "bargaining with the devil."[48] In his words,

> MR. ASSAD is a brutally repressive and dangerous leader who is responsible for most of the death and destruction that has plagued Syria in recent months,"[49]

The Syrian leader is definitely so different from King Abdullah of Transjordan, who annexed the West Bank in 1948, and was viewed by *The Time* as "The little man… [with] an impish smile… [who] had waited long to become cock of the Arab walk" (*Time*, May 24, 1948, p.33)[50]. He is neither Col. Muammar el-Qaddafi, whom Ronald Reagan once famously called the "Mad dog of the Middle East,"[51] nor Mr. Ben Ali, "The ousted [Tunisian] president"[52] nor even the Egyptian leader Mr. Hosni Mubarak whom a NYT editorial preferred to dub as "The all-powerful pharaoh...now powerless and facing justice,"[53] nor the "Fourth Arab autocrat forced from power in the wave of popular uprisings,"[54] the Yemeni leader Abdullah Saleh, who was granted an immunity from being prosecuted and allowed entry into U.S after a landmark deal approved by the Yemeni Parliament.

Admittedly, the NYT agency tends to deploy metaphors in its portrayal of the Muslim/Arab leaders in pre/post-Arab Spring. These metaphors are meant to trigger off particular images in the minds of Americans; hence bolstering the old-fashioned stereotypes that Arabs/Muslims are like animals, and this is why they are lagging behind. Drawing a comparison between Muslim/Arab leaders and other creatures and finding similarities between the two is something pervasive in the NYT pages.

Ben Laden, the ex-spiritual leader of al-Qaeda Organization, who was elevated to the realm of evil in the American imagination once reserved for dictators like Hitler and Stalin, is pictured in the NYT and other outlets as "The monster,"[55] the source of terror. He has doubtless inspired the Taliban fighters reported as the "Taliban Guerrillas."[56] Muslim intellectuals are also made uneasy by the appellation "axis of evil,"[57] a denomination initially used by the former U.S. President George W.

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[46] *Nasr, Vali. "If the Arab Spring Turns Ugly." The New York Times on the Web. 27 Aug. 2011. 20 Feb. 2012 <http://www.nytimes.com/2011/08/28/opinion/sunday/the-dangers-lurking-in-the-arab-spring.html>.*

[47] *Ibid.*

[48] *Noe, Nicholas. "In Syria, We need to Bargain With the Devil." The New York Times on the Web. 6 Feb. 2012. 20 Feb. 2012 <http://www.nytimes.com/2012/02/07/opinion/in-syria-we-need-to-bargain-with-the devil.html >.*

[49] *Ibid.*

[50] *Kamalipour, Yahya R. The U.S. Media and the Middle East: Image and Perception. USA: Greenwood Publishing Group, Inc, 1995. 41.*

[51] *Lbiya, "the Most Sureal Country on Earth." The New York Times on the Web. 7 Oct. 2011. 20 Feb. 2012 <http://www.nytimes.com/2011/10/09/magazine/reply-all-libya.html>.*

[52] *Kirkpatrick, David K. "Ex-Tunisian President Found Guilty in Absentia." The New York Times on the Web. June 20, 2011.<http://www.nytimes.com/2011/06/21/world/middleeast/21tunisia.html>.*

[53] *Editorial. "Mr.Mubarak on Trial." The New York Times on the Web. August 5, 2011. <http://www.nytimes.com/2011/08/06/opinion/mr-mubarak-on-trial.html>.*

[54] *Kasinof, Laura. "Yemen's Election Ensures Leader's Exit." The New York Times on the Web. February 21, 2012. <http://www.nytimes.com/2012/02/22/world/middleeast/yemen-votes-to-remove-ali-abdullahsaleh. saleh.html>.*

[55] *Zernike, Kate & Kaufman, Michael T. "The Most Wante Face of Terrorism." The New York Times on the Web. 2 May 2011. 22 Feb. 2012 < http://www.nytimes.com/2011/05/02/world/02osama-bin-laden-obituary.html>.*

[56] *Filkins, Dexter. "Afghan Tribe, Vowing to Fight Taliban, to Get U.S. Aid in Return." The New York Times on the Web. 27 Jan. 2010. 22 Feb. 2012 < http://www.nytimes.com/2010/01/28/world/asia/28tribe.html>.*

[57] *Clemens, Walter C. "Listening to the Axis of Evil." The New York Times on the Web. 4 Nov. 2011. 22 Feb. 2012 <http://www.nytimes.com/2011/11/04/opinion/listening-to-the-axis-of-evil.html>.*

Bush describing governments that he accused of supporting terrorism and seeking weapons of mass destruction. Mr. Bush would label Iran, Iraq and North Korea as the axis of evil often throughout his presidency.

It is believed that Islam has no problem with America; rather, the Judeo-Christian world has a problem with some aspects of Islam. Lawrence Cunningham, a U.S. scholar and a significant expert in law and accounting, talks about this never-ending conflict. He claims that,

> "The Antagonism between the Christian West and the world of Islam has a long and bitter history."[58]

It is an antagonism that reflects itself today in the persecution of Muslims and their portrayal as fundamentalist and backward terrorists. Laurie Goodstein confessed that Evangelicals sought converts and saw Islam as an "Evil" Faith.

> On a recent Saturday in a church fellowship hall here, evangelical Christians from several states gathered for an all-day seminar on how to woo Muslims away from Islam. The teacher urged a kindly approach: always show Muslims love, charity and hospitality, he said, and carry copies of the *New Testament* to give as gifts. The students, scribbling notes, included to pastors, a school secretary and college students who said they hoped to convert Muslims in the United States, or on mission trips abroad.[59]

In evangelical seminaries and churches, books and lectures criticizing Islam and vilifying Muslims and promoting strategies for Muslim conversions are gaining currency across America. Throughout history, evangelical scholars believed that all other religions are wrong. Yet, they would cite a wide range of reasons for their quickening interest in Islam:

> The American defeat of a major nation, Iraq, which may open it to Christian missionaries, while other Muslim nations remain closed; The 2001 terrorist attacks, which led many Americans to see Islam as a global threat; The great numbers and visibility of Muslims in the United States; The demise of Communism, once public enemy No.1 for many evangelical organizations.[60]

The evangelical teacher quoted above, has provided the would-be-missionaries with some snippets of advice on what to do to convert Muslim subjects with no problems. Don't approach them in groups. Don't bring them to your church, because they will mishear the singing and clapping as a party. Instead, do invite them home for a meal. Do bring them chocolate chip cookies. Do talk about how, in order to get saved, they must accept Jesus.

> "Our job," he said, "is not to make the Muslim a Christian, our job is to show them the love of Christ."[61]

As we mentioned somewhere above, historians observe that the enmity between Christianity and Islam dates as far back the Crusades, the fall of Byzantium and the reconquest of Spain. The news reporter fairly advocated that the evangelical teacher previously cited,

> Intermingled accepted facts with negative accounts of Islamic teaching, history and traditions. The pilgrimage to Mecca, he said, "is a dangerous event at which people are killed every year". Communal prayers each Friday are "a day of rage," he said.[62]

Despite the falsified and very-often-magnified images which the NYW propagates about Islam/Arabs, it should be made clear that Muslims fought to preserve American independence in the War of 1812 and for the Union of the Civil War. Also, thousand of them were involved on active duty in the American armed forces working side by side their American compatriots to fight "Terrorism." What is more, the U.S. Supreme Court building contains a likeness of the Prophet of Islam, whose vision of justice is cited as an important precedent to the U.S. Constitution.

CONCLUSION

[58] *Cunningham, Lawrence S & Reich, John J. Culture and Values: A Survey of the Humanities. USA: Wardswarth, 2010. 184.*
[59] *Goodstein, Laurie. "Seeing Islam as 'Evil' Faith, Evangelicals Seek Converts." The New York Times on the Web. 27 May 2003. 20 Feb. 2012 <http://www.nytimes.com/2003/05/27/us/seeing-islam-as-evil-faith-evangelicals-seek-converts.html>.*
[60] *Ibid.*
[61] *Ibid.*
[62] *Ibid.*

In a nutshell, stereotypes targeting Islam/Arabs would never help in any eventual interfaith or intercultural dialogue between America and the world of Islam. It is then high time for the Muslim and the American academia to work collaboratively to sensitize the world public of the great hazard in dehumanizing, or stereotyping a human being of whatever racial, religious or cultural background. The NYT, being the most widely-circulating publication, ought to in turn contribute to this dialogue via minimizing these stereotypes in its columns.

It is thus to be hoped that the American mass media, and the NYT in particular, must work to acknowledge the other's "right to be different" on the common understanding of universal human values shared by everybody, and the threats menacing these values. This, I do believe, may gradually evolve towards a real alliance between America and the world of Islam.

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The Role of Information Communication Technology in Quality Services Delivery at Babcock University Library, Ilishan-Remo, Nigeria

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ABSTRACT: The aim of this paper was to discuss the key role of information communication technology in quality services delivery at Babcock University Library. Libraries have always been regarded as service oriented centers which, if they integrate the use of ICTs, could provide timely, relevant, reliable and current information. The effective use of the ICT will make librarians more competent and this will, in turn, make their libraries more competitive in their strategic marketing plan. The paper, among other things, highlighted the user based components of ICT application and services that, when adequately put in place and effectively used, could afford Babcock University library a competitive advantage over other libraries. Finally, it concluded by making some recommendations to Babcock University library administrators on what could be done to create and maintain services that the customers will perceive as being more superior to those of their competitors.

KEYWORDS: Library, Information Communication Technology, Quality Services, Competitive Intelligence, Competitive Advantage.

INTRODUCTION

The library has always been regarded as a service oriented center. Its role is to support the mother institution by meeting the information needs of the users. The importance of the library, Onohwakpor (2006) emphasizes, is that it is a store of knowledge, indispensable to the success of any functional education. Afolabi and Abidoye (n.d) assert that the essential role of the library is to provide information services to support educational, recreational, cultural, economic, and technological endeavors. Further, the International Federation of Library Association and Institutions (IFLA) (2003) adds that the library and information services contribute effectively to the development and maintenance of intellectual freedom in that they provide unhindered access to essential resources for economic and cultural advancement. Consequently, education without the services of library is poor.

Quality services have to do with meeting the users' needs with current, adequate and quality product and services, Heat and Cook (2003). The evaluation of service quality is defined by customers for they are, to a large extent, the ones that judge what could be termed as quality. So, library resources and services should be adequate in quality, depth, diversity and currency to ensure that it supports the institution's curriculum effectively. Users of libraries all over the globe want information, irrespective of their format, to satisfy their curiosity or other aspects of needs. According to Bello (2010), users wish for an opportunity to have total and unlimited sources of information whether it is from internal and external environment or information without any kind of restriction. Therefore, meeting their expectations determines their intention to request for more services and, as well, in making regular use of the library information resources. This will, in turn, result in the library gaining competitive edge over their competitors. But if the library fails to offer quality services, users will look for an alternative means to meet up with their information need, which could lead to the loss of library customers. Based on this, Onohwakpor (2006) cautions that since information is scattered in many areas, libraries should keep track of them by

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utilizing the recent developments in information technology (ICT) for effective library services. The outcome of this could bring about better offering of quality services as well as meeting the information needs of the users.

According to Elisha (2006), there is no single way to define ICT. It has to do with uses of digital technology that already exist to help individuals use information. The ICT also covers products such as radios, television, cell phones that enable people to store, retrieve, manipulate, transmit or receive information electronically in a digital form. For Hamelink (cited in Islam and Islam, 2006), ICT has to do with the use of computers, telecommunications and microelectronics in the acquisition, storage, retrieval, transfer and dissemination of information, as well as to enhance literature search. From the above explanations, the application of ICT can facilitate work in the library. Therefore, the library, through the integration of ICTs, could provide timely, relevant, reliable and current information, and this is the core competence that confers competitive advantage.

Miller (2003) claims that competitive intelligence is a systematic and ethical program for gathering, analyzing, and managing information that can affect a company's plans, decisions, and operations. It could be regarded as the process of monitoring a competitive environment. This enables an organization to develop appropriate plans to compete successfully, (McGonagle and Vella, 2002). An important aspect of competitive intelligence, according to Liu and Oppenhiem (2006), is the competitive intelligence environment. This is the external ingredient of the market competitiveness as a whole. This encompasses politics, economics, culture, science and technology, law, the structure of the market, and competitors. They further identify benchmarking, which is the process through which an enterprise compares its own conditions and procedures with those of similar enterprises in the same field, as part of competitive intelligence factors. Based on benchmarking, the enterprise makes its analysis accordingly. Libraries, therefore, are to embrace this approach to provide adequate, quality and satisfactory services to their users.

REVIEW OF LITERATURE

According to Islam and Islam (2006), the use of information communication technology (ICT) in the libraries began in the 1960s. This enabled libraries to improve their efficiency in relation to internal operation and in providing access to resources outside the library. The use of ICTs in the library also helped in the interoperability of information systems as well as in the provision of access to local library resources. Accordingly, Omoniwa (2001) claims that the globalization of information and the adoption of information technology will be the hallmark of great libraries in this twenty-first century. The ICT user based services that could be found in some libraries include computers, the Internet, the Web, Intranet, Extranet, E-mail, On-line retrieval networking, and multimedia.

In the library, computers are facilitating the consolidation of huge amount of information in an organized way; enabling easy retrieval. The libraries and information centers can hardly function without the use of computers and ICTs. The Internet, as one of the user based services found in the library, according to Akintunde (cited in Okiy 2010), is perceived as one of the greatest technological advancements being experienced in this 21st century. Internet is a powerful and dynamic tool for communication and is seen to be the largest single source of information channel, Meheswarappa and Emmanuel (in Parameshwar and Patil, 2009). It has influenced the methods of information gathering and storage and is regarded as a reliable tool for information retrieval as well as dissemination, irrespective of one's geographical location. The Internet has made activities which were viewed as impossible, possible, Odunewu and Olasore (cited in Ikonne, Madukoma, and Onuoha, (2013); Anyira, (2011); Luambano and Nawe, (2004); and Dike, 2000).

Lund (1998) explains that with the use of the Internet, academic researchers and students can obtain information which previously would have required a trip to a specialist library. Libraries which have been experiencing difficulties in meeting the rise in the cost of printed journals have found their burdens eased "by cheaper access to a vast range of electronic journals accessible on the Internet." In addition, he notes that since the Internet was introduce; the growth of online courses have been steadily giving rise to the advent of "virtual University," and this has transformed the whole concept of distance education. Nwankwo (2006) opines that ICTs application to library works and services could be seen as the best way that could be used to assist researchers to adequately solve their literature need for effective research activities.

The issue of competitive intelligence is considered to be important in the library. Competitive intelligence is the ability of an organization to know what competitors have and their competitive strategy. The knowledge gained from this information is then used to enhance the organization's own competitiveness. Regarding competitive intelligence or advantage in library services, Helm (2011) expounds that in a competitive marketplace, up-to-date information can make the difference between "keeping pace, getting ahead, or being left behind." Hence, the essential element of a competitive advantage is the ability of the library, through the integration of information communication technologies (ICTs), to provide timely and adequate

services for the users of the library and to ensure that customers are provided with the level of service they require. Dominic, Goh, Wong and Chen (2010) posit that in this age of customer quality service delivery, an essential strategy to be taken into consideration in order to survive and succeed in today's competitive environment is competitive intelligence. So, for competitive advantage in libraries, information product and services need to be presented in a marketable format suitable for consumption.

Despite the importance of ICT in competitive library service, scholars like Adekunmisi, Osinulu and Ogunbote (2008) point out that some libraries have short sighted view about the services and products they offer. They remark that some libraries feel that their services are so relevant that people will always use them regardless of any input from them. These scholars believe that this is an erroneous assumption because the needs of the users must be met. Users want to be satisfied. Therefore, for a library to remain competitive or even more fundamentally remain relevant, Das and Karn (2008) assert that it has to change its image by shedding and stripping itself off the image of being a highly fortified storehouse of knowledge and of a place where the customer is perceived to be a probable thief. They further state that the new-age library should be a veritable service organization, having professionals who could identify speedily the kind of information their customers need and also helping the users in accessing information with least time and effort. Therefore, the new-age library should be a true service organization, thereby making services more responsive to user needs and wants, and this will improve users' satisfaction. They conclude that this is the purpose of marketing information services and product, (Das and Karn, 2008).

Libraries that neglect to match service capabilities to customer needs risk becoming marginalized and being perceived as irrelevant. The reason is that customers will always seek alternative and competitive offerings so as to meet their needs. Hence, the rapid processing and dissemination of information, the supply of relevant and timely information for improved decision-making, and the innovative use of information in the creation of new opportunities are some of the ways by which the libraries could achieve competitive advantage, (de Vries, 1994). Ultimately, the success of an organization, Gronrous (2000) concurs, depends on its ability to create and retain a customer base.

Farley, Broady-Perston and Hayward (1998) affirm that libraries must use marketing strategy to create and sustain competitive advantage if they are to transform the intrinsic threats of change into opportunities. For Low and Tan (1995), marketing deals with organizing a company's strength, experience, and resources so as to achieve acceptable level of profits and user satisfaction. This is concerned with aligning an organization's business objectives with those of the clients. Having recognized this, the library should then deliver the desired satisfaction of their customers more effectively than its competitors. One of the ways this could be accomplished is through environmental scanning and SWOT analysis. Library professionals do environmental scanning to determine the needs of the consumers. They also analyze these needs to know the organizations strength, weaknesses, opportunity and their threat. When these processes are done, the opportunities will be used to overcome the threats. So, making use of marketing strategy to create and sustain competitive advantage is an asset which the library could use in other to transform the intrinsic threats of change into opportunities.

USING THE ICT AS A COMPETITIVE APPROACH IN LIBRARY SERVICES

According to Seddom (in Alemna, 2001), information has become a very profitable commodity. Many profit-marketing organizations are now involved in the provision of information services and products similar to the services of the libraries. This situation has slightly increased the number of competitors in the information market place. Based on these challenges, Adekunmisi, Osinulu and Ogunbote (2009) assert that libraries should visibly show that they are extremely useful to the continued survival and sustenance of their organizations. To achieve this is by actively marketing their product and services. One way this can be accomplished is through the use of ICTs and its applications in the libraries.

According to Porter (1980), positioning is fundamental to the creation of a competitive strategy. An organization positions self by exploring those aspects of a service that distinguish it from its competitors and competitively pursue them to gain advantage. In this regard, the use of the ICT and its facilities in the library will position it to be more competitive in providing quality services to its patrons. The umbrella justifications of the ICT and its applications is that they provide access to learning resources, information and knowledge previously inaccessible by reason of distance, resources and the availability of relevant technology, (Afolabi and Abidoye, n.d.).

In view of the competitive advantage that ICT usage affords the library, as evident in the foregoing literature review, it is plausible that some user-based components of ICT application and services, when adequately put in place and effectively used, could confer on Babcock University library a competitive advantage over other libraries. Some of the key user-based components of ICT applications and services are described in the paragraphs that follow.

Computer: Computers have been referred to as the nucleus of ICT application. It is difficult to talk of ICT without mentioning computers. The availability of adequate number of and appropriate quality computers in the library is a crucial strategy. Idowu (2011), Afolabi and Abidoye (n.d.), and Islam and Islam (2006) enumerate some of the key roles that computers play in the libraries, namely:

- Ordering and acquisition
- Circulation
- Library data base
- Inter library loan by two or many libraries that are connected
- Documentation and administration
- Serials Management
- Desktop publishing
- Cataloguing and classification
- Audio visual management
- IT services
- E-library services
- Reprographic Service
- Selective dissemination of information (SDI)
- Computerized interactive search

These library services complement with the ICT and its applications. A library that is heavily fortified with functional working, quality computers will attract users to it. It will also assist in quality work performance and productivity.

Computer Networks (Network technology): Computer network is a system of interconnected computers for sharing information and resources. Islam and Islam (2006) explain that the key function of the computer network is to interconnect computers and other devices so that data can be transferred from one direction to another instantly. This, they posit, could involve two or more computers in a single office or several computers in different units across an organization or across the country. The networks, Olusanya and Oloyede (2003) add, include the local area network (LAN) and wide area network (WAN). Islam and Islam (2006) explain that the LAN is a communication network that covers a limited area such as the campus or a building while the WAN a wide geographic area such as a country or state. With computer network, libraries can access and share information in different locations and also download for users needs. On the contrary, without the computer network, libraries cannot speedily access and share information. It is not sufficient to be highly equipped with computers but the networks must effectively function, permitting users to get connected from their immediate environment to the outside world when searching for information sources and services. This is competitive intelligence strategy. Therefore, computer networks are crucial at BU library for effective transfer of data from one end to another.

Internet Facility: Internet is described as a worldwide network of computer and people. According to Brown (cited in Ossia-Ugbah, 2010), the internet is a global network of computers linked together over large distances. The internet makes it possible for thousands of dissimilar physical networks that are not connected to one another and that use diverse hardware technologies to connect and operate as a single communication system. It is an important tool for global on line services. For this reason, Islam and Islam (2006) conclude that the Internet could be referred to as a "virtual library where the world's information is gathered for the clientele." The use of the Internet, Luambano and Nawe (2004) observe, makes it possible for scholars and academic institutions to disseminate information to a wider audience around the globe. Ossai-Ugbai (2010) maintains that the provision of internet access to students through automated library service creates a large research pool for maintenance and sustenance of the academic culture of excellence. Rosenberg (2005) states that an adequate ICT infrastructure with a sufficient number of networked and Internet-connected workstations is essential if a library is to offer access to e-resources and develop e-services. Without the Internet, users might not be able to access these online resources. One of the boosts to effective Internet use is seen in the provision of the number of computers connected. The more computers provided to the users, the more the attraction to the library. Another crucial factor in relation to the Internet is the connectivity. Research has revealed that slow network speed and reliability are real barriers to using e-resources. This barrier must be rectified, by providing high-speed Internet connection, if the library wishes to retain its users. Rosenberg concludes that the "ideal situation for a digital library is to be connected to a campus backbone so that library resources can be accessed not only from within the library but from anywhere on the campus." Therefore, connectivity with the whole university (either with fixed point or wireless), enabling users to access the library from any point is an excellent market strategy for the library.

Electronic Mail (E-mail): This is a system of exchanging message in electronic format and it is the most used tool on the Internet. E-mail is a fast, easy and inexpensive way to communicate with others. Email has brought about revolutionary changes in communication because any type of information can be sent and received from anywhere in the world, even in the remote areas in a fraction of time, (Islam and Islam, 2006). Email is used to obtain important new resources for learning and teaching in schools. Elisha 2006 cites Oniyide (2005) who points out that it is possible to send out orders to publishers and producers of learning and teaching materials and equipment through the Internet. Based on this, Marklein (cited in Parameshwar and Patil, 2009) concluded that using the Internet for email services by the US college students was so common for some of them that, "It is like picking up a phone." So the provision of constant and quality internet services affords the users the opportunity to access and communicate with the outside world: and this is competitive advantage. When users' information needs are met, they will be satisfied and will keep on patronizing the library.

Video Conferencing and Skyping: Another ICT strategy that can bring users to the library is video conferencing. Offorma (2000) in Afolabi and Abidoye (n.d) describes video conferencing as a "means of linking up two or more remote computers, all of which have a small camera attached which enables the participants to see each other, to speak to each other and in some systems, to be able to start, [and] send documents through the linked computer." Some libraries use this medium to source for information that are not available in their own libraries. He further says that it is used to bring awareness to users who are ignorant of the available information resources in the library.

Expert System: This is a computer program that applies artificial-intelligence methods to problem-solving (Microsoft® Encarta® 2009). Without an expert system, the application of the ICTs will not be possible. Burton (cited in Afolabi and Abiodoye, n.d) explain, that expert systems encapsulate the knowledge and experience of the human expert and make them available to a wider audience. A lot of information may be gathered, synthesized and manipulated before conclusion and decisions are made on some complex areas of human knowledge. Within information work, Afolabi and Abidoye (n.d) cites MCDonald and Wickert (1991) confirm that expert systems have been applied in the area of cataloguing, classification and information retrieval.

CONCLUSION AND RECOMMENDATION

The success of any library is largely dependent on attracting users to the library by making them aware of available services. This goal is achieved through strategic marketing. It is imperative that strategic marketing planning becomes a necessity for libraries. The aim of such activity is to match organizational services with customer needs through the creation of an effective marketing strategy. Libraries should carry out competitive analysis to investigate their competitors in order to obtain an insight into those organizations that serve the same market segments, and their associated competitive offerings. This kind of investigation, in conjunction with an analysis of its strengths and weaknesses, Broady-Parston and Bayne (n.d.) argues, will make it feasible for the library to conceive of a strategy that will lead it to position its services so that the customers will perceive it as being more superior to those of the other competitors. The function of a library is dynamic and customer oriented. Librarians should provide services that will attract and satisfy their customer needs. Thus, gaining competitive advantage in libraries, information product and services need to be presented in a marketable format suitable for consumption. By marketing the library services through various ICT applications, the library stands the chance of gaining advantage over its competitors such as having larger and frequent library users within and without the University community, providing fast, current and up-to-date library information.

In the light of literature evidence, it is recommended that Babcock University library administrators should ensure adequate supply of computers and computer network systems, access to high-speed Internet facilities and constant connectivity, e-mail facilities, video-conferencing and Skype, and system experts in order to create and maintain services that the customers will perceive as being more superior to those of the other competitors.

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Étude comparative de deux espèces d'Afrique Centrale du genre *Leptactina* (Rubiaceae, Pavetteae)

[Comparative study of two Central Africa *Leptactina* species (Rubiaceae, Pavetteae)]

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ABSTRACT: This paper tests the validity of morphological characters used to distinguish two *Leptactina* species put in synonymy by Figueiredo (2007) on the basis of our unpublished works: *Leptactina arnoldiana* and *L. mannii*. Analyses of variances and discriminant analysis were used for that purpose. Significant differences exist between the used variables but the discriminant analysis brings to light only the number of nervure as discriminant character. We assert with Figueiredo (2007) that these two species are synonyms and an identification keys is proposed.

KEYWORDS: Rubiaceae*, Leptactina, L. arnoldiana, L. mannii*, synonymy.

RESUME: Cet article teste la validité de caractères morphologiques utilisés pour distinguer deux espèces du genre Leptactina mises en synonymie par Figueiredo (2007) sur la base de nos travaux inédits : Leptactina arnoldiana et L. mannii. Des analyses de variances et une analyse discriminante ont été utilisées à cet effet. Des différences significatives existent entre les variables utilisées mais l'analyse discriminante ne met en évidence que le nombre de nervures comme caractère discriminant. Nous concluons comme Figueiredo (2007) à la mise en synonymie de ces deux espèces et une clé d'identification est proposée.

MOTS-CLEFS: Rubiaceae*, Leptactina, L. arnoldiana, L. mannii*, synonymie.

1 INTRODUCTION

Le genre africain des Rubiaceae Leptactina Hook.f. est reconnaissable par ses grandes stipules entières, son calice à grands lobes foliacés, ses grandes fleurs et son ovaire biloculaire multi-ovulé [1] [2] [3] [4]. Il est représenté par 20 espèces distribuées dans la zone subsaharienne de l'Afrique. Ce genre a fait l'objet de différents traitements taxonomiques [1] [2] [3]. Celui de [1] concerne des espèces d'Afrique centrale. Il permet de mettre en évidence deux espèces très proches morphologiquement (L. arnoldiana De Wild. et L. mannii Hook.f.) que [5] [6] met en synonymie sur la base de nos travaux inédits, sans en souligner les raisons qui avaient conduit à notre conclusion taxonomique. Elle crée deux sous-espèces : L. mannii subsp. mannii Hook.f. et L. mannii subsp. arnoldiana (De Wild.) Neuba ex Figueiredo. En effet, ces deux espèces d'Afrique centrale se distinguent des autres taxons du genre par leurs stipules réfractées et gibbeuses-cucullées en combinaison avec des fleurs pentamères, des fruits oblongs et des anthères à apex poilu [1]. Malgré leur proximité, [7]

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considère qu'on peut baser les caractères différentiels sur la longueur des lobes calicinaux, du tube et des lobes corollins. Quant à [1], il base sa distinction sur le nombre de nervures et la longueur des pédicelles. Cependant, ces distinctions étaient basées sur un nombre limité d'échantillons [7]: 2 spécimens et de [1]: 30 spécimens) et sur des caractères quantitatifs dont la valeur discriminante reste aujourd'hui à vérifier.

Cet article a ainsi pour but d'évaluer la valeur discriminante des caractères utilisés habituellement pour la distinction de ces deux espèces dans le contexte global du genre *Leptactina* et de vérifier la validité des changements de [6].

2 MATÉRIEL ET MÉTHODES

Le matériel étudié est constitué de 222 spécimens provenant de BM, BR, BRLU, COI, G, K, LISC, MO, P et WAG [8].

Soixante-dix-sept spécimens complets (possédant au moins des lobes du calice complets) sur les 222 spécimens ont été analysés pour une étude comparative de ces deux espèces basée sur les caractères morphologiques: longueur du pédicelle (LPED), longueur des feuilles (LGF), largeur des feuilles (LAF), nombre de nervures (NN), longueur des lobes du calice (LGS), largeur des lobes du calice (LAS), longueur des lobes de la corolle (LCL) et largeur des lobes de la corolle (WCL). Toutes les observations ont été faites à la loupe binoculaire. A ces caractères morphologiques employés par [7] [1], nous ajoutons les dimensions des feuilles ; nos observations personnelles nous ayant amené émettre l'hypothèse que celles de *L*. *mannii* sont plus petites.

Nous suivons les méthodes de taxonomie d'herbier [9]. La terminologie utilisée suit en général [10], [11], [12]. Les cartes de distribution basées sur les 222 spécimens ont été dressées dans Grass Gis [13] Les données de reliefs proviennent de GTOPO 30. Ce modèle numérique de terrain, possédant une résolution de 1 km, nous semble être une bonne alternative à l'insuffisance de données écologiques. Le logiciel R [14] a permis de réaliser une analyse discriminante linéaire et des analyses de variance ne prenant en compte que les 77 spécimens complets de notre jeu de données morphologiques et toutes les variables sauf WCL, LCL. Pour ces dernières variables, il existe trop peu de spécimens complets. Nous utilisons la valeur du coefficient de discrimination linéaire pour tester l'importance des variables dans la distinction de ces deux taxons. L'analyse discriminante est une méthode de modélisation linéaire comme l'analyse de variance, la régression linéaire multiple. Elle teste les différences dans les différentes variables explicatives entre groupes. S'il existe une différence entre les groupes, elle recherche la combinaison linéaire des variables explicatives (fonction de discrimination) qui permet une bonne distinction des groupes [15]. Le coefficient de discrimination linéaire donne l'importance des variables dans la construction de la fonction de discrimination.

3 RÉSULTATS

Les feuilles des deux espèces possèdent un limbe elliptique, asymétrique, coriace, papyracé, très rarement soyeux chez *Leptactina arnoldiana*. Elles sont glabres chez les deux espèces avec des spécimens velus chez *L*. *arnoldiana*. Les dimensions des feuilles sont variables, mais celles les plus longues se rencontrent chez *L*. *arnoldiana* avec une moyenne de 30 cm contre 20 cm chez *L*. *mannii* (Fig. 1).

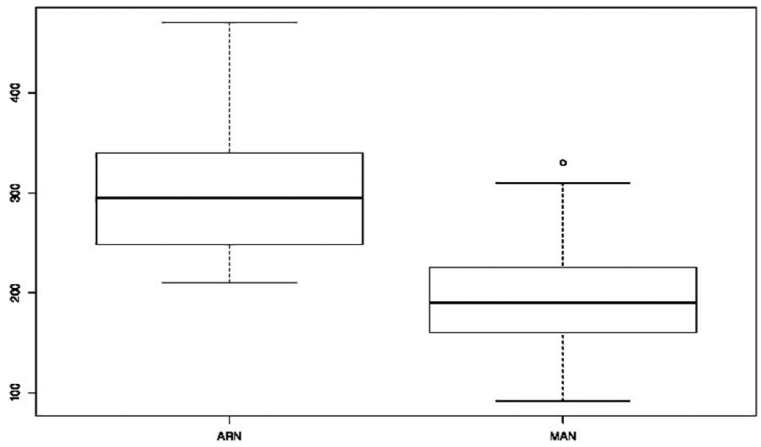

Fig. 1. Boxplot de la longueur des feuilles (mm). Les barres inférieures et supérieures indiquent respectivement les minimums et maximums. Les cotés inférieurs et supérieurs de la boite indiquent le 1er et 2nd quartile. Les poids indiquent des valeurs extrêmes

Le test t-student réalisé pour comparer les moyennes des deux espèces montre une différence significative ($p<0,05$). Les feuilles de *L*. *mannii* (moyenne 9,6 cm) sont également moins larges que celles de *L*. *arnoldiana* (moyenne 13,1 cm) (Fig. 2).

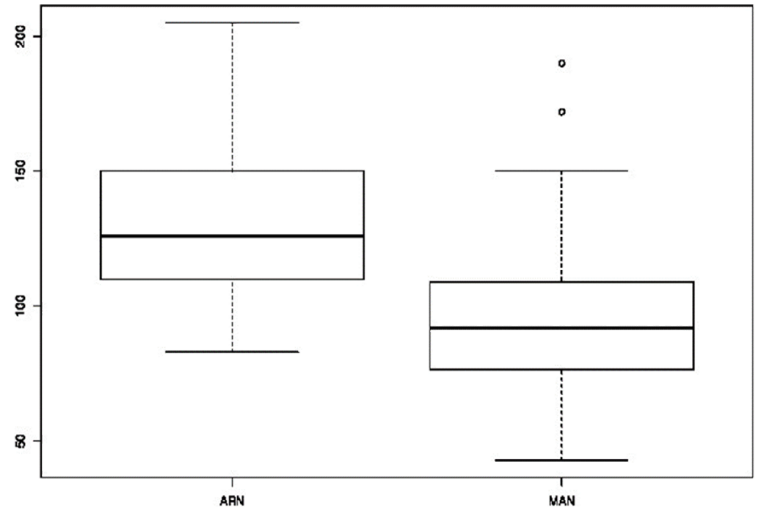

Fig. 2. Boxplot de la largeur des feuilles (mm). Les barres inférieures et supérieures indiquent respectivement les minimums et maximums. Les cotés inférieurs et supérieurs de la boite indiquent le 1er et 2nd quartile. Les poids indiquent des valeurs extrêmes

Il existe également une différence significative entre les moyennes de ces deux espèces. Il existe également une différence significative entre les moyennes des ratios longueur sur largeur de ces deux taxons ($p=0,02$). Chez *L*. *mannii* les feuilles possèdent entre 6 et 13 paires de nervures latérales tandis que chez *L*. *arnoldiana*, ce nombre varie de 12 à 24 (Fig. 3). Il y a une différence significative entre les moyennes du nombre de nervures chez ces deux espèces selon le test t-student ($p<0,05$).

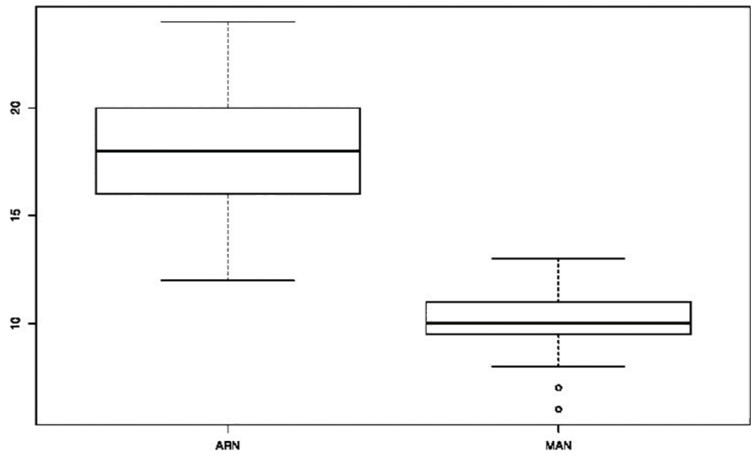

Fig. 3. Boxplot du nombre de paires nervures latérales. Les barres inférieures et supérieures indiquent respectivement les minimums et maximums. Les cotés inférieurs et supérieurs de la boite indiquent le 1er et 2nd quartile. Les poids indiquent des valeurs extrêmes

L'inflorescence, chez ces deux espèces, est terminale, rarement subterminale, multiflore, compacte à lâche, pouvant contenir jusqu'à 20 fleurs. Les bractées dans les deux espèces sont du même type, c'est-à-dire, linéaires ou trifides, 2-3 x 1-1,5 cm. Le pédoncule inflorescentiel est variable. En effet, L'inflorescence de *L. arnoldiana* est subsessile (3 mm) à pédonculée (23 mm) avec une moyenne de 9,52 mm (± 6 mm) de long (Fig. 4). Celle de *L. mannii* est sessile à rarement pédonculée (pouvant atteindre 17 mm de longueur) avec une moyenne de 4,62 mm (± 3,70). Le test t-student réalisé pour comparer les moyennes de la longueur du pédoncule inflorescentiel montre une différence significative ($p<0,05$).

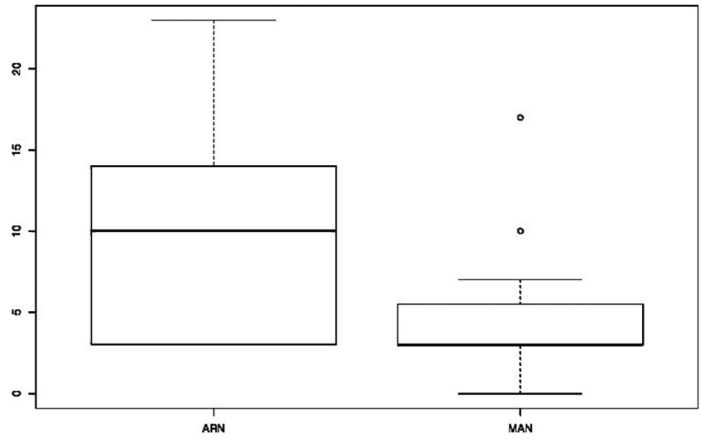

Fig. 4. Boxplot de la longueur du pédoncule inflorescenciel (mm). Les barres inférieures et supérieures indiquent respectivement les minimums et maximums. Les cotés inférieurs et supérieurs de la boite indiquent le 1er et 2nd quartile. Les poids indiquent des valeurs extrêmes

Les fleurs, à corolle longuement tubulaire de ces deux taxons, sont actinomorphes, pentamères et densément couvertes de poils courts. Le calice, brièvement tubulaire (tube mesurant moins de 2 mm chez les deux espèces), accrescent dans le fruit, possèdent de grands lobes, jusqu'à 5 cm de longueur. Les lobes calicinaux, subfoliacés, sont étroitement elliptiques, oblancéolés ou oblongs et asymétriques. Les anthères chez les deux espèces peuvent porter des poils sur leur appendice

stérile. Si les fleurs sont qualitativement similaires, elles peuvent différer quant aux dimensions des parties florales. Ainsi les lobes du calice de *L. arnoldiana* variant de 2,5 à 6 cm sont en général plus longs que ceux de *L. mannii*. Chez cette dernière espèce, la longueur du calice ne dépasse généralement pas 5 cm sauf chez un spécimen camerounais où il atteint 7,3 cm (Fig. 5). La comparaison des moyennes des deux taxons montre une différence significative (p=0,0001). Il en est de même pour la largeur des lobes de ces taxons (Fig. 6).

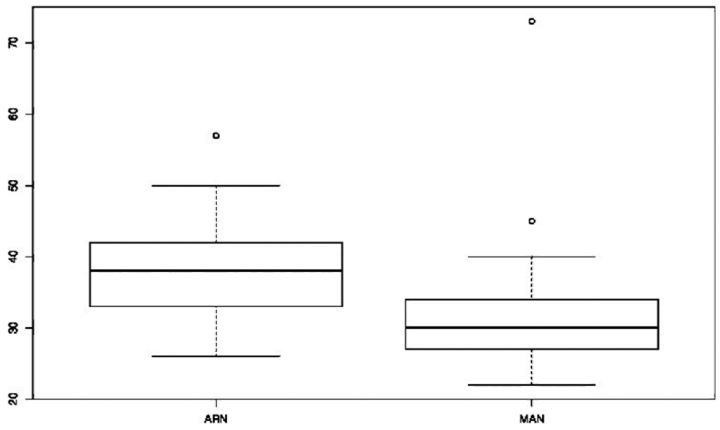

Fig. 5. Boxplot de la longueur des lobes du calice (mm). Les barres inférieures et supérieures indiquent respectivement les minimums et maximums. Les cotés inférieurs et supérieurs de la boite indiquent le 1er et 2nd quartile. Les poids indiquent des valeurs extrêmes

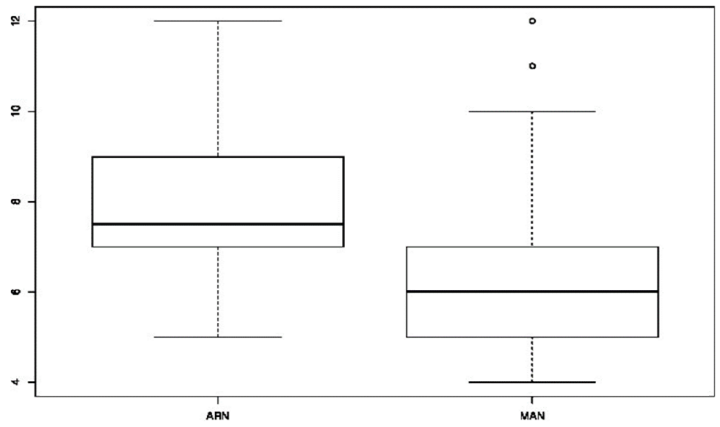

Fig. 6. Boxplot de la largeur des lobes du calice (mm). Les barres inférieures et supérieures indiquent respectivement les minimums et maximums. Les cotés inférieurs et supérieurs de la boite indiquent le 1er et 2nd quartile. Les poids indiquent des valeurs extremes

La moyenne des largeurs des lobes du calice chez *L. arnoldiana* est plus grande que chez *L. mannii* (p=0,00006). Les lobes de la corolle peuvent atteindre 11 cm de longueur chez *Leptactina arnoldiana*. Ceux de *L. mannii* même s'ils atteignent 14 cm de long ne sont pas significativement différents de *L. arnoldiana* (Fig. 7).

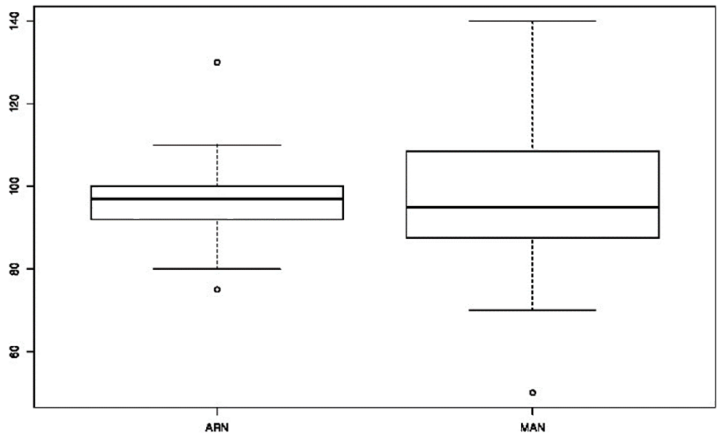

Fig. 7. Boxplot de la longueur des lobes de la corolle (mm). Les barres inférieures et supérieures indiquent respectivement les minimums et maximums. Les cotés inférieurs et supérieurs de la boite indiquent le 1er et 2nd quartile. Les poids indiquent des valeurs extremes

Les lobes de la corolle de *L. arnoldiana* avec une moyenne de 6,53 mm sont deux fois plus étroits que ceux de *L. mannii* (Fig. 8). Le fruit de *L*. *arnoldiana* est cylindrique avec des stries longitudinales, glabre à densément pubescent. La base du fruit est aigüe mais devient arrondie dans l'extrême sud-ouest de son aire de distribution (Angola). Le fruit de *L*. *mannii* est semblable à celui de *L*. *arnoldiana* mais garde sa base toujours arrondie dans toute son aire de distribution. Les résultats de l'analyse discriminante linéaire sont consignés dans l'annexe 1. Il en ressort que le nombre de nervures avec -0,42 possède le plus grand coefficient de discrimination linéaire suivie, de très loin, par la longueur des pédoncules inflorescentiels. Sur la base des mesures effectuées, ces deux espèces peuvent être valablement séparées à partir du nombre de nervures.

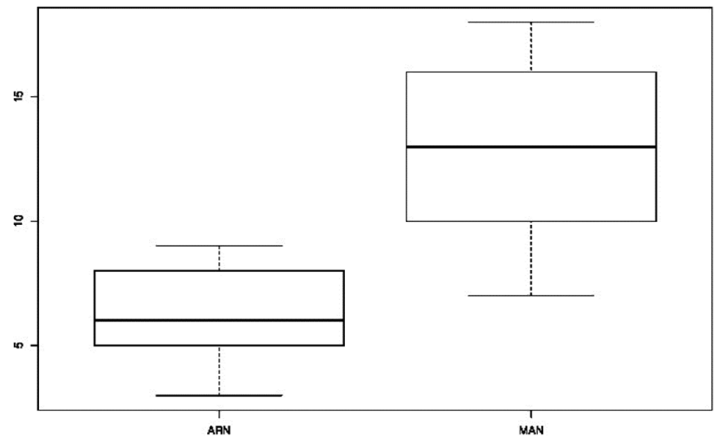

Fig. 8. Boxplot de la largeur des lobes de la corolle (mm). Les barres inférieures et supérieures indiquent respectivement les minimums et maximums. Les cotés inférieurs et supérieurs de la boite indiquent le 1er et 2nd quartile. Les poids indiquent des valeurs extrêmes

La figure 9 montre la distribution des récoltes de ces deux espèces par rapport à la distance à la mer et à l'altitude. Il ressort que les spécimens de *L*. *mannii* sont confinés dans la zone littorale de l'Afrique Centrale du Cameroun à la région du Cabinda, en Angola, à des altitudes habituellement inférieure à 300 m. Par contre *L*. *arnoldiana* est une espèce à très large distribution (Fig. 10), jusqu'à plus 800 km du littoral. Cette espèce est présente à des altitudes habituellement supérieures à

200 m. Dans le littoral cabindais, cette espèce apparaît à des altitudes inférieures à 200 m. La distribution de ces deux espèces peut être qualifiée de parapatrique.

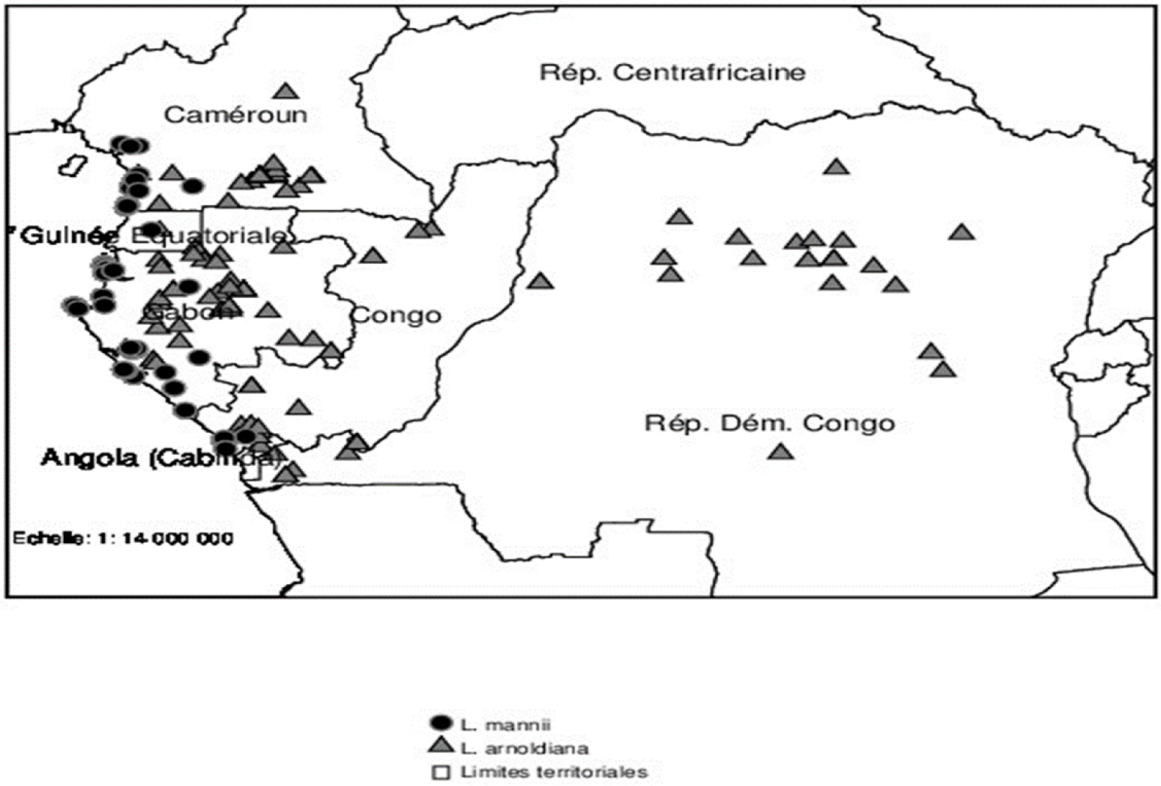

Fig. 9. Carte de distribution de L. arnoldiana et L. mannii en Afrique Centrale

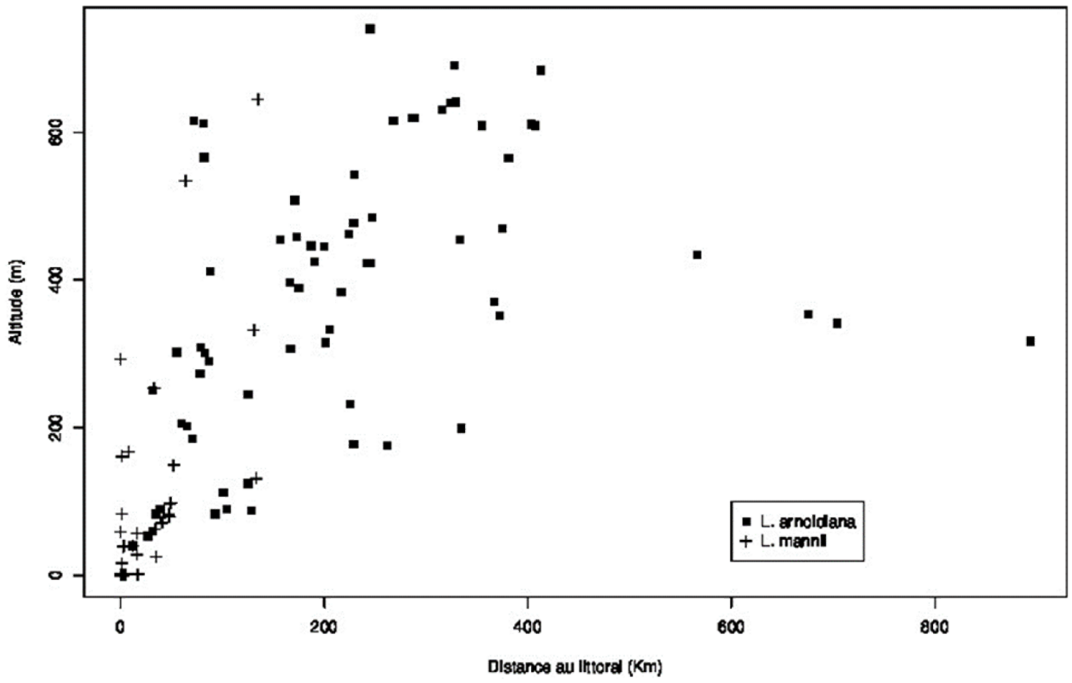

Fig. 10. Distance au littorale (km) sur l'altitude (m) en de L. arnoldiana et L. mannii

4 DISCUSSION

L'analyse des résultats de cette étude confirme les conclusions de [5] [6]. Elle conclut en effet que ces deux espèces sont synonymes et qu'il faudrait en considérer deux sous-espèces: *Leptactina mannii* subsp. *arnoldiana* (De Wild.) Neuba ex Figueiredo et *L. mannii* subsp. *mannii* Hook.f. Cela est d'autant vrai que si l'on se place dans le contexte du genre, ces deux espèces sont très proches. En effet, le genre *Leptactina* est connu pour ses stipules diversifiées et à forte valeur systématique ([1] [2] [3] [4]). Ces derniers permettent en effet de distinguer des groupes d'espèces suivant que celles-ci soient dressées ou recourbées. Cinq espèces du genre possèdent des stipules recourbées ([4]). *Leptactina mannii*, *L. arnoldiana* et *L. deblockiae* Neuba & Sonké ([16]) sont les seules espèces à posséder des stipules gibbeuses-cucullées et refractées. Les deux autres (*L. involucrata* Hook.f. et *L. platyphylla* (Hiern) Wernham) possèdent des stipules recourbées et non gibbeuses. *Leptactina arnoldiana* et *L. mannii*, taxons à inflorescence multiflore terminale, diffèrent de *L. deblockiae* qui possède une inflorescence uniflore axillaire. Elles font parties avec *L. laurentiana* Dewèvre et *L. rheophytica* Sonké & Neuba ([17]) des rares espèces à posséder des anthères à appendice stérile pourvu de poils caduques ([1] [4]).

Ces deux espèces diffèrent toutefois par le nombre de paire de nervures latérales de leurs feuilles. Celles-ci ne dépassent pas en général 13 chez *L. mannii* tandis qu'elles sont supérieures à 12 chez *L. arnoldiana*. Les lobes corollins sont deux fois plus larges chez *L. mannii* que chez *L. arnoldiana*. Les dimensions des feuilles, des lobes du calice et des pédoncules de l'inflorescence, même si elles peuvent être statistiquement différentes, ne sont utiles à la distinction de ces deux espèces que dans des cas extrêmes (par exemple : inflorescence sessile et moins de 13 paires de nervures latérales pour *L. mannii* et le contraire pour *L. arnoldiana*). De même les figures 1-4 laissent entrevoir beaucoup d'intermédiaires pour ces caractères. Dans le contexte du genre *Leptactina*, les caractéristiques de ces deux espèces n'autorisent pas, surtout que des analyses de biologie moléculaire ne sont pas encore disponibles pour tout le genre, à considérer deux espèces distinctes pour *L. arnoldiana* et *L. mannii*.

Leur proximité morphologique et leur distribution parapatrique en font des sous-espèces. Nous proposons la clé de distinction suivante :

- Feuille à plus de 13 paires de nervures secondaires, lobes corollins étroits, de 3 à 9 mm de large, inflorescences habituellement subsessiles à pédocnulées,

…….*L. mannii* subsp. *arnoldiana*.

- Feuille à moins de 13 paires de nervures secondaires, lobes de la corolle habituellement plus larges, de 7 à 18 mm de large, inflorescences habituellement sessiles à subsessiles.

…….*L. mannii* subsp. *Mannii*

5 CONCLUSION

Cette étude arrive à la conclusion que *L. arnoldiana* devrait être considérée comme synonyme de *L. mannii*. Nous reconnaissons comme [4] [5] qu'il s'agit d'une sous espèce de *L. mannii* que l'on pourrait distinguer sur la base du nombre de nervures et largeur des lobes corollins. D'autres caractères, comme la longueur du pédoncule inflorescenciel pourrait dans de cas extrêmes permettre de les distinguer.

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ANNEXE

Statistique des variables morphologiques utilisées dans l'analyse comparative de *Leptactina arnoldiana* et *L. mannii.* longueur du pédicelle (LPED), longueur des feuilles (LGF), largeur des feuilles (LAF), nombre de nervures (NN), longueur des lobes du calice (LGS), largeur des lobes du calice (LAS), longueur des lobes de la corolle (LCL), largeur des lobes de la corolle (WCL). Coefficient de discrimination linéaire (Cdl.)

Caractères	statistiques	*L. arnoldiana*	*L. mannii*
LGF (cm)	Min.	21	9,2
	moyenne	30	18
	Max.	47	33
	p-value	0	
	Cdl.	0,0025	
LAF (cm)	Min.	8,3	4,3
	moyenne	13,15	9,6
	Max.	20,5	19,2
	p-value	0,000001	
	Cdl.	0,005	
NN	Min.	12	6
	moyenne	18	10
	Max.	24	13
	p-value	0	
	Cdl.	0,42	
LPED (cm)	Min.	3	0
	moyenne	9,6	4,6
	Max.	23	17
	p-value	0.00000853	
	Cdl.	0,03	
LGS (cm)	Min.	2,6	2,2
	moyenne	3,8	3,2
	Max.	5,3	7,3
	p-value	0,001036	
	Cdl.	0,005	
LAS (cm)	Min.	5	4
	moyenne	7,8	6,4
	Max.	12	12
	p-value	0,0006218	
	Cdl.	0,0025	
LCL (cm)	Min.	4	5,7
	moyenne	6,5	7,1
	Max.	10,6	90
	P-value	0,2054	
WCL (mm)	Min.	3	7
	moyenne	6,53	12,47
	Max.	9	18
	p-value	0,00002	

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Comparative study of physical and chemical propriety of the oil of some varieties of olive trees

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ABSTRACT: Edible oils are an important constituent of human diet because they provide desirable nutritional properties, flavor and texture of food. Olive oil is one of the most frequently used edible oils. Therefore knowledge of its physicochemical properties is indispensable to assess its quality. In fact, there are many factors having an influence on the chemical and physical characteristics of olive oil, such as the climatic conditions, the agronomic and genetic factors.
In Morocco, different varieties have been developed in order to improve the yield and oil quality. But few comparative studies were made between the different product varieties. The aim of this study was to characterize the olive oils from five olive varieties most cultivated in Morocco. Then compare them by using the physic-chemical parameters with storage conditions (darkness and sunlight). Several parameters were studied, namely, quality indices defined by the International Olive Oil Council (IOOC): The acid value "Av", the peroxide value "Pv" and the specific extinctions "K_{232} / K_{270}". The results of different analyses show significant differences between these five varieties, and demonstrate that the Picholine de Languedoc variety is the most efficient in term of quality for the consumer.

KEYWORDS: Olive oil; Olive varieties; Acid value; Peroxide value, K_{232}, K_{270}.

1 INTRODUCTION

The olive tree (Olea europaea) has an important social and economical significance in the Mediterranean basin, which occupies 98% of the world's cultivated olive trees [1]. The virgin olive oil is a product with high added value. Land suitable for the cultivation of olive trees, favorable climate and ancient olive traditions are important competitive advantages for Moroccan olive oil sector [2].

Extra-virgin olive oil, especially consumed in the raw form, keeps all its vitamins, essential fatty acids and other nutrients including powerful antioxidants. For this reason, it is recognized as one of the best food for its capacity to prevent some pathology, such as cancer and cardiovascular diseases, and to reduce their incidence in the western population [3]. Numerous studies show that olive oil reduces cholesterol, lowers blood pressure and the incidence of breast cancer and inhibits platelet aggregation [4], [5]. Because of the high antioxidants content, olive oil appears to reduce dramatically the

oxidation of low-density lipoprotein (LDL) cholesterol, thus preventing heart disease. These same antioxidants also increase the stability, shelf life, and flavor of the oil. On the other hand, cell membranes contain fatty acids that are highly susceptible to free radical damage, producing lipid peroxides that can kill the cell.Consequently, the interest of many researches is focused on the controls of degradation of the olive oil during storage processes and on the methods to avoid it [6], [7].

The aim of this work is to evaluate the effects of storage conditions such as darkness and sunlight on the stability of physic-chemical properties of the olive oils from the following varieties: Moroccan picholine, Menara, Haouzia, Dahbia, Picholine de Languedoc and Manzanille.

2 MATERIALS AND METHODS

2.1 OLIVE SAMPLES AND OIL EXTRACTION

Olive fruits of five varieties: Picholine Marocaine (P), Picholine de Languedoc (La), Manzanille (M), Dahbia (D), Haouzia (Ha) and Menara (Ma), were collected in the same farm in Beni-Mellal and benefited from the same cultural practices. All olive samples of each variety were picked by hand at an optimal stage of maturity, and cultivars during 2010 season. After cleaning, fruits from each variety were triturated in our laboratory under the same conditions. The molding was carried out by traditional methods: Manual grinding using a grinding wheel, a Kneading (the dough with 50 % of weight in hot water) to prevent oxidation of the olive paste, in a closed room, not exceeding 45 min [8]. Then the obtained paste was filtered, and finally centrifuged for 11 min to remove water and keep the oil phase. All oil samples were stored in glass bottles prior to analyses.

2.2 ANALYTICAL METHODS

The acid value (Av), expressed as percent of oleic acid, peroxide value (Pv), given as milliequivalents of active oxygen per kilogram of oil and UV absorption characteristics (K_{232} and K_{270}) were determined following the analytical methods described in the standards of the International Olive Oil Council (IOOC) [9].

The acid and peroxide values were determined by volumetric method. Specific extinction coefficient at 232 and 270 nm (K_{232} and K_{270}) were determined using a JASCO spectrophotometer (V-630).

2.3 MONITORING OLIVE OIL SAMPLES

To study the influence of each storage condition (darkness and sunlight) on the stability of olive oil parameters, we follow the steps: A first batch of samples was placed in an enclosed space, protected from light and at room temperature. A second batch of sample was placed in a transparent box, and left in direct contact with sunlight. Analysis period consists of 1 month time intervals during 7 months.

3 RESULTS AND DISCUSSION

The determination of different quality indices (physic-chemical parameters) was made from five times, and that for the duration of storage of the studied olive oils. The medians were calculated and reported as parameters result.

It can be seen in **Table 1** that oils extracted from different olive varieties have an acid value less than 0.8%, Pv < 20 méq O_2.Kg-1, $K_{232} \leq 2.6$ and $K_{270} \leq 0.25$. The evaluation for initial quality of the oils studied allowed classifying them all in extra virgin olive oil [9].

The **Table 1** shows that olive oils extracted from five varieties, are very little oxidized because they have a peroxide value very low compared to other large studies [10], [11]. Thus, we notice that is almost the same for all the oils obtained. This can be explained by the fact that extraction was conducted under conditions strictly controlled and identical.

Also, the acid value is low, which can be attributed to the state of optimal maturity olives. In 2004, Dugo et al. showed that the early harvest produced olive oils with acidity less than 1% [12].

The evolution of the different parameters studied during storage of oils from the varieties described above is plotted against time in graphical form. **Fig.1**, **2** and **3** illustrate the results and represent the evolution of physic-chemical properties of olive oil over time and storage conditions.

To determine the relationship between the quality parameters in question, and the storage time in months, and the other, to evaluate the stability of these parameters for each variety of olive oil according to the storage conditions studied, we have tried to establish a linear equation for each case. Different equations obtained in both storage conditions are summarized in **Tables 2**, **3**, **4** and **5.**

3.1 CHEMICAL ANALYSIS

3.1.1 ACID VALUE

The acid value, expressed as oleic acid, is a factor of quality olive oil [9], which provides information on the deterioration of the oil by hydrolysis. **Fig.1** shows a linearly changing insignificant, especially when exposed to sunlight, depending on the duration of storage of oils.

Analysis of the variance values of acidity (**Table.2**) shows an effect of the variety and storage conditions on this parameter. The Av has increased significantly, during exposure to sunlight over the storage in the dark. The greatest variation is observed in oil from Manzanille with 0.41%, while the lowest was noticed in oils from Menara and Haouzia with only 0.05%, when exposed to sunlight.

3.1.2 PEROXIDE VALUE

The peroxide value is an important quality parameter of edible oils [9]. The initial PVs of all samples were within the legal limit of 20 meq. $O_2\ kg^{-1}$. The evolution of the peroxide value during storage is shown in **Fig.2**. When exposed to sunlight, there is usually an increase in peroxide value for all samples, indicating that light has a negative effect on olive oil. In fact solar radiation promotes self-oxidation of olive oil. Olive oil from Dahbia had the highest and olive oil from Picholine de Languedoc had the lowest Pv among the olive oil samples monitored (**Table.3**). Also, the peroxide value varies between 6.25 and 10.62 meq O2/kg for all oils. These low values of the peroxide confirm that the oil was extracted quickly after harvesting the olives. Moreover, this suggests that the oil does not oxidize rapidly, therefore, it will retain over time. Thus ensures that the extraction was carried out on healthy and fully ripe olives. In addition, according Nouros, a peroxide value, more than 10 meq O2/kg may mean that olive oil is less stable with a shorter life [13].

3.2 PHYSICAL ANALYSIS

The specific extinction oil is an important parameter of quality of oils. The absorbance of the oil at 232nm (K_{232}) gives an idea on the evolution in the oxidation process and the formation of linoleic hydro peroxide, whereas, the absorbance at 270nm (K_{270}) gives informations on the concentration of secondary oxidation product such as ketones and aldehydes [14], [15].

3.2.1 SPECIFIC EXTINCTION COEFFICIENT AT 232 (K_{232})

The evolution of the specific extinction at 232 nm is shown in **Fig.3**. The results show that, there is a variation of this parameter between the samples stored in the dark and samples subjected to sunlight, increasing the parameter of the specific extinction at 270 nm, has been outstanding after two months of exposure to sunlight. **Table.4** shows that the greater variation is observed in oils from Dahbia and Manzanille. The smallest change is known in oil from Haouzia.

3.2.2 SPECIFIC EXTINCTION COEFFICIENT AT 270 (K_{270})

Examination of the **Fig.4** reveals that the specific extinction coefficient at 270 nm evolves very weakly during storage for oils studied. This phenomenon could be explained by a slow processing of primary products into secondary oxidation products i.e at this moment it is the stage of the formation of hydroperoxides which is in action.

Also, **Table.5** shows that the greater variation is observed in olive oil from Dahbia and Manzanille. The smallest change is known in oil from Picholine de Languedoc.

In the end, the results found in the physical analysis coincide with the peroxide values which tend to increase slightly during the storage period in both conditions. This could mean that the spread of oxidation of olive oil has not reached its final stage: decomposition of hydroperoxides.

In fact, the oxidation resistance may be due to the storage conditions, especially in the dark, since the mechanism of the photo-oxidation is much faster than that of autoxydation. Caponio et al., showed that for olive oil stored in the dark, there is the formation of hydroperoxides, as evidenced by the extinction coefficient K_{232}. While in exposure to sunlight is the secondary oxidation compounds predominate, as evidenced by the extinction coefficient K_{270} [16].

4 TABLES AND FIGURES

4.1 TABLES

Table 1. The initial physic-chemical parameters of monovarietal olive oil samples (average of 5 tests).

Olive varieties	*Acid value (%)*	*Peroxide value (méq O_2.Kg^{-1})*	*K_{232}*	*K_{270}*
Menara	0.11	1.25	0.18	0.02
Picholine de Languedoc	0.68	1.23	0.27	0.04
Manzanille	0.65	1.25	0.08	0.01
Haouzia	0.13	1.27	0.4	0.01
Dahbia	0.38	1.26	0.18	0.01
Picholine Marocaine	0.39	1.2	0.17	0.01

Table 2. Evolution of the acid value over time "Av % = f (t)" in the olive oil varieties in both storage conditions.

Olive varieties	*Darkness*	*Sunlight*
Menara	Y= 0.0085t + 0.0987	Y= 0.0197t + 0.0917
Picholine de Languedoc	Y= 0.0451t + 0.5993	Y= 0.0761t + 0.564
Manzanille	Y= 0.1001t + 0.5147	Y= 0.1283t + 0.4865
Haouzia	Y= 0.0127t + 0.1128	Y= 0.0197t + 0.1058
Dahbia	Y= 0.0592t + 0.3102	Y= 0.062t + 0.3102
Picholine Marocaine	Y= 0.0818t + 0.2679	Y= 0.1213t + 0.2538

Table 3. Evolution of the peroxide over time "Pv (méq.O_2 Kg^{-1}) = f (t)" in the olive varieties in both conditions of storage oils.

Olive varieties	*Darkness*	*Sunlight*
Menara	Y= 3.125t – 2.0833	Y= 4.0625t – 3.125
Picholine de Languedoc	Y= 1.25t	Y= 2.5t – 1.25
Manzanille	Y= 1.875t – 0.4167	Y= 3.75t – 2.7083
Haouzia	Y= 3.4375t – 2.0833	Y= 4.7125t – 3.6083
Dahbia	Y= 2.1875t – 1.25	Y= 6.25t – 5.8333
Picholine Marocaine	Y= 1.875t – 0.8333	Y= 3.75t – 3.125

Table 4. Evolution of specific K_{232} extinction coefficient over time "K_{232} = f (t)" in the olive varieties in both conditions of storage oils.

Olive varieties	*Darkness*	*Sunlight*
Menara	Y= 0.2832t + 0.0055	Y= 0.2903t + 0.0444
Picholine de Languedoc	Y= 0.2092t + 0.0188	Y= 0.3039t – 0.082
Manzanille	Y= 0.3008t – 0.187	Y= 0.3114t – 0.1976
Haouzia	Y= 0.2263t + 0.3135	Y= 0.2194t + 0.3059
Dahbia	Y= 0.3192t + 0.0004	Y= 0.3081t + 0.0322
Picholine Marocaine	Y= 0.2665t + 0.0218	Y= 0.2872t + 0.0504

Table 5. Evolution of specific K_{270} extinction coefficient over time "K_{270} = ƒ (t)" in the olive varieties in both conditions of storage oils.

Olive varieties	*Darkness*	*Sunlight*
Menara	Y= 0.0267t - 0.0054	Y= 0.0366t – 0.0167
Picholine de Languedoc	Y= 0.0239t + 0.0154	Y= 0.0278t + 0.0144
Manzanille	Y= 0.0509t – 0.0399	Y= 0.0477t – 0.0345
Haouzia	Y= 0.0406t – 0.0313	Y= 0.0466t -0.0255
Dahbia	Y= 0.0474t – 0.0329	Y= 0.0524t – 0.0374
Picholine Marocaine	Y= 0.0448t – 0.0334	Y= 0.0404t – 0.0265

4.2 FIGURES

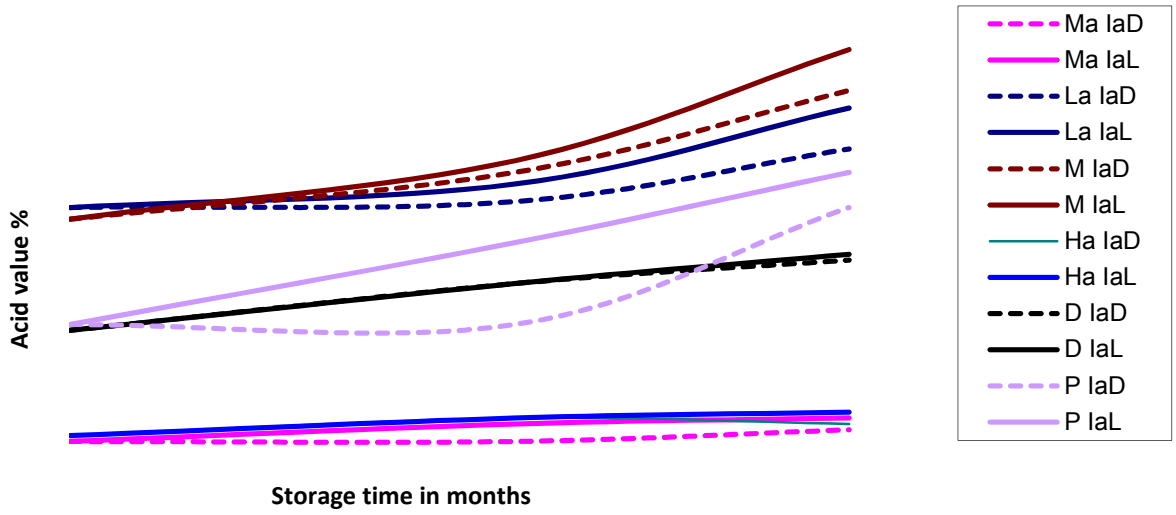

Fig. 1. Changes in the acid values of EVOO samples during 7 months storage period : Darkness (----) and Sunlight (-).

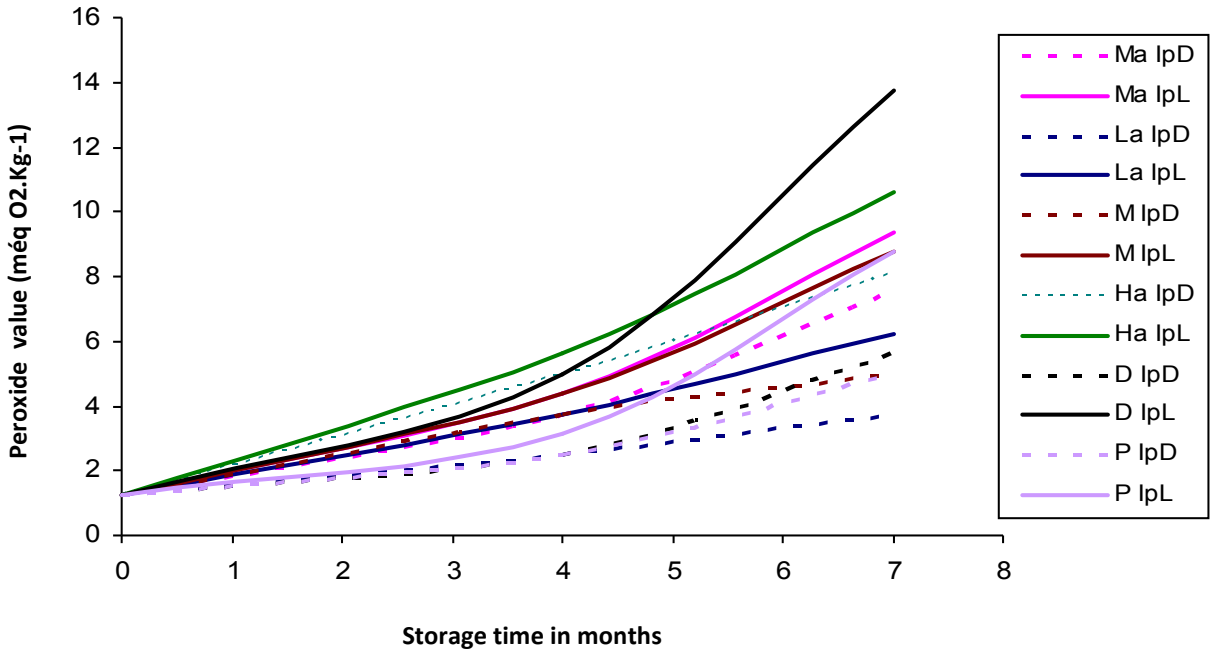

Fig. 2. Changes in the peroxide values of EVOO samples during 7 months storage period : Darkness (----) and Sunlight (-).

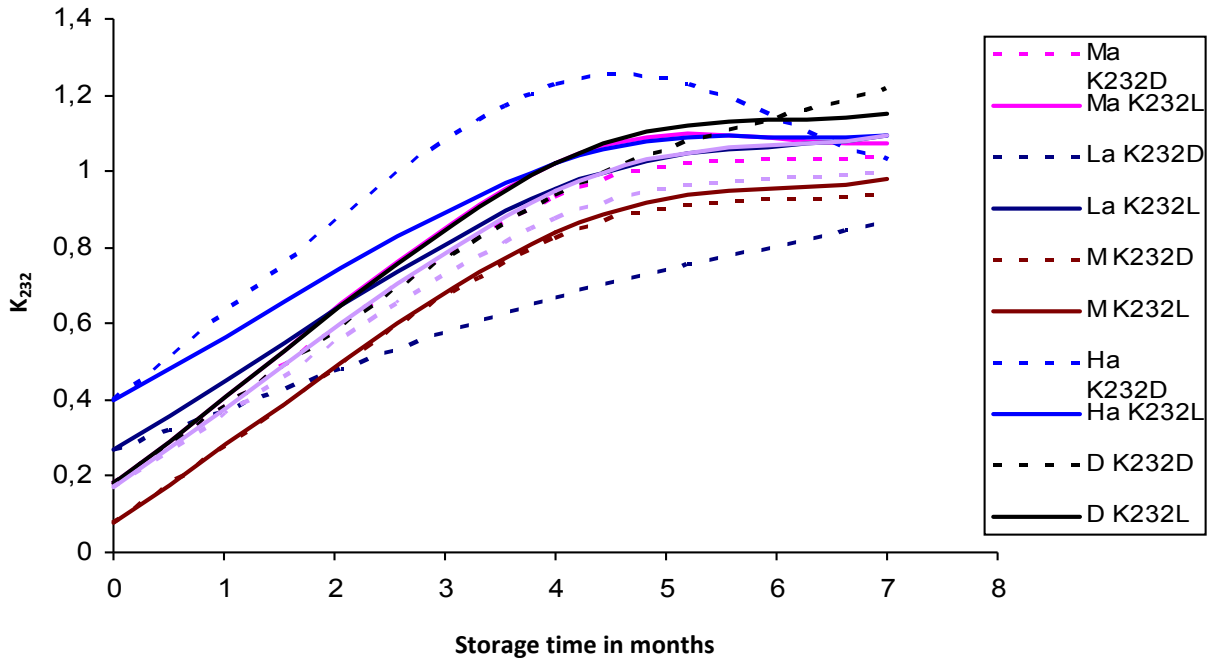

Fig. 3. Changes in the K_{232} of EVOO samples during 7 months storage period : Darkness (----) and Sunlight (-).

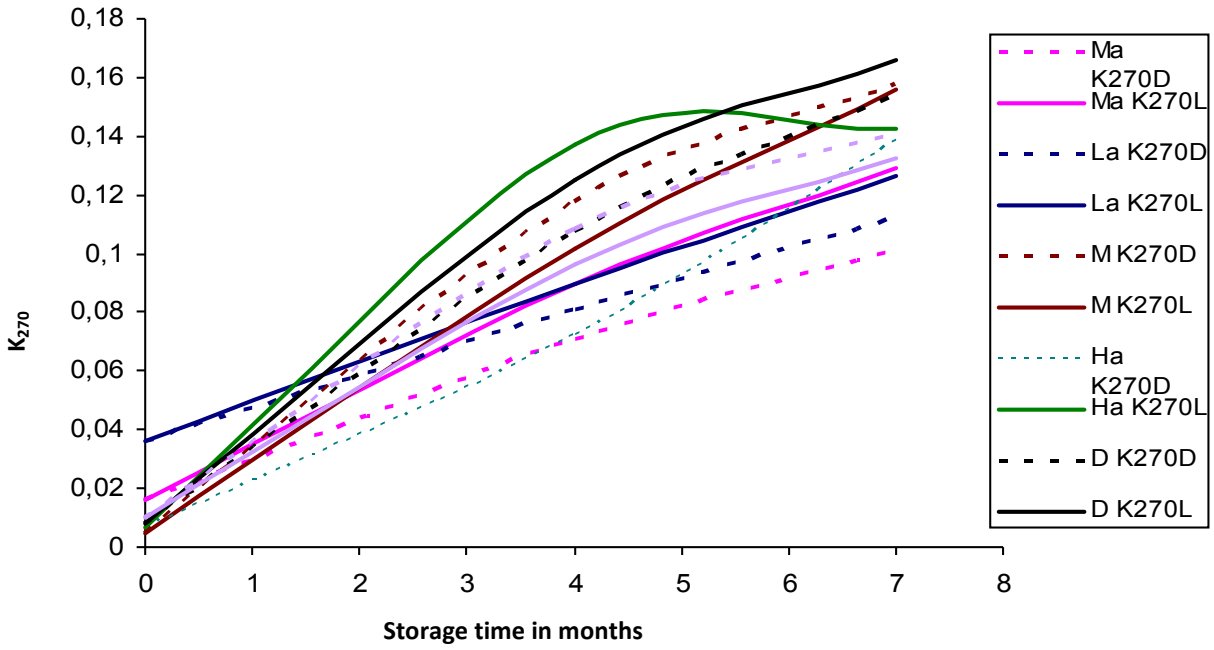

Fig. 4. Changes in the K_{270} of EVOO samples during 7 months storage period : Darkness (----) and Sunlight (-).

5 CONCLUSION

This study shows a significant effect of variety on the physic-chemical properties of the studied oils. Also, the sunlight has a more or less significant to the stability of physic-chemical properties of olive oil according to the variety. The acid value varies remarkably in olive oil from Manzanille, and therefore the appearance of a characteristic flavor 'rancid' which modify the marketability of the oil. The peroxide value varies significantly in olive oil from Dahbia. This will result in a rapid augmentation of rancidity. K_{232} and K_{270} extinctions vary greatly in olive oils from Dahbia and Manzanille. While olive oil Moroccan Picholine has moderate physicochemical stability. Which was not the case during its comparison with the Arbequina variety in other studies [17], [18].Then, we can say that these oils will be enriched by quickly oxidation products and then have a low storability. In short, these changes negatively affect the life span, sensory quality, nutritional and food security of olive oil.

From the above results it could be mentioned that acid value, peroxide value, K_{232} and K_{270} values were lower in extracted oil from Picholine de Languedoc. The physic-chemical properties of this olive oil, showed good stability when exposed to sunlight. Thus, it's the most recommended for use due to its high resistance to deterioration during storage.

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DROUGHT + POLITICS = FAMINE IN SOMALIA

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ABSTRACT: Disasters recognize no geographical boundary and cause disruption to human, social and ecological life of society. Every year natural disasters take a heavy toll on human lives and property. The Pan American Health Organization (PAHO) defines disaster as an overwhelming ecological disruption that exceeds the capacity of a community to adjust.

Besides natural disasters, present day mankind is also facing the brunt of man-made disasters like climate change, bioterrorism, industrial and technological disasters, ecological disasters, wild forest fire and so on. Whatever might be the nature or type of disasters, they cause irreparable losses and injuries to the mankind. Disasters are common occurrences all over the world.

Generally speaking the term disaster includes a natural or manmade disasters or a combination of both with its damaging affects in a large number which is large enough to disrupt the normal course of emergency and healthcare services.

Poor and developing countries are most vulnerable to these disasters. It is estimated that disaster losses in developing and third world countries are 20% higher than developed countries, as a percentage of GNP.

Out of many third world and developing countries, Somalia recently has faced a severe famine from 2011 to 2012. This famine was the worst disaster of the country's history. Both physical and human related factors contributed a lot to raise the severity of this famine. In the present paper an attempt has been made to study the causes (which are both natural and political), impacts of the famine. Moreover, some recommendations are also suggested.

KEYWORDS: Classic, Hazards, Degradation, Famine, Scarcity & Rehabilitation.

INTRODUCTION

Droughts are the classic slow-onset disaster. They develop slowly, tend to last a long time and cover a wide geographic area. Unlike earthquakes or cyclones, where the date of hazard can be identified, droughts do not become disasters, until time has passed. Because they develop slowly, it is difficult to determine exactly when the drought begins and ends.

A drought is defined as "a period of abnormally dry weather, sufficiently prolonged for the lack of water to cause serious hydrologic imbalance in affected area."[1] But there is a lack of standard quantitative definition of drought –how far from normal pattern does have to decline in order for a shortfall in rainfall to be a drought? 10% below normal over 6 months in time?, 50% below normal over an year? In fact given the prevalence of and destruction caused by drought, it is surprisingly that there is not more clarity or statistical analyses of droughts. While other hazards have their own data bases (e.g. the

[1] *NOAA, "What is Meant by the Term Drought?" http://www.wrh.noaa/gov/Fgz/science/drought.php? Wfo=Fgz*

Dortmouth Flood Observatory collects data on floods; earthquakes are studied and monitored by the United States Geological Survey). There is no specific database on droughts.[2]

Droughts kill more people than any other type of disaster. Below et.al. reviewed drought disasters from 1900-2004, finding that more than half of 22 million deaths associated with natural hazards were due to drought. And yet droughts accounted for only 35% of the 5.4 billion people affected by natural disasters. In comparison, floods affected far more people accounting 50% of those affected by natural disasters. In other words droughts kill proportionally more people while floods affect a higher number of people than droughts. Surprisingly, they also found that only 7% of the estimated 1 $1.2 trillion in economic losses from disasters occurring between 1900-2004 were due to droughts while floods, earthquakes and wind-storms each accounted for approximately 30%. It is so because droughts destroy crops and livelihoods, they rarely destroy or damage built structures or infrastructures.

"It is estimated that between five and six million hectares globally are permanently lost to agriculture each year through human induced soil degradation. Causes of land degradation include overgrazing, deforestation, agricultural, mismanagement, industry and urbanization. There is a high correlation between extreme poverty, land degradation and rural livelihoods.

OBJECTIVES OF THE STUDY

1. To assess the humanitarian situation in Somalia and effects of the current drought.
2. To identify real needs of people affected by droughts.
3. To collect information for proposal development and fund raising.

METHODOLOGY

This paper has used information obtained from various sources including articles from newspapers, magazines, internet and numerous books and research papers.

AREA OF STUDY

The country of Somalia is situated in Eastern Africa. It is also known as 'Horn of Africa'. Its climate is principally desert type in which rainfall is highly irregular. Reoccurring famines, deforestation, overgrazing, soil erosion, political instability, human health problems are major worries of this country. In present paper a detailed discussion will be made on drought conditions of the country who suffered nearly two lakh deaths due to droughts and problems associated with it.

[2] *Regina Below, Emily Grover – Kopec and Max Diley "Documenting Drought – Related Disasters : A Global Reassessment, "The Journal of Environment & Development, Vol. 16, No. 3, Sep. 2007, p. 332.*

CLASSIFICATION OF DROUGHTS

As per meteorological department, a drought is a situation when annual average rainfall is less than 75% of the normal. A drought prone area is the one where at least 20% of years have recorded rainfall deficit. If this percentage exceeds 40% then the area is designated as chronically drought prone area (Indian Irrigation Commission, 1972). Drought can be classified into following types:

(a) Meteorological Drought :

It is a situation when annual rainfall over an area in a year is less than 75% of the normal. An area is termed as drought area if it experiences drought conditions in 20% of time whereas if the frequency is more than 40% in certain areas, it is termed as chronically drought prone. Most of Somalia, and it's neighboring countries are included in this category.

(b) Hydrological Drought :

Prolonged meteorological drought results in hydrological drought with a marked depletion in surface water and consequence drying up of reservoirs, lakes, streams and rivers, reduction of flows and fall in ground water level. Subrahmanyam and Subrahmanyam (1964) found that aridity index, viz., per cent ratio of annual water deficit to annual water need, proposed by Thornthwaite (1948) was most useful parameter to classify droughts in terms of standard deviation for normal aridity index. Later on, Shastri and Ramkrishna (1980) modified the explanations to classify droughts in arid regions (Table-1).

Table 1. Classification of Droughts in Arid Region

Intensity of Drought	Category of Droughts
0 or above	No Drought
0 to -0.53	Mild Drought
- 0.5 to – 1s	Moderate Drought
- 1s or below	Severe Drought

s –signifies standard deviation
Sources: Ramakrishna, 1980.

(c) Agriculture Drought :

It means that when the requirement (evapotranspiration) difference between water and water availability during the cropping season. As such the intensity of drought depends upon water stress which occurs during different stages of crop growth. The intensity of agriculture drought can be determined if water stress during growth period is evaluated on the basis of water requirement.

(d) Ecological Drought :

It occurs when the productivity of natural ecosystem fails substantially due to environmental damage caused by distress.

(e) Socio-economic Drought :

It occurs when production of food grains fails and situation of acute food shortage prevails in affected area.

(f) Famine :

Famine situation occurs when there is a large scale collapse of access to food, which results in mass starvation unless there is some external assistance. As such, there is a great stress and sufferings with large scale migration and dying of livestock.

CAUSES OF FAMINE

Famines are the result of "triple failure" :

1. Production Failure :

In Somalia, a two year drought which is phenomenal in now being the driest year in the last 60 has caused record food inflation, particularly in the expectation of the next harvest being 50% of the normal. Somalia already had levels of malnutrition and premature mortality so high as to be in a "normalized state of permanent emergency". This is true too in pockets of the entire region.

2. Access Failure :

The drought has killed off the pastoralists' prime livestock assets (upto 90% animal mortality in some areas) slashing further their purchasing power. In addition Somalia's severe internal conflict has made development almost impossible to achieve and data difficult to access both accurately and credibly.

3. Response Failure :

Underlying it all has been the inability of Somalia's government and donors to tackle the country's chronic poverty which has marginalized vulnerable people and fundamentally weakened their ability to cope. There has been a lack of investment in social services and basic infrastructure and lack of good governance. Meanwhile donors have reacted too late and too cautiously. The response of international community to this humanitarian crisis has been very slow and inadequate. According to UN figures, $ 1 billion is required to meet immediate needs. So far, donors have committed less than $ 200m, leaving an $ 800 million black hole.

4. Vagaries of Weather:

Weather conditions over the Pacific Ocean, including an unusually strong La Nina, have interrupted seasonal rains for two consecutive seasons. The rains failed in 2011 and 2012 in Somalia. In many areas the precipitation rate during the main rainy season from April to June was less than 30% of average of 1995-2010. The lack of rain led to crop failure and widespread loss of livestock.

As a result, cereal prices rose to record levels while livestock prices and wages fell, reducing purchasing power across the region. The Crisis is further compounded by rebel activities around southern Somalia from Al-Shabab group.

IMPACT OF DROUGHTS IN SOMALIA

Its impact can be discussed under following headings:

1. General Drought Situation in Somalia:

Currently Somalia is experiencing the worst drought affecting both people and livestock in all parts of Somalia. The drought is hitting in all horn of African countries of Somalia, Kenya and Ethiopia. Somalia being the worst hit, north, central and southern regions situation is desperate. UNICEF has put the number of population that needs emergency livelihood and life saving assistance at 43 percent of population. Food security situation is worsening in all drought affected areas. The prices of food have risen up by 300 percent. Malnutrition in Children under five and adults has escalated. According to Oxfam International, about 25% of population to be actually malnourished in Gedo region.

2. Water Situation:

Water Scarcity is the first problem in entire affected areas. Almost all water points such as shallow wells, ponds and Birkas (an underground cistern) dried up because of long time lack of rains. There is high over utilization of the still working bore holes. A 200 liters of water costs $10 in Togdher region which is one of the worst hit region. Under these circumstances people are forced to drink dirty and stinking water remained at the bottom of the dried up wells. This has resulted in outbreak of water born diseases in many parts of the region. Water-trucking, construction and rehabilitation of boreholes, rehabilitation and de-silting of dams are the first intervention priority.

3. Pasture Condition:

It is quality and availability has been decreased severely in all affected areas. Water and pasture distance has increased significantly since major water points at posture areas have dried up.

4. Livestock Body and Health Condition:

The physical livestock condition in the country is very weak. It is very common to see left out cows after they could not move. In addition to lack of pasture and water, there are diseases like anthrax, black leg and pastreulossis which are killing animal.

5. Human Health Condition:

High malnutrition, diarrhea, dysentery and other water borne diseases are common in many parts of the country. There is an urgent need to increase the supply of medicines, therapeutic feeding, rehydration fluids, water purification chemicals for affected people to avert epidemics are urgently needed.

6. Food Security Status:

It is very below normal Food prices have risen by 300% and there is no market for livestock for example in normal times one goat was equivalent to 50 kg of wheat or maize but now five goats can't buy 50kg of wheat or maize. Failure of crops for two consecutive seasons i.e. 2011 and 2012 and pirates in the coasts of Somalia are responsible to the increase of food prices. In addition to the drought diseases in many parts of the country contributed in low demand of livestock in the markets in the country.

7. Copping strategies of people:

As the magnitude of this drought is very large, options left to the people is limited. Moving to cities for begging and seeking casual labor, selling properties, selling firewood and water in the cities are the copping strategies that people are using. This severe drought has forced the people of rural areas to left their birth places and move towards cities for their survival. For example in the South many people went to the capital Mogadishu where they prefer to live under the fight and bombardment over starving in their localities. There is daily fighting between government troops and the Al-Shabab militia which controls the whole southern region and most of the capital.

8. Internally Displaced Persons (IDP) Camps in Togdher

Togdher is one of the 12 regions of Somaliland. This region borders with Puntland in South, Ethiopia in West and Berbera and Hargeisa on the east and north respectively. Burao is the seat of the region and one of the biggest livestock market of the East Africa with a total population of 217689 . The life in these camps is very difficult, no shelter, no food, no health or education services. There is still shortage of food. Generally women and children go to Burao town for begging, seeking daily labor. Men also seek casual labor in town. Availability of water is poor in camps. The nearest source of water is Burao, an hour to go and an hour to come back. No health services at all, incidents of diarrhea is common from all camps. Malnutrition is high in children and elderly people. Post natal death is also very high in the camps. Unlike other camps, Aden Suleiman has primary health care centre where UNICEF provides medicines irregularly. Near the camp there is functional boreholes constructed by Somalian government.

RECOMMENDATIONS

The effect of drought is very huge and deep. It is the natural result of long time rain failure in an arid and Semi-arid are where rains are scarce and less intense. Gaps created by drought is very big and cannot be covered the community unless the external support is combined with local efforts. Following are some recommendations:

1. For Water:

There is a gap between water availability. Currently, the price of water is escalating. Rehabilitation of malfunctioning boreholes is another problem. To reduce the number of displacement of lack of water and to relief burdens on functioning boreholes, water trucking is urgently needed particularly in the areas where water points exhausted. Rehabilitation of malfunctioning boreholes is also repeatedly requested. To solve water shortage in the long run, construction of more boreholes, dams, wells and birkas should be considered.

2. For Livestock:

More than 55% of population is Somalia is nomads depending upon livestock for their livelihood and are most hit by this current drought. Normally the outbreaks of livestock diseases are very common during droughts because of hunger, long distance journeys in search of water and fodder. To save the life of these livestock emergency treatment and vaccination campaigns should be conducted.

3. Emergency Food Distribution:

There is a big short fall in food in all affected areas. Due to no harvest over last few years the prices of food are sky-rocketing. Emergency food distribution and therapeutic feeding is needed to save life and minimize malnutrition.

4. Human Health:

Health services are very poor. Drought affected people do not have enough access as well as purchasing power to purchase medicines even from government agencies. Hence emergency health interventions in most affected areas and IDP camps should be considered.

CONCLUSION

Although droughts occur elsewhere with devastating effects, it is particularly prevalent in Africa. Drought unlike floods or cyclones, generally has a long lead time. The famine that struck the Somalia has resulted in deaths of tens of thousands of people and animals.

The 2011 to 2012 famine in Somalia was not only a natural phenomenon but also a product of human made factors, including lack of governance, political instability and conflict, which undermined traditional coping strategies that have evolved over generations in response to the natural hazard of drought.[3] As Amartya Sen pointed out decades ago, famines do not occur in democracies.[4] The best way of preventing famines is not simply a technical issue of coming up with better warning systems or did delivery mechanisms, but engaging in for more difficult task of creating political systems capable of protecting and assisting their people when natural hazards occur.

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Nigerian Small and Medium Scale Enterprises' Access To Finance: What is the story since Bank Consolidation in 2005

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ABSTRACT: This paper examined the impact of bank consolidation on credit access and availability to small and medium scale enterprises (SME's) in Nigeria for the period 1999-2012. The main objectives are (1) To examine whether or not bank consolidation in Nigeria brought about increased lending to SME's.(2) Determine the level of lending risk to SME's .(3) Determine if there is any significant difference between SME's financing in pre and post consolidation in 2005.Data on commercial bank loans to SME's as percentage of total credit was the main variable used and were obtained from CBN Statistical Bulletin 2012. The mean, standard deviation descriptive statistics and the t-test tool were used for the analysis. The study found out that bank consolidation in Nigeria led to a drastic reduction of SME's financing to less than one percent (0.37%) on average. The lending riskiness of banks to SME's in post consolidation reduced while there is no significant difference between SME's financing in pre and post consolidation era. The results however go contrary to the much taunted belief that bank consolidation will lead to increased SME's financing in Nigeria. The study recommends improved transparency of SME's accounting and reporting of their activities, banks should relax some of the stringent lending measures to SME's while government should design policies that should group SME's in such a manner for proper identification and planning (specifically according to trade and industry) so that it can guarantee credit facilities and ensure prompt repayment through designated agencies.

KEYWORDS: SME'S, Access to finance, Bank consolidation, Economic growth.

1 INTRODUCTION

It is an accepted realism that economic development of any nation depends largely on the existence, growth and survival of small, medium scale enterprises (SME's) sector. As a propeller of economic growth, SME's require serious attention so that their developmental role and sustainability will provide the much needed sustainable development of a nation with regard to job and wealth creation. Eigbe (1996) observed that small and medium enterprises are a catalyst to socio-economic development of any country. They are a veritable vehicle for the attainment of national macro-economic objectives in terms of employment generation at low investment cost and the development of entrepreneurial capabilities and indigenous technology. He stressed that the roles of SME's have been amply displayed in many countries such as Japan, South Korea, India and Malaysia. Further, he argued that SME's contribute substantially to gross domestic product (GDP), export earnings and employment opportunities of these countries. The promotion of small businesses is a cornerstone of economic policy for a large number of industrialized countries. While public support for small enterprise appears to be based on a widely held perception that this sector is an incubator of economic growth, in other words SME's are viewed as a place where innovation takes place and where new ideas are generated that makes business enterprises to be economically viable.

As documented by available literature, the strategic importance of SME's in propelling economic growth and development is critically hampered by non availability and access to finance to fund their activities. In Nigeria, SME's access to finance is seriously constrained despite the many efforts government have made to mitigate the situation. Ogujuiba et al (2004) recorded that the Association of Nigerian Development Finance Institutions in 2004 issued a statement stating why SME's performed poorly in Nigeria. They argued that truly finance is a major constraint, while this may be true empirical

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evidence shows that finance contributes to only about 25% of the success of SME's. World Bank (2001), however, reported that almost 50% of micro, 39 and 37 percent of the small and medium scale firms are financially constrained in Nigeria as opposed to 25% of the very large firms. This suggests clearly that small and medium scale enterprises are either discriminated against or cannot access funds at the credit market owing to a number of reasons. A major reason is the stringent conditions attached to loans and credit approvals by banks in Nigeria which largely have undermined the capacity of SME's to access finance.

The consolidation of the Nigerian banking sector in 2005 was seen as a welcome development believed to address and ease SME's access to finance. As the CBN (2006) convincingly argued that with consolidation banks in Nigeria would be able to expand their branch networks and mobilizes more funds to lend to the SME's and other deserving sectors of the economy. This argument was premised on the underlying theory that consolidation enables banks to extend more credit to SME's due to the supposed positive relationship between capitalization and deposits on one hand and deposits and credit size on the other hand.

However, researches on bank consolidation in Nigeria have generated conflicting findings which have raised a lot of attention and curiosity. For instance banks' management claim that consolidation has done a magic wand by increasing credit size to SME's while SME's owners contend that consolidation has not solved their financial problems. Another strand of thought in the literature contends that consolidated banks seem to turn away from SME's financing to bigger ticket financing. Could this be the story in Nigeria? Therefore against this background, this paper is poised to assess the impact of bank consolidation on credit access and availability to SME's in Nigeria. The main objectives are (1) To examine whether or not bank consolidation in Nigeria brought about increased lending to SME's.(2) Determine the level of lending risk to SME's .(3) Determine if there is any significant difference between SME's financing prior to and after consolidation in 2005.

Arising from the main objectives, the probable hypotheses for the study are:

1. H_{01}: Bank consolidation did not bring about increased lending to SME's in Nigeria
   $H_{A1:}$ Bank consolidation brought about increased lending to SME's in Nigeria
2. H_{02}: Bank consolidation did not lead to increased lending risk to SME's in Nigeria
   $H_{A2:}$ Bank consolidation led to increased lending risk to SME's in Nigeria
3. H_{03}: There is no significant difference between SME's financing in pre and post bank consolidation.
   $H_{A3:}$ There is a significant difference between SME's financing in pre and post bank consolidation.

The remainder of the paper is organized in five sections. Section 2 will deal with literature review; section 3 will outline the methodology; section 4 will highlight the data presentation and analysis; section 5 will discuss the findings; while section 6 will deal with conclusion and policy recommendations.

2 LITERATURE REVIEW

2.1 CONCEPTUAL REVIEW OF SME'S

Ayyagari et al (2007) noted that small and medium scale enterprises have been long recognised as an instrument of economic growth and development. The growing recognition of this fact has led the World Bank group on SME's sector to ensure that it is the core element in its strategy to foster economic growth, employment generation and poverty alleviation.

However, there is no one definite definition of SME's and its classification is based on value judgment which makes it subjective. The Organization for Economic Co-operation and Development (OECD)(2004) notes that SME's are a mixed group found in a wide array of business activities and the concept of SME's is relative and dynamic. Ganbold (2008) submits that the statistical definition of SME's varies by country to country and is usually based on the number of employees, value of sales and /or value of assets and size of capital. Ayaggari et al (2003) however, contend that the definition of SME's varies according to the context, author and countries.

Ekpeyong and Nyang (1992) notes, that in countries such as USA, Britain and Canada, small scale business is defined in terms of annual turnover and the number of paid employees. In Nigeria, a clear cut definition between small and medium scale enterprises does not exist. According to CBN (1998) monetary policy circular No.22 of 1998, small scale industries are those enterprises which have annual turnover not exceeding 500,000 Naira. But in 1990, the Federal government of Nigeria for the purpose of commercial bank loans defined small scale enterprises as those enterprises whose annual turnover does not exceed five hundred thousand naira (N500,000) and for merchant bank loans, as those enterprises with capital investment not exceeding two million naira(N2M) (excluding the cost of land) or a minimum of five million naira(N5M). Ogechukwu (2006) writes that in the wake of the Structural foreign exchange market (SFEM) and Structural Adjustment

Programme (SAP) in 1993, the value definition of SME's were reviewed and subsequently increased to five million naira (N5M).Arising from this situation; there may be a need to classify the small scale business into micro and super –micro businesses. Responding to this observation, Osa-Afiana in Ango (2011) reports Nigeria Bank of Industry definition and categorization of SME's. The categorization was into micro/ cottage, small scale and medium enterprises. Which are as follows:

- *Micro/ cottage enterprises: these are enterprises with capital of not more than 1.5 million naira (or US$11,278) including working capital but excluding cost of land and/or labour size of not more than 10 workers.
- *Small scale enterprises: these are enterprises with capital investment in excess of 1.5 million naira but not more than 50 million naira (US$375939) including working capital but excluding cost of land and/or labour size of not more than 11-100 workers.
- Medium scale enterprises: these are enterprises with investment worth over 50 million naira but not more than 200 million naira (US$1, 503,758) including working capital but excluding cost of land and/or labour size of not more than 100-300 workers.

SMALL AND MEDIUM SCALE ENTERPRISES AND ACCESS TO FINANCING

According to Beck et al (2008), SME's access to finance has been a subject of great interest to policy makers and researchers of both developed and developing economies because of the pivotal and significant role of SME's in growing the private sector and by extension the economies of nations around the world. There exists diverse definition of the concept ''access to finance'. World Bank (2007) defined access to finance as the absence of price and non-price barriers in the use of financial services determined by the forces of demand and supply. As the literature documents, a number of issues are connected with access to financial services. Dela Torre et al (2009) notes that improving access to finance entails improving the degree to which financial services are available to all at a fair price. Claesen (2005), opine that one of the issues connected to access to finance relates to the question of whether financial services are available and in what quantity. The second relates to cost; that is, at what price both implicit and explicit are financial services available including opportunity cost. The third is about the range, type and quality of financial services being offered.

Ganbold (2008) argue that the problem of access to finance by SME's exists when projects that could be financed internally in the event of resources availability do not get external financing due to what Stiglitz and Weiss (1981) referred to as principal–agents and transaction cost. He contends that this happens when there is a lock between the expected internal rate of return of the project and the rate of return that external investors require to finance it. Further, he asserts that the importance of SME's access to finance is predicated upon four reasons which he outlined as follows: One is that empirical evidence has shown that the expansion of access to finance may reduce prevailing poverty particularly in developing countries. Two, the channels through which financial development may lead to growth often include access related stories. Three, there is a lack of financial services in emerging economies compared with the extent of access in developed countries. Four, there is lack of access to financial services by agents of economic growth and development.

FINANCING OF SME'S IN NIGERIA

Financing of SME's in Nigeria has been a thorny issue. Nwachukwu (2012) submits that SME's in Nigeria have not made the expected desired impact on the economy and this may not be unconnected to the numerous challenges facing the SME's among which is finance. Drawing on this, Olorunshola (2001) asserts that the major gap in Nigeria's industrial development process is the lack of long-run and in some cases short-term finance for SME's. As noted from the literature, finance sources can be categorized into informal and formal sources. According to Ango (2011), the informal sources comprise of owner's savings/retained earnings, contribution/borrowing from friends, relations etc. Okungwu and Saleh (2004) observed that finance generated from informal sources fall short of the required capital for the SME's. As a way of support Ango (2011) comment that to raise the balance of the required finance, entrepreneurs look up to the formal sources which comprise of banks, other financial institutions,co-0perative Societies and government loan agencies.

Lawal and Ijaiye (2010) in their study observed that SME's face a lot of challenges in raising finance through the formal sources especially as it affects banks and other financial institutions. In support, Oboh (2002) writes that most of the banks are not willing to advance loans to SME's mainly because of the absence of the so called collateral security. Main-while, SME's are in dire need of loans for improvement in local technology, transfer of foreign technology, domestic capital formation, provision of more employment opportunities as well as earn more foreign exchange than oil exports earns for the country. The paucity of finance and the rigorous process to obtain it by SME's prompted the Federal government of Nigeria

to initiate different financing programmes and policies in a bid to intervene through dedicated ministries and agencies. Ango (2011) chronicle these efforts to include:

i. Provision of direct financial assistance through government owned financial institutions which include the Nigerian Agricultural Cooperative and Rural Development Bank, the Federal Mortgage Bank of Nigeria etc.

ii. Provision of packages of subsidized or discounted loan portfolio through special schemes arranged between government and commercial banks. For instance in 2001 the Medium Industries Investment Scheme was established. This scheme require banks to set aside 10% of their profit before tax for equity investments in SME's

iii. Provision of capital to SME's through soft loans advanced by government owned financial institutions such as the Nigeria Industrial Development Bank established in 1964,the Nigerian Bank for Commerce and Industry established in 1973, the Peoples Bank established in 1986,the National Economic Reconstruction Fund established in 1989.

iv. Funding of SME's in liaison with multilateral financial institutions such as the World Bank, the African Development Bank, the International Finance Corporation (IFC) etc. In 1989, for instance the World Bank gave Nigeria a facility of $270 million out of which a total of $267.7 million was set aside for lending to SME's through eligible participating banks.

v. Issuance of directive on mandatory credits to SME's through the Central Bank of Nigeria (CBN) credit guidelines to commercial banks. In 1992, the Federal Government through the CBN directed commercial banks to mandatorily allocate 20% of their credits to SME's.

Osa-Afiana (2004) observed that this scheme was only partially successful mainly due to the reluctance of banks to advance loans to SME's without collateral security and appropriate credit guarantee scheme. Some banks did not comply and were more interested and comfortable paying the penalty attached for default. This directive was eventually abolished in 1996.

MANDATORY BANKS' CREDIT ALLOCATION TO SME'S IN NIGERIA

The period 1992-1996 was very significant as government was committed to extend credit to SME's through mandatory banks' credit allocation. This commence with the Monetary Authority's policy on indirect financing of SME's which began in 1992.To implement the policy, small scale enterprises were classified with agriculture as preferred sectors of the economy. A mandatory credit allocation of 20% of the total credit to the economy was mandated on banks. In 1992 the total credit stood at N41.8 billion.N20.4 billion of this amount representing 48.8% was actually loaned to small scale enterprises. As time went by, the compliance level of banks began to decline. As Obasan and Arikewuyo (2012) noted, the total credit to the economy increased to48.1 billion and N92.6 billion in 1993 and 1994 while the share of credit to SME's declined to 32% representing N15.5 billion in1993 and N20.6 billion representing 22.2% in 1994.Morever, in 1995 total credit to the economy rose up to N141.1 billion and the share of SME's rose less proportionately to N32.4 billion, representing 22.9% of total credit in that year. However, with the abolishment of the mandatory banks' credit allocations to SME's (including agriculture) on 1st October,1996, the total credit to the economy rose to N169.2 billion out of N42.3 billion representing 25% was released as loan to SME's. The table 1 below presents the analysis above.

Table 1. Showing total loans to the economy and loan granted to SME's during the period of 20% mandatory sectoral allocation in Nigeria (from 1992-1996)

Year	Total loan to the economy(N'M)	Total Loan amount granted to SME's (N'M)	Percentage of loans to SME's on total loans to the economy(%)
1992	41810.0	20,400.0	48.8
1993	48050.0	15462.9	32.2
1994	92,624.0	20,552.5	22.2
1995	141,146.0	32,374.5	22.9
1996	169,242.0	42,302.1	25.0

Source :CBN Statistical Bulletin,2012

Banks' Before Consolidation Era (from 1997-2005)

This period marked the abolishment of mandatory 20% credit allocation to preferred sectors as the federal government embarked on the policy of liberalization. The liberalization policy dismantled all forms of restriction and controls hitherto

were in force thereby creating a free market economy in Nigeria. This policy had effects on the lending preferences of banks beginning from 1997.Aggregate credit to the economy in1997 almost double rising to about N240.8 billion while credit to SME's declined to N40.8billion.This represent a sharp decrease to 17% of the loan to SME's to total credit to the economy. This ratio from then began to decline steadily until it got to 2.7% in 2005. Table 2 below succinctly presents the analysis.

Table 2. Showing total loan to the economy,total loan to SME's and percentage of loans to SME's on total loans to the economy for the period 1997-2005

Year	Total loan to the economy(N'M)	Total Loan amount granted to SME's (N'M)	Percentage of loans to SME's on total loans to the economy (%)
1997	240,782	40,844.3	17.0
1998	272,895.5	42260.7	15.5
1999	353,081.1	46824.0	13.3
2000	508,302.2	44,542.3	8.7
2001	796,164.8	52,428.4	6.6
2002	954,628.8	82,368.4	8.6
2003	1,210,033.1	90,176.5	7.5
2004	1,519242.7	54,981.2	3.6
2005	1,898,346.4	50,672.6	2.7

Source: CBN Statistical Bulletin 2012

Banks Post Consolidation Era (from 2006 -2008):

This period witnessed large increases in aggregate credit to the economy and drastic reduction of loans to SME's as shown in table 3 below. The total credit to the economy increased from N2.6 trillion level in 2006, N4.8 trillion in 2007 and N7.7 trillion in 2008.Despite these increases, the loans granted to SME's declined drastically from N25.7 billion representing 0.99% in the year 2006, N41.1 billion representing 0.85% in 2007 and N13.4 billion representing 0.17% in 2008.In 2009 up to 2012 commercial bank credit to the economy continued an upward increase while loans to SME's continued a downward reduction. The ratio of loans to SME's to total credit continued to decline in a likewise fashion. Table 3 below provides the vivid picture analysed above.

Table 3. Showing total loan to the economy,total loan to SME's and percentage of loans to SME's on total loans to the economy for the period 2006-2012

Year	Total loan to the economy(N'M)	Total Loan amount granted to SME's (N'M)	Percentage of loans to SME's on total loans to the economy (%)
2006	2,609,289.4	25,713.7	0.99
2007	4,820,695.7	41,100.4	0.85
2008	7,799,400.1	13,512.2	0.17
2009	9,667,876.7	16,366.5	0.17
2010	9,198,173.1	12,550.3	0.14
2011	9,614,445.8	15,611.7	0.16
2012	10,440,956.3	13863.5	0.13

Source:CBN Statistical Bulletin 2012

BANK CONSOLIDATION AND SME'S FINANCING

Cost of intermediation in post consolidation has been identified as a reason for the persistence of SME's perennial financial problems. In post bank consolidation in Nigeria, bank still lend at terrible interest rates of about 20% as against zero percent, 5 percent and 3 percent interest rate in China, Japan and Malaysia (Olutunla and Obamuyi, 2008). But evidences

however show that banking sector consolidation has many benefits which include but not limited to increased liquidity, efficiency and better diversification that may also support macroeconomic stability and sustainability in the long run.

Noted, concerns have been expressed that the consolidation of banks into larger and complex banks, no doubt, will significantly affect the financing of SMEs. As the literature documents, consolidation of banks in most countries has resulted into a large number of small banks that are specialized traditionally in providing credits to SMEs. Marsh Schmieder and Aerssen (2007) differ in their opinion. They argue that larger banks typically have a smaller propensity to lend to SMEs. In support, Craig and Hardec (2004) averred that the reason why larger banks are less likely to lend to SME;s is that larger banks tend to rely on formal formulaic methods for determining whether to grant credit or not and the amount to give .They argue further that SMEs are more opaque in terms of information than larger ones and smaller banks overcome these due to their comparative advantage and relationship banking. But Jiaobing andYuany (2011) insist that smaller banks enjoy comparative advantage in overcoming information problem. Supporting this assertion, Kauffmann (2005) opines that, this is why a market with small banks financing SMEs is high. In opposition, De Haas et al (2010) maintain that bank consolidation is believed to reduce the number of smaller bank as such there will be decrease in SMEs financing because these loans were considered to be less profitable for larger banking organization that emerged due to consolidation.

Another strand of argument has it that banks consolidation may lead to banks efficiency through cost synergies or by takeover of the inefficient banks by efficient ones and increase market power which may influence the supply of credit to SME's (Degryse, et al 2005). As Somoye (2008) notes, competition in banking sector, might also increase. SMEs financing as it forces banks to search for additional profit opportunities.

In another dimension, consolidation of banks may result in bank concentration. Beck et al (2009) observed that greater concentration lead to reduced credit access through any lending technology, which may occur in several ways: they may choose to raise profits through higher interest rates or fees on loans to SMEs; or reduce risk or supervisory burden by tightening credit standards to SMEs; and/ or they may choose to be less aggressive in finding or servicing credit worthy SMEs. However, the literature documents both positive and negative effect of bank concentration. For instance Jayaratne and Strahan (1998) declared that some studies found unfavourable effects from high banking market concentration and restrictions on competition. Peterson and Rajan (1995) on the contrary, maintain that other studies found favourable effect of bank concentration. Continuing the argument Beck et al (2008) averred that other studies found that the effects may differ with the lending infrastructure or economic environment.

REVIEW OF EMPIRICAL STUDIES

A number of empirical studies have been carried out on SME's access to financing. For instance, Charles (2002) through interview technique investigated the factors that influence the growth, performance and development of SMEs in Nigeria and other implication on policy. He found that accessibility to finance and good management are central to SMEs growth and development. Sanusi (2003) study showed that SMEs accessibility to formal financial system in Nigeria is very limited. Moreover, observational study of CBN (2007) indicates that as at the end of the first quarter of 2007, out of the N38.2billion contributed to SMEs financing scheme by banks, only N18.1billion representing 47.3% had been assessed by the SMEs, which clearly shows that there has always been a gap between the supply capabilities of banks and the demanding needs of the SMEs. Obamuyi (2007) investigated the level of loan delinquency among SMEs in Ondo State of Nigeria and banks' lending behaviour towards them. The result of the study revealed that poor credit worthiness, lack of collateral security and constraint imposed on banks' capital regulations are responsible for banks' attitude not expanding loan portfolio to SME's.

Olutunla and Obamuyi (2008) in their study using fixed effects regression model based on a balanced panel data on 115 SMEs randomly selected in Ondo State, Nigeria examined the relationship between profitability, bank loans, age of business and the size of SMEs. The results revealed that there is interdependence between bank loans and profitability of SMEs and a significant relationship between profitability and size of business. Oyefuga et al (2008) evaluation of the impact of SMEEIS on the growth of Nigerian SMEs revealed that inappropriate business plans and poorly packaged projects were the main reasons why SMEs find it difficult to access funds from the new scheme. He noted further that though the scheme has been helpful to some SMEs, but most of them are not even aware of their activities.

Obasan and Arikewuyo (2012) investigated the effects of pre-post bank consolidation on the accessibility of finance to SMEs in Nigeria. Using the ordinary least square, the study found out that banks consolidation has failed to foster a vibrant and competitive SMEs sector that could enhance job creation and economic growth in Nigeria. Ishmael et al (2012) study based on a survey Neolithic literature and dissemination of questionnaires on a sample size of 50 SMEs within Ikeja Local Government Area of Lagos State using random sampling technique revealed that SMEs do not have better access to finance through banks, do not have absolute rapport with the financial institutions due to their financial background and are

financially handicapped which limits their size and capacity to embark on bank loans with high interest rate arising from the neo-reorganisation in banks occasioned by consolidation.

Luper (2012) examined banks financing to small and medium scale financing in Nigeria with a view to determining if there is any difference between SME's financing before and after banking sector reforms (bank consolidation in 2005).Using descriptive and sample t-test the findings revealed that banking sector reforms led to a decline in SME's financing from 5.78 percent to less than one (0.47) percent on average and there is significant improvement in SME's financing in Nigeria after bank consolidation.

Mamman and Aminu (2013) investigation of the effect of 2005 banking reforms on loan financing of SMEs in Nigeria based on a sample size of 500 SMEs and using chi-square test reveal that there is no significant effect of 2005 banking reform on loan financing of SMEs in Nigeria.

Iloh et al (2013) assessed the implications of bank consolidation on lending (financing) to SMEs in Nigeria. Using ordinary least square, correlation matrix test and Granger-causality test, the study found out bank deposit impacted on lending which has insignificant effect on SME's.

3 METHODOLOGY

In order to measure the impact of bank consolidation on SMEs financing in Nigeria, the study employed the research design approach. It concerns itself with the loans and advances commercial banks have lent to SMEs for the period 1999-2012. This period is further divided into two periods – 1999-2005 pre- consolidation era and 2006-2012 post consolidation era. The data on loans and advances are obtained from the Central Bank of Nigeria Statistical Bulletin of 2012. In specific terms, commercial bank loans to SMEs as a percentage of total credit will be the main variable for this analysis. To achieve objective 1 which is to examine whether or not bank consolidation in Nigeria brought about increased lending to SME's descriptive statistics particularly the mean will be used. To achieve objective 2 which is to determine whether lending risk to SME's increased or decreased. To achieve objective 3 which is to determine if there is any significant difference between SME's financing prior to and after consolidation in 2005.The paired t-test statistics will applied to test if there is any significant difference between SMEs financing by banks before and after consolidation in Nigeria. These statistics have been selected for use because they are the most appropriate tools considering the sample size and the analysis required. Moreso, these tools have been used extensively by several related studies in the literature.

4 DATA PRESENTATION AND ANALYSIS

As stated in the methodology, bank loans to SMEs as a percentage of total credit will be the specific variable for the study and the computation is based on the data obtained from CBN statistical bulletin for the period 1999-2012 which are presented here under.

Table 4. The Ratio of commercial banks loans to SMEs and other sector total credits

Periods	**Before consolidation**		**Periods**	**After consolidation**	
	Commercial bank loans to SMEs as percentage of total credit (%)	Commercial bank loans to other sectors as percentage of total credit (%)		Commercial bank loans to SMEs as percentage of total credit (%)	Commercial bank loans to other sectors as percentage of total credit (%)
1999	13.26	86.74	2006	0.99	99.01
2000	8.76	91.24	2007	0.85	99.15
2001	6.59	93.41	2008	0.17	99.83
2002	8.63	91.37	2009	0.17	99.83
2003	7.45	92.55	2010	0.14	99.86
2004	3.62	96.38	2011	0.16	99.84
2005	2.67	97.33	2012	0.13	99.87
Average(mean)	7.28	92.67		0.37	99.63

Source:Author's computation 2014

The table above shows that the ratio of loan and advances to SME's to total credit in pre consolidation era 1999-2005 peaked at 1999 standing at 13.26% and started declining steadily up-to 2005 settling at 2.67.However, the ratio of commercial bank loans to other sectors increased steadily during the period. In the post consolidation era the ratio declined further and got worsened. It was 0.99% in 2006 and deteriorated all through the years settling at 0.13 % in 2012.On the other hand, the ratio of commercial bank loans to other sectors was on the increase during the period.

Table 5. Shows the descriptive statistics for pre and post consolidation using the descriptive statistical tool of E-views 7.software

	X	Y
Mean	7.282857	0.372857
Median	7.450000	0.170000
Maximum	13.26000	0.990000
Minimum	2.670000	0.130000
Std. Dev.	3.533788	0.376241
Skewness	0.292021	0.981528
Kurtosis	2.390848	2.025605
Jarque-Bera	0.207716	1.400886
Probability	0.901353	0.496365
Sum	50.98000	2.610000
Sum Sq. Dev.	74.92594	0.849343
Observations	7	7

From table 5 above X distribution represents the pre consolidation commercial bank loans to SME's as a percentage of total credit while the Y distribution represents the post consolidation commercial banks loans to SME's as a percentage of total credit.

Table 6. This shows the computation of the paired sample t-test statistic

Years	Pre-Consolidation (X)	Post–Consolidation (Y)	Difference D=(X-Y)	Difference Squared (D^2)
1999/2006	13.26	0.99	12.27	150.55
2000/2007	8.76	0.85	7.75	60.06
2001/2008	6.59	0.17	6.42	41.22
2002/2009	8.63	0.17	8.46	71.57
2003/2010	7.45	0.14	7.31	53.44
2004/2011	3.62	0.16	3.46	11.97
2005/2012	2.67	0.13	2.54	6.45
			48.21	395.26

Source:Author's computation 2014

The data in table 6 above were used in calculating the t-test and the results compared with critical t value at 5% level of significance. The t-test statistical tool of Statistical Package for Social Science Software (SPSS) was used to analyse the data. The results of the analysis are presented below in table 7:

Table 7. The results of the paired T-Test Analysis

Paired Samples Statistics

T-TEST PAIRS=X WITH Y (PAIRED)
/CRITERIA=CI(.9500)/MISSING=ANALYSIS.

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	X	7.2829	7	3.53379	1.33565
	Y	.3729	7	.37624	.14221

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	X & Y	7	.767	.044

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	x - y	6.91000	3.25401	1.22990	3.90054	9.91946	5.618	6	.001

Source:Author's computation 2014 using SPSS

5 DISCUSSION OF FINDINGS

To achieve the first objective, the mean statistic was chosen as the tool of analysis. From table 4, the average (mean) credit before consolidation is 7.28 while for post consolidation is 0.37.The difference between the average (means) of pre and post consolidation is 6.91.This shows that financing of SME's decreased by that figure. These statistics are indicative that bank consolidation was not favourable to SME's financing in Nigeria. This is not unconnected with the assumption that with consolidation, banks loan-able funds increased but found other sectors other than the SME's sector more lucrative for lending hence there was significant reduction of amount of credit to SME's in post consolidation era .We accept the null hypothesis (H_{o1}) that bank consolidation did not bring about increased lending to SME's in Nigeria and reject the alternate hypothesis ($H_{A1)}$.

For the second objective, the standard deviation statistic was chosen as the appropriate analytical tool. From table 5,the standard deviation for pre consolidation is 3.533788 while for post consolidation is 0.376241.It shows clearly that the lending risk of commercial banks to SME's was higher during the pre consolidation era compared to the post consolidation period. This result gives a clear indication of commercial banks divestment in the loan portfolio to SME's in post consolidation given the riskiness of the sector.We accept the null hypothesis(H_{o2}) that bank consolidation did not lead to increased lending risk to SME's in Nigeria and reject the alternate hypothesis ($H_{A2)}$.The finding is a further reaffirmation of the argument that banks in post consolidation era find SME's as risky ventures to advance credit to because they are incapable of meeting lending requirements and conditions arising from insufficient or no collateral security, lack of proper accounting of their operation, information asymmetry, unaudited financial accounts and reports etc. The findings aligns with BIS (2011) submission that due to credit crunch, all firms in risky sectors find it difficult to get finance and SME's are more affected as banks restrain lending to them.

For the third objective to be achieved, the paired t-test was chosen as the proper analytical tool. The results are shown in table 7.The The calculated t-value is 5.618 while the critical value of t at 5% level of significance with degree of freedom of 6 is 2,447.Since the t calculated is greater than t-critical value and is positive it infers that there is no significant increase in

credit to SME's in Nigeria in post consolidation era, In this regard the study accepts the null hypothesis($H_{o3)}$ that there is no significant difference between SME's financing by commercial banks in Pre and Post 2005 bank consolidation and reject the alternate hypothesis (H_{A3}**)**. The implication therefore, is that there is no improvement in SME's financing in post consolidation which is attested to by the average decrease of SME's credit from 7.28 in pre-bank consolidation to 0.37 in post bank consolidation.

Overall,the study findings are in agreement with Elyasiani and Goldberg (2004) , Dongarawa (2009), Obasan and Arikewuyo (2012),Luper (2012) , Mamman and Aminu (2013) who have shown that bank consolidation in Nigeria has no significant positive impact on the amount of credit advanced to SME's.

6 CONCLUSION AND RECOMMENDATIONS

The result of the study clearly indicates that bank consolidation in Nigeria led to a drastic reduction of SME's financing to less than one percent (0.37%) on average. The lending riskiness of banks in post consolidation reduced while there is no significant difference between SME's financing in pre and post consolidation era. This result however goes contrary to the much taunted belief that bank consolidation will lead to increased SME's financing in Nigeria. In addition it supports empirical findings and bank consolidation theories that assert that bank consolidation will lead to credit contraction to SME's in Developing countries.

Given the importance of SME's in economic growth process, the study recommends improved transparency of SME's accounting and reporting of their activities which would improve their project proposals and make them attractive to bank funding. Banks should relax some of the stringent measures which SME's must comply to access finance .Government should design policies that should group SME's in such a manner for proper documentation, identification(according to trade and industry) so that it can guarantee credit facilities and ensure prompt repayment. The Central bank of Nigeria, should as matter of urgency, license small banks with specific focus to provide finance for SME's in the country. This, no doubt would improve relationship banking between the banks and SME's.

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Prevalence and antibiotic-resistance of Salmonella isolated from chicken meat marketed in Rabat, Morocco

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ABSTRACT: Salmonellosis is a one of the major food-borne diseases with a high incidence and severity. In recent years, an increase in the occurrence of antimicrobial drug–resistant Salmonella spp. has been observed in several countries including Morocco. This study examines the prevalence of different *Salmonella enterica (S. enteric)* serotypes and their susceptibilities to commonly used drugs for treatment of Salmonella infections. In total, 300 chicken meat samples collected from 2011 to 2012 were investigated. Isolated Salmonella were characterized by serotyping and susceptibilities were determined for 16 antimicrobial drugs using the disc diffusion assay. Salmonella was isolated in 12.66% (n=38) specimens. 13 different serotypes have been identified, including S. Kentucky (n=9) 23.68% was the most common, followed by S. Enteritidis (n=5) 13.15%, S. Muenster (n=5) 13.15%, S. Typhimurium (n=3) 7.89% S. Istanbul (n=3) 7.89% S. Saintpaul (n=2) 5.26% and 2.63% for each of the other serotypes. Test results of antibiotic susceptibility showed that 65.78% of the isolates (n=25) were resistant to at least one antibiotic. Resistance to tetracycline and nalidixic acid was the most common (50%), followed by resistance to ampicillin (39.47%), streptomycin (34.21%), the sulfonamide (31.57%), noting that our strains were resistant to ciprofloxacin (26.31%), chloramphenicol (13.15%), amoxicillin + clavulanic acid (18.42%), and trimethoprim sulfamethoxazole (5.25 %). None of the isolates were resistant to cephalosporins of the 3rd generation. Multidrug resistance (>3) was observed in 42.1% of isolates, mainly S. Kentucky, S.Virchow, S.Muenster, S.Fillmore and S.Istanbul. As these resistant bacteria can be transmitted to humans through food (chicken) they constitute a major public health problem in Morocco and transmission of multiresistant strains mainly S. Kentucky.

KEYWORDS: Salmonella, antibiotic-resistance, chicken meat, Morocco.

1 BACKGROUND

The contamination of food products with Salmonella generates serious health and economic consequences, which have stimulated numerous studies designed to investigate the survival capacity and the transmission routes of these organisms in different farm animals and the environment [1]. Salmonellosis is one of the most widespread food-borne zoonoses in industrialized as well as developing countries [2], [3], [4], [5]. In most cases, salmonellosis is caused by contaminated food products, particularly those of animal origin such as poultry, eggs [4], [6], [7], [8]. Different studies conducted in Morocco indicated considerable prevalence of Salmonella in poultry [1], [9].

Antimicrobial resistance represents a major problem that threatens public health worldwide because it reduces the effectiveness of antibacterial treatment and increases morbidity, mortality, and costs for health-care assistance [10]. The use of antimicrobials in any venue, including disease treatment and growth promotion in domestic livestock, can potentially lead

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to widespread dissemination of antimicrobial-resistant bacteria [11]. In recent years, an increase in the occurrence of antimicrobial drug–resistant Salmonella spp. has been observed in several countries including Morocco [1], [9], [12], [13].

Antimicrobial-resistant Salmonella are increasing due to the use of antimicrobial agents in food animals at sub-therapeutic level or prophylactic doses which may promote on-farm selection of antimicrobial resistant strains and markedly increase the human health risks associated with consumption of contaminated meat products. Antimicrobial use in animal production systems has long been suspected to be a cause of the emergence and dissemination of antimicrobial resistant Salmonella [3]. The short and long-term consequences generated by bacterial resistance are severe. Reports have shown that 50-60% of the majority of nosocomial infections in some countries are caused by antibiotic-resistant bacteria [10]. Fatality rates are higher for patients with infections caused by drug-resistant Salmonella spp., and these patients are more likely to require hospitalization and to be hospitalized for longer periods than are patients with infections caused by antimicrobial drug–susceptible Salmonella spp [13].

The present study was undertaken to evaluate the occurrence of Salmonella in foods in Morocco. The identification of circulating serotypes and the antimicrobial resistance profiles of Salmonella isolates collected in Morocco during 2011-2012 were also evaluated.

2 MATERIAL AND METHODS

2.1 FOOD SAMPLES COLLECTION

During the period from June 2011 to December 2012, a total of 300 chicken meat samples were collected from retail raw chicken meat in Rabat in Morocco. Approximately 50 g of each sample was collected in a sterile plastic pouch and transported to the laboratory refrigerated at 4 –10° C not later than 24 hours after collection and samples were immediately analyzed.

2.2 MICROBIOLOGICAL ANALYSIS

The samples were analyzed using standard method the [14]. Twenty-five g of each sample was blended in 225 ml buffered peptone water (BPW), Bio-Rad (Marne-la-Coquette- France) homogenized in Colworth Stomacher and incubated 16-20 hours at 37°C as pre-enrichment for Salmonella. From each pre-enriched sample, 0.1 ml was used to inoculate 10 ml of the Rappaport-Vassiliadis medium (RV) Bio-Rad (Marne-la-Coquette- France) and 1 ml of the pre-enriched sample was used to inoculate 10 ml of the selenite-cystine medium (SC) Bio-Rad (Marne-la-Coquette- France). Samples were incubated for 7-8 hours at 42°C (RV) and at 37°C (SC), respectively. Bacterial isolation was achieved on Hektoen and XLD media Bio-Rad (Marne-la-Coquette- France) at 37°C for 18-24 hours. Lactose-negative colonies were kept for further studies. Salmonella was identified using the API20E system (Sanofi Diagnostics Pasteur). Serotypes were identified by agglutination tests with Salmonella specific anti-sera Bio-Rad (Marne-la-Coquette- France) as described by Le Minor and Popoff [15]. The antigenic formula was determined according to the Kauffman-White scheme [16].

2.3 ANTIBIOTIC SENSITIVITY TEST

Each of the Salmonella isolates was tested for susceptibility to antimicrobials on Muller-Hinton agar following the disc diffusion method according to the recommendation of the Clinical and Laboratory Standards Institute (CLSI) [17]. by using 16 commercial antibiotic discs Bio-Rad (Marnes-la-Coquette- France): ampicillin (10µg), amoxicillin + clavulanic acid (20+10µg), cefotaxime (30µg), ceftazidim (30µg), Ceftriaxone (30µg), chloramphenicol (30µg), gentamycin (500µg), Kanamycin (30µg), trimethoprim (5µg), Spectinomycin (100µg), streptomycin (10µg), sulfonamides (300µg), Sulphametoxazole (300µg), tetracyclin (30µg), ciprofloxacin (5µg) and nalidixic acid (30µg). In this study, the isolates showing a decrease in susceptibility (intermediate) were considered as resistant. *Escherichia coli* ATCC 25922 was used as a control.

3 RESULTS

3.1 PREVALENCE OF SALMONELLA IN CHICKEN MEAT SAMPLES

A thirty eight out of three hundred (12.66%) chicken meat samples examined at the Food Control laboratory of National Institute of Hygiene during 2010 and 2011 were found positive for Salmonella.

3.2 SEROTYPING OF SALMONELLA ISOLATES

A total of fourteen different serotypes were identified among *S. enterica* isolates; the top five included the following serotypes: Kentucky (n=9) 23.68% was the most common, followed by Enteritidis (n=5) 13.15%, Muenster (n=5) 13.15%, Typhimurium (n=3) and Istanbul (n=3) 7.89%. Serotypes Saintpaul (n=2), Djugu (n=1), Fillmore (n=1), Hatford (n=1), Indiana (n=1), Othmarschen (n=1), Tennessee (n=1), Virchow (n=1) and Zerifin (n=1) were also identified. Two isolates were nontypeable strains. These were positive for Salmonella in biochemical tests; however, during grouping, they were found to be positive with polyvalent O antisera but negative with the available monovalent antisera. Serotype prevalence and distribution in chicken meat samples are reported in Table 1.

Table 1. Predominant serotypes (%) of S. enterica isolated in chicken meat samples

Serovars	Number	%
Kentucky	9	23,7
Muenster	5	13,16
Enteritidis	5	13,16
Typhimirium	4	10,53
Istanbul	3	7,89
Saintpaul	2	5,26
Salmonella Spp	2	5,26
Fillmore	1	2,63
Djugu	1	2,63
Virchow	1	2,63
Indiana	1	2,63
Othmarschen	1	2,63
Tennessee	1	2,63
Hatford	1	2,63
Zerifin	1	2,63
Total	38	100

3.3 RESISTANCE TO ANTIMICROBIALS

Drug susceptibility assay revealed that 34.21% (n=13) of the Salmonella isolates investigated were fully susceptible to all fifteen antimicrobials tested. No resistance to cefotaxime, ceftazidim, ceftriaxone, gentamicine, kanamycin and spectinomycin was observed. Twenty five (65.79%) exhibited resistance to at least one antimicrobial, while twenty (52.63%) were resistant to two or more tested drugs. Resistance to antimicrobials was identified mostly in serotypes Kentucky (9/9), Enteritidis (5/5), Muenster (4/5), Istanbul (3/3), Typhimurium (2/4), Fillmore and Virchow (1/1). However, Salmonella strains serotype Djugu, Hatford, Indiana, Othmarschen, Saintpaul, Tennessee, Zerifin and the nontypeable Salmonella isolates did not show any resistance phenotype. The most common resistance observed was to tetracycline and nalidixic acid, accounting for 50% of isolates, followed by ampicillin 39.47%, streptomycin and the sulfonamide found in 34.21% and 31.57% of isolates respectively. These resistances were variously distributed among different serotypes. Resistance to ciprofloxacin 26.31% and amoxicillin + clavulanic acid 18.42% was found mainly in serovar Kentucky with a rate of 9/10 and 5/7 respectively, while resistance to chloramphenicol 13.15% was found in serovar Muenster (4/5). Resistance to sulfamethoxazole and trimethoprim 5.25% each were observed to a lesser extent and was common in serovar Typhimurium (2/2). It was also evident from the results that 42.1% (n=16) of isolates showed multiple drug resistance (resistant to > 3 drugs) and one strain among the 9 found of serovar Kentucky was Extended-spectrum beta-lactamases (ESBL). The resistance pattern, the origin, and the serotypes of the resistant strains are shown in Table 2.

Table 2. Distribution of antibiotic resistance by serotype identified in S. enterica isolates.

antibiotic	Number of resistance	% of resistance
Acide Nalidixique	19	50
Tétracycline	19	50
Ampicilline	15	39,47
Streptomycine	13	34,21
Sulfonamide	12	31,57
Ciprofloxacine	10	26,31
Amoxicilline	7	18,42
Acide Clavulanique	5	18,42
Chloramphénicol	2	13,15
Trimetoprime	2	5,25
Gentamicine	0	0
Spectinomicine	0	0
Ceftriaxone	0	0
Ceftazidime	0	0
Kanamycine	0	0
Cefotaxime	0	0

4 DISCUSSION

Food-borne diseases caused by non-typhoid Salmonella represent a major public health problem worldwide [6]. *S. enterica* is a prevalent foodborne pathogen that can carry multidrug resistance (MDR) and pose a threat to human health [18]. The control of Salmonella and antibiotic resistance are closely related to each other. It means, the control of Salmonella in animal, animals' food, environment and humans is the best possible way for control of antibiotic resistance [2].

The overall prevalence (12.66%) of Salmonella isolated among chicken meat samples in this study was consistently close at that reported from other countries [8], [19]. This result is significantly high to be a potential source of foodborne salmonellosis. The result is higher than a study conducted by Ashraf et al. [20] and Akbar et al. [21] who reported a prevalence of 4.3% and 5.26% respectively and lower than a study conducted by Ta et al. [22] and Wang et al. [23] who reported a prevalence of 43.3% and 48.7% respectively. The difference may be due to different hygienic status of locals where the samples of chicken meats were collected. The analysis of the isolated Salmonella strains in this study showed different serotypes with a strong variability in samples collected in the outlets where hygienic conditions are not satisfactory. The most prevalent Salmonella serovar was Kentucky (23.68% of isolates). This result was consistently close at that reported from other study [9], [24], [25]. Similarly, our study showed a high proportion (52.63%) of Salmonella isolates were resistant to two or more of the antimicrobials that are commonly used in the veterinary and public health set up. This may pose difficulties in the treatment of human clinical cases and other bacterial diseases. This correlates with several studies performed in Morocco [1], [9]. In comparison, Ammari et al. [1] found low level of resistance to nalidixic acid (25%) and the same level of resistance to amoxicillin-clavulanic acid (18.75%) among Salmonella isolated from human and food samples. Bouchrif et al. [9] reported 63% of 30 clinical isolates of S Kentucky obtained in Casablanca between Jan 1, 2003, and Dec 31, 2011 were resistant to ciprofloxacin. In addition, there was one strain among the 9 found of serovar Kentucky Extended-Spectrum Beta-Lactamases (ESBL). The demonstration that meat products are a source of antibiotic resistant Salmonella strains is a serious concern for public health and food safety.

The most important cause of antibiotic resistance is consumption of antibiotic as a growth promoter and treatment for animals and human. Therefore it is very important decrease the consumption of antibiotic in animal and humans [2]. The widespread overuse and misuse of antimicrobial agents are associated with the development of resistance to these drugs that has emerged as a major problem worldwide [26]. Because antimicrobial-resistant bacteria may be transferred to humans through the food chain and the selection of novel antimicrobial resistance mechanisms in Salmonella in animals which specify resistance to antibiotics used in humans, is troubling [11].

The currents study indicated the necessity of a further investigation on the prevalence and antimicrobial susceptibility pattern of Salmonella, by considering it as a potential food borne pathogen. Molecular characterization of the isolates with emphasis on resistant strains is also necessary to identify mechanisms of antibiotic resistance. More over judicious and

prudent use of antimicrobials in the veterinary and public health sectors is mandatory since high rate of antimicrobial resistant Salmonella isolates were identified.

5 CONCLUSION

Three key findings in our study should be noted. First, high proportion (52.63%) of Salmonella isolates was resistant to two or more of the antimicrobials. The second notable finding was that the most prevalent Salmonella serovar was Kentucky (23.68%) and 9 of 10 of this serovar identified were resistant to ciprofloxacin. Third, the detection of one strain of serovar Kentucky was Extended-spectrum beta-lactamases (ESBL).

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Organochlorine pesticides in sediments from the atlantic coast of Morocco

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ABSTRACT: Organochlorine pesticides (DDT and its metabolites, HCH isomers and cyclodiènes compounds) were determined in sediment collected from five locations of the moroccan atlantic coast during the period of January – December 2010. Samples were analysed according to the UNEP/FAO protocol using non polar solvent extraction and a conventional GC-ECD apparatus. The highest levels of organochlorine pesticides were found in Sebou estuary (27.53 ng/g) and Moulay Bousselham lagoon (25.58 ng/g). DDT and its metabolites presented high concentrations at all locations, the concentration of DDTs ranged from 2.40 ng/g to 25.40 ng/g. HCH isomers were also present but at low levels, the concentration of γHCH ranged from 1.93 ng/g to 5.93 ng/g. Cyclodiènes compounds (Aldrin, Endrin, Dieldrin, Heptachlor and Heptachlor epoxide), banned since 1984 in Morocco, were only detected in a few sample locations at low concentrations, it implies that the exhibition to these products stopped. In five locations, the concentrations of parent compound (p,p' DDT) were always higher than other metabolites p,p'DDE and p,p' DDD in all sediment samples. The ratio p,p' DDT/DDE indicated slow degradation of DDT or recent input in this environment. The use of all OCP has been prohibited in Morocco since 1984, the reason for organochlorine pesticides contamination in this sites can be related to the still widely and illegal use of OCP in agriculture

KEYWORDS: Organochlorine pesticides, DDT, HCH, sediment, Atlantic coast, Morocco.

1 INTRODUCTION

Organochlorine pesticides (OCPs), such as DDTs (dichloro-diphenyl-trichloroethanes) and HCHs (hexachlorocyclohexane), represent an important group of persistent organic pollutants (POPs) that have caused worldwide concern as toxic environmental contaminants [1], [2], [3].

Because of their toxicity, persistence, accumulation in biota, and adverse impacts on wildlife, the majority of organochlorine pesticides were banned in the developing countries during 1970 [4]. In Morocco, these compounds were banned since 1984 except for lindane (γHCH) and DDTs that are tolerated in public health emergencies [5].

Organochlorine pesticides were widely used from 1960-1984 in Morocco both for agricultural and sanitary purposes. It estimated that about 10000 tons were used annually and DDT accounted for 50% of this group [6].

Many authors have been investigating the occurrence and distribution of OCPs in the marine sediment around the world. Some of the important publications in the field in the last decade are as follows : [1], [2], [4], [7], [8], [9], [10], [11], [12], [13],

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[14]. In Morocco, only one survey has been achieved on the OCPs in sediment and biota of the Moulay bousselham lagoon [15].

The purpose of the present study is to evaluate the levels of some organochlorine pesticides in sediments collected from five locations of the Moroccan Atlantic coast. The study includes the most important estuaries and coastal lagoons in Atlantic coast of Morocco: Moulay Bousselham lagoon (S_1), Sebou Estuary (S_2), Bou Regreg Estuary (S_3), Oum Rbia estuary (S_4) and Oualidia lagoon (S_5). (Fig. 1)

2 MATERIALS AND METHODS

2.1 STUDY SITES

We studied two stations in each location:

The Moulay Bousselham lagoon, commonly called merja zerga, is situated on the atlantic north coast of Morocco (34.83ºn, 6.27ºe, fig.1). the lagoon has an ellipsoidal shape in a north-south direction, is 9 km in length and 5 km wide in its widest portion; its area is 35 km². The lagoon system receives drainage mainly from the drader river to the east and the nador canal to the south. The drader river channel divides the lagoon into two sub-basins, merja kahla to the north with an average depth of 0.3-0.5 m and merja zerga to the south with 1-1.5 m depth. . The main activities are land cultivation and cattle raising, artisanal fishing and shellfishing.

The basin of the Sebou river (88°n and 35°n to 4°w and 7°w) covers an area of 40,000 km2. The river that empties into it passes through the gharb plain that has extensive agricultural and industrial activities. Kenitra harbor, about 10 km from the ocean, has commercial trafic, while Mehdiya harbor at only 1 km from the mouth is busy with fishing activities (fig. 1). The average Sebou river output reaches 200 $m^3 s^{-1}$. The annual input volume is about $5x10^9$ m3 of freshwater and may double in rainy seasons. According to Combe et al. [16], the tidal height varies from 0.9 to 3.10 m along the estuary, depending on location.

The catchment of the Bou Regreg river has an area of 9700 km2. The estuary (34°n– 6°50'w) located between the cities of Rabat and Sale (fig. 1), extends for some 23 km from the ocean to a dam (sidi Mohamed Ben Abdellah) built in 1974, and recently to a breakwater implanted at 18 km upper to the mouth. The absence of a real fluvial flow, following the disappearance of flooding events, clearly influences the estuary's functioning, where the hydrodynamics are governed by the tides (their height varies from 0.5 to 3.3 m). The estuary is dominated by seawater, with minimal influx of freshwater for most of the year. near the mouth, there are agricultural and industrial areas. Some urban sewage from Rabat and Sale is directly discharged into the estuary.

The basin of the Oum er Rbia river covers an area of 34,335 km2. The hydrological parameters of this river were studied by Snoussi [17]. Downstream, the annual average output reaches $117m^3s^{-1}$. The seasonal fluctuations reveal a maximum in spring occurring from the middle and grand atlas rivers. The summer outputs emanate mainly from the grand atlas sources. The estuary extends for some 15 km, from the ocean to a breakwater (33°21'n–8°21'w, fig. 1). The city of Azemmour, sited along the west bank, discharges urban waste water directly into the lower estuary (fig. 1). Upstream, the catchment is mostly influenced by agricultural activity and associated light industry. The removal of any important freshwater inputs and any flooding events make Oum er Rbia a system similar to the Bou Regreg estuary.

The Oualidia lagoon (32°40'4"n- 32°47'07"n and 8°52'30"w – 9°02'50"w) is located on the atlantic ocean (fig. 1). This lagoon is 7 km long, on average 0.5 km wide, and exchanges water with the ocean through a major inlet about 150 m wide and 2 m deep. During spring tides there is also a secondary, shallower inlet about 50 m wide. An internal delta with a surface area of about 0.2 km2 is normally found close to the inlet. The lagoon morphology is characterized by side channels, connected to a meandering main channel, in which the mean depth is 2 m and the maximum depth during flood tides does not exceed 5 m [18]. The major aquaculture activity in the lagoon is oyster culture. To date, five oyster farms occupy one-sixth of the lagoon surface. In addition, during summer Oualidia lagoon is the site of intense tourism activities. Discharging farm and domestic sewage water without treatment can cause increased contamination.

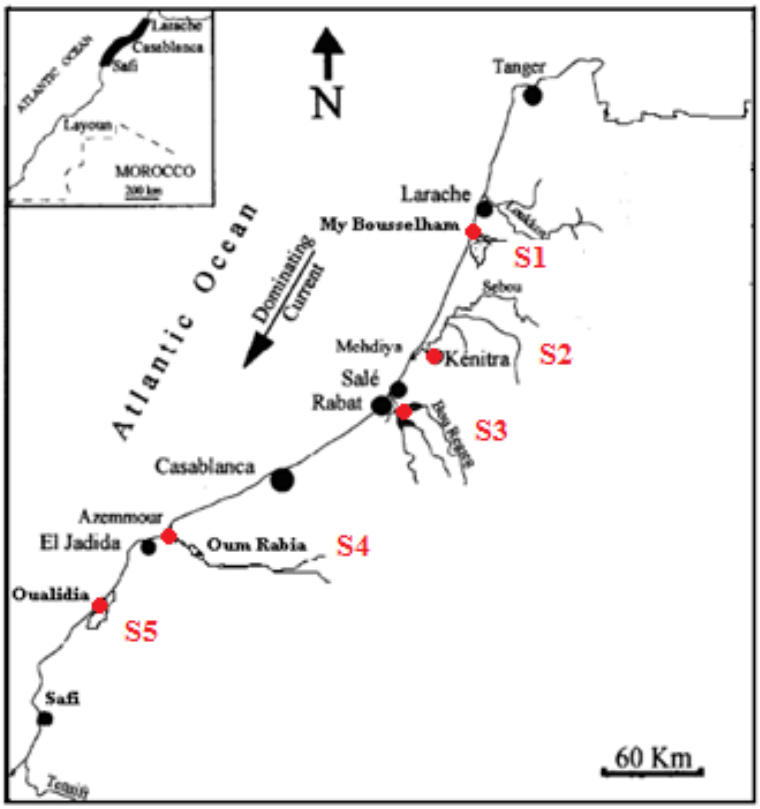

Fig. 1. Location of surveyed sites

2.2 SEDIMENT SAMPLING

A total of 40 sediment samples in five sites were collected during sampling campaigns on February, May, August and November 2010. Fig.1. shows the study area and the sampling locations.

The superficial sediments (top 0–3 cm) were collected with a stainless steel grab and then placed into polytetrafluoroethylene (PTFE) bags. All the samples were immediately transferred to the laboratory and kept at – 20°C in the refrigerator.

2.3 EXTRACTION AND ANALYSIS

The analytical procedures used for the extraction, purification and quantification of organochlorine pesticides in sediment were identical to those recommended by UNEP/FAO [19]. The samples were freeze-dried, homogenized and passed through a 63-µm sieve. Approximately 20g were spiked with ε hexachlorocyclohexane (εHCH) as an internal standard and extracted in a soxhlet extraction apparatus for 8 hours with 200 ml n- hexane. The extracts were concentrated to about 15 ml. These extracts were treated then by mercury to remove sulphur compounds. The separation was achieved by florisil column chromatography. The florisil was activated in the oven to 130 °C during 12 hours then it was partially deactivated with 0,5% distilled water (W/W). Approximately 2 cm of sodium sulphate were added evenly over the florisil to remove humidity.

The organochlorine pesticides were separated and quantified by gas chromatography using a VARIAN GC-3380 gas chromatograph equipped with ^{63}Ni electron capture detector (ECD). The separation was performed on a fused silica capillary column (CP-Sil 8 CB, 30 m x 0,25 mm id, and 0,25 µm film thickness) with nitrogen as carrier gas and make up gas. The operating conditions were as follows : Injector temperature 260 ° C; detector temperature 280 °C; oven temperature: initial 50 °C for 2 min, programmed to 160°C at 5°C/min, followed at 2°C/min to 260°C, final 260°C for 10 min.

The residue levels of OCPs were quantitatively determined by the internal standard method using peak area. For every set of five samples, a procedural blank and a spiked sample with standards were run to check for the interference and cross-

contamination The detection limits (LD) of OCPs were determined as the concentration of analyses in a sample that gives rise to peak a signal –to-noise ratio (S/N) of 3. The pesticides recoveries were determined relative to the ratio of direct injection of extract and the working standards prepared in hexane. The mean recovery of OCPs was estimated at mean concentration levels.

2.4 QUALITY CONTROL

A strict regime of quality control was employed before the onset of the sampling and analysis program. OCPs recoveries were undertaken to demonstrate the efficiency of the method.

Analytical standards of composite OCPs including DDTs (p,p'-DDT, p,p'DDD, p,p'DDE) and HCHs (αHCH, γHCH) as well as aldrin, endrin, dieldrin, heptachlor, heptachlor epoxide, HCB and α endosulfan were provided by IAEA/ILMR Marine Environmental Studies Laboratory in Monaco. The spiked recoveries of OCPs using 200 ng of composite standards were in the range of 87–103% and the relative standard deviation (RSD) values ranged from 2% to 14%. Table 1 listed the detection limits (DL), mean recovery and relative standard deviation (R.S.D.) of the methods.

Table 1. Mean recovery, relative deviation (R.S.D.) and detection limit (DL) of OCPs in sediment (at 10ng/g –dw)

OCPs	Sediment (n=5) Recovery (%)	R.S.D (%)	DL (ng/g- dw)
4,4'DDT	74	6	0.12
4,4'DDE	82	8	0.40
4,4'DDD	88	5	0.14
γ HCH	83	10	0.12
α HCH	78	5	0.14
Aldrine	75	6	0.12
Endrine	85	8	0.12
Dieldrine	76	6	0.12
Heptachlor	77	5	0.14
Heptachlor époxide	76	6	0.14
HCB	84	8	0.12
α Endosulfan	83	6	0.12

3 RESULTS AND DISCUSSIONS

3.1 CONTAMINATION STATUS OF OCPS

The analytical results for studied compounds in sediment from five locations are represented in table 2.

The total organochlorine pesticides (OCPs) concentration in sediments varied from 13.17 to 27.53 ng/g with an average 20.52 ng/g of wet weight. The concentrations of $\sum$OCPs were higher at Sebou Estuary (27.53 ng/g), Moulay Bousselham lagoon (25.58 ng/g) an Oualidia lagoon (22.86 ng/g). The minimum value was observed at Bou-regreg Estuary (13.17 ng/g).

Among compounds searched, the DDT and its metabolites (DDTs) and the lindane (γHCH) are the most fluently detected (83 -100%). The DDT group of compounds was detected in relatively high concentrations in all sediment samples, but the contribution of individual metabolites showed differences. The concentration of $\sum$DDTs reached maximum value at Sebou Estuary (17.73 ng/g) followed by Moulay Bousselham lagoon (17.03 ng/g) and Oualidia lagoon (14.46 ng/g). The minimum value of DDT total was recorded at Bou-regreg Estuary (7.10 ng/g) and Oum Rbia Estuary (5.73 ng/g).

Table 2. Concentration range and mean (ng/g wet wt.) of Organochlorine pesticides from the five sampling sites

Compounds		**My Bousselham Lagoon** n=8	**Sebou Estuary** n=8	**Bou Regreg Estuary** n=8	**Oum Rbia Estuary** n=8	**Oualidia Lagoon** n=8
4,4'DDT	x ±SD	8.24 ± 3.43	7.95 ± 3.45	3.71 ± 1.98	2.67± 0.90	8.33 ± 3.43
	Range	6.25 -10.60	5.60 – 14.40	1.20 – 6.80	1.82 – 4.10	4.88 – 13.10
4,4'DDE	x±SD	4.85 ± 0.56	5.13 ± 1.83	1.79 ± 0.61	1.91 ± 0.45	3.62 ± 2.29
	Range	3.58 - 5.70	2.40 – 7.60	1.20 – 2.50	1.40 – 2.60	1.04 – 5.21
4,4'DDD	x±SD	3.94 ± 1.50	4.23 ± 0.61	1.60 ± 0.90	1.15 ± 0.48	2.51 ± 1.28
	Range	1.58 - 6	3.4 – 5.20	<0.14 – 2.47	0.80 – 1.96	0.9 – 4.69
∑ DDTs	x±SD	17.03 ± 4.49	17,31 ± 5.89	7.10 ± 3.49	5.73 ± 1.83	14.46 ± 7
	Range	11.41 – 20.50	13.20 – 25.4	2.40 – 11.87	4.22 – 7.29	7.49 - 23
γ HCH	x±SD	3.64 ± 2.26	5.83 ± 1.20	1.93 ± 1.31	2.96 ± 2.25	3.46 ± 0.88
	Range	<0.12 – 6.20	3.78 –6.80	<0.12– 4.10	0.88 – 6.30	2.40 – 4.40
α HCH	x±SD	1.65 ± 1.55	1.01 ± 1.31	0.96 ± 1.15	<0.14	1.70 ± 1.00
	Range	<0.14 – 4.10	<0.14 – 3.30	<0.14 – 2.50		<0.14 – 4
∑ HCHs	x±SD	5.29 ± 3.81	6.84 ± 2.51	2.89 ± 2.46	2.96 ± 2.25	5.16 ± 1.88
	Range	1.40 – 6.20	3.78 – 9.10	<0.14– 6.20	0.88 – 6.30	2.54 – 6.20
Aldrine	x±SD	0.60 ± 0.68	0.80 ± 0.99	1.06 ± 0.71	1.10 ± 0.21	0.50 ± 0.52
	Range	<0.12– 1.5	<0.12– 2.45	<0.12 – 1.25	<0.12– 1.30	<0.12– 1.25
Endrine	x±SD	0.84 ± 0.90	0.35 ± 0.48	0.52 ± 0.40	0.65 ± 0.51	0.46 ± 0.40
	Range	<0.12– 2.45	<0.12– 0.95	<0.12– 0.85	<0.12– 1.15	<0.12– 1.96
Dieldrine	x±SD	0.46 ± 0.52	0.28 ± 0.40	0.45 ± 0.74	0.80 ± 0.49	0.45 ± 0.78
	Range	<0.12 – 1.2	<0.12– 0.85	<0.12– 1.75	<0.12– 1.25	<0.12– 1.50
Heptachlor	x±SD	0.40 ± 0.44	0.28 ± 0.40	0.34 ± 0.54	0.69 ± 0.39	0.38 ± 0.30
	Range	<0.14–0.85	<0.14 - 0.90	<0.14– 1.20	<0.14 – 0.95	<0.14– 0.80
Heptachlor époxide	x±SD	0.13 ± 0.31	0.26 ± 0.37	<0.14	0.32 ± 0.43	0.28 ± 0.49
	Range	<0.14 – 0.78	<0.14 – 0.85		<0.14– 0.85	<0.14– 0.85
HCB	x±SD	0.70 ± 0.79	1.06 ± 0.85	0.79 ± 0.69	0.48 ± 0.65	0.57 ± 0.58
	Range	<0.12– 1.75	<0.12– 1.85	<0.12– 1.75	<0.12– 1.25	<0.12– 1.25
α Endosulfan	x±SD	0.12 ± 0.30	0.30 ± 0.42	<0.12	0.70 ± 0.40	0.55 ± 0.57
	Range	<0.12–0.75	<0.12 - 0.95		<0.12– 0.95	<0.12– 1.25
∑OCPs		25.58	27.53	13.17	13.46	22.86

x = mean, SD = Standard deviation
∑ DDTs = sum of DDT, DDE and DDD
∑ HCHs = sum of γ HCH and α HCH
∑ OCPs = sum of total organochlorine pesticides

The concentrations of total HCHs (sum of α and γHCH) ranged from 2.89 ng/g to 6.84 ng/g. The levels are comparable to those found in sediment of Moulay Bousselham lagoon reported by Mehdaoui et al. [15]. γHCH (lindane) was the major HCH compounds being over 50% at most stations. Concentrations of HCHs in all sediment samples from five locations of Moroccan atlantic coast were much lower than those of DDTs (table2).

The isomeric of HCH was not uniform. The Concentration of γHCH ranged from 1.93 ng/g to 5.93 ng/g, were always higher than αHCH (<0.14 –1.70 ng/g). The mean percentage composition of α and γHCH to ∑HCHs for sediments analysed in our study are 0 - 33% and 66 - 100 % respectively.

Compounds cyclodiènes (Aldrin, Endrin, Dieldrin, Heptachlor and Heptachlor epoxide), banned since 1984 in Morocco, were only detected in a few sample locations at low concentrations, it implies that the exhibition to these products stopped. Aldrin was detected in 50 % of all sediments collected, with higher frequency in samples from S_1 at low concentration range (<0.12-2.45 ng/g). Endrin was only detected in a few sample locations at low concentrations between 0.35 ng/g and 0.84 ng/g. Concentrations of dieldrin were lower, ranging from 0.28 ng/g to 0.80 ng/g. Heptachlor was detected at up 1.20 ng/g and heptachlor epoxide, a degradation product of heptachlor, at a peak concentration of 0.85 ng/g.

3.2 SPATIAL AND TEMPORAL DISTRIBUTION OF OCPS IN SEDIMENT

The distributions of ∑DDT and ∑HCH in sediments in four seasons along the five sampling sites were shown in Figs. 2 and 3 respectively. Fig.2 shows that the concentrations of ∑DDT in sediments for samples S1 and S2 collected from Moulay Bousselham lagoon and Sbou Estuary displayed different high distribution.

The level of contamination of sediment by POC especially DDTs presented a temporal variation (Fig. 2), for all stations the highest concentrations are obtained in may (spring) and the lowest in the november (autumn). Whereas, the level of lindane showed no temporal and spatial variation (Fig. 3).

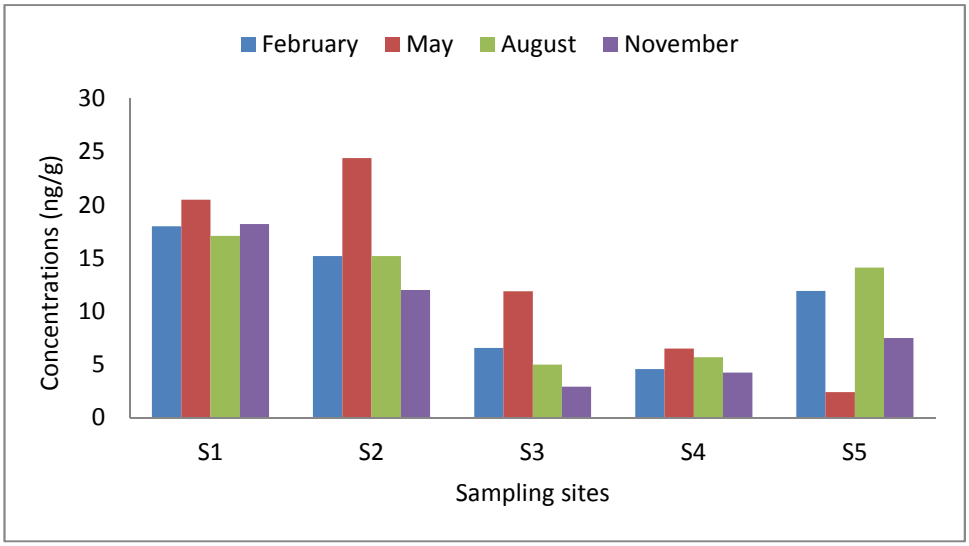

Fig. 2. Distribution of DDTs in sediments from five sampling sites

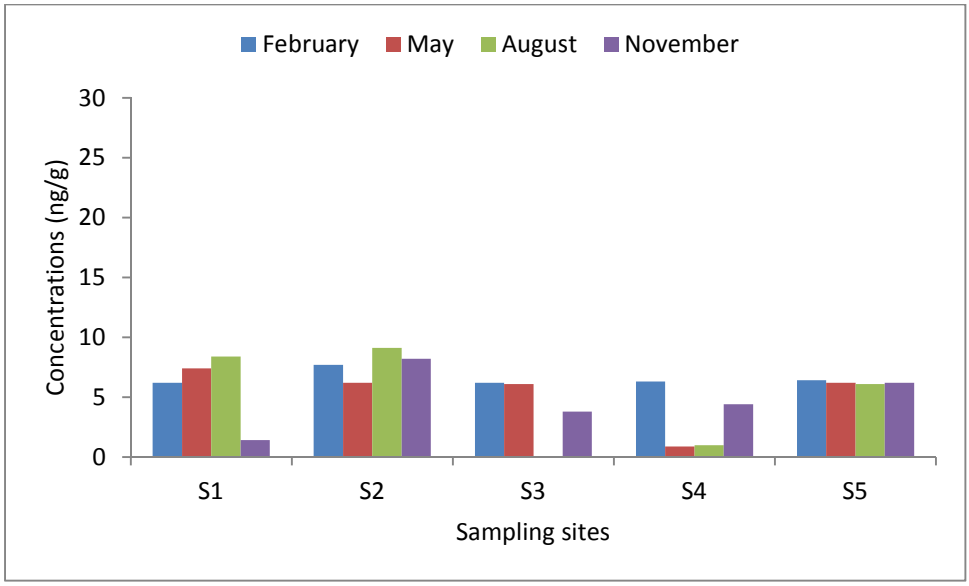

Fig. 3. Distribution of HCHs in sediments from five sampling sites

The analysis of variance carried out on the levels of pesticides organochlorines (POC) and DDTs in sediment revealed through the Fisher test significant differences ($p < 0.05$) between stations and seasons (Table 3). Furthermore, comparison of the levels of the variances on Lindane showed no significant difference between the sediment in different stations.

Table 3. ANOVA for pesticides total organochlorines (POC), DDTs and lindane in sediment (F test significant if p <0.05).

	POC	DDTs	Lindane
locations	0.0084	0.0069	0.3042

3.3 COMPOSITION ANALYSES IN SEDIMENTS

The relative concentrations of the parent compounds and their metabolites are very useful in providing information on source and history of input to environment and possible degradation pathway involved. In this investigation, the concentrations of parent compound (p,p' DDT) were always higher than other metabolites p,p'DDE and p,p' DDD in all sediment samples. The occurrence of DDT isomers is predominant in the following order : p,p' DDT> p,p'DDE > p,p' DDD. The study showed p,p'DDT contributed to 48 %, 46 %, 52 %, 47 % and 57 % of the total DDT at the sites in S_1, S_2, S_3, S_4 and S_5 Respectively. The predominance of DDTs in the sediment was reported by Mehdaoui et al. [15] from Moulay Bousselham lagoon.

According to Strandberg at al. [20], the ratio of p,p'-DDT /p,p'DDE provides a useful index to know whether the DDTs at given site is fresh or aged. Further, a value <0.33 generally indicates an aged input. In the present study, the value of >0.33 was found in five locations, indicating slow degradation of DDT or recent input of DDT in this environment.

Composition differences of HCH isomers in the environment could indicate different contamination sources [21]. Regarding the composition of HCH isomers measured in this study, a high percentage of γHCH was recorded in five sampling sites. The average composition of HCH isomers measured in this sediment samples are α-HCH: 25 %, γ-HCH : 75 % (Fig). It can be concluded that lindane may be used recently in this environment

3.4 COMPARISON OF OCPS LEVELS IN DIFFERENT REGIONS

The comparison of organochlorine pesticide concentrations from various regions was shown in Table 4. Level of OCPs in surface sediment in this study were generally low in comparison with other Atlantic coastal areas (lagoon of Abidjan and road of Brest), Mediterranean coastal areas (Alexandria Harbour, Lake Manzala) and coastal areas of Asian including Arabian Sea, juilong river estuary, Hanoi region and Pearl river estuary. The residues of OCP in all sites of Moroccan Atlantic coast were similar to those found in Victoria harbour (Hong Kong), Salton Sea and Sparta, IL (USA), but much higher than those reported for Northeastern coast (India) and Rio Palizada (Mexico).

Table 4. Comparison from other marine environments in the world of total Organochlorine pesticides OCPs (ng/g, dry wet)

Locations	OCPs	References
Abidjan Lagoon, Ivory coast	2.52-48	[22]
Road of Brest, France	4 - 49	[23]
Alexandria Harbour, Egypt	5.13-1214	[24]
Victoria harbour, Hong Kong	3.5-32	[25]
Arabian sea, India	4.25-68.40	[26]
Juilong river Estuary, China	15-115	[27]
Lake Manzala, Egypt	9-114	[28]
Rio Palizada, Mexico	0.88- 18	[29]
Northeastern coast, India	0.65-2.48	[1]
Salton sea, California, USA	19-34	[4]
Hanoi region, Vietnam	8-86	[13]
Pearl river estuary, China	10.4-70.6	[30]
Sparta, Il, USA	8-35	[31]
Atlantic Coast, Morocco	13.17-28	Present study

4 CONCLUSION

The analyse of sediment samples from five sites of Moroccan Atlantic coast showed a very lower contamination by organochlorine pesticides although the use of these compounds is only banned since 1984 in Morocco. The high percentage

composition of DDT observed in this study clearly illustrates that DDT usage has not been eradicated yet in country, and there might be new input of DDT to the coastal marine environment. Morocco continued to use extremely DDTs and lindane (γ HCH) in control of some pest disease.

Consequently, the reason for organochlorine pesticides contamination in this sites can be related to the still widely and illegal use of OCP in agriculture. Although use of all OCP has been prohibited in Morocco by a decision made by Moroccan government in the 1984, we observed the unfortunately illegal use of some OCP such as DDT still continues in Morocco

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Les mécanismes de réponse pour la participation du Cameroun aux négociations des Accords de Partenariat Economique (APE) avec l'Union européenne (UE), le Mandat et les structures de négociation

[The response of mechanisms for Cameroon's participation in the negotiations of Economic Partnership Agreements (EPAs) with the European Union, Negotiating mandate and structures]

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ABSTRACT: Matters relating to the negotiation require a clear and rigorous procedure. As such, any political negotiation is spared and every candidate in the negotiation party should have an effective mechanism in response to the different offers that are made. As part of this work, the goal of ours is to assess the negotiating mandate, structures, capacities and response mechanisms for Cameroon's participation in the negotiations of Economic Partnership Agreements (EPAs) with the European Union (EU). To achieve this, we have taken advantage of any existing documentation from which we were able to show the negotiation process follows its normal course. However, the differentiating character of the parties' negotiations blocks developed to date, the ratification of the EPA is not always done. This blockage is partly due to the incompatibility of provisions that confer this agreement with Cameroon commitments in the latter part of sub-regional integration. At this stage, a comprehensive EPA would be the best solution in order to limit the negative effects of this agreement on the survival of regional integration in Central Africa.

KEYWORDS: trade, economy, liberalization, market access, measures.

RESUME: Les questions relatives à la négociation requièrent une procédure claire et rigoureuse. A ce titre, aucune politique de négociation n'est épargnée et chaque partie candidate à la négociation devrait disposer d'un mécanisme efficace en réponse aux différentes offres qui lui sont faites. Dans le cadre de ce travail, l'objectif qui est le nôtre c'est d'évaluer le mandat de négociation, les structures, les capacités et les mécanismes de réponse pour la participation du Cameroun aux négociations des Accords de Partenariat Economique (APE) avec l'Union européenne (UE). Pour y parvenir, nous avons mis à profit, toute la documentation existante à partir de laquelle, nous avons pu montrer que le processus de négociation suit son cours normal. Cependant, le caractère différentié des intérêts des parties bloque les négociations au point qu'à ce jour, la ratification de l'APE intérimaire n'est pas toujours faite. Ce blocage est en partie dû à l'incompatibilité des dispositions que confer cet accord au Cameroun avec les engagements pris par ce dernier dans le cadre de l'intégration sous régionale. A ce stade, un APE global serait la meilleure solution, afin de limiter les effets négatifs de cet accord sur la survie de l'intégration régionale en Afrique Centrale.

MOTS-CLEFS: commerce, économie, libéralisation taux d'ouverture, accès au marché, mesures.

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INTRODUCTION

La négociation définie comme la recherche d'un accord, centrée sur des intérêts matériels ou des enjeux quantifiables entre deux ou plusieurs partenaires pour une période donnée, est au cœur des compromis dans le monde. La recherche d'un consensus à travers la négociation implique la confrontation des intérêts incompatibles sur divers points que chaque partie va tenter de rendre compatibles, par un jeu de concessions mutuelles. Dans le cas de notre étude, il s'agit de discuter des questions liées aux négociations commerciales en cours entre l'union européenne et le Cameroun au sujet de l'accord de Partenariat Economique (APE) dit d'étape.

En effet, l'accord de partenariat économique (APE) qui se veut un instrument commercial au service du développement, est complémentaire de l'accord de Cotonou dont il partage les objectifs. Au regard de l'objet et du but des APE, Ces accords visent le renforcement de l'intégration régionale entre les pays africains d'une part, et entre les économies de la Communauté européenne et les différentes configurations régionales des pays ACP ([1]). Cet objectif passera par la libéralisation progressive et asymétrique du commerce des marchandises et des services entre les parties en négociation, par l'élaboration et l'adoption des règles transparentes pour faciliter et promouvoir les échanges. Les règles dont il est question, ici, portent principalement sur la facilitation du commerce, les règles d'origine, les normes techniques, les mesures sanitaires et phytosanitaires, la propriété intellectuelle, etc. Cependant, les modalités et le degré d'ouverture des marchés de chaque région ACP seront déterminés à l'issue des négociations.

A travers ces accords, il est question de faire la promotion et l'accélération du développement économique, culturel et social des Etats ACP, mais aussi d'assurer la réduction de la pauvreté et l'insertion progressive desdits pays dans l'économie mondiale. Selon le commissaire européen au commerce, « les APE font partie d'une approche globale. Ils sont la clé pour revitaliser la relation de développement entre l'UE et les pays ACP » ([1]). Pour la Banque Mondiale, « si les APE offrent un meilleur accès au marché de l'UE, ils diminuent les barrières commerciales tant intra régionales que entre les groupements régionaux des ACP tout en réduisant, aussi bien, les obstacles institutionnels au commerce que les bénéfices en terme de développement seront grands». Tel est la finalité de l'accord.

Face aux blocages que connaissent les négociations des APE UE -Afrique Centrale, le Cameroun et l'UE ont conclu un APE intérimaire le 17 décembre 2007 un APE intérimaire. Cet accord a été négocié pour éviter la perturbation des exportations du Cameroun vers l'UE après le 31 Décembre 2007, date à laquelle les dispositions commerciales de l'accord de Cotonou devraient expirées. L'APE intérimaire a donné plus de temps aux négociateurs pour parvenir à un APE régional plus global. Les négociations régionales continuent depuis cette date avec le but de remplacer l'accord intérimaire par un accord régional complet ([2], [3]).

La nature contradictoire des arguments (intérêts) à la base de la négociation nous amène à nous interroger sur la manière dont il convient de conduire les débats. C'est-à-dire, quelles sont les étapes à suivre pour un résultat meilleur des négociations ? Vu sous cet angle, la manière dont les négociations sont conduites dans le cadre de l'APE Union Européenne - Cameroun, est –elle satisfaisante ? Quelles en sont les résultats attendus ?

Pour répondre à ces interrogations, l'objectif qui est le notre dans ce travail, est d'évaluer le mandat de négociation, les structures, les capacités et les mécanismes de réponse pour la participation du Cameroun aux négociations des Accords de Partenariat Economique (APE) avec l'Union européenne (UE) De ce point de vue, dans notre analyse, nous essayerons une analyse du processus des négociations et les résultats actuels.

1 PRÉSENTATION ET EVALUATION DU MANDAT DES NÉGOCIATIONS DE L'APE

Selon le dictionnaire Larousse, un mandat est un pouvoir conféré par une personne (le mandant) à une autre (le mandataire) afin qu'elle puisse agir en son nom pour un ou plusieurs actes juridiques comme l'achat, la vente etc. Un mandat de gestion ou de décision est la transmission d'un pouvoir décisionnel à un autre acteur économique ou juridique. Au regard de cette définition, on comprend le geste du Conseil des Ministres de la Communauté Economique et Monétaire de l'Afrique Centrale (CEMAC) qui, le 11 décembre 2000 a donné mandat au Secrétariat Exécutif du conseil des ministres, conjointement avec le Secrétariat Général de la CEEAC, de préparer les futures négociations entre l'Afrique Centrale et l'Union Européenne au sujet de la signature de leur Accord de Partenariat Economique ([4]). Pour la bonne marche du processus des négociations, le Conseil a créé le 03 août 2002 un Comité Régional des Négociations chargé de préparer et de conclure ces accords. Selon les déclinaisons de la feuille de route des négociations de l'APE Afrique Centrale publiée en 2012, l'essentiel des négociations porte sur les points ci-dessous :

- la création progressive, conformément aux règles de l'OMC, d'une zone de libre-échange entre la CEMAC-SAO TOME ET PRINCIPE et l'Union Européenne pendant une période de douze ans à compter du 1er janvier 2008 ;
- la priorité au développement ;
- l'approfondissement du processus d'intégration en Afrique Centrale ;
- la coopération dans les domaines liés au commerce ;
- l'amélioration de la compétitivité : renforcement de capacités et mise à niveau.

En outre, un mandat en matière d'engagements que le comité de négociation devrait prendre au nom des Etats a été ajouté aux dispositions préalables de la feuille de route initiale. Ce mandat a été délivré au cours d'une réunion tenue à l'Hôtel SAWA à Douala au Cameroun le 22 Février 2010 sous la coordination de S.E. Monsieur MOUSSA Pierre, président en exercice du conseil des Ministres de l'UEAC ([5]). Celui-ci s'articule autour de six points à savoir : les dimensions de commerce, de développement, les domaines liés au commerce et les autres questions de l'APE. Le tableau ci-dessous présente dans les détails le contenu du mandat,

Tableau 1 : contenu du mandat de négociation

Dimension commerciale	
a- Accès au marché des marchandises	-Renforcement des capacités de production et d'offre afin de bénéficier de l'ouverture ; Taux d'ouverture 60% -Période de démentiellement tarifaire de 20 ans dont 5 ans de période transitoire
b-accès au marché des services	-Mode 4 (mouvement temporaire des personnes physiques),-admettre une plus grande flexibilité de la part de l'UE, afin qu'elle améliore l'offre faite à l'Afrique Centrale par rapport à celle faite au niveau multilatéral. -Entreprendre des négociations avec certains pays de l'UE, en vue d'aboutir à l'adoption de mesures facilitant les mouvements temporaires de certaines catégories de personnes dans l'espace européen.
c- Les Mesures de sauvegarde	Renforcement des mesures de sauvegarde proposées dans le projet du texte actuel de l'accord, en insistant sur le caractère asymétrique et opérationnel, le seuil de déclenchement et le contenu, en vue de faciliter la mise en œuvre de ces mesures dans la région.
d- La clause de nation la plus favorisée	Ne pas inclure la clause NPF dans l'accord en ce qui concerne le commerce des marchandises et des services.
e- Les subventions	Laisser la possibilité à l'Afrique Centrale de soutenir dans les conditions particulières, les sociétés ou secteurs en difficulté en raison de la conjoncture économique ou sociale nationale et dans le cadre de la mise à niveau des entreprises.
f-Les taxes à l'exportation	Introduction des taxes à l'exportation sur certains produits selon certaines circonstances.
g- Les règles d'origine	Se référer aux travaux en cours au niveau « tous ACP » en vue d'adopter des règles d'origine communes et élargir les possibilités de cumul à tous les pays ACP et aux pays du groupe ACP
Dimension développement de l'APE	
a-Impact fiscal net de l'APE, du renforcement des capacités et mise à niveau des économies de l'Afrique centrale ainsi que de l'approfondissement de l'intégration régionale en Afrique Centrale	Renforcement des outils de l'intégration : harmonisation des instruments fiscalo-douaniers, La consolidation des infrastructures à vocation régionale et l'harmonisation des politiques sectorielles.
b- L'harmonisation tarifaire	Le SG de la CEEAC doit poursuivre les sensibilisations permettant à différentes administrations et aux opérateurs économiques de la région de s'approprier ces instruments communautaires
c- Les mesures d'ajustement fiscal	L'Introduction des réformes fiscales véritablement rigoureuses sont suggérées dans l'Accord et font office d'engagements des parties afin d'en faire des règles juridiquement contraignantes
d-Impact fiscal net	Négocier un accord sur une méthode commune de calcul de l'impact fiscal net

e- Le renforcement des capacités et la mise à niveau des économies de l'AC	Obtenir le financement du renforcement des capacités des pays de l'AC doit être effectué par les ressources spécifiques, distinctes des fonds habituellement alloués par la coopération classique ACP/U Définir les moyens pour tirer pleinement profit de l'opportunité offerte par les divers instruments de coopération en matière de mobilisation de l'aide au développement et de l'aide au commerce.
Financement du partenariat	
a-Fonds régional de l'APE	Elaboration des modalités de contribution, l'évaluation des besoins à financer ainsi que sur la possibilité de mettre en place un financement régional
b- La TCI et la CCI	Pour la suite du plan de réforme de la TCU/CCI dans le cadre des réunions tripartites Afrique Centrale (CEMAC, CEEAC). Bureau régional Afrique Centrale de la commission économique des Nations Unies pour l'Afrique (CEA/BRAC)
Domaines liés au commerce	
a-Marchés publics, la concurrence, les investissements et la propriété intellectuelle	La consolidation des engagements relatifs aux programmes régionaux existants en la matière ; l'amélioration du transit des marchandises, la facilitation des transports, le renforcement des capacités des administrations douanières et le parachèvement de la libre circulation des personnes et des biens
Questions en attente d'examen **Ouverture des négociations aux questions de règlement des différends, aux institutions de l'APE**	
Autres questions	
a-La clause de non-exécution	Rejet de l'introduction de la clause de non-exécution dans l'APE
b- Les régimes commerciaux spécifiques **c)-accord d'étape du Cameroun**	-Report du démentiellement tarifaire qui aurait dû commencer depuis le 1er janvier 2010 -Soutien à la demande du Cameroun suite au report du calendrier de démantèlement tarifaire jusqu'à la conclusion d'un Accord régional complet, juste et équilibré.

Source : *[6]*

De l'observation des composantes de ce mandat de négociation, plusieurs remarques émergent:

Tout d'abord, les APE traduisent la vision des politiques en matière d'insertion des économies de l'Afrique Centrale dans le commerce mondiale. Malheureusement, il pêche dans la mesure il est assez globalisant. La distinction commerce des marchandises et commerce des services ne suffit pas pour garantir les gains commerciaux à escompter dans cet accord au regard de la structure de ces économies.

Ensuite, les négociations sur l'APE ont commencé en 2004, le mandat n'a été officiellement fait qu'en 2010. Alors quel a été le plan de suivi des négociations de la part des mandataires des pays de l'Afrique Centrale avant 2010 ?

2 EVALUATION DE LA STRUCTURE DE NÉGOCIATION DE L'APE

- **Présentation de la structure du plan des négociations**

Les négociations des APE entre l'Afrique Centrale et la Communauté Européenne se déroulent en trois comités : le Comité Ministériel Commercial conjoint, le Comité des Négociateurs et le comité des Groupes des experts **(**[2], [7] et [8]**).**

1- Le Comité Ministériel Commercial conjoint:

Composé des Ministres du Commerce des Etats de la CEMAC et de Sao Tome et Principe, le Comité Ministériel Commercial de l'Afrique Centrale a pour mission d'assurer la supervision des négociations au plan politique. De ce point de vue, il a mandat de contrôler le fonctionnement des structures de négociations, d'approuver les résultats des négociations, et de donner de nouvelles orientations pour la poursuite des négociations.

2- Le Comité des Négociateurs :

L'Afrique Centrale est représentée dans les négociations par le Comité Régional des négociations. Ce dernier est présidé par le Secrétaire Exécutif de la CEMAC assisté par le Secrétaire Général Adjoint de la CEEAC en qualité de vice-président. La mission du comité est de conduire les négociations au plan technique, conformément au Règlement CEMAC n° 02/02 –UEAC-085-CM-08 du 03 août 2002. Pour la Commission Européenne, les négociations sont conduites par le Directeur chargé des relations commerciales avec la région, qui préside conjointement le comité([6]). Le comité est chargé en plus, d'établir les groupes thématiques de négociations, de fixer leur mandat respectif et leur calendrier de travail selon l'évolution des négociations et d'évaluer les résultats de leurs travaux. En outre, il doit adopter les conclusions provisoires et soumettre les rapports au Comité Ministériel Commercial conjoint pour approbation ([6]).

3-Les Groupes des Experts :

Pour ce qui est des groupes des experts, ils ont pour mission d'assister techniquement le Comité des Négociateurs. Ils sont co-présidés pour l'Afrique Centrale, par les Directeurs chargés du Commerce de la CEMAC-CEEAC, sous la supervision du Secrétaire Exécutif de la CEMAC et du Secrétaire Général de la CEEAC. Ces experts proviennent des Etats membres, des Secrétariats de la CEMAC-CEEAC, des institutions spécialisées de la CEMAC-CEEAC, ou de tout organisme indépendant. En dehors des structures qui conduisent les négociations, un « groupe de contact » et une « task force de préparation régionale » sont créés afin de suivre les évolutions des travaux de négociation ([6]). Il convient donc de passer en revue toutes ses entités.

a- Le groupe de contact :

L'Afrique Centrale et la Commission Européenne ont mis en place à N'djamena le 17 juillet 2003, un Groupe de Contact composé de représentants du Secrétariat Exécutif de la CEMAC, du Secrétariat Général de la CEEAC et de la Commission Européenne, désignés sur la base de leur expérience. Ce groupe est chargé d'assurer le secrétariat des négociations, de préparer l'agenda des réunions et de diffuser les documents de négociations deux semaines avant chaque réunion. En outre, il doit préparer les rapports des réunions avant de les soumettre au Comité des négociateurs pour approbation. Il gère le suivi des études d'impact recommandées par les différents groupes techniques, ainsi que des échanges de données sur le commerce des marchandises, des services, sur les tarifs, les mesures non tarifaires et sur la réglementation dans les différents domaines de négociation ([6]).

b- La Task force de préparation régionale :

La Task Force de préparation régionale (TFPR), composée coté Afrique Centrale d'un représentant de l'ordonnateur régional et un représentant au maximum, expert en commerce et/ou développement, désigné par chaque ordonnateur national. Du coté de la Commission Européenne, elle est composée d'un représentant de chaque Direction Générale concernée. L'objectif de la TFPR est de faciliter la mise en œuvre des instruments de la coopération financière. A cet effet, elle traduit les besoins en termes de soutien identifiés au cours des négociations en idées opérationnelles pour l'assistance au commerce et dans tous les domaines traités dans l'APE. En outre, elle est chargée de transformer ces idées en projets d'actions susceptibles d'être financés ([6]). A cette fin, elle effectuera les tâches suivantes :

- évaluer toute initiative existante (activités de recherche ou projets et programmes liés au commerce et à tout domaine traité dans l'APE) susceptible de répondre aux besoins identifiés et en informer les négociateurs ;
- traduire, là où c'est approprié, les besoins identifiés en idées plus élaborées qui devraient mener à la pré-identification de nouvelles initiatives (activités de recherche ou projets et programmes liés au commerce et à tout domaine examiné dans le cadre de l'APE ;
- contribuer, à la demande des négociateurs, à l'ébauche des termes de référence pour ces activités de recherche ou de la préparation des projets et programmes liés au commerce et à tout autre domaine retenu ;
- suggérer des ressources de financement pour ces projets et programmes, et donner des conseils d'une part, sur les modalités nécessaires pour assurer la mise en œuvre et d'autre part, sur les partenaires /ordonnateurs à qui les demandes de financement pourraient être soumises ;
- faciliter l'identification des parties prenantes (étatiques et non étatiques) ainsi que les bailleurs qui devraient être consultés pendant cette phase préparatoire.
- Assister les délégations de l'UE dans la région et les ordonnateurs au niveau national, régional, ou « Tous ACP » dans le suivi de la préparation et/ou de la mise en œuvre des projets et programmes finançables sur le Fond Européen de Développement (FED).

3 LES MÉCANISMES DE NÉGOCIATION ET RÉPONSE

Selon les informations contenues dans la feuille de route des négociations de l'APE Afrique Centrale, le mécanisme des négociations de cet accord passe par plusieurs niveaux de réflexions lors des rencontres d'échange d'idée et de concertation selon [4].

3.1 -Au niveau du Comité Ministériel Commercial conjoint

Le Comité Ministériel Commercial conjoint se réunit à l'ouverture et à la fin de chaque phase de négociations. Il approuve les résultats de négociations et donne les nouvelles orientations pour la suite des discutions.

3.2- Au niveau du Comité des Négociateurs

Le Comité des Négociateurs se réunit lorsque des progrès suffisants auront été réalisés par les groupes techniques, en principe au minimum deux fois par an. Son rôle consiste à désigner les membres des groupes techniques thématiques, à fixer leur mandat et leur calendrier de travail selon l'évolution des négociations. Ainsi, il évalue les résultats de leurs travaux, adopte des conclusions provisoires et soumet les rapports au Comité Ministériel Commercial conjoint.

3.3- au niveau des Groupes des experts :

Le Groupe des experts ne joue qu'un seul rôle, préparer les travaux du Comité des Négociateurs**.** De ce fait, pour atteindre ses objectifs, un calendrier a été mise en œuvre et pour un plan d'action bien ficelé ([9]**)**. Celui-ci se présente comme suit.

- De **Septembre 2004 à juillet 2005,** une priorité est donnée aux travaux partant sur l'intégration économique et commerciale en Afrique Centrale et la fixation du cadre de référence de l'APE dans ces domaines avec en prime, la formulation et le lancement des programmes de l'amélioration de la compétitivité et de mise à niveau des économies. Pour la même période, les travaux du lancement de la mise en œuvre des programmes d'approfondissement du processus d'intégration et d'amélioration de la compétitivité sont suivis par ceux relatif à l'identification de domaines prioritaires d'intégration de la région Afrique Centrale et de l'établissement du cadre de référence pour la mise en œuvre de l'APE dans ces domaines ([9]**)**.
- **De septembre à octobre 2004,** l'essentiel des travaux ont porté sur l'identification de la boîte à outils adaptée au processus d'intégration régionale en Afrique Centrale.
- De **Novembre 2004 janvier 2005,** c'est période a été le moment propice de l'examen des conditions de facilitation des échanges, des barrières au commerce et des mesures Sanitaires et Phytosanitaires.
- **Février 2005-avril 2005,** il était prévue, de négocier sur les mesures de protection aux frontières pour la négociation de l'APE et évaluation relative au commerce des services
- **Mai 2005 – juillet 2005,** c'est l'étape de définition des objectifs et procédures sur les investissements, la concurrence et la propriété intellectuelle
- **Septembre 2005 à juillet 2006,** Architecture globale de l'APE et projet d'Accord dans les domaines liés au commerce, à l'agriculture, aux questions de développement, à la pêche.
- **Septembre 2006 à fin 2007,** Négociations de libéralisation et la conclusion de l'APE.

4 ETAT DES LIEUX DES NÉGOCIATIONS ET SITUATION ACTUELLE

Il est question dans cette partie de notre travail, de présenter, dans la mesure du possible, l'évolution des négociations. De ce point de vue, nous allons faire le point de la négociation à mi-parcours avant de se focaliser sur la situation actuelle pouvant conduire à la conclusion (Ratification) de l'accord par les différents Etats.

4.1-Evaluation à mi-parcours des négociations

L'accord de Partenariat de Cotonou signé le 23 Juin 2000 entre l'UE et les Etats ACP établit un nouveau cadre de coopération commerciale qui doit remplacer par le régime actuel d'accès préférentiel unilatéral des ACP aux marchés européens, couvert par une dérogation à l'article 1^{er} du GATT de 1994, obtenue par l'UE en 1994 puis renouvelée en 2001 à la $4^{ème}$ conférence ministérielle de l'OMC à Doha (Qatar) et qui a expiré en 2007 ([7])

Le processus de révision complet et formel des négociations des APE a été lancé en juillet 2006 par l'UE conformément à l'article 37.4 de l'accord de Cotonou. Les résultats de cet exercice sont spécifiques pour chaque région, mais ils ont toutefois

permis de mettre en lumière, d'une part, le manque d'avancement des négociations et le désaccord persistant entre les parties négociantes sur un grand nombre de thèmes et, d'autre part, le manque d'information, de préparation ainsi que les contraintes en termes de capacités des pays de l'Afrique Centrale à s'approprier le processus, à coordonner leur technique de négociation autour des points de l'accord qui soient favorables à leur développement ([8]) .

A la base, les APE visent le développement des pays ACP. De fait, la Banque Mondiale pense que « si les APE offrent un meilleur accès au marché de l'UE, diminuent les barrières commerciales tant entre les pays d'une même région qu'entre les pays de régions différentes (groupements régionaux des ACP) et aussi réduisent les obstacles institutionnels au commerce, les bénéfices en terme de développement seront grands». De ce point de vue, toutes les rencontres, tous les résultats ont tendance à œuvrer pour une réussite de cette initiative. Cependant, l'évolution des négociations est assez timide. Cette timidité est liée à la résistance du groupe africain, en raison des pertes potentielles de la mise en application des dispositions relatives à l'APE. De plus la difficulté de trouver un consensus sur la question allonge les négociations ([8]).

4.2-Présentation de la situation actuelle et des principaux points de désaccords à l'origine du blocage de la conclusion de négociations

Suivant le calendrier ci-dessus présenté, les négociations ce sont poursuivi normalement. A cet effet, en avril 2007, la Commission a annoncé son offre d'accès au marché, consistant en un accès total et immédiat pour l'ensemble des exportations ACP à la date de signature des APE, à l'exception de certains produits sensibles (riz, sucres, bananes) qui feront l'objet d'une phase transitoire dans un souci de compatibilité avec les réformes internes du marché européen. Cette offre qui, selon les experts, avait pour ambition d'accélérer le processus des négociations n'a pas eu les effets escomptés ([5]).

De ce point de vue, au lendemain de la date butoir, les négociations se sont intensifiées entre la commission et les différentes régions ACP. Au regard du niveau de blocage observé dans les négociations pour la conclusion de l'APE, la commission a proposé une approche en deux étapes en vue de garantir la continuité du processus de négociation tout en évitant le risque de perturber les échanges entre les deux parties ([5]).

Cette approche consistait en la conclusion des accords intérimaires limités au commerce des marchandises et compatibles avec les règles de l'OMC, en tant qu'étape vers un APE complet. Cependant, pour les pays qui ne signeraient pas d'accord intérimaire ou complet au moment de la date butoir, la Commission se proposait d'appliquer en leur endroit, le Système de préférences généralisées (SPG). Face à la complexité de la situation, la CE a proposé et encouragé la signature des accords intérimaires. Cette possibilité a trouvé un écho favorable dans la partie adverse. Cet aspect positif de la négociation s'est confirmé avec le nombre de pays ayant (en moyenne 35 pays ACP) paraphés ou signé un APE total ou intérimaire. Parmi ceux-ci, on dénombre 21 pays dont ceux de l'Afrique non-PMA ont signé - soit individuellement soit dans le cadre d'une configuration régionale - un accord intérimaire, couvrant principalement le commerce des marchandises ([5]).

La motivation de la signature de l'APE étape a été motivée par la crainte de perdre l'accès privilégié au marché européen par les pays ACP. Face à cette situation la Côte-d'Ivoire, le Ghana et le Cameroun ont signé des accords intérimaires. La décision du Cameroun de signer un APE étape a perturbé le processus des négociations en Afrique Centrale. Cette décision du Cameroun de négocier un APE intérimaire voit le jour le 17 décembre 2007 date à laquelle le Cameroun paraphe l'accord d'étape avec l'UE suivi de sa signature le 15 janvier 2009 ([5]). En fait, au titre des négociations de l'APE Afrique Centrale, et en vertu du règlement 1528/2007 du 20 décembre 2007, le Cameroun accède au marché de l'Union Européen en franchise de droit de douane et sans contingentement. Malgré la signature de l'accord intervenue en 2009, le Cameroun n'a pas encore ratifié l'APE étape. Cette lenteur dans la ratification de l'accord par le Cameroun, le place en situation de ballotage défavorable par rapport au privilège que l'UE lui concède au titre de la signature de l'accord étape. A cet égard, l'UE menace de suspendre le Cameroun de ses préférences commerciales si d'ici le 1er Octobre 2014, cet accord n'est pas ratifié ([5]).

Cependant, au niveau régional, les négociations des APE se poursuivent depuis 2008 sans de véritables avancées. Car les négociations ont une fois de plus été bloquées lors de la rencontre de Bangui en Novembre 2011 ([5]).

Or, les négociations, en vue de la signature d'un Accord de Partenariat Economique (APE) entre l'Union Européenne et l'Afrique Centrale, sont rendues à une phase déterminante et cruciale, influencée ou même « conditionnée » par l'accord d'étape paraphé par le Cameroun et signé par le Cameroun, l'un des pays non PMA de la région qui en compte cinq ([5]).Les parties se sont retrouvées en Février 2008 pour relancer les discussions avec pour but principal, trouver un terrain d'entente sur les points faisant l'objet de désaccord. A l'issu des conclusions de cette rencontre de février 2008, il ressort que l'accord d'étape s'effacerait devant l'accord régional. Il est, cependant important de noter que cette situation ne sera pas sans conséquence pour la suite des négociations ; puisque la partie européenne inviterait ou « exigerait » des autres pays de la région, et implicitement à la région elle-même, à s'y conformer aux dispositions d'accès à ses marchés des marchandises et des services. L'UE semble en effet faire une interprétation exclusive (et sans doute « intéressée » ?) de l'article 24 du GATT,

qu'il a « fait partager » à la trentaine des pays engagés dans la signature d'un accord d'étape ([5] et [10]**)**. A ce titre, les schémas ci-dessous, donne une présentation globale de l'APE étape et des points en suspension se présentent comme suit :

Tableau2 : la présentation globale des APE Cameroun-UE

parafé	**le 17 décembre 2007**
signé	**Le 15 janvier 2009**
objectifs	**Préserver l'accès au marché des produits camerounais sur le marché de l'Union Européen**
Domaines couverts	- **Le commerce des marchandises ;** - **Les questions liées au commerce des marchandises**
Autres Caractéristiques	- **Existence de beaucoup de clause de rendez-vous pour négocier d'autres aspects notamment les questions de développement** - **Taux de libéralisation 80 % des importations avec l'UE** - **Calendrier de libéralisation sur 15 ans avec 2 ans de période préparatoire ; le début de la libéralisation étant prévu le 01 janvier 2010** - **Trois groupes de produits à libéraliser**
L'accord du Cameroun sera remplacé par l'accord régional en cas de conclusion	

Source : ([5])

4.3 APE D'étape: les questions en suspens

L'APE d'étape est incomplet, couvre particulièrement le domaine du commerce des marchandises et comporte des clauses de rendez-vous sur des questions non encore négociées

Tableau3 : la présentation des points en suspens de l'APE étape du Cameroun

Quelques Clauses de Rendez-vous dans l'APE d'étape	Echéance	Article
Mise en place d'un fonds régional APE (FORAPE)		9
Mise en place des mesures d'assistance technique et financière dans le cadre de la coopération financière et fiscale		10
Elaboration d'une méthode commune d'évaluation de l'impact fiscal net		10
Partenariat pour le développement et modalités de mise en œuvre (Renforcement des capacités et mise à niveau des économies de l'Afrique, etc.)	2008	12
Commerce des services	01/01/2009	54
Paiements courants et mouvements des capitaux	01/01/2009	56
Autres Règles liées au Commerce (Concurrence, Propriété intellectuelle, marchés publics)	01/01/2009	57, 58 et 59
Développement durable	01/01/2009	59
Comité APE	2008	92

Source : ([5]**)**

4.4-Pourquoi l'APE étape du Cameroun n'est pas ratifiée ?

Le Cameroun pays membre de la Communauté Economique et Monétaire de l'Afrique Centrale, est candidat au projet d'intégration économique de la sous-région. A cette fin, sa décision de signer un APE étape seul, met à mal un certain nombre de dispositions collectives dans le cadre de la CEMAC-CEEAC [10] et [3]**)**. L'essentiel de ces dispositions sont ci-dessous présentées.

- L'APE étape sapera le processus d'intégration régional, qui est un objectif fondamental de l'APE en Afrique Centrale. En effet, l'application de l'APE du Cameroun fera coexister au sein de la CEMAC deux Tarifs Extérieurs Communs et donc mettra à mal la zone de libre-échange ;
- Il sera en désaccord avec la résolution des orientations des Chefs d'Etat de la CEMAC sur la question: la résolution de la 9^{ième} Conférence des Chefs d'Etat de la CEMAC tenue à Yaoundé en Juin 2008, prévoyait que les négociations de l'APE soient l'occasion pour eux de sauvegarder la cohésion régionale en vue de préserver les acquis de l'intégration régionale en Afrique Centrale.
- Il limitera la poursuite harmonieuse et sereine des négociations au niveau régional.
- Il est incomplet: selon les Ministres d'Afrique Centrale, l'APE doit être complet, viable, juste, équilibré et mutuellement bénéfique pour toutes les parties**)**.

4.5.-Négociations APE au niveau régional et points de désaccord

Après l'échec constaté en octobre 2007, les négociations au niveau régional se sont poursuivies en 2008, puis ont connu un arrêt en 2009 et 2010. Cet arrêt a été provoqué par :

4.5.1 Le changement de l'équipe de négociateurs

Le changement de l'équipe de négociateurs côté européen a permis de renouer le contact en Décembre 2010 à Douala, pour une intensification des négociations en 2011 et un fonctionnement optimal des groupes techniques constitués (GTAD, GTSI, GTMA) ([5]),

- aucun round de négociation n'a eu lieu entre les deux parties depuis octobre 2011.
- plusieurs points de désaccord restent en suspens, mais deux nous semblent très importants : **le degré d'ouverture des économies d'Afrique Centrale et les mesures d'accompagnement** (renforcement des capacités, mise à niveau des économiques, méthodologie d'évaluation de l'impact fiscal net, financement desdites mesures).

4.5.2 le degré d'ouverture des économies d'Afrique Centrale,

- l'Union Européenne juge insuffisante l'offre de l'Afrique Centrale (AC) (en terme des produits à libéraliser) faite après les travaux régionaux de novembre 2011 à N'Djamena.
- l'offre faite par l'AC comportait **3816** lignes tarifaires représentant un pourcentage de **73%** à libéraliser contre **1408** à l'exclusion pour un pourcentage de **27%**. Le volume global des échanges proposé à la libéralisation représente 67% [5].
- l'UE estime que l'Afrique Centrale devra porter son offre de libéralisation à au moins **80%** de ses importations d'origine UE.
- Cette proposition de l'Afrique Centrale se justifie par ses faibles capacités de production dont une libéralisation importante pourrait porter un très grave préjudice à la structure des économies des pays membres.
- La durée de démantèlement tarifaire. L'Union Européenne estime que la libéralisation devrait intervenir en 15 ans et l'Afrique Centrale exige une période de libéralisation plus longue de 20 ans.
- La période de transition (période durant laquelle aucun démantèlement n'interviendra) constitue également un point de désaccord : l'Afrique Centrale sollicite une période de 5 ans alors que l'union Européenne préconise 2 ans.

4.5.3 Les mesures d'accompagnement

Pour ce qui est des mesures d'accompagnement (renforcement des capacités, mise à niveau des économiques, méthodologie d'évaluation de l'impact fiscal net, financement desdites mesures) ([11], [12] et [13]) :

- Elles visent à renforcer les capacités des économies et la mise à niveau des entreprises pour leur permettre de faire face à la concurrence liée à 'APE.
- L'UE reste très réticente à la prise en compte et surtout au financement de telles mesures.
- Les deux parties peinent à trouver un consensus sur le contenu du PRADA où l'UE tend à privilégier des investissements «soft» au détriment des investissements en matière d'infrastructures plus porteur de développement.
- Pour l'AC, les mesures d'accompagnement sont indispensables pour soutenir le processus de libéralisation au regard de la vulnérabilité des économies.

CONCLUSION

Un APE qui ne s'inscrit pas dans la dynamique d'un développement durable et qui ne comportent pas des financements adéquats des mécanismes d'ajustement pourrait entraîner des conséquences économiques dramatiques que la simple application du Système de Préférence Généralisé (SPG). Au stade actuel des négociations de l'APE Afrique Centrale, on peut noter une avancée considérable tant au niveau régional qu'au niveau du Cameroun malgré les blocages observés du fait de certains désaccords.

En effet, l'objectif déclaré des APE est de contribuer à une meilleure insertion du Cameroun dans le commerce mondial en favorisant l'intégration régionale et en améliorant l'accès des produits camerounais au marché européen. Cependant, les mesures d'accompagnement notamment l'investissement dans le capital humain et productif ne sont pas considérées par le Cameroun comme étant au niveau du volet de libéralisation des échanges ([11]). Cet argument se confirme par le fait que les demandes d'allocation financière additionnelle du Cameroun pour accompagner la mise à niveau de son économie n'ont pas été prises en compte à date.

A ce sujet, le processus ouvert par l'Accord de Cotonou est aujourd'hui perçu par les pays ACP en général et le Cameroun en particulier comme une négociation sur les instruments de développement réduite à une discussion commerciale. Or, pour l'UE, la signature des APE lui permettrait de conserver son lien commercial privilégié avec le Cameroun dans un contexte de concurrence accrue entre les grandes puissances économiques pour l'obtention de nouveaux marchés et sources d'approvisionnement ([11]) [14]**)** . En plus, l'UE par le biais des APE, souhaite maitriser flux migratoires. Ainsi, il argumente que les APE doivent offrir des perspectives d'avenir positives aux populations du Cameroun, notamment en termes de création d'emplois. Il faut dire que la vision de l'UE n'est pas totalement fausse : tout réside dans la capacité de négociation des experts camerounais. De ce fait, par la voie des négociations, la Cameroun peut avoir gain de cause et assurer la remise à niveau de son économie. De ce point de vue, les APE deviendront un des vecteurs de développement, de lutte contre la pauvreté, de sécurité alimentaire (disponibilité, accessibilité) et d'insertion de l'Afrique dans l'économie mondiale.

Cependant, l'APE d'étape du Cameroun ne comporte pas le volet développement et sa mise en application pourrait mettre à mal la dynamique d'intégration régionale d'une part et le développement économique du Cameroun d'autre part. Cette situation est confortée par de nombreuses études menées dans le cadre de l'impact des APE sur les recettes fiscales au Cameroun et dans les pays ACP ([11]). Ses pertes seraient en moyenne de 5 à 8 fois plus importantes que le recours au Système de Préférence Généralisé (SPG) [11]). Quelle que soit l'alternative (SPG ou APE), le débat sur la diversification des partenaires commerciaux du Cameroun mérite d'être approfondi. Aussi, les questions relatives aux mécanismes de négociation et de la structure des équipes de négociation reste de mise pour la réussite de l'accord en gestation.

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LISTE DES ACRONYMS

CEMAC :	Communauté Economique et Monétaire de l'Afrique Centrale
CEEAC :	Communauté des Economique des Etats de l'Afrique Centrale
OMC :	Organisation Mondiale du Commerce
UECA :	Union Economique de l'Afrique Centrale
NPF :	Nation la Plus Favorisée
TFPR :	Task Force de préparation régionale
FED :	Fond Européen de Développement
GATT :	General Agreement on trade and tariff
ACP:	Afrique caraïbe et pacifique