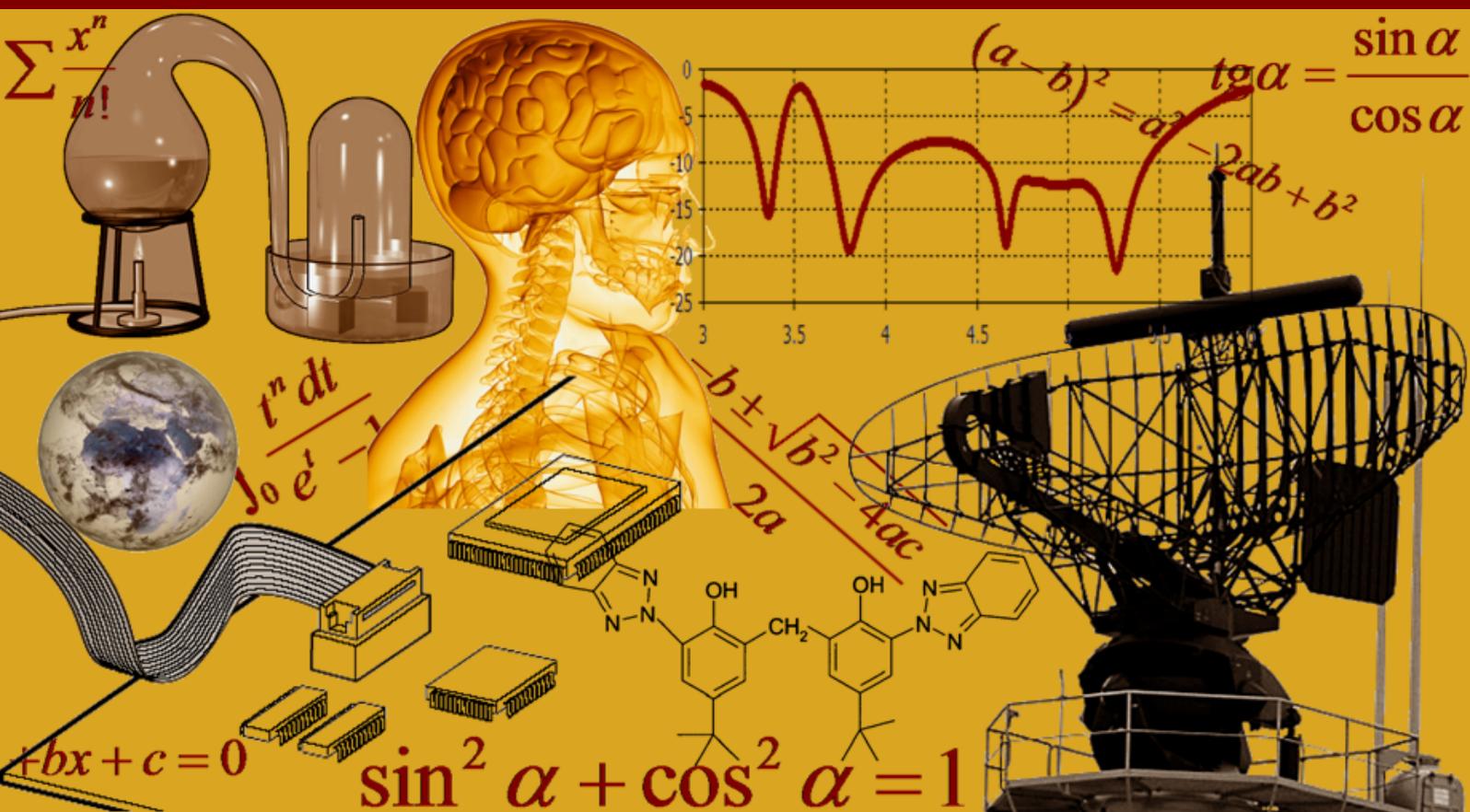


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Fatalistic beliefs and risk-taking on the covid-19 pandemic: Effect of level of study

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ABSTRACT: The objective of this research was to study the relationship between fatalistic beliefs, level of study and risk-taking of Cameroonians vis-à-vis COVID-19. Indeed, this pandemic that appeared in China towards the end of 2019 causes thousands of deaths around the world. In Cameroon, despite the many measures enacted by the Government, statistics indicate an evolution in the number of cases (nearly 20,000 cases, MINSANTE, 2020). Using the simple random sampling technique, 219 participants aged 18 to 63 were asked to complete a composite questionnaire (fatalistic belief scale, Shen et al., 2009; Protection Motivation Theory Scale, Rogers, 1973, sociodemographic variables). The results from the analysis of variances, correlations and regressions confirm our hypotheses. Overall, it is observed that the level of study influences fatalistic beliefs ($F(2,115) = 5.83, p = .004$) and risk-taking ($F(2,115) = 9.29, p = .001$). On the other hand, fatalistic beliefs explain the risk-taking vis-à-vis COVID-19 [$r(219) = 0.175, p < 0.01; \beta = 0.175, t(217) = 2.613, p = 0.010, F(2,217) = 6.826, p = 0.010$]. Such results show the place of certain socio-demographic variables and fatalistic beliefs and the need to take them into account when addressing the issue of safety behavior.

KEYWORDS: Fatalistic beliefs, COVID-19, safety behaviors, prevention.

1 INTRODUCTION

The outbreak of the Covid-19 pandemic in China towards the end of 2019, has caused thousands of deaths worldwide and is a real public health concern. It generates substantial costs and is a burden, an economic brake for all societies (WHO, 2020; www.who.int/). There are approximately 11,797,213 cases of contamination with 6,415,379 cured and 543,595 deaths worldwide (WHO, 2020; www.who.int/). In the United States, for example, there are approximately 3,048,072 confirmed cases with 918,298 recoveries and 133,322 deaths. In Brazil, there are approximately 1,674,655 confirmed cases with 1,072,229 recoveries and 66,868 deaths. In India, there are approximately 2,647,663 confirmed cases with 1,919,842 recovered cases and 50,921 deaths. In Russia, there are about 694,230 confirmed cases with 463,880 recoveries and 10,494 deaths. In Egypt, there are about 77,279 confirmed cases with 21,718 cases of recovery and 3,489 deaths. In South Africa, there are approximately 215,855 confirmed cases with 102,299 recoveries and 3,502 deaths. In Kenya, there are approximately 8,067 confirmed cases with 2,414 recoveries and 164 deaths. In Cameroon, figures indicate about 18,118 confirmed cases with 16,540 recoveries and 401 deaths. Given the significant costs generated by the rise in the number of cases, the prevention of this pandemic has become a real concern for public authorities and the scientific community.

In general, human behavior very often comes back at the top of the list of factors mentioned to explain the insecure behavior of individuals (Chow & Mullan 2010; Clayton & Griffith, 2008; Milton & Mullan, 2012; Mullan & Wong, 2009; Yiannas 2009; Wright & Leach, 2013). The risks associated with non-compliance with barrier measures are one of the first risks for contamination because of their frequency. It is important to note that, for an individual to agree to respect barrier measures, he must first accept that the disease exists and that he is vulnerable. The concept of risk acceptability, the definition and determinants of which are not yet consensual, uses the perception of risks by the various actors but also their perception of barrier measures and risk management policy (Kouabenan, 1998). This brings to light the idea that changing behavior could go a long way towards reducing the number of infections linked to this pandemic.

Numerous studies highlight two major cognitive processes that underpin the adoption of protective behavior. This is the perception of risk (Kouabenan et al., 2006; Slovic et al., 1981) and the explanation of events (Kouabenan 1999). Kouabenan (2009) explains, for example, that these two cognitive processes have in common the fact that they are based on the representations and beliefs of

individuals, which beliefs can directly affect behaviors. Fatalistic beliefs (Claassen et al., 2010; Kouabenan, 1998; Norenzayan & Lee, 2010; Omari & Baron-Epl, 2013; Ttirkiim, 2006), beliefs of control (White et al., 2006), beliefs in God's control (Howsepian & Merluzzi, 2009; Ngueutsa, 2012) and cultural beliefs are the increasingly studied forms of belief in social psychology. Taking into account beliefs thus becomes a widely used approach to better understand health and safety issues, and to define more effective and sustainable preventive actions (Bergvik et al., 2012; Kayani et al., 2012; Kouabenan 1998; Ngah Essomba, 2012; Sloan et al., 2009; Weinstein 1993). Among these forms of belief, fatalistic beliefs are presented in different models of adoption of protective behaviors as being able to directly affect insecure behaviors (Gouertoumbo Mete, 2019; Kouabenan, 2009; Mvessomba et al., 2017; Nguetsa & Kouabenan, 2014). They refer to an individual's belief that death is inevitable in case of grave danger (Powe & Jonhson, 1995). According to Mvessomba et al. (2017) and Ngah Essomba et al. (2022a), fatalism is a doctrine based on a belief or set of beliefs that denies the individual the ability to act on events, especially future ones. Whatever security measures he adopts, it will have no impact on what needs to happen to him. It's all about chance or luck or divine control and can be easily explained by theology or metaphysics (Mvessomba et al., 2017; Ngah Essomba et al., 2022a). The fatalist refuses the ability to deliberate on what will happen, he believes that even his own behavior does not depend on him.

Fatalism therefore leads to a type of information processing characterized by denying personal control (Neff & Hoppe, 1993) and the belief that death is inevitable in case of serious danger (Powe et al., 2005). It highlights one or all three dimensions: the individual perceives the lack of internal control over the events of his life (Chavez et al., 1997; Davison et al., 1992; Neff & Hoppe, 1993; Straughan & Seow, 1998); notions of fate, fate and predestination of an unfortunate problem or event (Cohen & Nisbett, 1998; Davison et al., 1992; Straughan & Seow, 1998) and perceptions of helplessness, despair, and insignificance due to expectations of negative consequences (Sheier & Bridges, 1995; Powe & Johnson, 1995).

It can therefore be said that the processing of the fatalist's information leads him to make external attributions on life events such as the contamination of COVID-19. Hence the pre-eminence of the concepts of predestination, luck and pessimism among most researchers who describe the conduct of the fatalist (Shen et al., 2009). Such attitudes are likely to influence behavior and cause the individual to make no effort to comply with safety measures, i.e. not be motivated to protect himself. Shen et al. (2009), in their work, highlighted the fact that fatalism is a multidimensional construct, composed of predetermination, luck and pessimism. Predetermination is a belief in a world predefined by the divine order, where a pandemic like COVID-19 is perceived as a punishment from God. Luck is a belief that tends to consider everything that happens to an individual as a matter of fate, chance or fate. Therefore, if you are to be infected with COVID-19, no matter how hard you try, you have to be lucky to be spared. Pessimism, on the other hand, is the belief that people's behaviors will not prevent anything and that contamination from a pandemic like COVID-19 is inevitable. Let us also note with Maercker et al. (2019) that fatalistic beliefs are universal. They are accentuated by a very high exposure to health information through the media and promote the adoption of inappropriate behaviors to fight diseases such as cancer, cardiovascular diseases, HIV/AIDS, etc. (Lee & Chae, 2016; Maercker et al., 2019; Mvessomba et al., 2017).

Much research has focused on the influence of fatalistic beliefs on the behaviors of individuals. For Powe and Winnie (2003), fatalistic beliefs lead to the rejection of the adoption of changes in cancer behavior. Other studies show that fatalistic people tend to neglect respect for protective behaviors towards cardiovascular disease (Urizar & Sears, 2006); diabetes (Egede & Bonadonna, 2003); extreme stress (Yeh et al., 2006; Zimrin, 1986); HIV/AIDS (Varga, 2001); cigarette consumption (Schnoll et al., 2002); safe behaviors on the road (Gouertoumbo Mete, 2019; Ngah Essomba, 2017; Rudmo & Hale, 2003) and even healthy sexual practices (Kalichman et al., 1997). The objective of all this research briefly mentioned was to show the need to eliminate fatalistic beliefs to maximize the likelihood of adopting safe behaviors and at the same time reduce risk-taking among individuals. However, few studies have tested the link between fatalistic beliefs and risk-taking in the context of a health crisis. The fact that the fatalist feels that he has no power over what happens to him risks leading him to a biased perception of the causes of events, which would not allow the adoption of precautionary measures and would lead to risk-taking. To this end, we therefore formulate in the context of this research the hypothesis that fatalistic beliefs induce risk-taking vis-à-vis Covid-19. In an attempt to explain the effect of these beliefs on protective behavior, the model of health beliefs and the theory of motivation for protection are regularly convened.

The Health Belief Model (HBM), which has its origins in the - theory developed by Watson (1930), shows that individuals take risks because their beliefs filter or amplify risk. This model is based on perceived vulnerability, perceived threat, perceived severity, effectiveness of recommendations and the ability to implement preventive measures. It can then be said that individuals who take risks rely on beliefs that do not allow them to assess them objectively (Mvessomba et al., 2017). HBM is often used as a support for the explanation and development of prevention strategies.

The Motivation to Protect model (Rogers, 1983) was developed to study the conditions and factors that may cause individuals to protect themselves by engaging in safe behaviors. This model is based on perception and evaluation. It is actually the perception of vulnerability, the severity of the threat, the effectiveness of the recommendations, the ability to put into practice the recommendations (the barrier measures to deal with COVID-19). For Rogers (1983), the individual will engage in risky behavior (e.g. not wearing a protective mask), if he considers the costs (masking his beauty, personal beliefs, etc.) above the benefits. It is a question of an individual making a

deliberate choice of the means that allow him to achieve the intended objectives so that individual efforts are made according to a cost-benefit approach. If the individual finds that the behavior he seeks to adopt (wearing a mask or washing hands) will be beneficial for him, he will adopt it; otherwise, it will not adopt it. In relation to the COVID-19 pandemic, if the individual finds that compliance with barrier measures allows him to avoid the disease, he will respect them; but if, on the other hand, he finds that he will waste time and energy unnecessarily by respecting these measures, he will not respect them. Rogers (1975) explains that the adoption of safe behavior is a combination of three variables (the probability of occurrence of the threat or vulnerability; the severity of the threat; the effectiveness of the recommendations) that are likely to arouse motivation for protection. This awakening of motivation is likely to promote the adoption of the recommendations proposed by a prevention message. For example, an individual will comply with barrier measures if the message persuades him that he may be contaminated in case of non-compliance with these measures (vulnerability) and that he may be in respiratory distress following COVID-19 (severity) or that an effective way to avoid COVID-19 is to comply with these measures (effectiveness of the recommendation).

The originality of PMT is that it has succeeded in highlighting the complex nature of the cognitive processes of a threat (to health) (Ngha Essomba, 2017). With this in mind, health messages must be conceived as appeals to fear that would lead to the adoption of preventive behavior. TMP shows that the degree of motivation to protect oneself results from two parallel cognitive information processes in response to a health threat: the assessment of the threat and the evaluation of measures to deal with it. The development of motivation to protect oneself depends on the conditions and factors that prevent and promote health behaviors. The ambition of this research is therefore to highlight the relationship between fatalistic beliefs and compliance with security measures in the context of a health crisis (hypothesis 1).

Another point in this work concerns a third variable that is discussed here: the level of study. Some studies on the relationship between fatalistic beliefs and risk-taking add culture as a third variable. From this perspective, it appears that risk-taking varies according to the cultures specific to certain nationalities. For example, for Sivak et al. (1989b), Germans are more cautious during a road crossing than Americans and Spaniards. In addition, some studies show that people from different countries have perceptions and attitudes towards risk that more or less reflect the ways of thinking and living specific to their cultural environment (Vaughan & Nordenstan, 1991). This study addresses the level of education as a new variable in this field. This variable is operationalized based on the primary, secondary and university model as practiced in Cameroon.

This study therefore explores the relationship between fatalistic beliefs and health risk-taking in three levels of study: primary level (person who has studied from kindergarten to middle school), secondary level (person who has obtained a Certificate of Primary Education and has done pre-university studies) and university level (person who has obtained a bachelor's degree and has done post-secondary studies). Starting from the idea of Powe (2001) who states that people with little education are more fatalistic than those with a better education and that of Shen et al. (2009), Mvessomba et al. (2017) and Ngueusta (2012) who show that people with a low level of education (primary) are categories of participants who are particularly fatalistic and take more risks, we predict an effect of the level of study on fatalism and on the risk-taking of participants (hypothesis 2).

2 METHOD

2.1 PARTICIPANTS AND PROCEDURE

Our sample consisted of 219 participants aged 18 to 63 years (108 men and 111 women, mean age = 26 years). The sample consisted of 48% men and 52% women. The average age of participants was 28 years (SD = 12 years). More than 45% of respondents are under the age of 36 and just over 60% have less than 10 years of seniority. 88 participants had a primary level of education, 71 participants had a secondary level of education, and 60 participants had a university level of education. Tous were French speakers from the city of Yaoundé selected using the simple random sampling technique. The study was presented as an investigation into attitudes towards Covid-19. Participants who met the inclusion criteria were first informed verbally of the purpose of the study, the confidentiality and voluntariness of their participation, and the possibility of withdrawing from the study at the desired time. They were then given an informed consent form that they had to read and sign if they approved the study. For those who agreed to participate, they completed the questionnaire and gave it to the researcher.

2.2 INSTRUMENTS

Fatalistic beliefs were assessed using the measurement scale proposed by Shen et al., (2009). This instrument is composed of 20 items that question participants about how they felt over the past month. For each item, participants were invited to position themselves on a five-point Likert-type response device ranging from "from not at all agree (1) to completely agree (5)". The factorial structure of the construct of fatalistic beliefs revolves around three dimensions: **Predetermination** (10 items, example: "If someone was predestined to have COVID-19, no matter the barrier measures, he will have this disease"), **Luck** (4 items, example: "My good health is a matter of luck"),

and **Pessimism** (6 items, example: "I will suffer a lot from my vulnerability in society"). Analysis of the internal coherence index (α) yielded acceptable Cronbach alpha scores (fatalism $\alpha = .67$; predetermination $\alpha = .70$; chance $\alpha = .69$; pessimism $\alpha = .79$).

Risk-taking was measured through the items of motivation to protection and attitude to barrier measures namely wearing a mask and washing hands. For this model, five measurements were made: the intention to wash hands with soap and wear the protective mask in public; perceived vulnerability (if I have COVID-19 for lack of handwashing with soap, I will probably be very severely weakened); perceived severity (if I go out without a mask, I will probably be infected with COVID-19); effectiveness of the recommendation (if I always wash my hands with soap, I won't have COVID-19) and the cost of motivation (regular handwashing with soap wastes my time). The attitude was measured using a 5-point bipolar item (For you, washing your hands with soap is bad/good, serious/not serious, exciting/not exciting).

2.3 DATA ANALYSIS

The data collected was processed from the analyses of variance, correlation and regression on SPSS software version 23. First, the analysis of variance made it possible to test the effect of the level of study on fatalism and risk-taking vis-à-vis the Covid-19 pandemic. Then, the correlation analysis made it possible to test the linear relationship between the dimensions of fatalism and those of risk-taking. Finally, the regression analysis made it possible to test whether fatalism is a predictor of risk-taking vis-à-vis the Covid-19 pandemic.

3 RESULTS

The results of this study are presented in two stages. First, we test the effect of the level of study on fatalistic beliefs and on the motivation to protect one self. In a second step, correlations and regressions are analyzed. The results, through the indices of linear associations (r), make it possible to assess the strength of the links between the variables of the study and their respective dimensions. Subsequently, we report on the analysis of the regression between fatalistic beliefs and risk-taking related to Covid-19. This regression analysis will examine the causal relationship between these two quantitative variables, highlighting the weight of the effect of the first (fatalistic beliefs) on the second (risk-taking related to Covid-19). This weight is concretely analyzed thanks to the standardized beta coefficients (β) and beta t -values.

Table 1. Effect of level of study on fatalistic beliefs and risk-taking

	Primary	Secondary	Academic		
	M	M	M	F	p
	(SD)	(SD)	(SD)		
Predetermination	2.71	2.59	2.28	5.46	.0006
	.531	.720	.731		
Luck	2.76	2.11	1.92	7.12	.002
	1.015	.865	.853		
Perceived vulnerability	3.80	3.29	3.34	3.61	.032
	.885	1.06	1.15		
Intention	4.50	3.74	3.69	14.8	.001
	.624	1.08	1.13		
Perceived severity	3.79	3.30	3.01	4.21	.019
	1.13	1.11	1.25		
Effectiveness of the recommendation	3.86	3.24	2.84	7.41	.0001
	1.07	1.17	1.30		
Cost of the recommendation	4.25	3.78	3.85	3.71	.029
	.788	1.01	1.55		

Table 1 shows that the level of education has an effect on fatalistic beliefs ($F(2,115) = 5.83, p = .004$), and on risk-taking ($F(2,115) = 9.29, p = .001$). In other words, the degree of fatalism and risk-taking among participants varies according to the level of study. On the one hand, at the level of fatalism, this variation is expressed at the level of predetermination and luck. At the level of predetermination, compared to participants with a university level of education, participants with a primary education level tend to feel that the world is predefined by a divine order and therefore a pandemic like COVID-19 is perceived as a punishment from God ($F(2,115) = 5.46, p = .0006$). At the level of luck, compared to participants with a university level of education, participants with a high school level tend to consider

that everything that happens to an individual is a matter of fate, chance or fate. Therefore, for them, if you are to be infected with COVID-19, no matter how hard you try, you have to be lucky to avoid it ($F(2, 115) = 7.12, p = .002$). On the other hand, at the level of risk-taking, this variation is expressed in the level of perceived vulnerability, intent, perceived severity, effectiveness of the recommendation and cost of the recommendation.

In terms of perceived vulnerability, compared to participants with secondary and university education, those with primary education feel that they will not be sick even if they do not wear a mask or wash their hands regularly ($F(2, 115) = 3.61, p = .032$). In terms of intent, compared to participants with secondary and university education, those with primary education do not show an intention to respect mask wearing and do not wash their hands regularly ($F(2, 115) = 14.8, p = .001$). In terms of perceived severity, compared to participants with primary education, those with secondary and university education feel that they are likely to be very severely weakened if they do not wear a mask or wash their hands regularly ($F(2, 115) = 4.21, p = .019$). In terms of the effectiveness of the recommendation, unlike participants with secondary and university education, those with primary education consider that mask wearing or routine handwashing is not effective against COVID-19 ($F(2, 115) = 7.41, p = .0001$). Finally, with regard to the cost of the recommendation, compared to participants with secondary and university education, those with primary education consider it a waste of time to wear a mask and wash their hands regularly ($F(2, 115) = 3.71, p = .029$). These results confirm our first hypothesis that the level of study influences fatalism and risk-taking. To test the second hypothesis we proceeded to the calculation of correlations and regressions.

Table 2. Correlations between COVID-19 beliefs and risk-taking

	Pr	Attmask	Attmain	Vul	Intention	Grav	Eff	Cost
Fatalism	.175**	-.206**	-.163*	.156*	.062	.213**	.105	.106
Pessimism	.153*	-.127	.033	.110	.099	.238**	.089	.022
Predetermination	.071	-.140*	-.182**	.146*	-.048	.076	.013	.065
Luck	.175**	-.205**	-.163*	.061	.164*	.214**	.189*	.172*

Note: Pr: risk-taking; Attmask: attitude towards the mask; Attmain: attitude towards hand washing; Vul: perceived vulnerability; Grav: perceived gravity; Eff: effectiveness of the recommendation.

** The correlation is significant at the 0.01 level (bilateral). * The correlation is significant at level 0.05 (bilateral); with $n = 219$.

Table 2 presents the results of the correlations between fatalistic beliefs and the dimensions of risk-taking with which it has a significant correlation. Overall, it appears that individuals with fatalistic beliefs tend to neglect compliance with COVID-19 barrier measures ($r(219) = 0.175, p < 0.01$). Detailed analysis indicates that the three dimensions of fatalistic beliefs are correlated with different indicators of risk-taking. Individuals who feel that there are certain things in life, including serious events, that would occur regardless of the measures they take tend to neglect hand washing with soap ($r(219) = -0.182, p < 0.01$) and wearing a mask in public ($r(219) = -0.140, p < 0.05$). They also estimate that if they have COVID-19 for lack of hand washing with soap or not wearing a mask in public, they will probably be very seriously weakened ($r(219) = 0.146, p < 0.05$). Subsequently, pessimistic participants, i.e. those who tend to view things on the wrong side, in the present or in the future, take the risks ($r(219) = 0.153, p < 0.05$). For the latter, if they go out without a mask, they estimate that they will probably be infected with COVID-19 ($r(219) = 0.238, p < 0.01$). Finally, participants for whom life events such as being infected with COVID-19 are random, neglecting behaviors such as washing hands with soap ($r(219) = -0.163, p < 0.01$) and wearing the mask in public ($r(219) = -0.205, p < 0.01$). For the latter, the intention to wash their hands with soap and wear the protective mask in public is not useful ($r(219) = -0.164, p < 0.05$). They also estimate that, if they go out without a mask, they will probably be infected with COVID-19 ($r(219) = -0.214, p < 0.01$). They also feel that even if they always wash their hands with soap or regularly wear the mask in public, they would still have COVID-19 if it were to happen to them ($r(219) = -0.189, p < 0.05$). For them, washing their hands regularly with soap wastes their time ($r(219) = 0.172, p < 0.05$).

Table 3. Regression analysis (fatalistic beliefs, risk-taking)

Predictor	Vd	Beta	t	GIS	R2 adjusted	F	GIS
Fatalism	Pr	.175	2.613	.010	.026	6.826	.010 ^b
	attmask	-.163	-2.438	.016	.022	5.943	.016 ^b
	attmain	-.206	-3.099	.002	.038	.606	.002 ^b
	Grav	.213	3.210	.002	.045	10.302	.002 ^b
Pessimism	Grav	.238	3.609	.000	.052	13.026	.000 ^b
Predetermination	attmask	-.140	-2.076	.039	.015	4.309	.039 ^b
	attmain	-.182	-2.727	.007	.029	7.438	.007 ^b
	vul	.146	2.710	.031	.017	4.708	.031 ^b
Luck	Pr	.211	3.173	.002	.040	10.080	.002 ^b
	attmask	-.205	-3.078	.002	.037	9.472	.002 ^b
	Grav	.214	3.232	.001	.042	10.434	.001 ^b

Note: PR: risk-taking; attmask: attitude towards the mask; attmain: attitude towards hand washing; Vul: perceived vulnerability; grav: perceived gravity.

Table 3 presents all the predictors that are relevant for a dimension of risk taking. Overall, we observe that fatalistic beliefs explain risk taking ($\beta = 0.175$, $t(217) = 2.613$, $p = .010$, $F(2,217) = 6.826$, $p = 0.010$). Moreover, we observe at the level of the pessimism dimension that the participants who think that there are certain things in life, including serious events, which are justified whatever the measures they will take tend to estimate that 'they go out without a mask or if they do not wash their hands regularly, they will probably be contaminated ($\beta = -.238$, $t(217) = 3.609$, $p = .000$, $F(2,217) = 13.026$, $p = .000$). On the other hand, with respect to the predetermination dimension, the belief that if an individual was predestined to have COVID-19, regardless of the barrier measures, he will have this disease explains the non-wearing of a mask ($\beta = -.140$, $t(217) = -2.076$, $p = .039$, $F(2,217) = 4.309$, $p = .039$); not washing hands with soap ($\beta = -0.182$, $t(217) = -2.727$, $p = .007$, $F(2,217) = 7.438$, $p = .007$) and the fact that participants would probably be very seriously weakened in case of contamination ($\beta = .146$, $t(217) = 2.710609$, $p = .031$, $F(2,217) = 4.708$, $p = 0.031$). Finally, with respect to the luck dimension, the belief that good health is a matter of luck predicts risk taking ($\beta = .211$, $t(217) = 3.173$, $p = .002$, $F(2,217) = 10.080$, $p = .002$). Participants who believe their lifespan depends on luck tend to neglect wearing a mask in public ($\beta = -.205$, $t(217) = -3.099$, $p = 0.002$, $F(2,217) = 9.472$, $p = .002$) and estimates that they will probably be contaminated with COVID-19 in the event of non-compliance with barrier measures ($\beta = .214$, $t(217) = 3.232$, $p = .001$, $F(2,217) = 10.434$, $p = .001$).

4 DISCUSSION

The objective of this study was to examine the relationship between educational attainment, fatalistic beliefs and risk-taking related to barrier measures in the face of the COVID-19 pandemic. The analysis of the data collected from our sample highlights the effect of the level of study on fatalism and risk-taking. Indeed, the results of the first hypothesis confirm that the level of study acts on fatalism and risk-taking. In other words, participants with a relatively low level of study (primary), tend to be more fatalistic and less respect barrier measures. This result can be understood to the extent that those with a low level of study do not have enough knowledge about the disease, do not properly master the transmission/contagion process. They regularly use beliefs in their daily lives and therefore use them to act. Indeed, when an individual at a low level of study, he is more inclined to believe that he has greater control over life events. The lack of education prevents him from acquiring scientific and technological skills but also and above all from increasing his cognitive abilities (Cuna & Neckman, 2007). As a result, these individuals regularly appeal to fatalistic beliefs when called upon to explain complex life events such as the onset and contagiousness of COVID-19.

Kouabenan (2007) explains, for example, that during risk assessment, an ordinary individual is subjected to a complex operation that requires a large cognitive load to process five registers of information. Thus, to assess a situation as risky or not (the case of COVID-19), the individual is called upon to integrate simultaneously: multiple active variables to be taken into account to have a satisfactory description of the situation; clues from multiple sources that need to be gathered and integrated to get an idea of the risk; uncertainty related to the equivocal nature of the meaning of the signs and indices used to describe the risk; the presence of positive objectives whose activities implemented to achieve them are at the origin of the risky situation to be assessed and the assessment of the effects of the risk in the short and long term, at the individual, group and societal levels. Thus, simultaneously processing these five registers of information to assess the risk is almost a difficult bet for the ordinary individual. This is the reason why people with a low level of education regularly resort to beliefs. This is also shown by the work of Powe (2001), Nguesta (2012), Shen et al (2009), Freeman (1989) for whom the level of education influences fatalistic beliefs and therefore risk-taking.

The results from the correlation and regression analysis confirm our second hypothesis. In other words, fatalistic beliefs that reflect a lack of control are linked to risk-taking related to barrier measures vis-à-vis the COVID-19 pandemic. These results confirm those of previous studies showing that fatalistic beliefs can have a negative effect on the achievement of safety-related actions and can reduce the motivation to engage in safety-related behaviors (Claassen et al. 2010; Kayani et al. 2012; Kouabenan 1998; Peltzer & Renner 2003;). For example, Kouabenan (1998) shows that fatalists generally tend to attribute road accidents to factors over which the driver has no control in order to minimize the role of factors involving initiatives on their part. For him, “fatalistic beliefs, which can lead to a weak sense of control over events, are likely to induce resignation and passivity with regard to measures of security and self-protection” (p. 339). Claassen et al. (2010) state that a fatalistic belief is a belief that risk is unavoidable and can “harm the motivation to engage in risk-reducing behavior” (p. 184). In other words, participants for whom the conviction that death is inevitable in the event of serious danger, will tend to neglect compliance with barrier measures. In the same logic, Straughan and Seow (1998) add that the perceived lack of internal control of the individual over the events of his life (external locus of control) promotes resignation and therefore neglect of compliance with security measures. The notions of fate, chance, perception of powerlessness, despair, insignificance are for this purpose elements on which the fatalists rely to emit a behavior (Chavez et al., 1997; Cohen & Nisbett, 1998 Davidson et al., 1992; Neff & Hoppe, 1993; Straughan & Seow, 1998).

For Powe and Johnson (1995), fatalistic individuals rely on fear, inevitable death, pessimism and predetermination in explaining the serious events that happen to them. In addition to these factors, Straughan and Seow (1998) add the perceived lack of the individual's internal control over life events (external locus of control). The notions of fate, luck, perception of powerlessness, despair, and insignificance will also be taken into account in the explanation of life events (Chavez, Hubbel, Mishra & Valdez, 1997; Cohen & Nisbett, 1998; Davidson, Frankel & Smith, 1992; Neff & Hoppe, 1993; Straughan & Seow, 1998).

The results obtained in this study can also be explained by reference to the theory of motivation for protection (Rogers, 1983). This theory shows that, in general, the effectiveness of a response minimizes the rejection of a protection message (Lewis et al., 2008). As a result, the lower the effectiveness of a perceived response (e.g. wearing a mask), the less individuals believe in the recommended conduct to overcome the threat and the more they adopt less safe behaviors. As a result, predetermination that leads to biases on participants' perception of the effectiveness of recommendations that suggest wearing a mask in public or washing hands regularly with soap to avoid or reduce the risk of COVID-19 contamination leads to non-compliance with barrier measures. This theory also suggests that self-efficacy is an important component capable of successfully stimulating behavior change. The stronger the individual's perceived self-efficacy, the more effort he will make to implement the recommended behavior (Bandura, 1977). It therefore turns out that the bias generated by predetermination is also noticeable on the participants' ability to comply with the recommendation that suggests wearing the mask in public or washing their hands regularly with soap. In addition, the HBM gives an important place to the beliefs of the individual in its adoption of preventive measures (Mvessomba et al., 2017). This theory holds that beliefs influence individuals whether or not to adopt security measures. Thus, luck that conveys the belief that life events are random, lucky or bad luck could have a detrimental influence on the adoption of safe driving. For Teigen (1998), luck increases in the individual who believes in it self-confidence and generates an illusion of control. The latter will minimize losses and overestimate gains when he has to engage in driving. The individual who believes in luck is the one who consciously engages in risky conduct and gets away with it. The latter will therefore associate the favourable outcome of the exposure to the risk with the behavior it has adopted. Luck thus increases self-confidence without increasing skills, which also amplifies reactions (Teigen, 1998). The individual who believes in luck will try to repeat the lucky action, but in addition he will do it with more confidence.

Several studies show that believing in luck or bad luck promotes an underestimation of risk and pushes individuals to adopt less safe behaviors (Kouabenan; 1998, 1999, 2006, 2009; Ngueusta, 2012; Peltzer & Renner, 2003). These authors show that individuals who believe that life events are a matter of chance, feel that they have control over happy events and that they do not have control over unfortunate events. A pessimistic individual on the other hand is one who has experienced several negative events in his life, he believes that these events are uncontrollable and that there is no point in protecting himself. We generally observe in the pessimist a form of resignation that will lead him not to believe in the effectiveness of the recommendations that aim to protect him. Referring to our results, it is therefore understandable why pessimistic participants do not believe in the effectiveness of the recommendation that suggests wearing the mask in public or washing hands regularly with soap to avoid or reduce the risk of COVID-19 contamination.

5 CONCLUSION

Going through the literature on issues relating to the consideration of compliance with safety measures, it is clear that many studies have looked at it while insisting on the need to adopt the prescribed behaviors in order to minimize complications, negative consequences and risk factors, of the disease. Overall, these studies show that perceptions related to disease are decisive in the health behaviors of populations and that their influence is often at the origin of non-compliance, which particularly affects compliance with safety measures in the event of a pandemic (Maercker et al., 2019). The results obtained in this work point in the same direction. They showed that the level of study influences the use of fatalistic beliefs and risk-taking on the one hand. On the other hand, they show that

fatalistic beliefs influence the respect of barrier measures in participants. The present work has therefore made it possible to highlight to some extent the place occupied not only by certain beliefs but also by the level of study in the adoption of safety behaviors. In particular, when an individual feels unable to act on events (mainly in those with a relatively low level of education), especially future ones regardless of the security measures he adopts, and this will have no impact on what should happen to him. The fatalist refuses the ability to deliberate on what will happen; he believes that even his own behavior does not depend on him (Mvessomba et al., 2017). This study offers important results in the field of prevention. It points out that, like previous studies, awareness related to hygiene or barrier measures is necessary but insufficient to trigger safety or protective behavior (Clayton et al. 2002; Kouabenan & Ngueutsa, 2016). It suggests improving the design of preventive measures oriented towards actions that take into account the beliefs of the target population. It is therefore important to design actions and messages aimed at generating beliefs not only in the effectiveness of preventive measures but also in the ability of populations to implement them. This could be done both by highlighting the effectiveness of security measures and by creating conditions for their implementation that requires less effort. Awareness programs must demonstrate to the public the effectiveness of preventive measures rather than simply enacting barrier measures.

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Being a confined teacher: Dealing with the psychological effects of confinement during the covid-19 outbreak and getting out of it

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ABSTRACT: The new coronavirus due to its rapid spread and its numerous victims represents a real public health problem and requires great resilience in individuals. Since then, confinement has been recommended or even imposed on populations despite the large literature on its negative psychological effects. The study explores the experience of confinement through its psychological consequences and the strategies that teachers adopt to improve their subjective well-being and get out of it. From a composite questionnaire administered online between April 30 and June 08, 2020, based on three tools, we measured perceived stress, anxiety and depression on 244 teachers. The results show that 66.0% of the participants experienced continuous stress during confinement compared to 56.5% who indicated a moderate/severe level of anxiety and 21.7% for a moderate/severe depression. Finally, they indicate that after being supplied with basic foodstuffs, the teachers engaged in learning activities during confinement. The study suggests the need for the adoption of reassuring communication, producing meaning in the eyes of third parties and stakeholders but also the need to keep contacts between teachers and learners/relatives by technological means.

KEYWORDS: Covid-19, stress, anxiety, depression, teachers, psychological effects.

1 INTRODUCTION

The majority of studies devoted to the psychological consequences of confinement during the major pandemics that the world has experienced have been carried out among general populations (Bhat et al., 2020; Caleo et al., 2018; Huang & Zhao, 2020; Zhang & Ma, 2020). Specifically, one part concerned different social groups, including survivors of victims (Desclaux et al., 2017; Kim et al., 2017), people at risk or presenting certain pathologies (Drain & Garrett, 2020; Jeong et al. 2017) and health workers (Greenberg et al., 2020). Another, smaller part has looked at the psychological effects of confinement on education in general (Akaba, 2020); on students (Cao et al., 2020; Duraku & Hoxha, 2020) or simultaneously on students and school administrative staff (Sahu, 2020). But few studies have evaluated the psychological consequences for teachers (Talidong & Toquero, 2020). However, they are the first category of social actors whose professional activity was suspended completely for a while during confinement. In Cameroon, their activities were entirely halted from March 17 to May 31, 2020. Apart from the minority that was involved in distance learning, the large majority remaining experienced a long period of professional inactivity. Furthermore, analysing Cameroonian responses to COVID-19 in the education sector, Béché (2020) has revealed that the Cameroonian education system is plagued by disorganisation, educational inequalities and exclusion – problems that affect learners' and teacher's daily lives on a personal level. This cannot be without consequences in terms of mental health.

The aim of this study is to understand the lived experience of this period of confinement via two objectives: evaluate the psychological consequences of confinement on teachers (1) and, identify the strategies they adopted to improve their subjective well-being and overcome these difficult events (2). Beyond what precedes, the choice to carry out such research on teachers is linked to the fact that teaching is presented in the literature as one of the service professions which leads to a high level of stress due to many psychosocial factors in the school milieu (Hafsi et al., 2017; Kyriacou, 2001; Lantheaume, 2011); but also to the fact that the teacher be described as the public service worker with the highest rate of psychological distress (Ilgan et al., 2015). It therefore seemed interesting to us to assess whether the stressful situation due to the teaching profession or milieu was relieved by the fact of no longer going to school in the Covid-19 period. In other words, assessing the level of psychological suffering of inactive teachers during confinement could help understand the effects of confinement during Covid-19 pandemic on teachers.

BRIEF CLARIFICATION OF SOME VOCABULARIES IN LINK WITH COVID-19

The history of the changing world is punctuated with major infectious diseases and epidemics: the accidental occurrence of a large number of cases of a transmissible infectious disease, or a considerable increase in the number of cases, in a given region or community; and pandemics: an epidemic that affects a large number of people over a very large geographical area. From the world's first plague epidemic between the 6th and 7th centuries until the Ebola epidemic in 2014, the loss of life has been inestimable (Bilmans, 2015). This is still the case today with the Covid-19. As the world approaches 1 million deaths from COVID-19, adding to the fact that two categories of disease are interacting within specific populations—infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and an array of non-communicable diseases, Horton (2020) argued that COVID-19 is not a pandemic but a syndemic. This concept is so far used to describe how COVID-19 clusters with pre-existing conditions, interacts with them and is driven by larger political, economic, and social factors (Singer et al., 2017). In case of epidemics, pandemics or syndemics, public policies have always been mobilized for responding to acute phenomena: detecting, isolating, quarantining, confining and, henceforth, vaccinating (Cambon et al., 2021).

In the case of a pandemic, isolation is one strategy among others which consists in isolating people suspected of being infected by a virus from the rest of the population to minimize contamination (Tecirli et al., 2020). This definition differs from quarantine which refers to the separation and restriction of movement of people who, although not yet confirmed sick, have been exposed to an infectious agent and who, therefore, are likely to become infectious themselves (Bilmans, 2015). However, the two terms are often used interchangeably, especially in communication with the public (Manuell & Cukor, 2011). The other strategy is confinement which consists of isolating people and families in order to limit the propagation of the virus (Hartley et al., 2020). It is the most efficient strategy to limit high risk of contamination in case of a pandemic. Isolation, quarantine and confinement are several public health measures to prevent the spread of an infectious disease. This is why Cameroonian teachers have been asked to confine themselves during the Covid-19 crisis despite its considerable psychological impact for those concerned (Brooks et al., 2020).

PSYCHOLOGICAL CONSEQUENCES OF CONFINEMENT ON TEACHERS

Studies on the effects of confinement are about four historic epidemics: SARS, MERS, Ebola and H1N1 influenza. These studies reveal that living in an epidemic context is not psychically neutral because a global epidemic is a traumatic event. Indeed, whether we are directly concerned or more from a distance because it directly confronts us with death, or at least with a threat of death (Thiébaux, 2020). At the very beginning of the Covid-19 spread, Brooks et al. (2020) carried a rapid review of evidence on the psychological impact of quarantine and how to reduce it. They found over 3166 papers and analysed 24 in their review. Most reviewed studies reported negative psychological effects including post-traumatic stress symptoms, confusion, and anger (Brooks et al., 2020). Beyond quarantine or confinement due to an epidemic, studies indicate that being forced to stay at home creates a context of "worry" (Soulet, 2005) and has negative psychological effects on the mental health of populations (Flahault, 2020). Meaning that this kind of event can generate a strong emotional charge very difficult to control, which can have many repercussions at the psychological level. Thus, several studies, while recognizing the efforts made by many States to stop the Covid-19 pandemic, recall that more schools will remain closed and that the duration of the confinement is extended, the negative consequences on the physical and mental health of the populations are accentuated (Deloche-Gaudez, 2020; Wang, G. et al., 2020). We can thus observe in populations emotional fatigue, sleep disorders, permanent concerns about the future, fear of others and of being contaminated, impaired judgment, mood disorders, the tendency to hypochondria (Thiébaux, 2020). Other reactions like fear, stress, depressive symptoms are mentioned by a lot of research (Rajkumar, 2020; Brooks et al., 2020). Mengin et al. (2020) mention the presence of addictive behaviours, eating and sleep disorders, the immediate and delayed risk of depression and suicide. Other stressors included longer quarantine duration, infection fears, frustration, boredom, inadequate supplies, inadequate information, financial loss, and stigma (Brooks et al., 2020).

Rubin (2020) has shown that putting an entire city under quarantine has negative psychological effects on populations. Moreover, studying the consequences of the closure of universities due to the new coronavirus outbreak on the education and mental health of students and academic staff, Sahu (2020) concludes that the rapid expansion of this disease creates doubt and anxiety among students and teachers about the future. He adds that the quarantine is potentially generating a very high level of stress within the university

community, including among the students. Baht et al. (2020) notes that 67.5% of the population of Kashmir recognize that confinement has been the source of psychological problems. Cao et al. (2020) assessed the psychological impact of Covid-19 on 7,143 Chinese college students. It appears that 0.9% of the respondents were experiencing severe anxiety, 2.7% moderate anxiety, and 21.3% mild anxiety. They also indicate that living in urban areas, family income stability and living with parents were protective factors against anxiety. In addition, emotions such as fear were reported by the press among English citizens during the confinement. This situation leads individuals to compare what was happening at the “end of the world”, not to mention the panic scenes reported in the city of Wuhan (Robin, 2020). Added to fear, is also a high level of anxiety. Indeed, confinement implies the absence or reduction of social contact, the loss of daily routines and the return to the monotony that are sources of boredom. Boredom combined with other factors are the causes of anxiety in individuals (Mengin et al., 2020).

COPING WITH AND RECOVERING FROM THE PSYCHOLOGICAL EFFECTS OF CONFINEMENT

Many researchers have suggested that during this period of confinement due to covid-19 a good organisation at the personal, family and community levels is key to reinforcing individual coping mechanisms. To this effect, the WHO (2020) has made several recommendations to improve on the psychological well-being of populations in general, as well as that of specific groups: health workers, children, the elderly and people in isolation. The following are recommended: reduce time spent watching television; protect oneself and protect others by respecting barrier measures and having a healthy lifestyle; create situations that provide positive emotions and allow you to keep hope; share the positive experiences of healed people; honour and encourage health workers who take care of people sick with Covid-19. Some of these strategies have also been identified by several authors (Deloche-Gaudez, 2020; Wang, G. et al., 2020).

Studying the reaction of Filipino teachers to anxiety during confinement due to Covid-19, Talidong and Toquero (2020) reveal that they have engaged in personal online learning, in exchanges with the community to reduce worry. According to literature review carried by Brooks and colleagues (2020), in situations where quarantine is deemed necessary, officials should quarantine individuals for no longer than required, provide a clear rationale for quarantine and information about protocols, and ensure sufficient supplies are provided. Appeals to altruism by reminding the public about the benefits of quarantine to wider society can be favourable.

2 METHOD

2.1 PARTICIPANTS

The study uses a quantitative approach based on the simple random sampling technique. Its involved 244 teachers, including 154 women and 90 men, chosen based on the following inclusion criteria: 1) having spent at least 14 days of confinement, 2) having been on duty in an educational institution at the time classes were interrupted on March 17, 2020, and 3) not having another job that would occupy them during the period of interruption. Thus, those of the trained teachers who were not yet practising before March 17 were excluded from the sample, as were those with less than 14 days of confinement. At the end, the participants (n = 244) were between 19 and 60 years old (M = 37.57; SD = 8.57). They came from the three classic cycles of education in Cameroon. The nursery / primary cycle with 41.4% (n = 101), the secondary with 49.6% (n = 121) and that of the higher education with 09% (n = 22). They were mostly from the public sector 79.5% (n = 194) than from the private 20.5% (n = 50). They lived more in the regional capitals for 86.9% (n = 212) than in the departmental capitals 13.1% (n = 32). In addition, teachers were in service in nine out of ten regions of Cameroon except for the South West. The most represented regions are: Centre 72.1% (n = 176), South 07% (n = 17) and Littoral 5.7% (n = 14) and Far North 5.3% (n = 13). Finally, 10 participants (4.1%) manifested coronavirus disease while 21 (8.6%) declared having had a neighbour or relative declared positive for Covid-19.

2.2 INSTRUMENTS

A questionnaire comprising of two open questions making it possible to obtain qualitative data on the strategies adopted by teachers to cope with the psychological effects of confinement and, three Likert-type scales making it possible to measure stress, anxiety and depression. We chose these questionnaires because they are among the most used tools in the literature to assess these psychological distress but also because there are adapted French versions. Those scales are: Perceived Stress Scale, Beck Depressive Inventory, and Generalized Anxiety Disorder -7.

Perceived Stress Scale [PSS] (Cohen et al., 1983). The French version of the PSS proposed by Quintard (1994) was used to measure perceived stress. Its 10 items allow you to measure the importance with which life situations are perceived as threatening. The participants responded by positioning themselves on a 5-point scale with 1 = Never; 2 = Almost never; 3 = Sometimes; 4 = Quite often and 5 = Often. The final score is obtained by adding the scores to the different items. A high score indicates high perceived stress, while a low score indicates low perceived stress.

Beck Depressive Inventory [BDI 13] (Beck & Beamesderfer, 1974). Translated into French by Collet and Cottraux (1986), the BDI-13 makes it possible to measure depressive cognitions by proposing, for each of the items (13 in total), a series of four statements representing increasing degrees of symptoms. For each series of the four propositions, you must read, then choose the one that best describes your condition during the last two weeks by encircling the number of the proposition. The overall score is obtained by adding the scores of the 13 questions. The higher the score, the more depressed the subject.

Generalized Anxiety Disorder -7 [GAD-7] (Spitzer et al., 2006). GAD-7 is a rapid, reliable, validated and relevant screening tool for the screening of generalized anxiety disorder. The GAD-7 scale is made up of the seven items marked with zero to three (0 = never; 1 = several days; 2 = more than half the time; 3 = almost every day, for the past two weeks). The total score is obtained by adding the score obtained for each item (score ranging from 0 to 21).

2.3 PROCEDURE

Data was collected indirectly and in digital form between april 30th and june 08th 2020. This strategy was adopted due to the restrictions imposed by Covid-19 pandemic. Also, according to Hohwü et al. (2013), this filling mode (Web-based questionnaires) could replace traditional paper questionnaires with minor effects on response rates and lower costs. After the questionnaire was designed, it was digitized using the Google Forms platform (<https://docs.google.com/forms/>) then distributed to Gmail, Yahoo mail and Hotmail mail systems; as well as through social networks such as WhatsApp and Facebook. In practice, some of the teachers addresses that we had were invited through electronic mail and the other party invited through the various WhatsApp, Telegram and Facebook forums dedicated to teachers. The data does not, however, make it possible to specify the proportion of teachers in the sample who actually responded by messaging from those who responded through social networks.

Before the distribution of the final version, a pre-test was carried out with about twenty teachers, to verify the understanding of the items constituting the different scales. The Cronbach internal consistency index alpha (α) of the different scales was calculated: PSS ($\alpha = 0.72$); BDI-13 ($\alpha = 0.85$) and GAD-7 ($\alpha = 0.91$). The extracted quantitative data was exploited under SPSS 20.0, while the qualitative data was analysed using the technique of content analysis. The qualitative material comes from two open questions contained in our questionnaire, the purpose of which is to identify the strategies put in place by our participants to deal with the psychological effects of confinement. It concerns 30 participants drawn at random from among the 86 who fully completed these two questions: only criterion for inclusion.

ETHICAL CONSIDERATIONS

Prior to administering the questionnaire to participants, they were reassured that all information they provide will be kept confidential, and shall only be used for the purpose of the study. They were also informed that their participation is voluntary and free of any charges. Furthermore, they were informed they could withdraw from the study at any time they wished.

3 RESULTS

3.1 PSYCHOLOGICAL CONSEQUENCES OF CONFINEMENT AMONG TEACHERS

Only the psychological consequences most frequently observed in times of crisis and more evaluated by different authors were considered (Fardin, 2020; Desclaux et al. 2017; Hawryluck et al., 2004). These are stress, anxiety and depression.

STRESS AMONG CAMEROONIAN TEACHERS DURING CONFINEMENT DUE TO COVID-19 OUTBREAK

Stress is a normal physiological response to an abnormal situation allowing an organism to adapt to the multiple positive or negative events that it experiences. Stress appears and disappears on its own, depending on whether or not one is in the presence of stressors (Québec.ca, 2020, www.quebec.ca/). Extended exposure to stressors makes stress chronic and harmful to health. In our study, 11.1% of participants were able to cope with stress during confinement versus 89.9% who suffered from it, with 66.0% who suffered from it throughout confinement. In addition, effects of the number of confinement days is not significant $F(2, 241) = 1.106, p = 0.333$. While the effect of the educational cycle on the level of perceived stress is significant $F(2, 241) = 5.03, p = 0.007$. Primary school teachers suffered the most from stress than secondary and university lecturers. However, there is no significant difference between those in secondary and higher education lecturers according to the Tukey's multiple comparison test.

Table 1. Different stress thresholds depending on certain characteristics of the participants

Variables	Stress level n (%)			P
	Mild	Moderate	Severe	
Gender				
Male (n =90; M =28.43; SD =6.53)	11 (4.5)	17 (7.0)	62 (25.4)	.652
Female (n =154; M =28.87; SD =7.67)	16 (6.6)	39 (16.0)	99 (40.6)	
Order of education				
Public (n =194; M =28.30; SD =7.18)	20 (8.2)	51 (20.9)	123 (50.4)	.087
Private (n = 50; M =30.28; SD =7.43)	7 (2.9)	5 (2.0)	38 (15.6)	
City/Town of Residence				
Region (n = 212; M =29.17, SD = 6.82)	16 (6.6)	53 (21.7)	143 (58.6)	.009
Department (n =32; M =25.59, SD = 9.23)	11 (4.5)	3 (1.2)	18 (7.4)	
Confinement habit				
Yes (n = 153; M =27.87, SD = 7.74)	23 (9.4)	38 (15.6)	92 (37.7)	.02
No (n = 91; M =30.10, SD = 6.16)	4 (1.6)	18 (7.4)	69 (28.3)	
Sick of Covid-19				
Yes (n =10; M =21.40, SD = 10.97)	5 (2.0)	0 (0.0)	5 (2.0)	<.001
No (n =234; M =29.02, SD = 06.93)	22 (9.0)	56 (23.0)	156 (63.9)	
Affected loved one/ neighbour				
Yes (n =21; M =32.52, SD= 5.57)	1 (0.4)	1 (0.4)	19 (7.8)	.012
No (n =223; M =28.34, SD = 7.31)	26 (10.7)	55 (22.5)	142 (58.2)	

Note. M: average; SD: standard deviation; n: sample; p: critical probability

ANXIETY AMONG CAMEROONIAN TEACHERS DURING CONFINEMENT DUE TO COVID-19 OUTBREAK

Unlike fear, which is a response to a definite and very real threat, anxiety is a response to a vague or unknown threat. Anxiety manifests itself when we believe that a dangerous or unfortunate event can occur and we anticipate it. Perception of the event has a great influence on the intensity of the anxiety experienced (Québec.ca, 2020; www.quebec.ca/).

Table 2. Different anxiety thresholds depending on certain characteristics of the participants

Variables	Anxiety level n (%)				P
	Absence	Mild	Moderate	Severe	
Gender					
Male (n =90; M =10.43; SD =6.07)	20 (8.2)	20 (8.2)	23 (9.4)	27 (11.1)	.855
Female (n =154; M =10.58; SD =6.14)	29 (11.9)	37 (15.2)	40 (16.4)	48 (19.7)	
Order of education					
Public (n =194; M =10.13; SD =6.09)	41 (16.8)	51 (20.9)	43 (17.6)	59 (24.2)	.052
Private (n = 50; M =12.02; SD =5.95)	8 (3.3)	6 (2.5)	20 (8.2)	16 (6.6)	
City/Town of Residence					
Region (n = 212; M =10.67; SD =5.88)	37 (15.2)	54 (22.1)	54 (22.1)	67 (27.5)	.323
Department (n =32; M =9.53; SD = 7.42)	12 (4.9)	3 (1.2)	9 (3.7)	8 (3.3)	
Confinement habit					
Yes (n = 153; M =9.59, SD = 6.27)	40 (16.4)	39 (16.0)	33 (13.5)	41 (16.8)	.002
No (n = 91; M =12.11, SD = 5.48)	9 (3.7)	18 (7.4)	30 (12.3)	34 (13.9)	
Sick of Covid-19					
Yes (n =10; M =7.60; SD =8.42)	5 (2.0)	1 (0.4)	0 (0.0)	4 (1.6)	.122
No (n =234; M =10.65; SD =5.97)	44 (18.0)	56 (23.0)	63 (25.8)	71 (29.1)	
Affected loved one/ neighbour					
Yes (n =21; M =13.47, SD = 6.38)	3 (1.2)	2 (0.8)	3 (1.2)	13 (5.3)	.02
No (n =223; M =10.24, SD = 6.01)	46 (18.9)	55 (22.5)	60 (24.6)	62 (25.4)	

Note. M: average; SD: standard deviation; n: sample; p: critical probability

Overall, 20.1% of the participants showed no signs of anxiety, against 79.9% who showed at least one sign and in the following proportions: 30.7% severe anxiety; 25.8% moderate anxiety and 23.4% mild anxiety. In addition, there is a significant effect of the educational cycle on anxiety, $F(2,240) = 6.47, p = 0.002$. Once again, primary school teachers were more anxious than secondary school teachers.

DEPRESSION AMONG CAMEROONIAN TEACHERS DURING LOCKDOWN DUE TO COVID-19 OUTBREAK

The Québec.ca site (2020, www.quebec.ca/) indicates that depression is a temporary state of weariness, discouragement and sadness that can manifest itself in different ways, both physically and psychologically. Its intensity varies from one person to another. More than half (54.5%) of the participants showed no signs of depression. Furthermore, we do not observe any effect of the number of days of confinement on anxiety, even if this effect is significant with the teaching cycle on depression, $F(2,237) = 3.54, p = 0.03$. However, the level of mild depression is expressed in 22.9% against 15% for moderate depression and 6.7% for severe depression.

Table 3. Different depression thresholds depending on certain characteristics of the participants

Variables	Depression level n (%)				P
	Absence	Mild	Moderate	Severe	
Gender					
Male ($n=89; M=4.25; SD=5.18$)	57 (23.8)	13 (5.4)	14 (5.8)	5 (2.1)	.232
Female ($n=151; M=5.13; SD=5.61$)	76 (31.7)	42 (17.5)	22 (9.2)	11 (4.6)	
Order of education					
Public ($n=190; M=4.46; SD=5.15$)	109 (45.4)	46 (19.2)	25 (10.4)	10 (4.2)	.056
Private ($n=50; M=6.12; SD=6.40$)	24 (10.0)	9 (3.8)	11 (4.6)	6 (2.5)	
City/Town of Residence					
Region ($n=209; M=5.06; SD=5.65$)	114 (47.5)	47 (19.6)	32 (13.3)	16 (6.7)	.061
Department ($n=31; M=3.09; SD=3.55$)	19 (7.9)	8 (3.3)	4 (1.7)	0 (0.0)	
Confinement Habit					
Yes ($n=149; M=4.37; SD=5.33$)	87 (36.2)	35 (14.6)	20 (8.3)	7 (2.9)	.117
No ($n=91; M=5.51; SD=5.62$)	46 (19.2)	20 (8.3)	16 (6.7)	9 (3.8)	
Sick of Covid-19					
Yes ($n=10; M=1.10, SD=1.59$)	9 (3.8)	1 (0.4)	0 (0.0)	0 (0.0)	0.28
No ($n=230; M=4.96, SD=5.51$)	124 (51.7)	54 (22.5)	36 (15.0)	16 (6.7)	
Affected loved one/neighbor					
Yes ($n=20; M=5.65; SD=5.13$)	9 (3.8)	8 (3.3)	1 (0.4)	2 (0.8)	.473
No ($n=220; M=4.73; SD=5.49$)	124 (51.7)	47 (19.6)	35 (14.6)	14 (5.8)	

Note. M: average; SD: standard deviation; n: sample; p: critical probability

3.2 COPING WITH PSYCHOLOGICAL EFFECTS DURING CONFINEMENT

Participants relied on different organizational modalities and on a variety of social, personal and spiritual factors to maintain a positive attitude during confinement. The descriptive analysis of the participants' speech indicates that 10.46% did not set up any particular organisation strategy during the lockdown. They were living as they did before the outbreak of the Covid-19 pandemic. In contrast, out of 90% of participants who took steps to ensure proper containment, the organisation consisted of four major activities. First, the provision of essential food and protective equipment such as a first aid kit, hydro-alcoholic gel and protective masks; with 27.78% of the indicators. Secondly, through learning activities (47.19%). In this strategy, university research comes first with 19.41%, followed by learning assistance to children (13.89%) and teachers' auto-didactic activities (13.89%). Thirdly, leisure activities and finally distance learning with respectively 11.11% and 8.33% of organisational indicators. Some have moved to rural areas to avoid the psychological effects of Covid-19.

4 DISCUSSION

Confinement has undeniable effects on the psychological well-being of those who are confronted with it. In the event of a pandemic, these effects are noticeable before, during and sometimes persist for several years (Jeong et al., 2016).

4.1 PSYCHOLOGICAL CONSEQUENCES OF CONFINEMENT AMONG TEACHERS

Our results show that from the announcement of the government decision marking the start of confinement, its modalities and duration, Cameroonian teachers experienced mixed emotional reactions including those with a positive connotation: joy, feeling of relief. The negative emotional reactions were mainly those of worry, fear, doubt, etc. These contrasting reactions would testify to the diversity of possible reactions to such a situation (Thiébaux, 2020). Moreover, these first negative psychological manifestations reflect the presence of a real or imminent threat. While it could not be associated with the confinement, it could still be understood. Because any pandemic period is potentially traumatic (Hartley et al., 2020), whether one is directly concerned or not (Thiébaux, 2020). The pandemic which first broke out in China and spread through Europe, sparked great worry when a first case of covid-19 was reported in Africa. The announcement of the start of confinement is thus seen as the beginning of a real ambiguous adventure (Kane, 1961) since all the experts predicted the worst for Africa (WHO, 2020; www.who.int/). Others then called for a reaction of solidarity for Africa and favelas (Cattacin, 2020; Nkengasong & Mankoula, 2020). Some of our participants, while finding relief from this decision setting the start of confinement, discreetly allows one to see that they were already in psychological distress by the general disease situation around the world. Therefore, the government's communication reassured teachers and helped them give sense to the situation (Soulet, 2005).

The academic level of our participants was deduced from their recruitment diploma. Contrasting studies emphasize that the level of education is not associated with psychological effects during confinement (Hawryluck et al., 2004; Zhang & Ma, 2020); our analysis rather suggests that the level of education (inferred from the educational cycle) is significantly associated with the psychological consequences during confinement. In fact, primary school teachers were more exposed to stress, anxiety and depression than their high school and college colleagues. Thus, if the interruption of primary school classes marked the end of any intellectual activity that could occupy a significant part of these teachers' time, this was not the case for secondary school teachers and even more so for those in higher education who have research and supervision as a complementary activity to teaching. Primary school teachers can therefore suffer from social isolation due to the feeling of loneliness, boredom resulting from the loss of daily routines (Deloche-Gaudez, 2020; Mengin et al., 2020). Research and research supervision constitute a source of activity during confinement for higher education teachers and justifies their relatively good mental health. However, the fact that secondary school teachers have a better mental health state compared to primary school teachers appears complex to understand.

Regarding stress, the results of this study show that the period of confinement was experienced with more difficulty for nearly 57% of participants. Specifically, 89.9% of our participants suffered from stress, with 66.0% throughout the confinement period. Other studies have reported very low numbers between 2% to 30% of the population for the levels: mild, moderate and severe (Cao et al., 2020; Zhang & Ma, 2020). Our conclusions are however very close to the 53.8% obtained from the Chinese population two weeks after the outbreak of the pandemic (Wang, C. et al., 2020). A few months after the Ebola crisis in West Africa, 76.4% of survivors were still suffering from stress (Jalloh et al., 2018). The very high stress scores obtained on the African continent are said to be due to the abundant communication around the small capacity of African countries to face major health crises (Cattacin, 2020; WHO, 2020; www.who.int/) and even the image of a "starving Third World" Africa conveyed for decades (Dumont, 1965, cited by Pumain, 2020). Africans would thus feel confronted with death or a death threat when an epidemic or pandemic is declared on their territory (Thiébaux, 2020).

Concerning anxiety, with the onset of the pandemic and the start of confinement, citizens' habits changed significantly. These changes, combined with other factors, are likely to generate anxiety symptoms or even establish disorders (Mengin et al., 2020). Our initial results show that 20.1% of the participants showed no signs of anxiety while 23.4% had a mild level of anxiety. 56.5% of the participants showed moderate/severe levels of anxiety. This proportion is close to the 48.6% obtained in Sierra Leone a few months after the Ebola crisis (Jalloh et al., 2018); but also, the 47.2% obtained during isolation due to Middle East Respiratory Syndrome (Jeong et al., 2016). On the other hand, this threshold is twice as high as the 33.6% (moderate/severe anxiety) reported in Hong Kong during the SARS-CoV-1 epidemic (Chan et al., 2007) and three times greater than the 23.8% reported in Great Britain during H1N1 influenza (Rubin et al., 2009). Our higher score is justified by the fact that the Covid-19 crisis was managed with much more difficulties than previous crises like that of SARS in 2003 (Fardin, 2020) which would have raised the worry threshold. It should also be noted that the number of days of confinement noted in these studies is relatively low (between 5 and 21 days) compared to that of our study (between 15 and 80 days). The duration of the confinement would justify that the participants had a high level of anxiety (Deloche-Gaudez, 2020). In this same perspective, several studies recommend not extending the confinement period for a long time to optimize the mental well-being of citizens (Ozamiz-Etxebarria et al., 2020; Wang, G. et al., 2020).

Concerning depression, 22.9% of the participants had mild levels of depression, compared to 15.0% for moderate levels and 6.7% for severe levels. Wang, C. et al. (2020) report similar proportions: 12.2% for moderate depression and 4.3%, severe/extreme depression. Our results are also close to 12.3% obtained in Hong Kong during the SARS-CoV-1 epidemic (Lee et al., 2006). These values are low compared to the 48.6% obtained a few months after the Ebola epidemic in Siéra Leone (Jalloh et al., 2018). Our thresholds would be linked to the multiplication of cases of coronavirus declared in Cameroon towards the end of March. After the identification of the first case on March 06, 2020, the curve rapidly rose to 529 cases two months later. The country then occupies third place in terms of

contamination in Africa after Algeria, Burkina Faso (www.afro.who.int/). Awareness of the reality of the threat due to Covid-19 would explain the lack of interest from participants. This is because, at the onset of the disease in China, not everyone took the threat of the disease seriously. With the arrival of the first cases and the start of confinement, people began to perceive the effects of monotony (Ozamiz-Etxebarria et al., 2020). The information shared on social networks and some official media could help understand this threshold for the expression of depressive symptoms. Indeed, information on the invulnerability of Africans to coronaviruses, the project to test an anti-covid-19 test on Africans had gone viral on social networks and certain international media. This type of information only keep populations in anxiety. Finally, our study reveals that age is not significantly associated with the expression of depressive symptoms. Gender was not determinant in the manifestation of depressive symptoms in our participants. These observations are supported by the conclusions of Huang and Zhao (2020).

4.2 STRATEGIES USED BY TEACHERS TO COPE WITH AND COPE WITH PSYCHOLOGICAL EFFECTS

Faced with any exotic and little-known situation such as that of the novel coronavirus, individuals develop various coping strategies. The descriptive analysis of the participants' speech indicates that nearly 90% of the participants took measures to reduce the psychological discomfort. Firstly, the provision of essential food and protective equipment such as hydro-alcoholic gel and protective masks. This attitude is in line with WHO recommendations (2020; www.who.int/) on the need to maintain a healthy lifestyle if one is called to stay at home during confinement. This includes: a suitable diet, regular exercise and above all maintaining social contact with loved ones by email or phone. Brooks et al. (2020) recognized that the provision of essential materials is fundamental to cope with the effects of containment. Only, this should be done before the start of confinement and a conservation plan must be made including relocation plans to avoid any surprises.

Secondly, come the learning activities (47.19%). In this strategy, university research comes first with 19.41%, followed by learning assistance to children (13.89%) and teachers' auto-didactic activities (13.89%). These teacher's activities thus contribute to maintaining a daily rhythm of activity. Just like leisure activities and distance learning. Sahu (2020) recognizes the importance and necessity of the establishment of online education by academic authorities as an effective strategy against the psychological effects of confinement due to the spread of the coronavirus. The Swiss Federation of Psychologists (SFP) recognizes that confinement is a burdensome situation that one should be lived without stress. To arrive at that, she says that the education of children or the resolution of conflicts between spouses should not be put forward. However, one must keep their usual daily routine activities and plan with precision the time slots dedicated to school time and leisure (www.psychologie.ch/fr/).

5 CONCLUSION

Our research aimed to understand the experience of confinement, its psychological consequences on Cameroonian teachers and the strategies they put in place to deal with it and get out of it. It appears that teachers suffered psychically during the period of confinement due to the new coronavirus. Stress appears to be the first psychological consequence, followed by anxiety and finally depression. Lack of appropriate information, over-information, the image of an incapable Africa and unrestricted information shared by traditional and new media could justify this high propensity for psychological suffering. In addition, to cope and improve their subjective well-being, teachers followed the recommendations of the WHO and mental health experts, by providing themselves with food supplies, and also by getting versed with distance education activities during confinement. The results of this study suggest continuing research on the psychological effects of confinement on teachers using a larger sample, to have an in-depth understanding of their experience of confinement, to identify the psychosocial factors associated with the psychological consequences, to implement methods of psychological intervention for them.

AUTHORS' CONTRIBUTIONS

SOH Gustave, conceptualization and background. TACHOM WAFFO Boris, methodology. WAMBA André, conceptualization and conclusion. SAAH Handson KEWIHNU, discussion. TAGNE NOSSI Alain, literature review and final draft. All authors have read and approved the final version of the manuscript.

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Abondance et richesse des culicidés dans l'arrondissement communale Niamey V (Niger)

[Abundance and richness of culicidae in the Niamey V communal district (Niger)]

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ABSTRACT: Throughout the year, the population of the right bank (Niamey) is confronted with the diseases and nuisances of culicidae. This study aims to make a systematic inventory of mosquitoes, to study their abundance and their specific richness. Mosquito larvae were collected using the dipping method, over the period July 2021 to June 2022, in Lake Lamordé and the rice fields of Kirkissoy. Stage three and four larvae were sorted and deposited in transparent tubs containing bedding water and fed. Emerged mosquitoes were counted, identified morphologically with a binocular loupe and a culicid identification key. During this study, 3947 larvae were collected of which 3033 evolved to the adult stage, i.e. an emergence rate of 76.84%. The genus *Anopheles* is more abundant in the lake (n=1238). In the rice fields, the genus *Culex* dominated (n=402). Statistical analysis showed that the mosquitoes were not evenly distributed in space and time. The taxonomic study identified 11 genera and species at the two sites. These were *Anopheles gambiae*, *Anopheles pharaonsis*, *Anopheles squamosus*, *Anopheles rufipes*, *Anopheles nili*, *Anopheles funestus*, *Culex tritaenyoehinchus*, *Culex decens*, *Culex aurentapex*, *Culex quinquefasciatus* and *Aedes aegypti*. These results show that mosquitoes proliferate over a long period of the year and that appropriate control measures must be taken to prevent diseases and avoid nuisance caused by them.

KEYWORDS: Culicidae, abundance, genus, collection, larva.

RESUME: Tout au long de l'année, la population de la rive droite (Niamey) est confrontée aux maladies et aux nuisances des culicidés. Cette étude vise à faire un inventaire systématique des moustiques, d'étudier leur abondance et leur richesse spécifique. Des larves de moustiques ont été collectées par la méthode de dipping, sur la période allant de juillet 2021 à juin 2022, dans le lac de Lamordé et les rizières de Kirkissoy. Les larves du stade trois et quatre ont été triées et déposées dans des bacs transparents contenant de l'eau du gîte et nourries. Les moustiques émergés ont été dénombrés, identifiés morphologiquement avec une loupe binoculaire et une clé d'identification des culicidés. Au cours de cette étude, 3947 larves ont été collectées dont 3033 ont évolué jusqu'au stade adulte soit un taux d'émergence de 76,84%. Le genre *Anophèles* est plus abondant dans le lac (n=1238). Au niveau des rizières, c'est le genre *Culex* qui a dominé (n=402). L'analyse statistique a montré que les moustiques ne sont pas repartis de façon équitable dans l'espace et dans le temps. L'étude taxonomique a permis d'identifier 11 genres et espèces au niveau des deux sites. Il s'agit de *Anophèles gambiae*, *Anophèles pharaonsis*, *Anophèles squamosus*, *Anophèles rufipes*, *Anophèles nili*, *Anophèles funestus*, *Culex tritaenyoehinchus*, *Culex decens*, *Culex aurentapex*, *Culex quinquefasciatus* et *Aedes aegypti*. Ces résultats montrent que les moustiques prolifèrent sur une longue période de l'année et que des mesures de lutte appropriées doivent être prises pour prévenir les maladies et d'éviter nuisances occasionnées par ces deniers.

MOTS-CLEFS: Culicidés, abondance, genre, collecte, larve.

1 INTRODUCTION

Du fait de leur grande amplitude écologique et de leur mode de dispersion, les moustiques ont colonisé tous les milieux, de l'équateur aux cercles polaires. Le milieu tropical chaud et humide, très propice à leur pullulation, est le plus marqué par l'abondance et la diversité de la faune culicidienne [1]. Les culicidae communément appelés « moustique » comprennent environ 3622 espèces dont 500 *Anophèles* [2]. La relation entre l'homme et le moustique a depuis l'origine été tendue, chacun étant une menace pour la survie de l'autre [1]. Les moustiques font l'objet d'intenses recherches dès la fin du 19^e siècle après qu'ils aient été formellement impliqués dans la transmission des agents de la fièvre jaune du paludisme et de la filariose de Bancroft [3]. Les espèces de moustiques piquant l'Homme sont les plus étudiées, mais les espèces présentant peu ou pas de contact avec les humains ont aussi fait l'objet d'études pour leur intérêt vétérinaire ou pour mieux comprendre leur écologie [4].

Dans la région sahéenne, les gîtes larvaires de moustiques suivent étroitement la hauteur des pluies. Le pic de multiplication des gîtes s'observe avec le pic des précipitations. Quand la pluie se fait rare, les petites surfaces d'eau disparaissent rapidement du fait de l'évapotranspiration sous le soleil accablant du sahel [5]. La juxtaposition des espaces résidentiels et agricoles, la domiciliation du bétail et la gestion inappropriée des eaux usées domestiques sont sources de pullulement des moustiques au sein des habitations [1].

Sur la rive droite du fleuve Niger, les conditions naturelles et socio-économiques sont favorables à la prolifération des moustiques. Tout au long de l'année, la nuisance des moustiques s'observe de façon continue mais a de degrés variables. Pendant la saison pluvieuse, la population de la ville de Niamey en général et celle de la rive droite en particulier voient leur sommeil perturbé par la nuisance des moustiques notamment le bruit et les piqûres.

Cette prolifération massive de moustiques suscite de connaître les différentes espèces responsables de la nuisance et de la transmission des maladies. Pour aboutir à cette fin, des larves de moustiques ont été collectées et élevés au laboratoire jusqu'à émergences des moustiques adultes. Par la suite, ces moustiques ont été identifiés à l'aide des clés spécifiques aux moustiques de la région africaine. Ceci pour dresser un inventaire systématique des moustiques, d'étudier leur abondance et leur richesse spécifique au niveau de cette localité.

2 MATÉRIEL ET MÉTHODES

2.1 ZONE D'ÉTUDE

Cette étude a été menée au cours de la période allant de juillet 2021 à juin 2022 au niveau l'arrondissement communal Niamey V (Niger). Cette zone est séparée de la ville par le fleuve Niger et regorge la quasi-totalité des rizières de la ville.

Deux sites ont été prospectés durant 12 mois du fait de leurs position géographique, la disponibilité de l'eau dans les gîtes larvaires. Il s'agit de la zone rizicole de Kirkissoye et la zone du lac à Lamordé [6].

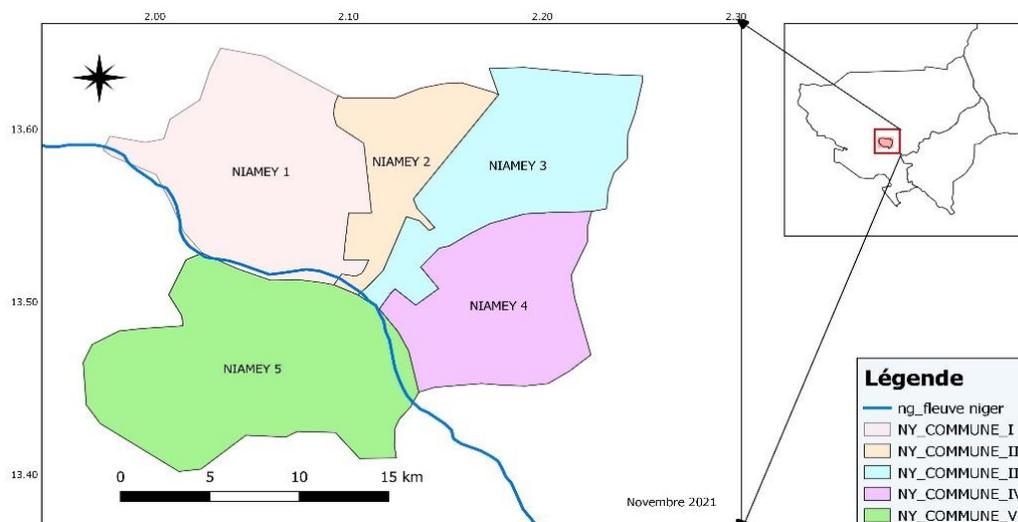


Fig. 1. Zone d'étude

2.2 ECHANTILLONNAGE

Au cours de cette étude, deux sites renfermant des gîtes larvaires ont été prospectés. Ces gîtes ont été choisis du fait de la disponibilité de l'eau et aussi de leur situation périphérique pour la zone I (site de kirkisoy) et centre-ville zone II (site de lamordé). Les larves ont été collectées dans la première moitié de chaque mois avec un rythme bimensuel. Les larves sont collectées à l'aide d'une louche d'une capacité de 100ml par la méthode de "Dipping" [7]. Elles ont été tamisées et déposées dans un seau en plastique transparent contenant de l'eau du gîte.

Pour avoir une hétérogénéité de données, les mêmes méthodes et outils sont utilisés lors de la collecte et du traitement. Ces larves sont traitées et élevées jusqu'à émergence au laboratoire d'entomologie de la Faculté de Sciences et Technique de l'Université Abdou Moumouni de Niamey.

2.3 ELEVAGE DES MOUSTIQUES

Les larves L3 et L4 de *Culex* et *Anophèles* ont été triées à l'aide d'une pipette pasteur et déposées séparément dans des bacs en plastiques transparents contenant de l'eau du gîte. Ces larves ont été conservées et nourries à l'aide de la croquette de chat. Les nymphes ont été triées et séparées des larves chaque matin et déposées dans des boîtes contenant de l'eau du gîte. Ces nymphes ont été conservées dans des cages conçues à l'aide de tulles moustiquaire jusqu'à émergence des moustiques adultes.

2.4 IDENTIFICATION DES MOUSTIQUES

L'identification morphologique a été réalisée sur des spécimens morts, à l'aide d'une loupe binoculaire et de la clé d'identification de moustiques [8].

2.5 ANALYSE DES RÉSULTATS

L'analyse des données a été réalisée par le calcul des indices écologiques (composition et structure de la population des moustiques) et des méthodes statistiques. La richesse spécifique (S) et l'abondance relative ($\pi_i = n_i/N$ où n_i = effectif de l'espèce de rang i , N = effectif total) de chaque espèce ont été déterminés par la méthode de [9].

L'indice de Simpson ($1/S \sum \pi_i^2$) nous a permis d'exprimer la diversité; l'équitabilité ($E_s = 1/S$) nous a permis de définir l'équipartition des effectifs entre les espèces présentes. Le degré de similarité des communautés a été exprimé par l'indice de Sorensen ($2c/a+b$) où a = nombre d'espèces du site 1, b = nombre d'espèces du site 2, c = nombre d'espèces communes aux deux sites) [9].

Le test de corrélation de Pearson a été utilisé pour évaluer les relations entre les larves de moustiques et les facteurs climatique.

3 RESULTATS

3.1 INDICES ÉCOLOGIQUES

3.1.1 RICHESSE SPÉCIFIQUE

Au cours de cette étude, nous avons noté la présence de 11 espèces de Culicidés dans les deux sites (Rivière et rizières de l'arrondissement communal Niamey V). Les espèces identifiées sont réparties en deux sous-familles (Culicinae et Anophelinae) et à trois genres (*Culex*, *Aedes* et *Anophèles*). Il s'agit de: *Anophèles gambiae*, *Anophèles pharaonsis*, *Anophèles squamosus*, *Anophèles rufipes*, *Anophèles nili*, *Anophèles funestus*, *Culex tritaenychinthus*, *Culex decens*, *Culex aurentapex*, *Culex quinquefasciatus* et *Aedes aegypti*.

Sept (7) espèces ont été collectées dans les gîtes de la rivière de lamordé. Il s'agit de: *Anophèles gambiae*, *Anophèles pharaonsis*, *Anophèles squamosus*, *Anophèles rufipes*, *Culex tritaenychinthus*, *Culex decens* et *Culex quinquefasciatus*. Toutes les espèces identifier dans cette étude ont été collectées dans les gîtes des rizières de Kirkisoy (tableau 1). Par ailleurs, le test de normalité effectué sur les larves collectées indique que la différence est fortement significative $P < 0,05$.

Tableau 1. Richesse spécifique des culicidés

Sous-famille	Genre	Espèce	Richesse spécifique (S) Site1	Richesse spécifique (S) Site2	Richesse spécifique (S) Total	Richesse moyenne (S')
Anophelinae	<i>Anophèles</i>	<i>Gambiae</i>	X	X	X	126,92
	<i>Anophèles</i>	<i>Pharaonsis</i>	X	X	X	41,83
	<i>Anophèles</i>	<i>Funestus</i>	X	0	X	10,4
	<i>Anophèles</i>	<i>Nili</i>	X	0	X	1,58
	<i>Anophèles</i>	<i>Squamosus</i>	X	X	X	16,92
	<i>Anophèles</i>	<i>Rufipest</i>	X	X	X	0,08
Culicinae	<i>Culex</i>	<i>Aurantapex</i>	X	0	X	5,42
	<i>Culex</i>	<i>Decens</i>	X	X	X	30,92
	<i>Culex</i>	<i>Tritaeniorhynchus</i>	X	X	X	11,58
	<i>Culex</i>	<i>Quinquefasciatus</i>	X	X	X	6,42
	<i>Aedes</i>	<i>Aegypti</i>	X	0	X	0,67
			11	7	11	

X/0: présence, absence de l'espèce; S: richesse spécifique; S': richesse moyenne

3.1.2 ABONDANCE RELATIVE

Durant notre étude, 3947 larves de moustique ont été collectées et 3033 larves ont évolué jusqu'au stade adulte soit un taux d'émergence de 76,84%. Les *Anophèles* représentent 78% de l'ensemble des moustiques ayant atteint le stade adulte, soit plus du double de la proportion des Culicinae ayant émergé. *Anophèles gambiae* (n=1523) est l'espèce la plus abondante (tableau 2).

Tableau 2. Abondance relative des culicidés

Genres	Espèces	Site1	Site2	Total	Pourcentage
<i>Anophèles</i>	<i>Gambiae</i>	669	854	1523	50%
<i>Anophèles</i>	<i>Pharaonsis</i>	251	251	502	17%
<i>Anophèles</i>	<i>Funestus</i>	125	0	125	4%
<i>Anophèles</i>	<i>Nili</i>	19	0	19	1%
<i>Anophèles</i>	<i>Squamosus</i>	70	133	203	7%
<i>Anophèles</i>	<i>Rufipes</i>	1	0	1	0%
TOTAL				2373	78%
<i>Culex</i>	<i>Aurantapex</i>	65	0	65	2%
<i>Culex</i>	<i>Decens</i>	246	125	371	12%
<i>Culex</i>	<i>Tritaeniorhynchus</i>	83	56	139	5%
<i>Culex</i>	<i>Quinquefasciatus</i>	8	69	77	3%
<i>Aedes</i>	<i>Aegypti</i>	8	0	8	0%
TOTAL				660	22%

3.1.3 FRÉQUENCE D'OCCURRENCE

Les onze espèces de moustiques retrouvés au cours de cette étude sont réparties dans des gîtes larvaires divers. Ainsi la fréquence d'occurrence calculé par espèce montre qu'il existe un rapport étroit entre l'occupation du gîte et l'espèce en question. L'exploitation de la figure 2 nous montre que *An. gambiae*, *An. pharaonsis*, *C. decens* et *C. tritaeniorhynchus* sont des espèces du premier groupe au niveau des gîtes prospectés. *An. squamosus*, *C. aurentapex* et *C. quinquefasciatus* sont des espèces du second ordre. Les autres espèces de moustiques retrouvés sont des espèces accidentelles.

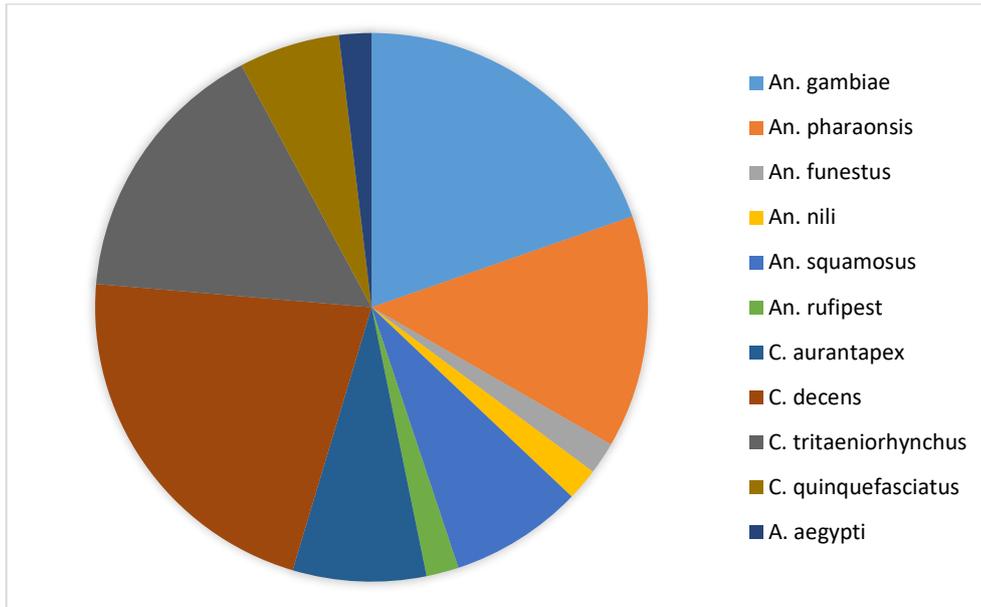


Fig. 2. Fréquences d'occurrences des moustique identifiés

3.1.4 VARIATION DU NOMBRE DES LARVES EN FONCTION DES FACTEURS CLIMATIQUES

Les données climatiques utilisés dans cette étude sont fournies par la station météorologique: 610520 (DRRN). Les températures les plus élevés sont enregistré durant la saison des pluies et de soudure. Les précipitations sont enregistrées au cours des mois de juillet, août, septembre et octobre. Le pic des précipitations est atteint au mois d'août (210,81 mm). La température moyenne est de 30,45°C. L'amplitude thermique est de 35,2°C et la somme des précipitations est de 479,81 mm figure 3.

Par ailleurs, le nombre des larves collectées varie en fonction des facteurs climatique à savoir l'humidité relative, la température et les précipitations. Le plus grand nombre des larves est collecté durant le mois d'août ou les précipitations et l'humidité relatives étaient à leur maximum comme l'indique les fortes corrélations obtenues respectivement $r=0,78$ et $r=0,56$. Cependant il existe une faible corrélation entre la température et le nombre des larves collectées $r=0,16$. figure 4.

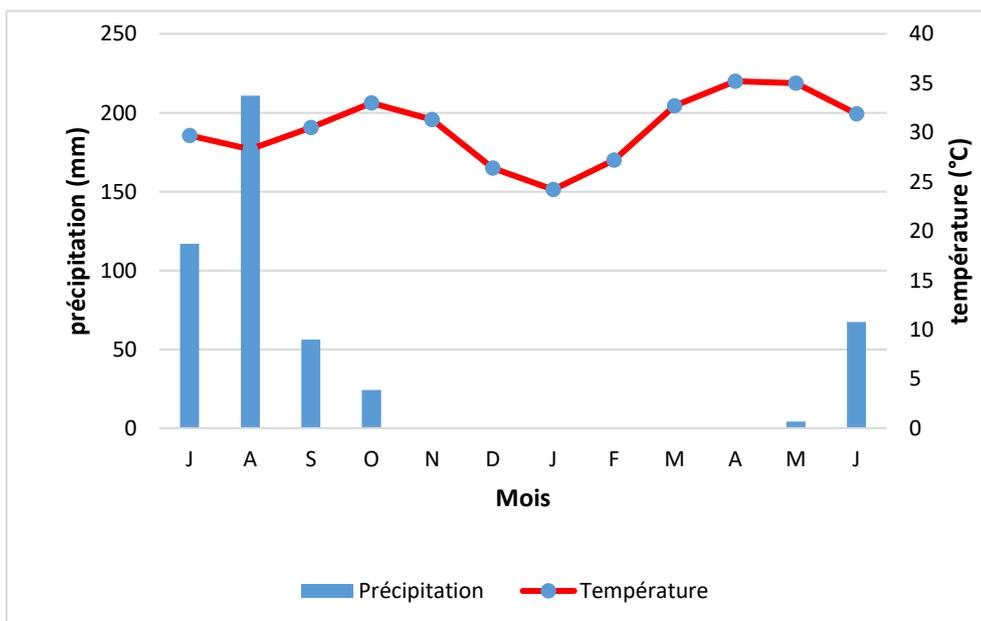


Fig. 3. Diagramme ombrothermique de la région de Niamey

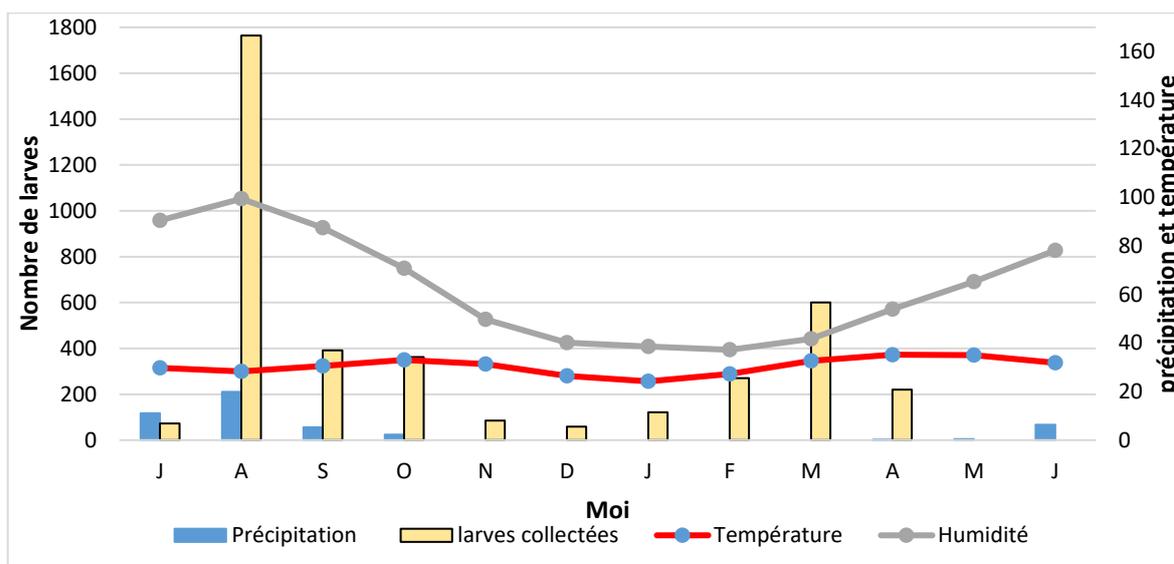


Fig. 4. Variation du nombre des larves en fonction des facteurs climatique

3.2 INDICES DE STRUCTURE

3.2.1 EVOLUTION DE LA DIVERSITÉ SPÉCIFIQUE EN FONCTION DU BIOTOPE

Les résultats mentionnés dans le tableau 4, présentent les valeurs de l'indice de diversité de Shannon-Weaver (H'), de la diversité maximale (H'_{max}) et d'équipartition (E).

L'indice de Shannon et Weaver calculé à partir des données enregistrées sur chaque site montre que la diversité est plus élevée dans la zone de rizière ($H'=0,39$) que dans la zone de lac (tableau 3). En effet, la zone de lac enregistre la plus petite richesse spécifique (7) et la plus petite abondance ($n=1488$). Le peuplement des moustiques paraît plus homogène dans zone rizicole que dans la zone du lac, au regard de la valeur d'indice d'équitabilité. L'indice de Sorensen ($Is=54,55\%$) indique par ailleurs que les moustiques étudiés dans les deux sites appartiennent à la même communauté.

Tableau 3. Indices de diversité et d'équitabilité des espèces Culicidienne dans la zone d'étude

	Lac (site2)	Rizière (Site1)
Shannon Weaver (H')	0,02	0,39
Hmax	1,95	2,98
Equitabilité	0,01	0,13

4 DISCUSSION

Cette étude a révélé que la zone 1 (zone de rizière) est plus riche en culicidés que la zone 2 (zone de lac). Deux sous-familles ont été identifiées au cours de cette étude il s'agit de la sous-famille des culicinae et la sous-famille des anophelinae. La sous-famille des anophelinae avec six espèces (6) est plus riche que celle des Culicinae qui compte cinq espèces (5). Le genre *Anophèles* (6 espèces) est plus riche que le genre *Culex* (4 espèces) et le genre *Aedes* (1 espèce).

En substance, les principaux genres et espèces identifiés dans la période de notre étude sont: *Anophèles gambiae*, *Anophèles pharaonsis*, *Anophèles squamosus*, *Anophèles rufipes*, *Anophèles nili*, *Anophèles funestus*, *Culex tritaeniyohinchus*, *Culex decens*, *Culex aurentapex*, *Culex quinquefasciatus* et *Aedes aegypti*. Toutefois, les espèces du genre *Anophèles* en particulier l'*An. gambiae* ($n=1523$) domine toutes les autres espèces. En effet, *An gambiae* constitue le principal vecteur de paludisme au Niger et à Niamey en particulier. A ce point, nos résultats corroborent ceux de [10] qui ont montré un grand contraste dans l'espace et dans le temps, de l'abondance de cette espèce dans la zone ouest du Niger.

Par contre, nos résultats sont différents de ceux obtenus par [11] qui ont relevé la présence de cinq espèces qui sont: *An. gambiae*, *An. funestus*, *An. rufipes*, *An. pharoensis* et *Ae. aegypti* à Niamey, lors de leur étude portant sur les moustiques

vecteurs de maladies ou constituants des nuisances dans la ville de Niamey. D'autre part, nos résultats diffèrent aussi de ceux de [12] qui n'ont identifié que *An. gambiae*, *An. funestus*, *An. rufipes* et *An. pharoensis* à Niamey lors de leur étude qui a porté sur les *Anophèles* du Niger. Ces différences peuvent s'expliquer par le fait que la période d'étude et les méthodes de collectes de données ne sont pas les mêmes. D'autre part, ces différences peuvent être dues aux conditions démographiques et écologiques qui ont varié considérablement. Par ailleurs, notre étude est limitée au niveau d'une seule commune de la ville de Niamey. Cependant, une étude menée récemment par [4], indique que les espèces identifiées au cours de notre étude y compris *An. nili*, appartiennent aux taxons présents et autochtones au Niger et qui peuvent se disséminer dans les régions avoisinantes.

La présence de *An. nili* à Niamey reste à confirmer par des méthodes moléculaires car selon les études antérieures, son aire de répartition est limitée au Nord du pays, bien que cette espèce occupe la quasi-totalité du continent africain et se révèle comme un important vecteur de paludisme en Afrique Centrale [13], [14].

Les larves de *Aedes aegypti*, ont été collectées en très faible quantité. Ceci peut s'expliquer par la position des gîtes prospectés par rapport aux habitations et la dimension de ces gîtes. Selon [15] les larves de *Aedes aegypti* se développent dans des petites collections d'eau douce en zone urbaine, (flaque, pots de fleur).

Notre étude montre que les moustiques sont plus abondants dans la zone des rizières (n=1545) que dans la zone de lac (n=1488). En effet, le test de normalité de Shapiro ($p < 0,05$), montre que les individus collectés ne sont pas uniformément répartis dans l'espace et dans le temps dans les deux sites d'étude. Ceci peut s'expliquer du fait que dans la zone des rizières, les gîtes contiennent constamment de l'eau qui est renouvelés au moment de remplissage des planches à l'exception de la période de récolte du riz (Mai et juin). Par contre, dans les gîtes du lac l'eau tarie rapidement avec le temps et sous l'action conjugué de la chaleur. En plus, cette zone de lac, constitue un dépotoir des ordures ménagers auquel s'ajoute les débris végétaux et animaux qui constituent une source de pollution l'eau. D'autre part, cette zone subit une forte pression anthropique occasionnée par les jardinages temporaires et la pêche. A ce niveau nos résultats diffèrent de ceux obtenus par [16] au Cameroun. En substance, ces auteurs ont montré que les moustiques prolifèrent plus dans le lac, malgré les activités anthropiques et le niveau élevé de pollution de l'eau. Les différences observées peuvent être dues aux conditions climatiques et aux types activités anthropiques locale.

Le Niamey est une ville du sahel où les conditions climatiques sont favorables à la prolifération des moustiques. Dans la période de notre étude entre juillet 2021 et juin 2022, l'amplitude thermique était de 35,2°C. les précipitations sont maximales au cours du mois d'août avec 210,81 mm de pluie avec une température moyenne de 28,3°C de même que l'humidité relative 71,1%. En effet, toutes les conditions climatiques sont réunies tels que la température élevée pour favoriser la prolifération des moustiques [17]. Le niveau élevé de pluviométrie favorise l'augmentation du nombre des gîtes larvaires ce qui a permis de collecter le plus grand nombre des larves au cours de cette étude (n=1764). Ces résultats sont confirmés par les travaux de [16] qui ont montré que la production des larves de moustique est plus importante pendant les saisons de pluies dans le lac. Le nombre des moustiques est plus élevé dans la période ou la pluviométrie est plus élevée. Ceci peut s'expliquer par le fait que, pendant la saison des pluies, les gîtes larvaires sont plus abondants comme le montre les fortes corrélations existantes entre les larves collectées et l'humidité relative (0,56) et la pluviométrie (0,78). A ce niveau nos résultats sont proches de ceux rapportés dans le bulletin n°3 climat-santé du Niger [18] et par [19] qui ont montré que les moustiques prolifèrent plus pendant la saison de pluie. En Côte-d'Ivoire, [20], ont rapporté des résultats similaires. Ces auteurs ont montré que la dynamique de la production larvaire est régulière aussi bien en saison sèche qu'en saison des pluies en milieu rural et que la pluviométrie et les habitudes de conservation de l'eau dans les récipients en saison sèche favorisent la productivité des gîtes. Les *Anophèles* ont été collectées durant toute la période de notre étude à l'exception des mois de Mai et Août. Ceci peut s'expliquer par le fait que les gîtes ont tari au cours de ces deux mois. [21] au Maroc, ont rapporté que les *Anophèles* se sont adaptés aux différentes conditions climatiques et prolifèrent durant toutes les saisons de l'année. Par contre, [22], ont montré que *Culex* était le genre dominant au cours de leur étude au Maroc. Ces différences peuvent s'expliquer par la nature des gîtes prospectés et les activités anthropiques effectuées aux tours des gîte.

En fonction du biotope, on constate que la zone de rizière est plus diversifiée que la zone de lac. En substance, la diversité des Culicidés est relativement faible dans nos deux sites puisque l'indice de diversité de Shannon-Weaver (H') appliquée aux peuplements de moustiques est compris entre 0 bit et 0,39 bits. La diversité est maximale dans la zone de rizière avec onze (11) espèces alors que la zone de lac compte quatre (4) espèces, comme l'indique les valeurs de la diversité maximale (H_{max}) qui sont $H_{max}=1,95$ dans le lac et $H_{max}=2,98$ dans la rizière. Concernant l'équitabilité, les valeurs restent relativement faibles et tendent vers 0. Dans la zone des rizières l'indice d'équitabilité est de $E=0,13$ alors que dans la zone des lacs, il est de $E=0,02$. Ceci implique que les espèces présentes dans le lac et la rizière, ne sont pas en équilibre entre elles. Ainsi, on constate que *An. gambiae* est l'espèce dominante au niveau des deux sites. L'étude de l'équitabilité permet d'affirmer que plus celle-ci est élevée dans le peuplement, plus ce dernier peut être considéré comme étant en équilibre. La variation saisonnière ainsi que

les facteurs climatiques peuvent expliquer la variation du nombre des espèces de moustiques observées au cours de notre étude sur les deux sites. En effet, Les larves d'*An. gambiae* ont été collecté en grande quantité au cours des mois d'août et octobre. Cette situation peut s'expliquer par le fait que la pluie est plus abondante dans cette période et *An. gambiae* occupe de préférence les gîtes bien aéré en ensoleillé qui taris vide sous l'action de la chaleur. Cela peut également expliquer la disparition des larves au niveau du lac car les petites collections d'eau qui taries ne sont pas alimenté. A ces propos nos résultats corroborent ceux de [23], [24], [25]. Ces auteurs ont rapporté que *An. gambiae* occupe des gîtes temporaires et ubiquiste. Par contre, nos résultats sont différents de ceux obtenus par [26]. Cet auteur a obtenu un indice de diversité de 2,92 bits et une équitabilité de 0,78 dans l'un des gîtes de son étude au Maroc. Les différences observées peuvent s'expliquer par le nombre des gîtes prospectés et les conditions écologiques des différentes espèces de moustiques collectées.

5 CONCLUSION

Ce travail est une étude préliminaire sur la richesse spécifique et l'abondance des culicidés dans la ville de Niamey. Il ressort de cette étude que les rizières de kirkissoye et le lac de Lamordé hébergent des vecteurs du paludisme (genre *Anophèles*) et de filarioses (genres *Anophèles* et *Culex*). La pullulation des Culicidae est favorisé par la saison des pluies dans le lac. Dans les rizières cette production devient amplifiée par l'augmentation de petites collections d'eau.

Les activités anthropiques favorisent et maintiennent la production des culicidae pendant la saison sèche. Des mesures d'assainissement appropriés doivent être prise pour réduire les nuisances et l'incidence des maladies à transmises par les moustiques.

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Impact of Small and Medium Enterprises on Household Poverty Reduction in Goma

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ABSTRACT: The unprecedented proliferation of Small and Medium Enterprises has been witnessed in Goma. This is the reason for our subject on «Impact of Small and Medium Enterprises on the reduction of household poverty in the city of Goma. Our concern was to assess the impact of SMEs (Small and medium Enterprises) on household poverty reduction in the city of Goma.

After our research, the study reveals that investments based on income from SMEs increase the chances of households to reduce their poverty, own their own housing and improve their nutritional condition by taking at least a balanced diet. This indeed increases the possibility of the household to improve the living condition and pay the taxes and duties related to the income-generating activity initiated. This allows its sustainability. On the other hand, expenses related to the education of children and health care on the basis of the sole income of the SME, give the manager of the SME less chance of lifting the household out of extreme poverty and increasing the income of the SME. It should be noted that investments in human capital remain commendable in the long term.

These results led to the definition of economic policies oriented towards the consolidation and development of small and medium-sized enterprises with a view to the economic development of the city of Goma.

KEYWORDS: Small and Medium Enterprises, SMEs, household, poverty, Goma.

1 INTRODUCTION

In poor countries and many developing countries, small and medium-sized enterprises (SMEs) represent an important part of businesses. They represent more than 95% of all companies and 60 to 70% of employment; they are the ones that create a large part of the new jobs in the economies. They have their own advantages and disadvantages which may call for special measures. Due to new technologies and globalization, economies of scale are becoming less important in many activities, so that the potential contribution of small businesses is enhanced. At the same time, many of the problems they traditionally face, namely: insufficient funding, difficulties in exploiting technologies, limited managerial capacities, low productivity, cumbersome regulations; are accentuated in a globalized context where technology is becoming predominant (OECD, 2000). Most jobs in SMEs are in the service sector, which now accounts for more than two-thirds of economic activity and employment in OECD countries. Small businesses are particularly found in wholesale and retail trade, hotels and restaurants, communications and business services, and construction. They also represent a large percentage of manufacturing enterprises in many countries and at least half of the employment in this sector.

Strong empirical data confirms that SMEs are a real engine of job creation. However, the analysis of these data also reveals that they form a very heterogeneous sector. It is therefore very difficult to design policies applicable equally to all companies in this size class. Supporting SMEs because of their important contribution to employment without differentiating them by sub-segments risks favoring quantity at the expense of quality, because this sector is also made up of many micro-enterprises that generate jobs that are neither productive nor decent ([www.ilo.org > public > documents > meetingdocument > wcms_358290](http://www.ilo.org/public/documents/meetingdocument/wcms_358290)).

The promotion of SMEs is today a priority of Congo's economic policy. The economic crisis, unemployment, precarious wages push many people to create informal SMEs. The creation of these SMEs is undoubtedly the sign of the vitality of the Congolese people in general and the households of the city of Goma in particular and their ability to adapt to new situations.

This creativity largely contributes to liberating certain situations of poverty experienced by households in Goma through economic integration and consolidation of the middle classes as well as job creation. Thus, in an attempt to reduce poverty, many people think of creating jobs on their own by hiring employees to survive.

Starting from the observation of the peoples of the whole world, of the Democratic Republic of Congo in general and those of the city of Goma in particular; it appears that households are going through a difficult life, because they are unable to cope with the unemployment rate and underemployment. We see the population resorting to a source of hope in order to improve their living conditions. This is how the population manages to create Small and Medium Enterprises (SMEs) to reduce poverty and meet their household needs.

However, private enterprise appears to be an essential development factor, endowed with total autonomy and able to ensure rapid economic growth.

Therefore, in the course of this study, it is imperative for us to examine the contribution of small and medium-sized enterprises in reducing household poverty in the city of Goma.

Indeed, this study proposes to put in place elements of policies based on the consolidation and development of small and medium-sized enterprises, with a view to reviving economic activity in the DRC, considering above all, the extreme poverty that plagues many of households in an environment of reduced employment.

In doing so, we want in the course of this scientific achievement, to assess the effect of small and medium enterprises on reducing household poverty in Goma.

Based on the above, we think a priori that the effect of SMEs on household poverty reduction in Goma is significant considering the improvement in living conditions associated with the Income Generating Activities implemented.

In addition to the introduction and conclusion, this study first defines the concepts, then presents the study environment; It also brushes on the impact of small and medium-sized enterprises on household poverty reduction in Goma, where we present and analyze survey data using SPSS software first, then STATA, with a view to above all, the verification of our formulated hypothesis.

2 RELATIONAL APPROACH BETWEEN SMES AND POVERTY REDUCTION

2.1 SMALL AND MEDIUM ENTERPRISES

The term SME covers a panoply of definitions. Nevertheless, the number of employees in a company together with the turnover, seem to be retained as criteria of definition.

In the course of the charter of the DRC on small and medium-sized enterprises, it is necessary to understand by Small and Medium Enterprise, any economic unit whose property belongs to one or more natural or legal persons and which has the following characteristics: - number of permanent jobs from 1 (one) to 200 (two hundred) people per year; - turnover, excluding taxes, between 1 (one) and 400,000 USD (four hundred thousand); - value of the necessary investments put in place for the activities of the company less than or equal to 350,000 USD (three hundred and fifty thousand); - concentrated management mode. Fit into this category; the micro-enterprise or the very small enterprise, the small enterprise and the medium-sized enterprise which can be victims as sole proprietorships or companies (RDC / Ministère de PME, 2009, p.5).

2.2 DEFINITION OF POVERTY

Poverty being understood as a lack of monetary resources, a lack of education and health, or else the absence of freedom, the impossibility of participating in a community or the lack of a feeling of belonging to a given society; for the World Bank and the UNDP, poverty results from "a lack of (access to) assets, insufficient or inadequate economic growth, and poor governance. The World Bank and the UNDP (United Nations Development Programme) remain the two leading institutions in the fight against poverty. The two organizations agree on the causes of poverty but nevertheless have differences as to its definition and its quantification. The UNDP specifically defines three concepts: Extreme poverty or absolute poverty: a person lives in a condition of extreme poverty if he does not have the necessary income to meet his essential food needs defined on the basis of minimum caloric needs (1800 calories per day and per person (WHO)), General poverty or relative poverty: a person lives in general poverty if they do not have sufficient income to meet their essential non-food needs: clothing, energy, housing, as well as food. Human poverty: is considered the absence of basic human capacities: illiteracy, malnutrition, reduced longevity, poor maternal health, preventable disease. The UNDP does not officially define income poverty, but refers to it. It is human poverty that is at the heart of the analysis and this is linked to the notion of human development inspired by the work of Amartya Sen

(Nobel Prize in Economics – 1998): human development represents the widening of possibilities and choices offered to individuals. Thus, UNDP favors a multidimensional approach where human poverty is defined as "the denial of opportunities and prospects based on demand underlies all human development: to live a long, healthy, constructive life, and to enjoy a decent standard of living, as well as freedom, dignity, respect for oneself and others. » (Report on human development UNDP-Algeria 2006, p.17) As for the approach used by the World Bank, it is a monetary approach to poverty. His rationale is to identify two types of poverty: absolute poverty and relative poverty which have been defined earlier. The World Bank recognizes the different facets of poverty: its multiple dimension is therefore not neglected. It explains that the study of areas such as health, education, vulnerability, lack of power and lack of voice are particularly necessary to understand poverty in all its complexity. The monetary approach of the World Bank consists of "based on criteria of income or consumption, then combining different areas which are reinforced or worsened in order to reduce or increase the level of indigence of the poor populations. » www.bsi-economics.org › images › articles.

2.3 DEVELOPMENT OF SMES IN THE CITY OF GOMA

At present, the importance of small and medium-sized enterprises, micro-finance institutions and crafts in the process of combating poverty in the city no longer needs to be preserved. It is undeniable that the economies of many cities are essentially based on SMEs. The dynamism of the latter determines the evolution of local economies and, consequently, there are more and more States in the world which base their hopes for development and better being on SMEs. Indeed, through a certain aptitude for flexibility, SMEs allow, among other things, economists to design them and to experiment with simple and appropriate technologies, to use local resources and intensive labour.

In the city of Goma, SMEs currently constitute an important part of the private sector likely to promote the development of a local middle class. SMEs are established in various forms: individual, family, corporate... and are established in almost all sectors of the economy, to ensure the activities of production and distribution of goods and services, and financial services accessible to all.

They create jobs, distribute income and provide capital, factors of economic growth and development. However, these SMEs (in the broad sense) hardly benefit from the support necessary for their harmonious development, due to a lack of effective support from the government and development cooperation partners for the benefit of the SME sector.

3 SMALL, MEDIUM ENTERPRISES AND HOUSEHOLD POVERTY REDUCTION IN GOMA

The city of Goma is one of the typical cities of the DRC where extreme household poverty is at a record high, and where small and medium-sized enterprises are developing with a view to improving living conditions.

3.1 BRIEF PRESENTATION OF THE CITY OF GOMA

The city of Goma being the capital of the province of North/Kivu, it is located in the east of the DRC and more precisely in the province of North/Kivu. It is located at an altitude of 1,640, on the shore of Lake Kivu at 29°14' longitude, 1°45' from the South altitude. It is limited: To the north by the territory of Nyiragongo; To the south by Lake Kivu, and the province of South/Kivu; To the east by the Republic of Rwanda; To the West by the territory of Masisi.

The city of Goma covers an area of 66,450,180 km². Its climate is humid tropical and softened by the wind that blows over Lake Kivu and the volcanic mountains located in Virunga National Park. It has two seasons distributed as follows: From January 1 to February 15: a small dry season; From February 15 to May 15: a short rainy season; From May 15 to September 15: a great dry season; From September 15 to December 15: a long rainy season.

Generally, the city of Goma experiences a climate softened by the altitude and the breeze blowing from Lake Kivu. Towards Lake Kivu, the average temperature is between 19,60°C and 19,9°C. The total annual rainfall is 1207mm. Thermal and rainfall data show that the city of Goma has a humid tropical climate. The relief of Goma does not present any particularities.

In his example, it is a lava plain slightly inclined from North/Kivu to South/Kivu. Its altitude varies between 1461,80m and 2000m. the city of Goma is marked by the obstacles of the sadly famous lava in the memory of the population of Goma who devastated a good part of the city of Goma on 01/17/2002.

The soil of the city of Goma is volcanic but this one is insufficient as the major part is covered with rocks. This volcanic soil gives the city a place of choice for agricultural production. Its basement is dominated by sand renowned for the construction of houses and other infrastructures.

The vegetation of the city of Goma is characterized by a grassy savannah. It grows on expanses of volcanic origin. It is also characterized by the gardens of food crops, planting some fruit trees. Goma's fauna consists of small animals such as goats, sheep and pigs.

The urban outline of the city of Goma is completely devoid of waterways. This is linked to the volcanic eruption which around the 1800s covered the extent of the city with lava up to a certain km to the northwest, thus causing all watercourses such as streams and rivers to disappear. apart from the water of Lake Kivu which supplies the entire city with water, the city of Goma is bathed in the southern part by Lake Kivu. To the west there are two small lakes. Green lake and black lake at BUHIMBA (mare).

The city of Goma has a heterogeneous population and forms several tribes from the interior of the country. The poor living conditions of the population of the countryside, the insecurity push many of a rural exodus in the hope of accessing in town to stability in a well-paid job in leisure, etc.

The population drained a large flow of people to the city of Goma, the natural increase resulting from the balance between births and deaths of the urban population. The problem of the demographic growth of the population with the consequence of special expansion of the city persists especially in the rhythm and the extent of the growth which is not accompanied by measures of supervision by the politico-administrative authority.

Following the bad governance characterized by ethnic hatred and a policy of exclusion since the years 1992-1993, inter-ethnic conflicts broke out in the territories of MASISI and RUTSHURU which causes a large-scale rural exodus towards more secure Goma. This had as a corollary on the city, the knowledge of many neighborhoods like NDOSHO, KESHERO, and green lake: but also, a strong demographic push, the rural people came to inflate the number of unemployed and social marginalized people, who populate the city (Report City Hall of Goma, 2019).

3.2 SURVEY METHODOLOGY

We carried out our survey using a questionnaire administered to households. We spoke exclusively with the managers of small and medium enterprises, who were generally able to provide the necessary information concerning the reduction of poverty with the establishment of the Income Generating Activity. In addition, the data collected was subject to a consistency check before being used.

The questionnaire administered to households included the following sections: identification of the manager, description of the income-generating activity and reduction of household poverty. The identification of the manager, description of the IGA and reduction of household poverty sections enabled us to assess the impact of small and medium-sized enterprises on poverty reduction.

The living standard of living was considered to better understand the phenomenon of poverty. We considered for this purpose that a household lives in extreme poverty when the household income per capita, per day ranks the household among those with less than \$2/day as set by the World Bank (<https://www.banquemonde.org › news › 2015/10/04>, consulted on 26/04/2022, at 2: 47 p.m.).

3.2.1 CARRYING OUT THE SURVEY

The survey itself was carried out from March 05 to April 05, 2022 by ourselves. The sample size was limited to 100 randomly selected SMEs.

3.2.2 SURVEY RESULT

According to our survey, we claim that there is a clear mathematical relationship between small and medium enterprises and household poverty reduction in Goma. After analyzing and processing the data with STATA, our study retains 13 variables including a dependent variable and 12 independent variables as rectifiers taken into account to determine the impact of small and medium-sized enterprises on the reduction of household poverty in Goma. Let CSENJ (consumption per day, per person) be our dependent variable.

The independent variables are: NPEM (Number of years in the small and medium enterprise), EPME (Savings with the SME), IPME (Investment with the SME), SMP (Status of the household in the plot), EEPME (Child education with the SME), ASPME (Access to health care with the SME), NRJ (Number of meals per day), CRJ (Constitution of the meal taken per day),

ACPME (Improvement of living conditions with the SME), AAPME (Other income-generating activities with the SME), RPME (Revenue with the SME), PEFA (weight of the tax environment on the activity).

3.2.2.1 ECONOMETRIC MODEL BASED ON STATA

The objective of the present study being to determine the effect of Small and Medium Enterprises on the reduction of poverty, the lines which follow make an econometric estimation of the model appropriate to our study.

However, the model in general being accepted considering a $\text{Prob} > \chi^2 = 0.0000$ at the significance level of 95% as we can achieve in the following lines with the initial logistic model. It is imperative to note that the logistic regression retains 12 explanatory variables. Indeed, let us denote by CSEN RJ (consumption per day, per person), our dependent variable.

Note that, the model being dichotomous, we mean a statistical model in which the explained variable can only take two modalities (dichotomous variable). It is then generally a question of explaining the occurrence or not of an event, or of a choice. In our example, the households located in the SMEs do or do not consume \$2 per day, per person with regard to the extreme poverty threshold of the World Bank. We consider a sample of n individuals with indices $i=1; \dots; n$. For each individual, we observe whether the event has occurred and we set:

$$Y_i = \begin{cases} 1 & \text{if the event has taken place (per day, per person we consume \$2)} \\ 0 & \text{if the event did not take place (per day, per person we do not consume \$2)} \end{cases}$$

Note here the choice of coding (0, 1) which is traditionally used for dichotomous models. Indeed, this one makes it possible to define the probability of occurrence of the event as the expectation of the variable Y , since:

$$E[Y_i] = \text{Pr}(Y_i = 1) \times 1 + \text{Pr}(Y_i = 0) \times 0 = \text{Pr}(Y_i = 1)$$

The expectation Y_i therefore gives the probability that a household will not be poor, with regard to the pre-established threshold of \$2 per day/per person.

The objective of dichotomous models then consists in explaining the occurrence of the event considered according to k observed characteristics ($\beta_{i1}, \dots, \beta_{ik}$) for an individual i of the sample, for example household income, savings, investments, the status of the household in the plot, the number of meals taken, the composition of the meal, the development of other income-generating activities, etc.

Based on the above, we write the mathematical expression of the model as follows:

$$\text{CSEN RJ} = X_0 + (-)\beta_1 X_1 +, \dots \dots + (-)\beta_n X_n + \varepsilon$$

In the following lines, we make the econometric estimation of the model based on STATA. The table below gives us an overview.

It appears from our estimate of the marginal effects that the reduction of household poverty correlates significantly with the establishment of Small and Medium Enterprises set up in the city of Goma. Therefore, we deduce the regression equation as formulated below:

$$CSENJ = -0,108194EPME + 0,0368247IPME + 0,133493SMP - 0,0368477EEPME - 0,2094848ASPME + 0,6028805CRJ + 0,1331006ACPME - 0,1763042AAPME + 0,2853307PEFA$$

It emerges from the logistic equation above that, in the city of Goma, investments (IPME) based on income from SMEs, increase the chances of households to reduce their poverty, considering the consumption per day/per person in the household. This in fact increases the chances of households having their own accommodation (SMP) and improving the nutritional condition required for the constitution of the meal taken (CRJ), where the diet is balanced. From the same study, it also emerges that paying emissions from the SME set up by the household increase the possibility of the household improving the living conditions of residents and coping with the burden of the fiscal environment by paying taxes and duties related to the income-generating activity initiated.

In addition, current expenses relating to children's education (EEPME) and health care (ASPME) based on the SME's income alone, reduce the chances of the SME manager to emerge from extreme poverty and the fact that households resort to other activities, especially in the informal sector, in order to meet the needs related to human capital investments; which leads to the creation of other activities to supplement miscellaneous household expenses (AAPME) which would not all be covered on the basis of the SME alone. This, in turn, has a negative influence on consumption per day/per person within the household.

The above results call for implications in terms of economic policies geared towards the development of income-generating activities, with a view to reducing household poverty in the city of Goma.

4 IMPLICATION IN TERMS OF ECONOMIC POLICIES FOR THE CONSOLIDATION AND DEVELOPMENT OF SMES IN THE CITY OF GOMA

The obstacles that hinder the development of SMEs – as business owners perceive them – have been studied quite well. In all countries, the top three are difficulty in obtaining finance, limited access to electricity, and competition from informal businesses. However, the obstacles are not the same depending on the level of development of the country and the region of establishment. These factual observations must be constantly updated by means of surveys of representative samples of companies, such as those of the ILO, for example, to continue to enrich the reflection on the action to be taken.

Much less is known about the problems of SME workers or the disadvantages they face. There is strong evidence that SMEs generally rank lower than large companies on job quality indicators. There are no data for low-income and middle-income countries. This situation calls for three remarks. First, it proves that more information is needed on job quality in SMEs. Secondly, just because the available data indicates that SME jobs are of lower quality does not mean that we should stop supporting these companies: their contribution to job creation and poverty reduction is too important. On the other hand, they must be helped to increase their productivity and improve the quality of their jobs. This is why the ILO has made productivity and working conditions in SMEs one of its areas of primary importance. Thirdly, another important observation is that the quality of employment in SMEs depends more on the economic sector concerned than on the size of the company. Therefore, measures to improve the quality of employment could be more effective if they were tailored to the sector rather than to a particular size class.

Employers' and workers' organizations can help SMEs and their workers to overcome the difficulties they face. Increasing the representation of SMEs within them will enable them to strengthen their role as advocates for this category of companies. Moreover, the services that the social partners make available to their members can be very useful to SMEs. These are information, training, advice services for accessing public and private business support systems, connection with design and advice offices, business matchmaking and advice on best practices. business managers. Employer organizations should continue to assess the quality of the entrepreneurial environment through enterprise surveys, enterprise barometers and other tools (D. Chen, F.C. Lee and J.M. Mintz, 2002).

Indeed, this section sets out to present a summary of policies relating to the consolidation of SMEs with a view to creating jobs first, then reducing household poverty.

Access to finance and entrepreneurship education policies can help generate income and support the creation of more and better jobs, especially when combined. The majority of interventions evaluated to date have targeted micro-enterprises or the self-employed at the bottom of the pyramid. These programs must be maintained as they play a valuable role in ensuring stable incomes and creating additional jobs. Rigorous impact evaluations of policies aimed at non-micro SMEs are rare, and more evaluation of the effectiveness of policies for this sub-segment is warranted. These assessments should, among other things,

include the group of young, fast-growing SMEs, where most new jobs originate. With regard to the target groups in the labor market, interventions aimed at young people have a greater impact on employment than those aimed at other age groups. Therefore, youth entrepreneurship should continue to feature among the active labor market policies adopted to tackle youth unemployment. Interventions in favor of women entrepreneurs seem to give less good results in terms of income and employment creation. This finding invites us to review current approaches in order to provide better responses to the particular difficulties of women entrepreneurs. The ILO, already an important player in supporting entrepreneurship, has made considerable efforts and investments to carry out a rigorous evaluation of its interventions in this area. Evaluations of the impact of ILO interventions show good results in terms of income generation, but a mixed picture in terms of job creation. It is clear that more assessments are needed, and these should focus less on income generation and provide more information on the quality of jobs. Future evaluations should also include cost-benefit analyses, which to date neither the ILO nor even most other institutions have done (ILO, 2015).

There is strong evidence that a favorable environment is beneficial for employment and economic growth and that the smaller the business, the greater the employment effects. This confirms the hypothesis that an enabling environment and a level playing field are important for the development of SMEs. The ILO's own work on an enabling environment for sustainable enterprises does not go far enough back in time to provide any indication of impact. Interesting elements are beginning to emerge from the intermediate results, such as the adoption of reforms and the reduction of red tape. The DRC government should align itself with the ILO by stepping up its efforts to monitor and quantify the results of its enabling environment interventions (S. Djankov et al., 2010).

The formalization of informal SMEs is highly relevant to the overall ILO approach of facilitating the transition from the informal to the formal economy. Formalization appears as a means of breaking the vicious circle of low productivity and precarious working conditions that prevails in the informal economy. There is still little empirical data on what works and what does not work in the formalization of SMEs. Overall, the effects of interventions on formalization in terms of formality, business performance and employment are modest. It should be noted, however, that the evaluations carried out essentially concerned the reforms concerning the creation of enterprises. Successful case studies show that interventions need to go beyond lowering the costs for businesses to become formal and also offer lower costs and/or increased benefits associated with business status. Simplifying the tax system or social security provisions can promote formalization. Further research on different combinations of reducing costs, increasing benefits and strengthening law enforcement is needed (Fiala and M. Pilgrim, 2013).

With regard to interventions aimed at improving the working conditions and productivity of SMEs, it is clear that measures relating to working conditions and those relating to the improvement of the management of basic activities should be more integrated. Everything suggests that an improved systemic approach that includes working conditions in the basic activities of the company gives better results than isolated interventions activated on the improvement of a single aspect of working conditions. Further research is needed to establish the effectiveness of integrated sets of related measures.

There is growing interest in value chain development interventions because they focus on scale effects and financial sustainability. While to date there is no rigorous evidence on the effectiveness of such interventions, the ILO has recently launched a knowledge generation project on the labor market effects of value chain interventions and control of different results measurement systems. This should fill the information gap. Therefore, the following measures are essential for the development of SMEs in the municipality of Karisimbi: 1) Ensuring rigorous monitoring and measurement of results has now become a strong trend. Reliable measures of intermediate outcomes and ultimate impact are essential if organizations like the ILO are to rely on evidence to advise on what works and what does not, and the ILO remains a privileged partner. 2) Establishment of partnerships with companies in order to broaden the scope of interventions and improve their sustainability. However, it remains very difficult to determine the added value that partnerships bring to businesses. The ILO has recently started to increase its direct engagement with business. 3) Introducing an ecological dimension into the business activities of SMEs or facilitating the entry of SMEs into new markets for green products or services are aspects that are rapidly gaining in importance. Given the considerable public and private resources being invested, it is important to develop clear theories of change and reliable results measurement frameworks to effectively support SMEs. 4) The new trend of developing programs for high-growth enterprises requires technical expertise in areas such as mentoring, business incubators and angel investors, which the ILO does not yet have. The ILO should test this new approach and build such expertise in-house.

Therefore, access to financing for the training of entrepreneurship, an undeniable necessity considering that in the DRC, SMEs often have only limited access to financing. Many interventions are therefore designed to help them access financial services such as loans, guarantees, subsidies, savings products, insurance or even leasing. In general, interventions are not only expected to provide SMEs with access to these very often inaccessible services, but also to reduce their cost. Access to finance should allow companies the financial resources they need to maintain and develop their activities. This should improve the performance of SMEs, resulting in increased sales and profits, and ultimately increased labor demand, increased incomes and

improved working conditions. lives through the jobs created (M. Grimm and A.L. Paffhausen, 2014; and N. Fiala and M. Pilgrim, 2013).

The development and consolidation of SMEs in the city of Goma is the result of this perfect integration of the orientations of the ILO and other organizations advocating the reduction of poverty in the elements of policies with a view to emergence.

5 CONCLUSION

At the end of our study on "Impact of small and medium-sized enterprises on the reduction of household poverty in the city of Goma", the question at the center of the study was to assess the impact of SMEs on the reduction of household poverty in the commune of Karisimbi in view of the implications in terms of economic policies aimed at reducing household poverty.

To achieve our objective and verify our hypotheses, the inductive approach supported by the documentary technique, interview and survey questionnaire, served us. After applying the tools under study, including SPSS and STATA, the following results were achieved:

- With regard to household poverty reduction by SMEs, the study reveals that investments based on income from SMEs increase the chances of households to reduce their poverty, own their own housing and improve the dietary condition by taking at least a balanced diet. This indeed increases the possibility for the household to improve its living conditions and pay any taxes and duties related to the income-generating activity initiated. This justifies its durability.
- On the other hand, the expenses related to the education of children and health care on the basis of the sole income of the SME, give less chance to the person in charge of the SME to lift the household out of extreme poverty and to increase the range of choices during their short-term execution. It should be noted that investments in human capital remain commendable in the long term.

Considering the above, we confirm our hypothesis that the impact of small and medium-sized enterprises on the reduction of household poverty is significant, given the improvement in the related living conditions.

Not being perfect, we do not claim to have exhausted all the questions inherent in poverty reduction in the course of this scientific work. Other researchers can complete us or address issues that are still outstanding.

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Analyse des systèmes agricoles autour du parc national de Kahuzi-Biega et leurs effets sur ses ressources floristiques et faunistiques

[Analysis of agricultural systems around Kahuzi-Biega national park and their effects on its flora and fauna resources]

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ABSTRACT: The present study aims to analyze the effects of agricultural systems around the KBNP on the floristic and faunistic richness of the latter.

In addition to the documentary technique, direct observations and field surveys were conducted. Data analysis was carried out using Excel and R software.

The main activities carried out by the farmers are agriculture, livestock, wood exploitation and hunting (poaching).

Taking into account the agricultural parameters (agriculture and livestock) that were the subject of our study, the results on agriculture prove that soil restoration inputs are poorly used by farmers and that measures that could improve and maintain soil fertility are less considered. The livestock farming system practiced is of the extensive type with a divagation mode resulting in a decrease in the condition of the pastures.

Due to the poverty of the riparian population and the precariousness of the agricultural methods used in their farms, the threats weigh on the natural resources of the PNKB.

KEYWORDS: Agricultural systems, anthropic activities, natural resources, biological diversity, Kahuzi-Biega National Park.

RESUME: La présente étude poursuit l'objectif d'analyser les effets des systèmes agricoles autour du PNKB sur la richesse floristique et faunistique de ce dernier.

Outre la technique documentaire, les observations directes et les enquêtes de terrain ont été réalisées. L'analyse des données a été réalisée grâce aux logiciels Excel et R.

Les principales activités exercées par les paysans sont l'agriculture, l'élevage, l'exploitation du bois et la chasse (braconnage).

Tenant compte des paramètres agricoles (agriculture et élevage) ayant fait l'objet de notre étude, les résultats sur l'agriculture prouvent que les intrants de restauration des sols sont faiblement utilisés par les agriculteurs et que des mesures pouvant améliorer et maintenir

la fertilité des sols sont moins envisagées. Le système d'élevage pratiqué est du type extensif avec un mode en divagation se traduisant par une diminution de l'état des pâturages.

Du fait de la pauvreté de la population riveraine et de la précarité des méthodes agricoles utilisées dans leurs exploitations, les menaces pèsent sur les ressources naturelles du PNKB.

MOTS-CLEFS: Systèmes agricoles, activités anthropiques, ressources naturelles, diversité biologique, parc national de Kahuzi-Biega.

1 INTRODUCTION

Depuis plusieurs millénaires, les activités anthropiques, et particulier l'agriculture, ont conduit à la transformation progressive d'une grande partie des surfaces terrestres (Gropalli, 1993, cité par Burel et Garnier, 2008).

Depuis la conférence des Nations Unies en 1992, une prise de conscience mondiale s'est opérée pour dénoncer les menaces pesant sur la biodiversité qui, est essentiellement dû à la disparition, à l'altération ou à la fragmentation des habitats par les activités anthropiques (Anonyme, 2010).

Rahaingoson et *al.* 2013, attribuent la dégradation des zones forestières aux effets combinés des divers facteurs: climatique, anthropique et biologique.

En effet, le monde est plein de systèmes agricoles ingénieux dans des endroits inattendus. Dans chaque pays, il existe des zones où des générations d'agriculteurs ont exploité les possibilités locales pour développer des systèmes agricoles durables (Schoubroeck et *al.* 2006). Cependant, dans les pays en sous-développement, les systèmes agricoles n'ont encore atteint le niveau de développement agricole et sont souvent une menace aux écosystèmes naturels d'où de leur biodiversité.

Le pastoralisme, la culture itinérante, l'agriculture vivrière et l'agriculture intensive sont les plus importants systèmes agricoles (Griffon, 2002). Ces derniers, toujours non performants constituent des problèmes majeurs résultant de la médiocrité de rendement agricole et donc la biodiversité des écosystèmes forestiers qui en souffre.

En République Démocratique du Congo, plus particulièrement au Sud-Kivu dans les exploitations agricoles à côté des aires protégées, ces problèmes se font sentir car la population riveraine de ces aires exploite les ressources naturelles de toutes les façons pour subvenir à leurs besoins. Tel est le cas de la population riveraine du PNKB qui se livre à l'exploitation des ressources de tout genre présentes dans le site.

Toutefois, l'agriculture demeure la principale activité occasionnant la déforestation des zones périphériques des aires protégées en induisant des modifications structurales et biologiques qui se manifestent par des changements du microclimat, la raréfaction de certaines espèces et la surexploitation de certaines autres (Musumbu, 2004).

Dans la partie Est de la République Démocratique du Congo, on connaît actuellement le problème grave de conservation résultant de la démographie couplée non seulement avec la pauvreté mais aussi l'insécurité où les pressions croissantes des activités humaines sont essentiellement liées à l'exploitation directe des ressources naturelles pour la satisfaction de besoins de base (DFID et *al.* 2008; Regmi, 2001; Crawford et *al.*, 2004; International Alert, 2009) cité par (Karhagomba et *al.* 2013). Toutefois, ces activités sont de première importance dans la vie des ménages congolais et altèrent les forêts naturelles, surtout dans les écosystèmes secs, de montagne et en périphéries des villes. C'est pourquoi, la forêt de KAHUZI-BIEGA située à l'Est de la République Démocratique du Congo continue de subir des pressions anthropiques malgré les efforts de cogestion entrepris avec les populations locales à partir des années 1985 (Mushagalusa et *al.* 2013).

Pour ce faire, les effets résultant des activités anthropiques sur les ressources floristiques et faunistiques du PNKB ne sont pas les moindres du point de vue de la conservation des ressources de la biodiversité. En effet, l'homme joue tour à tour le rôle de destructeur et de protecteur de l'environnement (Mboma, 2009).

L'intérêt de celle-ci se base sur l'analyse des moyens pratiqués par les exploitants agricoles pouvant améliorer leur rendement en vue de limiter les dégâts sur les ressources floristiques et faunistiques du PNKB.

De ce qui précède, cette étude s'inscrit dans le cadre d'analyser les effets des systèmes agricoles autour du PNKB sur la richesse floristique et faunistique.

2 MATÉRIELS ET MÉTHODES

2.1 DESCRIPTION DE LA ZONE D'ÉTUDE

Créé en 1970, le Parc National de Kahuzi-Biega est situé dans la partie orientale de la R.D Congo dans la province du Sud-Kivu entre 1°36' et 2°37' de latitude Sud ainsi qu'entre 27°33' et 28°46' de longitude Est (Fischer, 1993), cité par (Mushagalusa et al. 2013). Ce site du patrimoine mondial s'étend sur trois provinces à savoir le Sud-Kivu, Nord-Kivu et le Maniema. Il partage aussi les limites avec les territoires de KABARE, KALEHE, WALUNGU, SHABUNDA et WALIKALE habités par divers groupes ethniques. Le parc doit son nom des monts KAHUZI (3308m) et BIEGA (2790m) (ICCN/PGG, 2009).

Le parc abrite une flore et une faune d'une diversité exceptionnelle qui en font un des sites les plus importants de la vallée du Rift Albertin, elle-même une des régions écologiquement les plus riches d'Afrique et au niveau du globe (UNESCO, 2013). Ainsi, il compte 136 espèces de mammifères, parmi lesquelles le gorille de plaine de l'Est qui est la vedette et 13 autres primates comprenant des espèces menacées comme le chimpanzé, le colobe bai, et les cercopithèques de l'Hoest et d'Hamlyn (UNESCO, 2013; ICCN, 2010).

Cependant, notre étude a été conduite dans le territoire de Kabare dans sa partie située au nord de la ville de Bukavu et plus spécifiquement dans les groupements riverains du Parc National de Kahuzi Biega (Irambi, Bugorhe, Miti et Mudaka). Il est situé entre 28°45-28° 55' de longitude Est et 2° 30'-2° 50' de latitude Sud, avec une superficie de 1 960 km². Sa population est estimée à 496 169 habitants, avec une densité moyenne de 250 hab/km².

Suite à la croissance démographique, dans cette zone, la forêt est pratiquement substituée par des surfaces agricoles jusqu'à une certaine altitude d'environ 1 800m où les conditions de l'agriculture deviennent de plus en plus défavorables.

2.2 MATÉRIELS

- Le matériel biologique utilisé a été composé des champs paysans autour du parc ainsi que de l'aire protégée de Kahuzi-Biega,
- Un stylographe pour la transcription des informations récoltées sur le terrain.
- Un carnet de bord dans lequel les données recueillies sur terrain étaient transcrites,
- Le questionnaire d'enquête nous a permis de récolter différentes informations auprès des exploitants agricoles des villages riverains du PNKB.

2.3 MÉTHODES

2.3.1 CHOIX DE LA ZONE D'ÉTUDE

Les villages environnant le parc ont constitué le cadre général de notre étude et ont été retenus en fonction d'un certain nombre des critères, notamment, leur proximité avec les limites de la forêt du parc ainsi que leur accessibilité par rapport au moyen de transport disponible. Les villages enquêtés choisis suivant les critères épinglés ci-haut sont: les villages KABUSHWA et MABINGU dans le groupement d'IRAMBI, les villages KABULUNGU et MULANGALA dans le groupement de BUGORHE, les villages CIBINDA, CIRARANGWA, COMBO, BUYUNGULE, MUYANGE dans le groupement de MITI et enfin, le village KASIRUSIRU dans le groupement de MUDAKA.

2.3.2 CHOIX DE L'ÉCHANTILLON

Sur l'ensemble des villages dans lesquels l'étude a été effectuée, notre échantillon a porté sur 180 personnes réparties en 18 individus par villages, ce qui donne un total de 10 villages environnant le PNKB. Ce choix a été fait aléatoirement de manière à avoir une représentativité de la population de cette contrée.

2.3.3 MÉTHODES UTILISÉES

Outre la documentation, ce travail a fait appel à deux techniques utilisées sur le terrain. Il s'agit de:

2.3.3.1 OBSERVATION DIRECTE DE TERRAIN

Celle-ci nous a permis d'effectuer des sorties dans les villages environnant le Parc National de Kahuzi-Biega pour être en contact avec le milieu afin de préparer les étapes consacrées aux enquêtes proprement dites.

2.3.3.2 ENQUÊTES DE TERRAIN

Cette partie de collecte de données a été réalisée de Septembre à octobre 2014 et a porté sur les principales interrogations adressées aux riverains. Pour ce faire, un questionnaire d'enquête a été soumis auprès des populations riveraines et cela, 180 questionnaires, représentant 180 agriculteurs, leurs avaient été administrés. Pour enrichir nos données recherchées et avoir une source d'informations plus fiables, l'enquête s'accompagnait d'un sondage particulièrement confidentiel auprès des populations tant pygmées que non pygmées, car par peur de représailles, ils ont tendance à cacher les informations.

2.3.4 L'ANALYSE DES DONNÉES

L'encodage et l'analyse des données collectées sur le terrain ont été effectués à l'aide du logiciel Excel. Cet outil nous a permis de faire une analyse statistique descriptive afin de représenter les résultats en tableaux croisés dynamiques générés en termes de pourcentage. En plus, la statistique multivariée par l'analyse en composantes principales (ACP) a été réalisée grâce au logiciel R. cela nous a permis de synthétiser en forme des graphiques, l'ensemble des données quantitatives d'au moins deux variables (Ludovic et al. 1995).

3 RESULTATS

3.1 ACTIVITES PRINCIPALES

Le tableau 1 indique les différentes activités principales exercées par la population riveraine du PNKB.

Tableau 1. Différentes activités exercées autour et au sein du PNKB

Activités principales	Groupement				Total général
	Bugorhe	Irambi	Miti	Mudaka	
Agriculture	50.0%	50.0%	44.4%	77.8%	50.0%
Carbonisation	8.3%	-	4.4%	-	3.9%
Chasse	-	-	14.4%	22.2%	9.4%
Élevage	25.0%	16.7%	16.7%	0.0%	16.7%
Exploitation bois	16.7%	33.3%	20.0%	-	20.0%
Total général	100.0%	100.0%	100.0%	100.0%	100.0%

Il en résulte de ce tableau que 50 % des ménages riverains ont comme activité principale, l'agriculture, vient ensuite l'exploitation du bois avec 20 % des ménages, l'élevage 16,7 %, enfin viennent la chasse et la carbonisation avec respectivement 9,4 et 3,9 %.

3.2 ANALYSES DES SYSTEMES AGRICOLES AUTOUR DU PNKB

Dans le cadre de cette étude, les systèmes agricoles considérés sont principalement ceux issus de l'agriculture et de l'élevage.

3.2.1 AGRICULTURE

3.2.1.1 LOCALISATION DES CHAMPS

Les résultats se rapportant à la localisation des champs dans les villages riverains sont repris dans le tableau ci-dessous.

Tableau 2. Localisation des champs dans les villages riverains

Localisation des champs	Groupement				Total général
	Bugorhe	Irambi	Miti	Mudaka	
Dans le parc	0.0%	0.0%	0.0%	50.0%	5.0%
Extérieur parc	25.0%	25.0%	10.0%	16.7%	16.7%
Limite du parc	75.0%	75.0%	90.0%	33.3%	78.3%
Total général	100.0%	100.0%	100.0%	100.0%	100.0%

Il découle du tableau 2 que la plupart (78,3 %) des champs de nos enquêtés se situent à la limite du parc, suivi de 16,7 % à l'extérieur du parc, tandis que les 5 % des enquêtés avouent la localisation des champs dans le parc.

3.2.1.2 DIMENSION DES CHAMPS

Les résultats issus de l'enquête en rapport avec les superficies des champs des paysans agriculteurs sont indiqués dans le tableau suivant:

Tableau 3. Classification de champs selon leur dimension

Dimensions des champs	Groupement				Total général
	Bugorhe	Irambi	Miti	Mudaka	
100m ² -1ha	88.9%	72.7%	72.2%	0.0%	74.4%
1ha-2ha	11.1%	27.3%	27.8%	100.0%	25.6%
Total général	100.0%	100.0%	100.0%	100.0%	100.0%

De ce tableau 3, on observe qu'une grande proportion (74,4 %) des enquêtés disposent des champs ayant une superficie comprise entre 100m² et 1ha contre 25,6 % disposant des champs dont la superficie se place entre 1ha et 2ha.

3.2.1.3 TECHNIQUES D'OUVERTURES ET INTRANTS DE RESTAURATION

Les résultats de l'enquête relatifs aux techniques d'ouverture des champs et d'intrants de restauration des sols utilisées par les agriculteurs sont présentés dans le tableau 9 qui suit:

Tableau 4. Technique d'ouverture et intrants de restauration utilisés

Techniques d'ouvertures champs	Groupement				Total général
	Bugorhe	Irambi	Miti	Mudaka	
Coupe de forêt	58.3%	58.3%	63.3%	66.7%	61.7%
Feux brousse	41.7%	41.7%	33.3%	33.3%	36.7%
NR	0.0%	0.0%	3.3%	0.0%	1.7%
Intrants de restauration					
Aucun apport	50.0%	50.0%	63.3%	100.0%	61.7%
Engrais chimique	16.7%	25.0%	0.0%	0.0%	8.3%
Engrais organique	33.3%	25.0%	36.7%	0.0%	30.0%

Soixante et un virgule sept pourcent des enquêtés confirment avoir coupé la forêt pour ouvrir les champs à cultiver contre 36,7 % témoignant de l'utilisation de feux de brousse tandis que les 1,7 % n'ont pas donné des réponses à cette question.

En termes d'intrants de restauration des sols, 61,7 % de nos enquêtés n'apportent aucun engrais dans leurs champs. Trente pourcent recourent à l'apport des engrais organiques et 8,3 % utilisent les engrais chimiques pour restaurer les sols.

3.2.1.4 PRATIQUE DE L'AGROFORESTERIE ET DE LA JACHERE

Les résultats présentés dans le tableau suivant donnent une connaissance de savoir si les agriculteurs pratiquent ou non l'agroforesterie et la jachère.

Tableau 5. Opinion des enquêtés sur la pratique de l'agroforesterie et de la jachère

Pratique agroforestière	Groupement				Total général
	Bugorhe	Irambi	Miti	Mudaka	
Non	50.0%	66.7%	60.0%	66.7%	60.0%
Oui	50.0%	33.3%	40.0%	33.3%	40.0%
Pratique jachère					
Non	83.3%	91.7%	86.7%	100.0%	88.3%
Oui	16.7%	8.3%	13.3%	0.0%	11.7%

L'analyse du tableau 5 montre que la majorité des enquêtés ne pratiquent pas ni l'agroforesterie (60 %) ni la jachère (88,3 %) contre 40 % des enquêtés qui pratiquent ou recourent à cette technique d'agroforesterie et 11,7 % recourant à la jachère.

3.2.1.5 REPARTITION DES CULTURES PRATIQUEES PAR LES RIVERAINS

L'analyse en composante principale (ACP) reprise sur la figure ci-dessous illustre la répartition des différentes cultures pratiquées dans le territoire de Kabare.

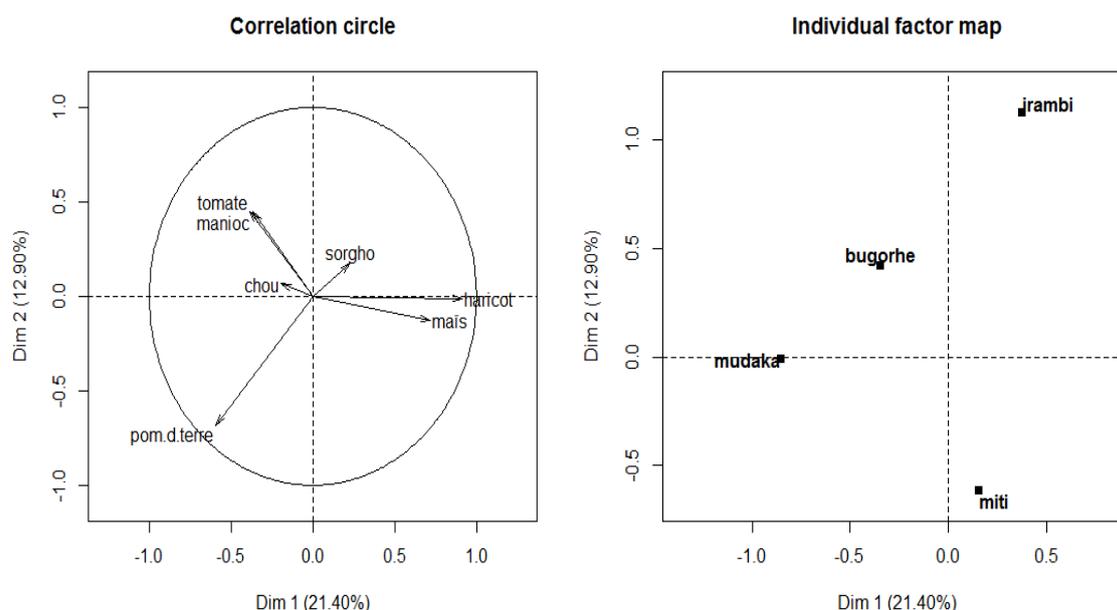


Fig. 1. Répartition des différentes cultures pratiquées dans le territoire de Kabare

Il découle de cette figure que les cultures pratiquées dans cette contrée sont réparties selon les aires de culture. Ainsi, on remarque le chou, la tomate et le manioc sont beaucoup plus cultivés dans le groupement de Bugorhe, par contre le sorgho n'est cultivé que dans le groupement d'Irambi, mais les paysans de cette partie de la province pratiquent aussi la culture de haricot. Les résultats obtenus montrent aussi le maïs est plus cultivé dans le groupement de Miti que partout ailleurs mais aussi la pratique de la pomme de terre est plus remarquée dans le groupement de Mudaka.

3.2.1.6 SYSTEME DE CULTURE ET ROTATION CULTURALE

Les résultats relatifs aux systèmes et rotation des cultures paysannes sont présentés par le tableau 6:

Tableau 6. Systèmes et rotation de cultures pratiqués

Système cultural	Groupement				Total général
	Bugorhe	Irambi	Miti	Mudaka	
Association	25.0%	50.0%	70.0%	50.0%	55.0%
Monoculture	75.0%	50.0%	30.0%	50.0%	45.0%
Pratique rotation culturale					
Non	75.0%	75.0%	83.3%	100.0%	81.7%
Oui	25.0%	25.0%	16.7%	0.0%	18.3%

A l'issu du tableau 6, on observe que 55 % des enquêtés pratiquent l'association culturale tandis que 45 % font la monoculture. Il en découle en plus que la majorité de la population enquêtée soit 81,7 % ne pratiquent pas la rotation culturale. Seule 18,3 % admettent cette pratique.

3.2.1.7 AMANDEMENT DU SOL DANS LES CHAMPS ET ESTIMATION (APPRECIATION) DE LA FERTILITE DES SOLS

Les résultats de l'enquête portant sur la connaissance de la pratique de l'amendement du sol et de l'estimation de la fertilité des sols par les paysans agriculteurs sont repris au tableau 7:

Tableau 7. Opinion des enquêtés sur l'amendement et l'appréciation de la fertilité des sols dans les champs

Amendement des sols	Groupement				Total général
	Bugorhe	Irambi	Miti	Mudaka	
Non	66.7%	75.0%	76.7%	83.3%	75.0%
Oui	33.3%	25.0%	23.3%	16.7%	25.0%
Appréciation de la fertilité des sols					
Assez bonne	8.3%	8.3%	13.3%	0.0%	10.0%
Bonne	58.3%	50.0%	53.3%	50.0%	53.3%
Excellente	0.0%	0.0%	3.3%	33.3%	5.0%
Médiocre	8.3%	25.0%	10.0%	0.0%	11.7%
Moyenne	25.0%	16.7%	20.0%	16.7%	20.0%

Les résultats repris dans le tableau 7 montrent qu'une grande proportion des enquêtés n'amende pas les sols de leurs champs. Vingt-cinq pourcent des enquêtés ont avoué l'amendement des sols et que 53,3 % des enquêtés estiment la bonne fertilité de leurs sols, suivis de 20 % qui ont dit que leurs sols ont une fertilité moyenne contre ceux-là qui ont parlé de l'état médiocre et assez bon de fertilité des sols représentent respectivement 11,7 et 10 %. Seulement 5 % des enquêtés ont estimé une fertilité excellente.

3.2.1.8 CONNAISSANCE DES IMPACTS DES PRATIQUES CULTURALES SUR LES RESSOURCES NATURELLES

Les résultats de l'enquête révélant la connaissance des impacts des pratiques culturales sur les ressources naturelles sont soutenus par le tableau 8.

Tableau 8. Opinion des enquêtés sur la connaissance des impacts des pratiques culturales sur les ressources naturelles

Impacts pratiques culturales sur RN	Groupement				Total général
	Bugorhe	Irambi	Miti	Mudaka	
Non	8.3%	0.0%	10.0%	33.3%	10.0%
Oui	91.7%	100.0%	90.0%	66.7%	90.0%
Total général	100.0%	100.0%	100.0%	100.0%	100.0%

Il résulte du tableau 8 que 90 % des enquêtés admettent que leurs pratiques culturales présentent des impacts sur les ressources naturelles du PNKB contre 10 % qui n'en connaissent rien.

3.2.2 ELEVAGE

3.2.2.1 ESPECES D'ELEVAGE

La répartition des espèces animales élevées dans le territoire de Kabare (villages riverains du PNKB) se trouve reprise sur la figure ci-dessous:

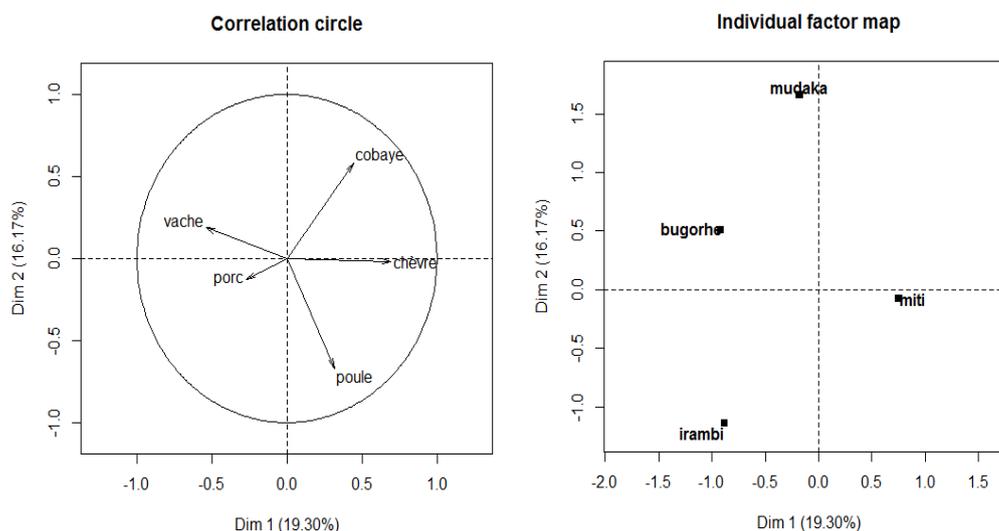


Fig. 2. Espèces animales élevées par les riverains

De cette figure on remarque qu'on élève les mêmes espèces animales dans les groupements de Mudaka et Miti et ce, le cobaye et la vache, tandis que le porc est beaucoup élevé à Irambi et qu'on élève beaucoup des poules à Miti. La chèvre quant à elle, elle est élevée tant à Miti qu'à Mudaka. De ces résultats, on peut se dire que les ménages élèvent les animaux de petits et gros bétails ainsi que ceux de basses courtes.

3.2.2.2 LOCALISATION ET ETAT DES PATURAGES

Les résultats de l'enquête en rapport avec la localisation et l'état des zones des pâturages sont présentés par le tableau 9.

Tableau 9. Localisation des pâturages et perception des éleveurs sur l'état des pâturages

Localisation pâturage	Groupement				Total général
	Bugorhe	Irambi	Miti	Mudaka	
Dans le parc	0.0%	0.0%	0.0%	25.0%	2.9%
Extérieur parc	50.0%	75.0%	82.4%	50.0%	71.4%
Limite parc	50.0%	25.0%	17.6%	25.0%	25.7%
Etat pâturage					
Diminution	66.7%	50.0%	76.5%	25.0%	62.9%
Fixe	33.3%	50.0%	23.5%	75.0%	37.1%

Il en résulte de ce tableau 9 que le pâturage de la plupart (71,4 %) des enquêtés se trouve à l'extérieur du parc. La limite du parc sert de pâturage à 25,7 % de nos enquêtés tandis que 2,9 % localisent le pâturage dans le parc. Il se montre une diminution de l'état des pâturages pour 62,9 % des enquêtés contre 37,1 % ayant admis que les pâturages sont dans un état fixe. Serigne Modou, 2008, dans son étude sur le parc national de deux Balés au Burkinafaso y dénote la forte présence des pâturages.

3.2.2.3 SYSTEME ET MODE D'ELEVAGE PRATIQUES

Les résultats de l'enquête sur le système et mode d'élevages pratiqués par les éleveurs sont dévoilés par le tableau 10.

Tableau 10. Système et mode d'élevage pratiqués par les riverains éleveurs

Système élevage	Groupement				Total général
	Bugorhe	Irambi	Miti	Mudaka	
Extensif	66.7%	62.5%	47.1%	50.0%	54.3%
Semi-intensif	33.3%	37.5%	52.9%	50.0%	45.7%
Mode élevage					
Divagation	66.7%	62.5%	70.6%	50.0%	65.7%
Piquet	16.7%	0.0%	11.8%	25.0%	11.4%
Semi-stabulation	16.7%	37.5%	17.6%	25.0%	22.9%

Il ressort du tableau 10 que le système d'élevage fréquemment pratiqué par les riverains est le système d'élevage de type extensif avec une proportion de 54,3 % des enquêtés et le système d'élevage de type semi-intensif avec 45,7 % tandis que la divagation est le mode d'élevage couramment pratiqué par les éleveurs et ce, il regroupe 65,7 % des enquêtés. Vingt-deux virgule neuf pourcent des éleveurs appliquent le mode en semi-stabulation et 11,4 % attachent leurs bêtes au piquet.

4 DISCUSSIONS

Toutes les activités pratiquées autour du site de notre étude ont un impact sur la conservation de sa diversité biologique.

La forêt du parc de Kahuzi-Biega étant une aire protégée, elle doit être exempte (préservée) de toute forme d'activité occasionnant sa dégradation. La localisation des champs dans cette aire, quel que soit leurs nombre et dimension, constitue un grand danger à ses ressources naturelles et donc un facteur menaçant pour la destruction des ressources naturelles de cet écosystème. Selon les informations de la part des paysans, la localisation de nombreux champs à la limite du parc et d'autres à l'intérieur se justifie par le fait qu'ils considèrent que c'est à ces endroits où les terres sont encore fertiles et que ces champs touchent sur la ligne même de limite du parc. A cet effet, des conflits surgissent entre cette aire protégée et la population locale à la suite des problèmes de dévastation des cultures par les animaux du parc.

Ces résultats sont en accord avec les littératures révélant que les activités anthropiques parmi lesquelles l'agriculture, menacent la conservation des ressources naturelles. Ainsi, le réseau CREF 2004, dénonce l'exploitation agricole dans les aires protégées de la RDC. En plus, Serigne Modou, 2008, dans son étude sur le parc national de deux Balés au Burkinafaso y dénote la forte présence des pâturages.

On constate que les riverains exploitent des champs de très petites étendues pour leur subsistance. Cela, par manque des étendues à cultiver. Ils doivent cependant pour surmonter ce problème, adopter une agriculture intensive (réduction des espaces à cultiver pour accroître le rendement par usage d'intrants adéquats).

Les pratiques d'ouverture des champs (coupe de forêt et feux de brousse) sont dangereuses non seulement pour les ressources naturelles mais également pour l'environnement telles qu'elles sont conduites tant dans le parc (coupe forêt) qu'à l'extérieur du parc (coupe forêt et feux de brousse). Elles constituent une source importante d'émission des GES dans l'atmosphère et conduisent à un recul du couvert végétal. Kandala (2010) révéla et identifia que la coupe de forêt et l'agriculture conduites sous un feu de brousse sont des techniques d'ouvertures des champs qu'utilise la population sur nos réserves naturelles.

Pour ce qui est des intrants de restauration, on dénote leur faible emploi aussi bien pour l'amendement organique que minéral. Cette faiblesse d'utilisation d'engrais entraîne l'obtention de rendements médiocres et/ou faibles. Selon les paysans, le manque de moyen financier serait à la base de ce fléau. Peters 2002 (cité par Débroux *et al*, 2007) démontre que le moyen financier nécessaire pour l'utilisation des engrais est l'élément qui contribue à dissuader les paysans de les utiliser. Ces aboutissements sont comparables de ceux trouvés par BUSIME (2013) indiquant dans son étude qu'environ 53 % des riverains enquêtés pratiquent la technique rudimentaire c'est-à-dire sans aucun apport extérieur tandis que 6 % recourent aux engrais chimiques et 41 % utilisent la matière organique. Cependant la disponibilité des engrais chez les petits producteurs constitue un véritable problème du fait de la mauvaise organisation du marché des intrants, de leur prix élevé et le faible revenu des agriculteurs (Zingore, 2007). Titonell *et al*. 2005 indique que la disponibilité de la matière organique chez les paysans africains n'est pas garantie. D'où des petites quantités sont appliquées surtout dans des champs de case.

La non pratique de l'agroforesterie de la part de paysans résulte de non connaissance des avantages qu'elle présente. Pourtant, c'est une pratique qui permet de maintenir la fertilité des sols des cultures. Une publication de la FAO 2012, stipule que l'agroforesterie est un système intégré et durable de gestion agricole et forestière. Ceci serait mis en œuvre et développé par la population pour réduire le risque d'impact environnemental, indique la même publication FAO.

La jachère étant une pratique qui permet la régénération de la fertilité des sols par une mise en repos de terres exploitables, elle n'est pas pratiquée par la plupart des paysans riverains du PNKB car selon eux, le manque de grandes étendues à cultiver reste la cause de la non application de cette dernière. La durée de jachère pour ceux-là qui la mettent en pratique est de 1 an au maximum. Malgré la courte durée de jachère, les paysans n'arrivent pas à faire d'elle une jachère améliorée qui, pourtant permet la reconstitution rapide de la fertilité des sols des cultures. C'est pourquoi l'accroissement des superficies cultivées serait un atout pouvant permettre aux paysans de mettre en pratique cette technique de jachère et vu les problèmes financiers qu'ils connaissent pour se procurer des engrais chimiques.

Les cultures pratiquées par nos enquêtés sont cultivées dans la province du Sud-Kivu en général, particulièrement dans le territoire de Kabare et constituent à cet effet des cultures vivrières principales pratiquées dans la province (Monsengwo, 2009).

L'association culturale est une technique très adoptée et pratiquée par les agriculteurs riverains du PNKB car selon eux, le choix de celle-ci découle d'un manque des étendues à cultiver pouvant leur permettre de cultiver une culture monospécifique. L'association devra être faite avec surtout des plantes légumineuses pour permettre à d'autres plantes de bénéficier de l'azote fixé par les légumineuses.

Vu les problèmes qui se posent, notamment ceux d'attaques culturales par des maladies, les rotations culturales et ce, des longues rotations pourront être adoptées par les agriculteurs pour pallier à ces problèmes. La même publication de la FAO 2012, stipule que le système des cultures associées et les rotations des cultures sont des systèmes intégrés et durables de gestion agricole et forestière. Ceci serait mis en œuvre et développé par la population pour réduire le risque d'impact environnemental, indique la même publication FAO.

Il est à signaler que les matières utilisées par certains agriculteurs dans l'amendement des sols sont constituées des bouses, des ordures ménagères ainsi que des engrais verts. Le faible rendement enregistré par les agriculteurs découle du non amendement des sols dans beaucoup de champs de nos enquêtés.

La majorité des champs étant à la limite du parc, les paysans considèrent que les sols y sont encore fertiles et/ou ont encore une bonne fertilité. Pourtant, la surexploitation du site, le non amendement, l'inapplication d'intrants de restauration des sols constituent les facteurs d'épuisement de ces sols, d'où le faible rendement. Sanchez et *al.* 1997 ont conclu que l'épuisement de la fertilité des sols dans les exploitations agricoles constitue la principale cause de la baisse de la production alimentaire par habitant en Afrique. Selon les paysans, la médiocrité de rendement ne leur permet donc pas de l'estimer en termes quantitatifs. Seuls les paysans possédant les champs dans le parc ont jugé leurs sols à fertilité excellente.

Malgré les pressions agricoles sur le parc quel que soit leur degré (intensité), un bon nombre des riverains ont quand même pris connaissance des impacts de leurs activités exercées sur les ressources naturelles.

L'élevage pratiqué aux environs ou dans les aires protégées constitue, par sa présence de pâturage dans le site, une menace de celui-ci.

La majorité des pâturages étant localisée à l'extérieur du parc et qu'il s'y observe une forte pression due au surpâturage, la diminution de l'état de pâturage s'accroît, d'où son appauvrissement. Ce dernier fait que les éleveurs envahissent bien la limite que le parc à la quête du pâturage, ce qui constitue un péril des ressources floristiques de ce site.

Bien qu'aucune ferme ne se retrouve dans le parc, la menace se fait également par les animaux qui trouvent leur pâturage tant à l'intérieur qu'à la limite. Cette menace engendre autant de conflits entre éleveurs et gestionnaires du parc.

Les éleveurs pratiquant le système traditionnel extensif exposent sans le savoir leurs animaux à divers risques pouvant engendrer des problèmes de maladies, de diminution de rendement, etc. Pour surmonter ces derniers, les éleveurs doivent mettre sur pied le système d'élevage moderne. En outre, la divagation des animaux entraîne un envahissement du site et constitue une fois de plus de problèmes conflictuels soulevés précédemment. OKITAYELA, 2010, souligne que la pratique d'élevage extensif est responsable du pâturage qui débouche sur les phénomènes de dégradation des sols. A cet effet, la pratique de celui-ci par les riverains du PNKB occasionne une dégradation des sols et donc l'épuisement de la fertilité des sols de cette contrée.

5 CONCLUSION

La présente étude poursuivait comme objectif, l'analyse des systèmes agricoles exercés par les paysans autour du PNKB.

Les résultats issus de l'enquête décèlent que l'agriculture, l'élevage, l'exploitation du bois, la chasse (braconnage) sont les principales activités y exercées par les paysans.

- Les résultats sur l'agriculture prouvent que les techniques d'ouverture des champs paysans se font par la coupe forestière et le feu de brousse, les intrants de restauration des sols sont faiblement utilisés par les agriculteurs et que des mesures pouvant améliorer et maintenir la fertilité des sols sont moins envisagées.
- Quant à l'élevage, le système d'élevage pratiqué est du type extensif avec un mode en divagation se traduisant par une diminution de l'état des pâturages.
- Enfin, du fait de la précarité des pratiques agricoles observées dans le site de notre étude, une forte probabilité de menace sur le parc par les riverains à la recherche de satisfaction de leurs besoins et ainsi réduire la pauvreté n'est pas redoutable.

De ces conclusions, les recommandations ci-après peuvent être formulées:

- **Aux gestionnaires du PNKB de:**
 - Former toute la population sur le développement des activités alternatives et génératrices de revenus pouvant mettre le parc à l'abri de toute menace;
- **Aux populations riveraines de:**
 - Utiliser les mécanismes de maintien et d'amélioration de fertilité des sols des villages ou mettre en œuvre la technique d'agroforesterie en vue d'obtenir les rendements élevés et ainsi limiter l'envahissement du PNKB;
 - Créer les pâturages des cultures à haute valeurs bromatologiques dans les villages constitue le seul moyen de conserver les ressources floristiques de cette aire protégée.

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Gender and Motivation in Problem-Based Learning

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ABSTRACT: Motivation is considered the heart of the learning process that is affected by many factors, among which there is gender. Therefore, the researcher conducted a quantitative research method to investigate the relationship between gender and motivation sub-themes while using problem-based learning. Nine female students and eleven male students of the second baccalaureate level participated in the current research through using the convenience sampling technique. The quasi-experimental research design, a quantitative research method, is used to conduct this study to analyse cause-effect relationships between the variables being studied. Then, the participants were given a five-point Likert scale questionnaire to fill in. The SPSS software was used to analyse data. The findings demonstrated that there was a positive relationship between gender and students' achievement and motivation sub-themes.

KEYWORDS: Gender, motivation, gender and problem-based learning.

1 INTRODUCTION

Many scholars acknowledge the importance of motivation in learning as it can influence what, when, and how a learner learns (Pintrich & Schunk, 2002). Whereas motivated students tend to engage in activities that they believe will help them learn, unmotivated students are not able to be systematic in making an effort in learning, as are motivated students (Chafi, 2016). The importance of motivation is often emphasized in the field of language learning. That's, students' learning process becomes more successful by using motivational teaching methods that can enhance students' learning efficacy, and engage both males and females in the learning process. However, based on the review of literature and some studies, students' motivation in problem-based learning differs between males and females. It is believed that female students are highly motivated in the learning process and perform better than male students. Thus, the main aim of this study is to find out the extent to which both male and female students differ in terms of motivation sub-themes while using problem-based learning.

The present study addresses the following research questions:

1. Is there a relationship between gender and intrinsic motivation while using problem-based learning?
2. Is there a relationship between gender and extrinsic motivation while using problem-based learning?
3. Is there a relationship between gender and attitude motivation while using problem-based learning?

2 RESEARCH HYPOTHESES

A research hypothesis is the prediction about the possible outcome of the research or the experiment a researcher is conducting (Stofile, 2017). For this research study, the following hypotheses are tested:

- a. There is a significant relationship between gender and intrinsic motivation while using problem-based learning.
- b. There is a significant relationship between gender and extrinsic motivation while using problem-based learning.
- c. There is a significant relationship between gender and attitude motivation while using problem-based learning.

3 DEFINING CONTEXT

3.1 MOTIVATION

Motivation is considered an important element for learning and teaching process, but there is no agreement on the exact definition of motivation. Different schools of thought dealt with motivation from different corners, which have made the concept very hard to define (Keblawi, 2009). The behaviouristic approach, for example, defines motivation as an outcome of prize and reward. However, the cognitivists see that motivation is related to learner's inner decisions. The constructivists consider that the individual and social interactions are the main factors that foster and increase learners' motivation. They suggest that both the learner and the learning environment should be at the centre in conceptualizing motivation. Although these schools of thought see motivation from different angles, they all agree on the idea that an individual has a desire to fulfil a need, and this need is seen as something rewarding.

When we think of how to encourage learners to be productive and self-reliant, we indeed deal with motivation. According to Williams (2013), motivation in education is one of the most important factors that teachers should target to improve learners' engagement in the learning process and achieve academic success. This is due to the fact that learners are complex with complex needs and desires. In other words, learners need to be all the time motivated so that learning can be a continuous consistent process.

PROBLEM-BASED LEARNING

Problem-based learning is an instructional method in which students are the centre of the learning process. They work in collaborative groups in order to solve a problem. They engage in self-directed learning and apply their prior knowledge to solve problems (Cindy & Hmelo, 2004). The role of the teacher in this method is to facilitate the learning process and provide the suitable learning environment for students. The goal of problem-based learning is to help students develop motivation, effective problem-solving skills, autonomous learning skills, and collaboration. To clarify, constructing extensive and flexible knowledge goes beyond learning only facts about the subject. It involves integrating information across multiple domains. Such knowledge is coherently organized around the deep principles in a domain (Chi, Bassok, Lewis, Reimann & Glaser, 1989). The development of problem-solving skills or metacognitive skills refer to the controlling processes of planning problem solving, monitoring progress, and evaluating whether goals have been met (Hmelo, 2004). Problem-based learning is well suited to helping students become active learners because it makes students bear the responsibility for the learning process (Collins, 1989).

3.2 GENDER AND LEARNING

Gender is about the characteristics of women, men, girls, and boys that are socially constructed. This contains norms, behaviors, and roles associated with being a man, a woman, a girl, or a boy, as well as relationships with each other. It is worth studying gender because it has a strong impact on the student's motivation and performance. Based on the review of literature, there is a difference between female and male students in terms of motivation and achievement in the learning process. Besides, according to Dayioglu & Turut-Asik (2007), gender affects learners' performance. That is to say, female students are more active and motivated in the learning process than male students, especially when they are given the chance to participate in the learning process. This requires that teachers should adopt modern teaching pedagogies that put both sexes at the heart of learning.

4 RESEARCH METHODOLOGY

The main aim of this study is to investigate the relationship between gender and motivation while using problem-based learning as a student centered learning pedagogy. A quantitative research method is used to statistically measure the relationship between the variables under study.

4.1 RESEARCH DESIGN

The research design is the structure of research that consists of all the elements in a research project together. The research design of this study contains: The research sample, the data collection method, the measuring instruments, the data collection procedure, the data analysis procedure, and the validity and reliability for the research instruments.

4.1.1 RESEARCH SAMPLE

To conduct the current study, the researcher creates a group of twenty participants: nine female students and eleven male students. They are from different classes of the second baccalaureate level in Kacem Amine high school. The researcher used the convenience sampling technique, a non-probability sampling type. This is due to the fact that this study is conducted only in one high school where participants are conveniently available because it is very difficult to have access to the full target population of all the second baccalaureate students in Morocco for a representative sample. Thus, the outcome of this study can be applicable only to the population of the high school where the present study is conducted.

4.1.2 DATA COLLECTION METHOD

The experimental research design, a quantitative research method, is used to conduct this study to analyse cause-effect relationships between the variables being studied. The results of the experimental design can be statistically analysed and so there can be little argument about the results.

4.1.3 MEASURING INSTRUMENTS

The current study uses a post-test and a five-point Likert scale questionnaire as main instruments to find answers to the research questions. These research methods are meant to collect data on gender motivation and achievement when they are assigned a problem-based activity.

4.1.4 DATA COLLECTION PROCEDURE

The researcher met all the participants in the classroom for two hours. The participants sat separately from each other. They were given a problem to solve in half an hour. The problem was related to the content of the textbook. Then, they were exposed to a post-test. After the test, they were given a five-point Likert scale questionnaire to fill in so that the researcher could know his participants' motivation and reactions about problem-based learning.

4.1.5 DATA ANALYSIS PROCEDURE

The Statistical Package for the Social Sciences (SPSS) is used to analyze raw data.

5 RESULTS**5.1 FINDINGS OF THE POST-TEST**

T-test was used to compare the means of female category and male category. Data was taken from the post-test grades. As stated in table#1#, the means of the two categories are different. The mean of females is 17, 67, whereas the mean of males is 14, 91. In addition, in the independent samples test table#2#, it is observed that the p-value is 0.001, which is smaller than 0.05. This indicates that there is a positive relationship between gender and motivation, and this relationship is statistically significant.

Table 1. Gender Distribution among Respondents

Group Statistics					
	Sex	N	Mean	Std. Deviation	Std. Error Mean
Students' grades	Female	9	17,67	,707	,236
	Male	11	14,91	1,044	,315

Table 2. Independent Sample Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Students' grades	Equal variances assumed	1,150	,298	6,741	18	<,001	2,758	,409	1,898	3,617
	Equal variances not assumed			7,010	17,484	<,001	2,758	,393	1,929	3,586

5.2 FINDINGS OF THE QUESTIONNAIRE

5.2.1 GENDER RELATIONSHIP WITH EXTRINSIC MOTIVATION

Pearson’s correlation tests are used to find the significant correlation between gender and students’ motivation sub-themes and the strength of the relationship between them. In one item of the extrinsic motivation items in the questionnaire, participants are asked if they are motivated by problem-based activity to receive attention, care, and good marks. The correlation table#3# shows that the correlation coefficient is (r =.508), and p-value=.022. As a consequence, there is a positive correlation between gender and extrinsic motivation, and this correlation is statistically significant.

Table 3. Correlations

Correlations

Gender	Pearson Correlation	1	,508 [*]
	Sig. (2-tailed)		,022
	N	10	10
Problem activities make me work hard to receive attention, care, and good marks from my teacher	Pearson Correlation	,508 [*]	1
	Sig. (2-tailed)	,022	
	N	10	10

*. Correlation is significant at the 0.05 level (2-tailed).

5.2.2 GENDER RELATIONSHIP WITH INTRINSIC MOTIVATION

Participants are asked if the problem-based activity revives their inner energy to be responsible for their learning. According to the correlation table#4#, there is a positive correlation between gender and intrinsic motivation because the correlation coefficient is (r =.532). This correlation is statistically significant at the.016 level.

Table 4. Correlations

Correlations

Gender	Pearson Correlation	1	,532 [*]
	Sig. (2-tailed)		,016
	N	10	10
Problem activities revive my inner energy to be responsible for my learning	Pearson Correlation	,532 [*]	1
	Sig. (2-tailed)	,016	
	N	10	10

*. Correlation is significant at the 0.05 level (2-tailed).

5.2.3 GENDER RELATIONSHIP WITH ATTITUDE MOTIVATION

Concerning the item of attitude motivation, participants are asked if the problem-based activity makes them love learning English, love their teacher, and classmates. According to correlation table#5#, the correlation coefficient is ($r = .554$). This correlation is statistically significant at the .011 level. This explains the fact that there is a positive correlation between the two variables, gender and attitude motivation.

Table 5. Correlations

Correlations			
Gender	Pearson Correlation	1	,554*
	Sig. (2-tailed)		,011
	N	10	10
Problem activities make me love learning English, love my teacher and my classmates	Pearson Correlation	,554*	1
	Sig. (2-tailed)	,011	
	N	10	10

*. Correlation is significant at the 0.05 level (2-tailed).

6 DISCUSSION

The findings of the independent Sample t-Test reveal that females and males differ on the level of their overall achievement and motivation. In other words, the means of the two categories are different. The mean of females is 17, 67, whereas the mean of males is 14, 91. Besides, the means of the two groups are statistically significant because the p-values are smaller than the theoretical significance level. Moreover, Pearson correlation tests are also used to measure gender relationship with motivation sub-themes, namely extrinsic motivation, intrinsic motivation, and attitude motivation. The correlation tests show that there is a positive and statistically significant relationship between gender and students' extrinsic motivation because the value of the correlation coefficient is ($r = .508$), and the p-value is (.022). There is also a positive and statistically significant relationship between gender and students' intrinsic motivation because the correlation coefficient is ($r = .532$), and the p-value is (.016). Concerning attitude motivation, the value of the correlation coefficient is ($r = .554$). Furthermore, the p-value is (.011), which is less than (.05). This means that there is a positive and statistically significant correlation between gender and students' attitude motivation. Consequently, the alternative hypotheses stating that there is a predictive link between gender and students' motivation sub-themes are accepted.

Similar to what has been shown by the findings of the current study where gender is associated with students' motivation, gender issues have been discovered to play an important role in motivation and learning. In other words, the findings of the present study are supported by numerous studies such as: Caro et al., (2009), Garkaz, Banimahd & Esmaili, (2011). These studies demonstrate that females perform better than males. The findings of this research are also supported by the study of Jelas & Ali, (2010). They claim that there are variances in the cognitive-motivational function of male and female in the learning process, and girls were found to have an extra adaptive attitude towards educational tasks.

7 CONCLUSION

Based on the findings of the present study and the findings of the previous studies that are conducted by other researchers to investigate the type of relationship between gender and students' achievement and motivation in the learning process, it is concluded that gender is one of the other main factors that affects students' achievement and motivation in the learning process. In other words, when female students are no longer passive learners and are given the chance to be responsible for their learning, they can be highly motivated and perform better than male students in the learning process. Besides, the gender variable is shown to have an effect on classroom participation. This, according to the study, may be due to the fact that most females are interested in the subject they are studying more than males, or it can be related to the teaching pedagogy the researcher relies on. Therefore, to make the subject more interesting for both males and females, teachers should create an active learning environment where students are given the chance to be the leaders of their learning process. This can be done

by adopting student-centred learning methods such as problem-based learning where students are put at the heart of the learning process.

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Lymphome splénique de la pulpe rouge révélé par une anémie hémolytique auto-immune

[Splenic diffuse red pulp small B-cell lymphoma revealed by autoimmune hemolytic anemia]

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ABSTRACT: Diffuse splenic small cell red pulp lymphoma (SDRPL) is a rare type of indolent non-Hodgkin's lymphoma composed of small B cells that involve the red pulp of the spleen, bone marrow, and peripheral blood. It was included in the 2016 revised WHO classification as splenic B-cell lymphoma/leukemia, unclassifiable.

We report through this observation the case of a patient in whom the SDRPL was revealed by an autoimmune hemolytic anemia, and whose study of the blood smear made it possible to suspect an initial diagnosis, consolidated secondarily by the results of immunophenotyping.

KEYWORDS: immunophenotyping, splenic lymphoma, villous lymphocytes, hemolytic anemia, blood smear.

RESUME: Le lymphome splénique diffus à petites cellules de la pulpe rouge (SDRPL) est un type rare de lymphome non hodgkinien indolent, composé de petits lymphocytes B qui impliquent la pulpe rouge de la rate, la moelle osseuse et le sang périphérique. Il a été inclus dans la classification révisée de l'OMS de 2016 dans la catégorie lymphome/leucémie splénique à cellules B, inclassable.

Nous rapportons à travers cette observation le cas d'un patient chez lequel le SDRPL a été révélé par une anémie hémolytique auto-immune, et dont l'étude du frottis sanguin a permis de suspecter un diagnostic initial, consolidé secondairement par les résultats de l'immunophénotypage.

MOTS-CLEFS: immunophénotypage, lymphome splénique, lymphocytes villos, anémie hémolytique, frottis sanguin.

1 INTRODUCTION

La classification 2008 de l'Organisation mondiale de la santé (OMS) a établi une nouvelle entité provisoire, le lymphome splénique diffus à petites cellules de la pulpe rouge (SDRPL). Il a été inclus, par la suite, dans la classification révisée de l'OMS de 2016 dans la catégorie lymphome/leucémie splénique à cellules B, inclassable [1].

Le SDRPL est une entité rare qui représente environ 9 % des lymphomes B spléniques, et moins de 1 % des syndromes lymphoprolifératifs B (SLP-B) avec dissémination sanguine; l'incidence étant toutefois difficile à évaluer compte tenu du faible nombre de séries publiées [2]. Il est défini par une atteinte diffuse de la pulpe rouge splénique par un infiltrat de petits lymphocytes B. La dissémination dans la moelle osseuse ainsi que l'identification des lymphocytes villeux dans le sang périphérique sont également des caractéristiques de cette entité pathologique, mais sont loin d'être spécifique [3].

Il existe un chevauchement considérable des caractéristiques cliniques et morphologiques avec d'autres lymphomes se manifestent par une splénomégalie et une hyperlymphocytose à lymphocytes villeux tels que le lymphome de la zone marginale splénique, la leucémie à tricholeucocytes et son variant [4], [1]. Dans 10% des cas, il est associé à des manifestations auto-immunes [1].

Nous rapportons à travers cette observation le cas d'un patient chez lequel le SDRPL a été révélé par une anémie hémolytique auto-immune, et dont l'étude du frottis sanguin a permis de suspecter un diagnostic initial, confirmé secondairement par immunophénotypage.

2 OBSERVATION

Il s'agit d'un patient de 64 ans, sans antécédents pathologiques particuliers, qui a présenté depuis 1 mois un syndrome anémique, une asthénie généralisée et un amaigrissement chiffré à 7kg. L'examen clinique a révélé un subictère, une pâleur, et une splénomégalie à 2 travers de doigt du rebord costal, sans hépatomégalie. Les aires ganglionnaires périphériques étaient libres. Une première numération formule sanguine (NFS) a été réalisée, et a objectivé une hyperleucocytose à 29G/l dont 26 G/l de lymphocytes, une anémie macrocytaire à 2,78g/dL et des plaquettes à 195 G/l. Le patient a bénéficié d'une transfusion en urgence et a été adressé à notre formation. Une deuxième NFS a été réalisée 10 jours après, et a objectivé une hyperleucocytose à 20 G/l sans formule leucocytaire, une anémie normochrome macrocytaire à 5,9 g/d, très régénérative avec un taux de réticulocytes à 314 000/ mm³ et des plaquettes à 161 G/l. L'étude du frottis sanguin a montré une hyperlymphocytose périphérique faite de 2 populations lymphocytaires: 70% de lymphocyte de petite taille, avec un rapport nucléo-cytoplasmique à 0,9, et chromatine dense et 30 % de lymphocyte de petite et moyenne taille, présentant un noyau mature à chromatine mottée sans nucléole visible ou de petite taille, un cytoplasme basophile d'abondance variable et présentant des villosités franches réparties en plusieurs pôles (Figure 1).

Un bilan biochimique d'hémolyse a été réalisé, objectivant une hyperbilirubinémie à 83 umol/L, à prédominance libre, avec une LDH à 689 U/L, et une hyperferritinémie à 775ng/mL. Le test direct de l'antiglobuline était positif. Devant ce tableau, le diagnostic d'une anémie hémolytique auto-immune a été retenu.

L'immunophénotypage des lymphocytes B circulants par cytométrie en flux a mis en évidence une population CD20+ (100 %), CD22+ (100 %), CD79b+ (95 %), CD11c + (87%), IgM+ (38 %), lambda+ (75 %), FMC7+ (93 %), CD180 +, CD 123-, CD24-, CD27-, CD5-, CD10-, CD23-, CD43-, CD25-, CD103-, CD 38-. Le score de Matutes calculé était à 0/5 éliminant ainsi le diagnostic de leucémie lymphoïde chronique, alors que le score de l'équipe lyonnaise était supérieur à 3 permettant ainsi d'individualiser le SDRP [5]. Le caryotype a été demandé, mais non réalisé, faute de moyen chez le patient. La tomodynamométrie thoraco-abdomino-pelvienne objectivait une splénomégalie avec 16,5 cm de grand axe, siège d'une lésion hypodense triangulaire périphérique, associé à de multiples adénopathies profondes cardio-mésentériques et latéro-aortiques, hépatiques, spléniques, axillaire et inguinales bilatérales, dont certaines sont supra centimétriques. Les sérologies des hépatites C et B étaient négatives.

Une splénectomie à visée diagnostique et thérapeutique a été réalisée montrant un processus tumoral d'aspect multi nodulaire, de couleur blanc grisâtre. L'examen microscopique a montré une prolifération lymphomateuse diffuse parfois nodulaire, faite de cellules de taille petite, au cytoplasme réduit amphophile et aux noyaux irréguliers, avec la présence en périphérie d'une infiltration sinusoidale.

3 DISCUSSION

Le SDRPL est un type rare de lymphome non hodgkinien indolent, composé de petits lymphocytes B qui impliquent la pulpe rouge de la rate, la moelle osseuse et le sang périphérique. Le SDRPL a d'abord été reconnu comme une entité provisoire dans

la classification OMS des néoplasmes lymphoïdes de 2008 [6], et est maintenant regroupé sous le lymphome/leucémie splénique à cellules B, inclassable selon la révision 2016 de la classification de l'OMS [1].

La véritable incidence du SDRPL est inconnue; Il représente moins de 10 % des lymphomes à cellules B diagnostiqués par splénectomie [7]. Les patients sont généralement âgés de plus de 40 ans et la représentation des hommes est légèrement plus élevée que celle des femmes [8].

La présentation leucémique est typique, avec une splénomégalie massive et une ampleur variable des cytopénies. Des manifestations auto-immunes peuvent être associés aggravant ainsi les cytopénies. Les frottis périphériques montrent la morphologie villeuse caractéristique imitant la leucémie à tricholeucocytes, variante de la leucémie à tricholeucocytes et les lymphomes de la zone marginale qui sont les principaux diagnostics différentiels, cependant, les nucléoles sont discrets [8]. Une atteinte de la moelle osseuse a été observée dans tous les cas signalés à ce jour, avec un schéma de croissance intrasinusoïdal et interstitiel [4].

Le diagnostic repose principalement l'histologie splénique, l'immunohistochimie et l'immunophénotypage. Les cellules lymphomateuses expriment les différents pan-B et en particulier fortement le CD22. Elles n'expriment généralement pas les CD5, CD23 et CD43. Il n'existe pas de marqueurs immunologiques spécifiques de cette entité, mais le SDRPL se distingue des autres lymphomes spléniques à petites cellules B par un profil particulier obtenu par cytométrie en flux: négativité des CD123/CD25/CD38/CD24/CD27 et forte positivité des CD11c/CD22 [9]. Une équipe lyonnaise a posé un score basé sur 5 paramètres (cinq points de valeur 1 ou 0): 1 point est attribué en cas de forte positivité des CD22, CD11c et CD76, de négativité des CD38 et CD27, et un score supérieur à 3 est en faveur d'un SDRPL [5].

L'histologie de la rate montre une infiltration diffuse de la pulpe rouge due à de petits lymphocytes monotones provoquant une quasi-oblitération de la pulpe blanche [2]. L'immunohistochimie des cellules néoplasiques montre une positivité pour CD19, CD20 et Bcl-2 et une négativité habituelle pour CD5, CD10, CD23, CD43, Bcl-6, MUM1, cycline D1, CD11c, CD25, CD123 et annexine A1 [7].

Aucune mutation génétique spécifique ou anomalie chromosomique n'a été identifiée, sur la base des études jusqu'à présent, bien que des cas occasionnels aient montré une del 7q, del 17p (TP53) et une trisomie 18 [4].

Le SDRPL suit une évolution cliniquement bénigne avec un taux de survie à long terme favorable. Le diagnostic de SDRPL doit être posé sur la base d'une constellation de caractéristiques cliniques, de la morphologie du frottis périphérique, de l'histologie de la moelle et de la rate, de l'immunophénotypage et de la cytogénétique. La différenciation est essentielle car le SDRPL a un bon pronostic et résiste à la chimiothérapie conventionnelle habituellement efficace pour le traitement des leucémies à tricholeucocytes, la variante de la leucémie à tricholeucocytes et les lymphomes de la zone marginale. C'est une maladie indolente mais incurable avec une bonne réponse après splénectomie.

4 CONCLUSION

Le SDRPL est une entité extrêmement rare, récemment reconnue par l'OMS. L'étude cytologique est une étape essentielle dans la démarche diagnostique. L'immunophénotypage, l'étude histologique et l'immunohistochimie permettent de le distinguer des autres lymphomes spléniques. Le cas présent souligne la nécessité de la recherche d'un lymphome lors de la découverte d'une AHAI.

POINTS À RETENIR:

- Le SDRPL est un type rare de lymphome non hodgkinien indolent
- Chevauchement considérable des caractéristiques cliniques et morphologiques entre le SDRPL, le lymphome de la zone marginale splénique, la leucémie à tricholeucocytes et son variant
- Importance d'une évaluation morphologique minutieuse du frottis sanguin
- Fréquence des manifestations auto-immunes qui peuvent être révélatrices
- Place angulaire de l'immunophénotypage, de l'histologie et de l'immunohistochimie pour la confirmation du diagnostic du SDRPL

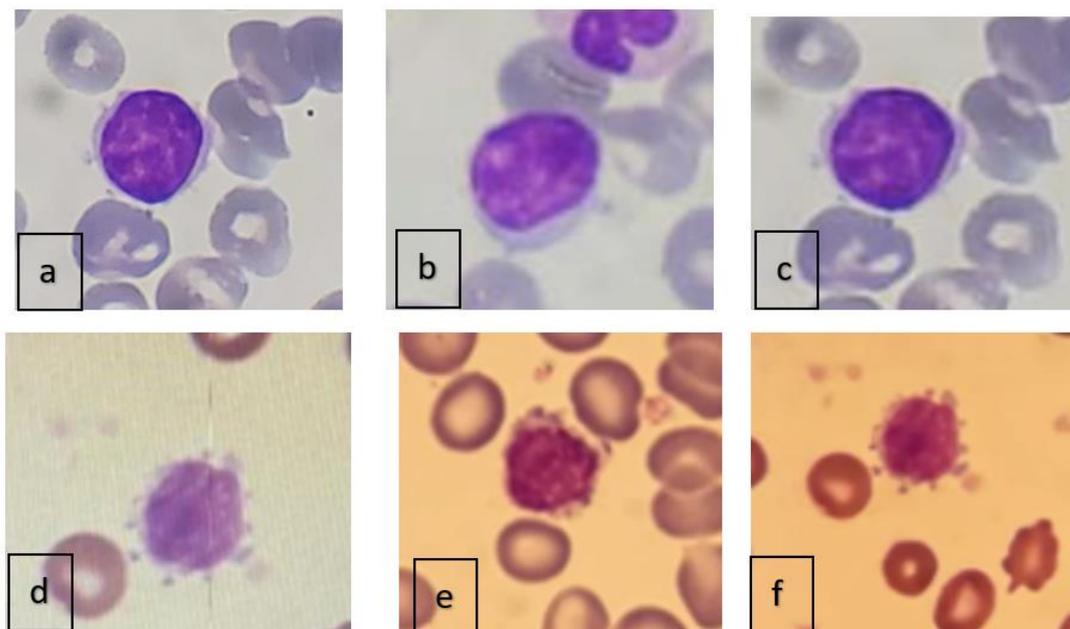


Fig. 1. Aspect cytologique du frottis sanguin (MGG x 100)

Les figures a, b, c, d, e, f montrent des lymphocytes villos retrouvés dans différents frottis sanguin. Ce sont des lymphocytes de taille petite à moyenne, présentant un noyau mature sans nucléole et un cytoplasme assez abondant légèrement basophile et une membrane externe émettant des projections villos polaires.

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Modélisation agro-hydrologique de l'impact des pressions anthropiques sur les flux d'eau entrant dans la retenue destinée à l'approvisionnement en eau potable de la ville de Issia (Centre-ouest de la Côte d'Ivoire)

[Agro-hydrological modelling of the impact of anthropic pressures on water flows entering the reservoir intended for the drinking water supply of the city of Issia (Central-Western Côte d'Ivoire)]

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ABSTRACT: The water of the Issia reservoir is used to supply drinking water to the local population. Unfortunately, the various anthropogenic pressures in the Lobo watershed threaten the quantity of water flows entering the Issia reservoir. The objective of this study is to assess the impact of the combined actions of anthropization and climate change on the water flows entering the Issia reservoir. The approach implemented was based on the coupling of remote sensing and agro-hydrological modeling with SWAT. The diachronic analysis of Landsat 7 ETM+ (2008 and 2013) and Sentinel-2 (2019) images through the method of supervised classification by maximum likelihood has allowed to discriminate five (05) classes of land use that are: forest, degraded forest, habitat and bare soil, crop and fallow, and water bodies. The overall accuracies obtained for the 2008, 2013 and 2019 classified images are 90%; 92% and 95.33% respectively. The Kappa indices of the confusion matrix for the three classified images are 0.88; 0.9 and 0.94 for 2008, 2013 and 2019 respectively. From 2008 to 2019, dense forest, degraded forest, and crops and fallow had overall regressions of 13.70%, 10.49%, and 1.29% respectively. In addition, bare soil and habitats and water bodies increased by 75.50% and 57.09% respectively. The graphical and statistical criteria of the SWAT model (NS and R2, greater than 0.5) showed good model performance for both calibration and validation. The water balance analysis for the 2050 time horizon indicates that water flows into the reservoir will decrease by 52% compared to current flows. This decrease could constitute a real threat for the population of the Issia locality in the years to come.

KEYWORDS: Satellite image, SWAT model, land use, water balance, human activities, Issia.

RESUME: L'eau de la retenue de Issia est utilisée pour l'alimentation en eau potable des populations locales. Malheureusement, les différentes pressions anthropiques exercées dans le bassin versant de la Lobo menace la quantité des flux d'eau entrant dans la retenue de Issia. L'objectif de cette étude est d'évaluer l'incidence des actions combinées de l'anthropisation et du changement climatique sur les flux d'eau entrant dans la retenue de Issia. L'approche mise en place a reposé sur le couplage de la télédétection et la modélisation agro-hydrologique avec SWAT. L'analyse diachronique des images Landsat 7 ETM+ (2008 et 2013) et Sentinel-2 (2019) à travers la méthode de classification supervisée par le maximum de vraisemblance a permis de discriminer cinq (05) classes d'occupation de sol que sont: la forêt, la forêt dégradée, l'habitat et sol nu, la culture et jachère, et les plans d'eau. Les précisions globales obtenus pour les images classifiées de 2008, 2013 et 2019 sont respectivement 90 %; 92 % et 95,33 %. Les indices de Kappa de la matrice de confusion pour les trois images classifiées sont de 0,88; 0,9 et 0,94 respectivement pour l'année 2008, 2013 et 2019. De 2008 à 2019, la forêt dense, la forêt dégradée et les cultures et jachères ont subi des régressions globales respectivement de 13,70 %, 10,49 % et 1,29 %. En outre, les habitats et sols nus ainsi que les

plans d'eau ont connu une progression respectivement de 75,50 % et 57,09 %. Les critères graphiques et les critères statistiques du modèle SWAT (NS et R^2 supérieurs à 0,5) ont montré une bonne performance du modèle à la fois pour la calibration et la validation. L'analyse du bilan hydrique à l'horizon 2050 indique que les flux d'eau entrant dans la retenue baisseront de 52 % par rapport aux flux actuels. Cette baisse pourrait constituer une réelle menace pour la population de la localité de Issia dans les années à venir.

MOTS-CLEFS: Image satellitaire, modèle SWAT, occupation du sol, bilan hydrologique, activités anthropiques, Issia.

1 INTRODUCTION

La dégradation continue des ressources naturelles que sont le couvert forestier et les ressources hydriques sont les principaux défis de l'époque contemporain en Côte d'Ivoire. L'agriculture, du fait de sa course au rendement est considérée comme le principal responsable de cette dégradation [1]. En effet, au lendemain de son indépendance en 1960, la Côte d'Ivoire a fait de l'agriculture, le pilier de son économie et le principal secteur d'emploi. Ainsi, parallèlement à la création des cultures de spéculation, le patrimoine forestier est soumis à une déforestation sans précédent. Par conséquent, de 15 millions d'hectares au début du siècle dernier, les surfaces de forêts denses ont été estimées à environ 2,5 millions d'hectares en 1996, soit une réduction de plus de 83% [2]. Or, selon les travaux de [3], la transformation des surfaces forestières en zones agricoles en Côte d'Ivoire n'est pas sans effet sur le climat et les régimes hydrologiques. En effet, d'importantes études, sur les fluctuations pluviométriques, menées par ([4], [5], [3], [6], [7], [8]) ont montré qu'une tendance à la sécheresse s'est manifestée à partir de la décennie 1960. Parallèlement à l'agriculture, la dégradation des ressources naturelles est accentuée par l'extraction artisanale de l'or (orpaillage). En effet, l'orpaillage a des effets négatifs considérables sur l'écosystème forestier et les ressources hydriques du bassin de la Lobo déjà fragilisé par les activités anthropiques et la péjoration climatique [9]. Ainsi, pour la stabilité des fosses, les orpailleurs utilisent des essences de bois très résistantes; ce qui contribue aussi à la destruction du couvert végétale. De même pour l'extraction de l'or, ils créent des fosses qui participent fortement à la perturbation du patron d'écoulement des eaux de surface. Si dans la partie sud du bassin, notamment à Issia, la situation n'est pas encore alarmante, l'ampleur des pénuries prononcées d'eau de la ville de Daloa appelle à des mesures urgentes. Du fait de l'étroite corrélation entre les variables hydroclimatiques et la modification du couvert végétal, la prise en compte des changements d'occupation du sol dans les études d'impacts de gestion des ressources en eau s'avère indispensable. Selon [10], un outil innovant qui est le couplage de la télédétection à la modélisation permet une meilleure gestion des ressources hydriques. Cette étude vise à évaluer l'impact des actions combinées de l'anthropisation et du changement climatique sur les flux d'eau entrant dans la retenue. La démarche méthodologique appliquée repose sur l'utilisation de la télédétection et de la modélisation agro-hydrologique avec SWAT.

2 MATERIEL ET METHODES

2.1 DESCRIPTION DE LA ZONE D'ETUDE

Le bassin versant de la Lobo est situé au Centre-ouest de la Côte d'Ivoire, précisément entre 6°05' et 6°55' de longitudes Ouest et entre 6°02' et 7°55' de latitudes Nord (Figure 1). Etendue sur une superficie de 12 722 km² le bassin a un périmètre de 650 km. La majeure partie du bassin est drainée à 2,08 % par le département de Bouaflé; 1,38% par le département de Buyo; 24,80 % par le département de Daloa; 0,97 par le département de Gagnoa; 19,77 % par le département d'Issia; 2,27 % par le département de Séguéla; 5,95 % par le département de Soubré; 34,06 % par le département de Vavoua; 5,44 % par le département de Zoukougbeu et 3,28 % par le département de Zuénoula. La ville de Daloa représente le pôle économique de la région ([9], [10], [5]).

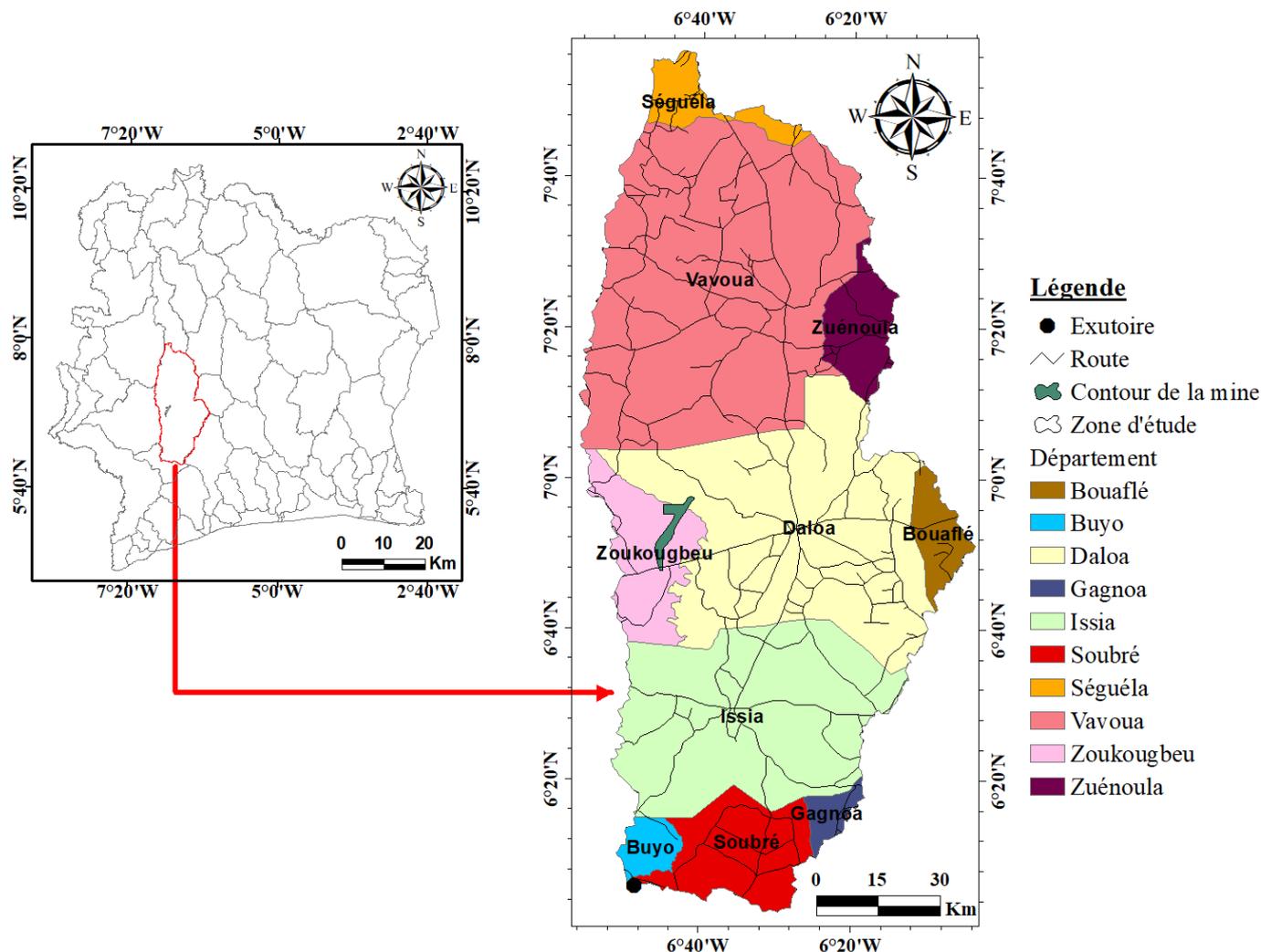


Fig. 1. Présentation de la zone d'étude

2.2 MATERIEL

Cette étude utilise différents types de données qui ont soit été téléchargées via des sites web ou octroyées par les structures en charge. Ainsi:

- Le Modèle numérique d'Altitude (MNA) a été téléchargé à partir du site web : <http://srtm.csi.cgiar.org/SELECTION/inputcoord.asp>. Il a une résolution de 90 mètres;
- La carte d'occupation du sol du bassin a été obtenue auprès du Centre de Cartographie et de Télédétection (CCT). Elle a été établie à l'échelle de 1/900 000 et date de janvier 2012;
- Les images satellitaires (Landsat 7 ETM+ et Sentinelles-2) ont aussi été téléchargées sur le site www.usgs.earth.explorer.com. Elles ont été acquises en saison sèche et datent du mois de janvier 2012. La prise en compte de ces dates est dictée non seulement par la présence d'orpailleurs, mais aussi par la plage de couverture des données hydrométriques;
- La carte pédologique du bassin de la Lobo établie par la FAO [11] avec une résolution spatiale de 10 km a été sollicitée. Le choix de cette carte repose sur la disponibilité des analyses des propriétés physico-chimiques des profils de sols (0 à 100 cm) réalisés par [12];
- Les données climatiques (pluies et températures) couvrant la période de 1979 à 2013, proviennent de la Société d'Exploitation et de Développement Aéroportuaire Aéronautique et Météorologique (SODEXAM). Du fait de leur proximité et des périodes d'enregistrement, les postes pluviométriques de Daloa (2000-2017), Gagnoa (2000-2017) et Vavoua (1953-2011) ont été sollicités. Au niveau de la température, seule la

station de Daloa avec des températures maximales et minimales journalières de 2000 à 2016 ont été utilisées;

- Les données hydrométriques collectées auprès de la Direction des Normes, Réglementation et de la qualité (DNRQ); structure sous tutelle de la Direction Générale des Infrastructures de l'Hydraulique Humaine (DGIHH) ont été mobilisées. Elles couvrent la période de 1992 à 2011 et sont au pas de temps mensuel;
- Les données morphologiques du réservoir de la retenue de Issia incluant la date de mise en marche ont été prises en compte. Celles-ci proviennent de l'Office National de l'Eau Potable (ONEP)

Pour traiter toutes ces données, plusieurs logiciels ont été utilisés; ce sont:

- Arcgis 10.0, pour la cartographie et le support du modèle agro-hydrologique;
- Envi 5.3, pour le traitement numérique des images satellitaires;
- Google Earth, pour la photo-interprétation des images satellitaires et la détermination de la matrice de confusion;
- La version 2009 du modèle SWAT (Soil and Water Assessment Tool) et l'algorithme SUFI-2 (Sequential Uncertainty Fitting) du logiciel SWAT-CUP (Soil and Water Assessment Tool-Calibration Uncertainties Program), pour la modélisation agro-hydrologique;
- Mapinfo 7.5, pour la digitalisation de la carte d'occupation de sol fournie par le CCT;
- TERR-SET 18.31, pour la prédiction de l'occupation du sol à l'horizon 2050

2.3 METHODES

2.3.1 EVALUATION DE LA DYNAMIQUE DE L'OCCUPATION DU SOL

La cartographie de la dynamique de l'occupation du sol a reposé sur la télédétection et les systèmes d'information géographique (SIG). L'extraction de l'information des images Landsat s'est déroulée à travers toute une série d'opérations regroupées en trois phases que sont le prétraitement, le traitement et le post-traitement.

2.3.1.1 PRÉTRAITEMENT D'IMAGES SATELLITAIRES

Le prétraitement des images satellitaires a permis de rendre compatibles les images prises à des dates différentes. Dans cette étude, le prétraitement a consisté à appliquer aux images Landsat 7 des corrections géométriques, radiométriques et d'extraire la zone d'étude. Quant aux images Sentinelle, elles n'ont subi que l'extraction de la zone d'étude.

2.3.1.2 TRAITEMENT DES IMAGES SATELLITAIRES

Le traitement des images satellitaires a combiné plusieurs techniques que sont: les indices de végétation, les compositions colorées et la classification supervisée. Les indices de végétation sont des rapports entre les bandes du visible, du proche et du moyen infrarouge. Les principaux indices calculés sont le NDVI (Normalized Difference Végétation Index) et le Tasseled cap. L'Indice de Végétation Normalisé fait intervenir les canaux du Rouge (R) et du Proche Infra Rouge (PIR). Cet indice a pour but de donner des images dont les pixels mesurent les caractéristiques physiques et biologiques de la végétation [13]. Le NDVI qui varie de -1 à +1 se calcule selon l'équation 1:

$$NDVI = \frac{PIR-R}{PIR+R} \quad (\text{Eq. 1})$$

Le Tasseled cap comprend plusieurs types d'indices dont les indices Brightness et Wetness. L'indice de Brillance des sols (Brightness Index (BI)) est un indice sensible à la brillance des sols [14]. Il se calcule selon l'équation 2.

$$BI = (R^2 + PIR^2)^{1/2} \quad (\text{Eq. 2})$$

Le Wetness Index (WI) ou indice d'humidité maximise la réflectance de l'eau et minimise celle des masses d'eau [14]. Il se calcule selon l'équation 3.

$$WI = \frac{PIR-MIR}{PIR+MIR} \quad (\text{Eq. 3})$$

Les compositions colorées ont consisté à afficher simultanément à l'écran, trois bandes d'images dans les canaux de base (Rouge/Vert/Bleu) afin de faciliter l'extraction d'informations. Les compositions colorées combinant les bandes 4-3-2 pour les Landsat 7 et Sentinelle-2 fut réalisée. La classification supervisée a eu pour but de mettre en rapport l'objet sur le terrain et la signature spectrale sur l'image.

2.3.1.3 POST-TRAITEMENT DES IMAGES SATELLITAIRES

La phase de post-traitement a consisté à évaluer d'une part, le taux moyen annuel antérieur d'expansion spatiale et d'autre part, l'occupation du sol future à l'horizon 2050. Le taux moyen annuel permet d'apprécier les changements intervenus au sein de chaque classe d'occupation du sol [15]. Les principaux changements ont été déterminés sur les trois (3) périodes (2008-2013), (2013-2019) et (2008-2019). Le taux de changement (Tc) ou taux moyen annuel d'expansion spatiale utilisé dans les études sur le changement d'occupation du sol [16] est traduit par les équations 4 et 5.

$$Tc = \left[(S2/S1)^{\frac{1}{t}} - 1 \right] \times 100 \quad (\text{Eq. 4})$$

$$Tg = [(S2 - S1) / S2] \times 100 \quad (\text{Eq. 5})$$

Avec Tc: taux de changement (taux moyen annuel d'évolution) (%); Tg: taux global de changement (%); S1: superficie d'une classe d'unité de surface à la date t1; S2: superficie de la même classe d'unité de surface à la date t2; t: nombre d'années entre les deux dates.

Une valeur positive de Tc indique une progression du changement d'occupation du sol, tandis qu'une valeur négative traduira une régression. En outre, une valeur de Tc proche de zéro indique que la variation de la classe est relativement faible. La carte d'occupation future du sol a été obtenue à partir du Land Change Modeler (LCM) du logiciel Terr-Set. Terr-Set s'est appuyé sur les connaissances passées et actuelles de l'occupation des terres pour prédire le futur.

2.3.2 QUANTIFICATION DES FLUX D'EAU DE LA RETENUE DE ISSIA

La quantification des flux d'eau s'est appuyée sur le modèle agro-hydrologique SWAT (Soil and Water Assessment Tool) [17], [18]. SWAT est un modèle déterministe semi-distribué, à base physique qui fonctionne sur une base continue avec un pas de temps journalier ([19], [20], [1], [21]). La mise en place du modèle SWAT sur le bassin de la Lobo est longuement décrite dans les travaux [22] et [10]. Toutefois, un certain nombre de réglages ont été effectués. Les principaux réglages effectués sont:

2.3.2.1 PHASE DE TRAITEMENT

L'aire seuil a été fixée à 100 km² en se basant sur les travaux de [23]. L'option « unité de réponse hydrologique (URH) dominant » a été retenue pour la discrétisation des unités spatiales de base de calcul. Au niveau des écoulements verticaux, l'infiltration a été évaluée suivant la méthode de Green et Ampt, tandis que l'évapotranspiration potentielle, par la méthode de Hargreaves. Quant aux écoulements horizontaux, le ruissèlement a été calculé selon la méthode SCS (Soil Conservation Service).

2.3.2.2 PHASE DE POST-TRAITEMENT

La phase de post-traitement consiste à évaluer la performance et la robustesse du modèle à reconstituer les écoulements. Ainsi, l'analyse de la sensibilité s'est basée sur les paramètres jugés sensibles dans la plupart des travaux sur la modélisation agro-hydrologique en Côte d'Ivoire; notamment sur le bassin de Taabo par [1], [24] et [25]; le bassin du lac de Buyo par [26]; et le bassin de la Lobo par [22] et [10]. Les fonctions objectives utilisées pour évaluer la performance du modèle sont le critère de Nash (NS) et le coefficient de détermination (R²). Ces critères ont été retenus car ils représentent mieux la performance du modèle. D'ailleurs, ils sont les plus utilisés dans la plupart des études de modélisation [24]. La calibration s'est étalée sur la période de 2002 à 2006. Quant à la validation du modèle, elle a couvert la période de 2007 à 2011. Trois années ont été utilisées pour le réchauffement du modèle.

2.3.2.3 EVALUATION PRÉDICTIVE DES FLUX D'EAU

Les flux d'eau futur ont été directement simulés par le model SWAT-CUP préalablement calibré et validé. Les seuls paramètres qui ont variés dans les nouvelles sorties de SWAT concernent, l'occupation du sol de l'année 2050 et les données climatiques journalières du scénario RCP 4.5. La période de 2011 à 2050 a été considérée comme futur vu que les données climatiques observées s'arrêtaient en 2011.

3 RESULTATS ET DISCUSSION

3.1 DYNAMIQUE DE L'OCCUPATION DU SOL

Les indices NDVI, WI et BI ont permis de caractériser la couverture végétale du bassin versant de la Lobo. En effet, bien que de nombreuses confusions aient été constatées lors de la classification des images, la classification par le maximum de vraisemblance adoptée a permis d'obtenir des précisions globales de 90 %, 92 % et 95,33 % respectivement pour les images de 2008, 2013 et 2019. Cette précision globale obtenue est au-dessus de 80 % comme préconisé par [27]. Elle reste aussi très proche des valeurs obtenues par d'autres auteurs ayant travaillé en Côte d'Ivoire, notamment [28] dans la région des Lacs (88,47 % et 90,46 % respectivement pour 1986 et 2002) et [29] dans la localité de Bonikro (91,48 % pour l'an 2007 et 88,56 % pour l'année 2016). Les coefficients de Kappa respectifs obtenus sont de 0,88; 0,9 et 0,94 pour les images de 2008, 2013 et 2019. Les cartes d'occupations du sol de 2008, 2013 et 2019 issues de la classification des images sont présentées à la figure 2.

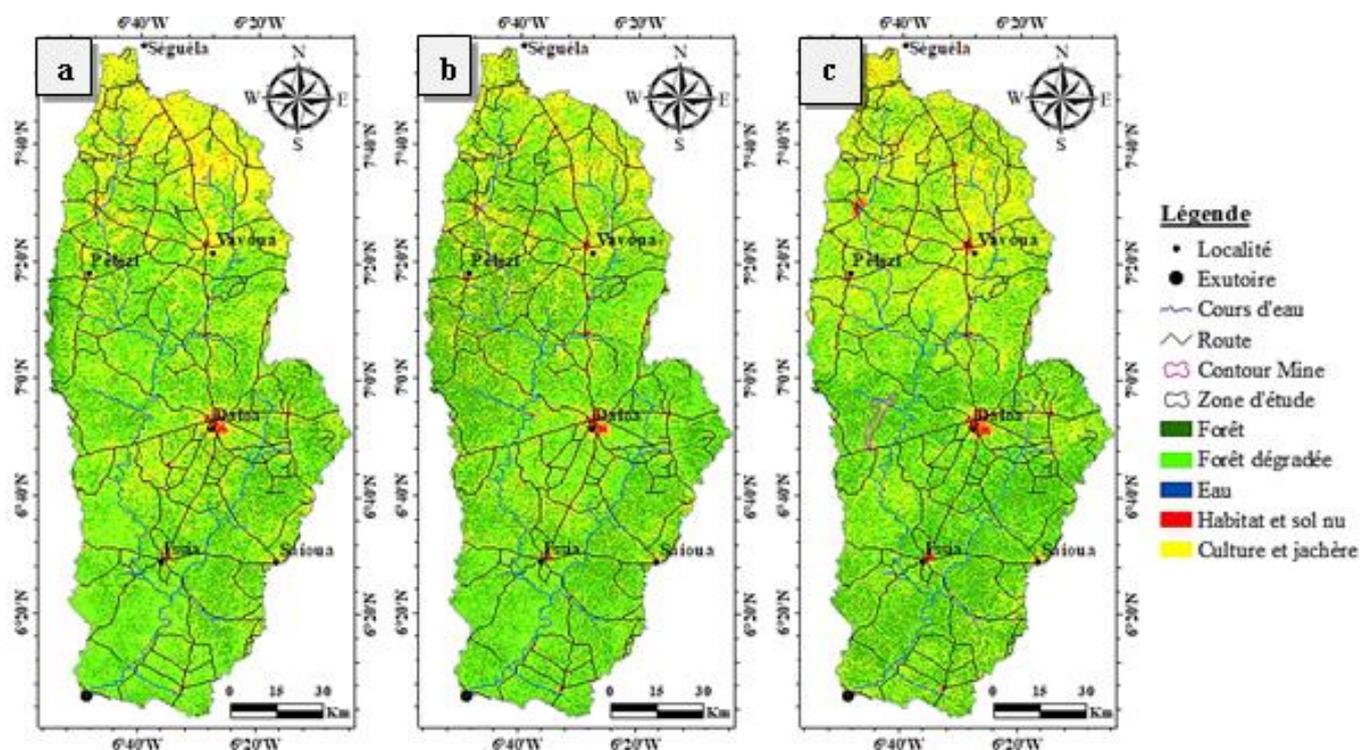


Fig. 2. Evolution de l'occupation du sol (a = 2008, b = 2013 et c = 2019)

L'évolution des superficies des différents types d'occupation du sol entre 2008 et 2019 est résumée dans le tableau 1.

Tableau 1. Proportion spatiale des différents types d'occupation du sol

Classes	2008		2013		2019	
	Superficie (Ha)	Pourcentage (%)	Superficie (Ha)	Pourcentage (%)	Superficie (Ha)	Pourcentage (%)
Habitat et sol nu	34 714,88	2,73	102 640,12	8,07	141 706,73	11,14
Forêt	487 799,17	38,34	356 735,75	28,04	429 010,31	33,72
Forêt dégradée	487 690,29	38,33	662 575,35	52,08	441 372,38	34,69
Culture et jachère	260 914,76	20,51	148 710,83	11,69	257 591,35	20,25
Eau	1 080,90	0,08	1 537,95	0,12	2 519,23	0,20
Total	1 272 200	100	1 272 200	100	1 272 200	100

La prévision de l'occupation du sol basée sur le LCM à l'horizon 2050 montre que les habitats et sols nus augmenteront de 141 707 ha à 180 560 ha entre 2019 et 2050. Les cultures et jachères augmenteront également de 257 591 ha à 1 018 867 ha entre 2019 et 2050. Par contre, la forêt, la forêt dégradée et l'eau diminueront respectivement de 429 010 ha à 24 246 ha, 441 372 ha à 48 300 ha et de 2 519 ha à 227. Si rien n'est effectué, il n'existera pratiquement plus de forêt sur le bassin versant de la Lobo d'ici 2050 (Figure 3).

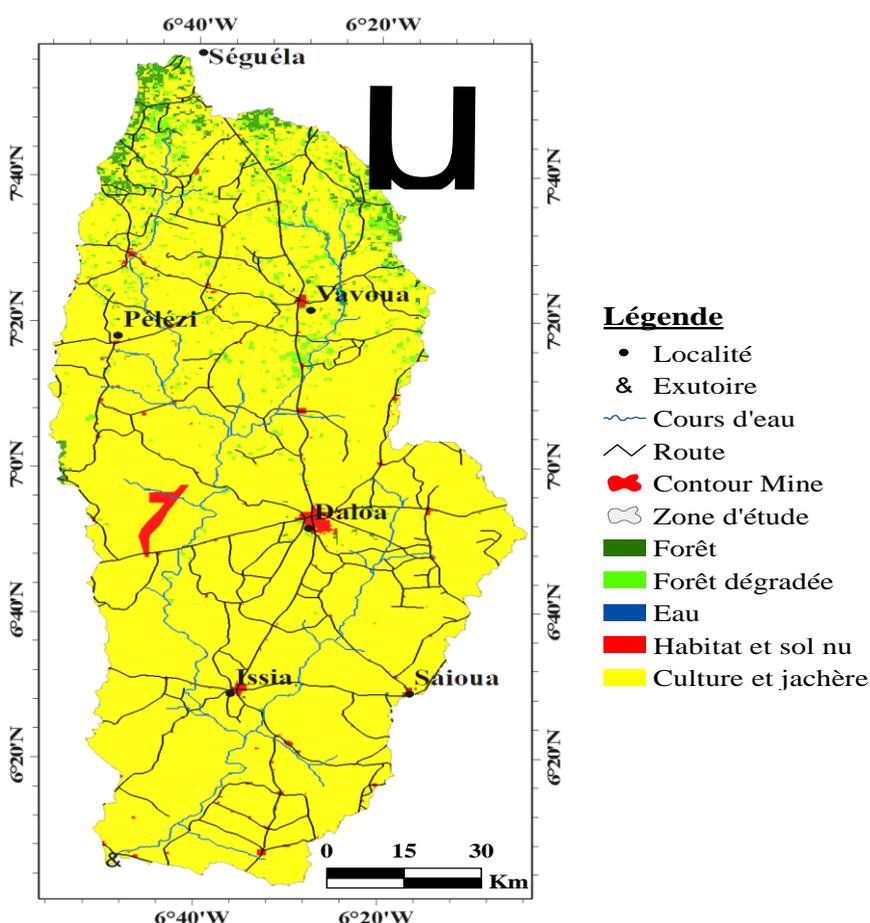


Fig. 3. Occupation du bassin versant de la Lobo à l'horizon 2050

Cette dégradation des superficies forestières au profit des mosaïques de cultures et jachères a été soutenue par [2] sur le Parc de la Marahoué en Côte d'Ivoire avec une disparition d'ici 2026, par [30] dans la région centrale du Bénin avec une disparition d'ici 2025. Ces auteurs expliquent la forte demande des terres cultivées et du bâti par l'augmentation de la population.

3.2 RESTITUTION DES DEBITS DE LA RETENUE DE ISSIA

La restitution des flux d'eau de la retenue de Issia à l'aide du modèle Agro-hydrologique SWAT a permis d'obtenir des résultats satisfaisants pour la calibration et la validation du modèle. En effet, les critères statistiques (NS et R^2 supérieurs à 0,5) ont montré une bonne performance du modèle à la fois pour la calibration et la validation (Tableau 2).

Tableau 2. Critères statistiques d'évaluation de la performance du modèle

N° du sous bassin	p_facteur	r_facteur	R ²	NS
Calibration	0,63	1,19	0,57	0,53
Validation	0,75	1,54	0,61	0,57

Les performances du modèle obtenues en calage comme en validation respectent les conditions de [31] et de [32]. L'analyse des critères visuelles montre aussi un bon synchronisme entre les débits observés et simulés. Toutefois, une légère sous-estimation des pics de crue simulés au niveau des deux périodes est observée sur la figure 4.

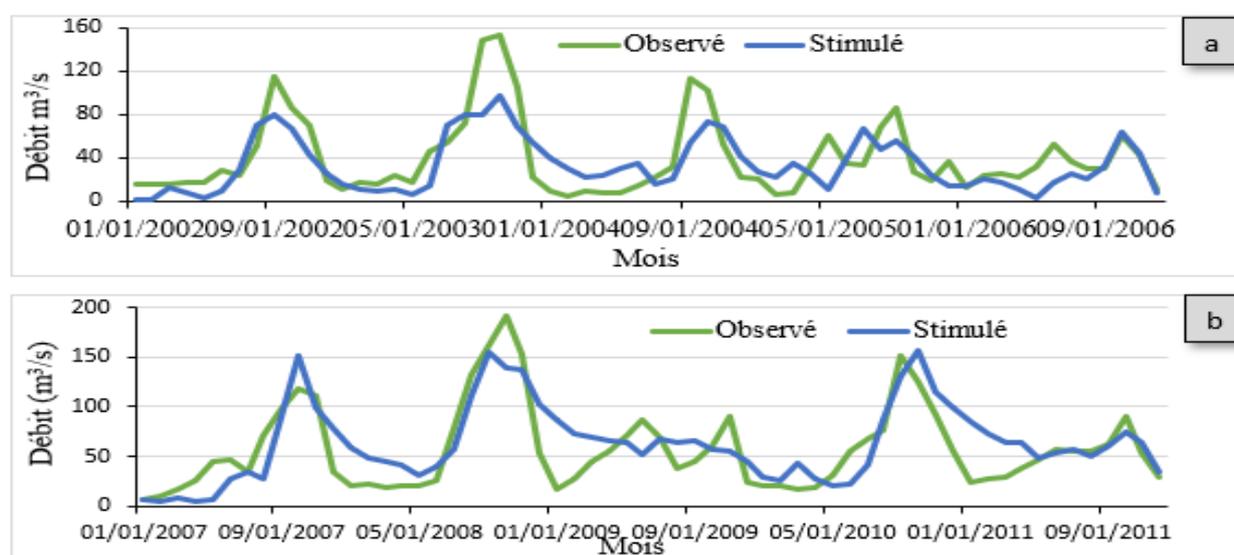


Fig. 4. Hydrographes des débits simulés et observés (a= calibration et b= validation)

Ces hydrographes montrent que les sorties du modèle sont entravées par de nombreuses lacunes. En effet, les données climatiques utilisées ne sont pas assez représentatives. De même, les données de débits comportent des lacunes avec des données manquantes et non étendues. Or, selon [1], la disposition spatiale des stations climatiques ne couvrant pas tous les régimes climatiques aura un impact négatif sur la restitution des écoulements. Aussi, moins la série de données d'entrées est importante et répartie dans l'année, moins les résultats en calage et en validation sont bons [32]. Parallèlement aux données ponctuelles, la résolution spatiale des données raster, notamment la carte pédologique constitue une limite à l'atteinte d'une très bonne performance du modèle. Selon [33] et [34], le modèle SWAT reste extrêmement sensible à la qualité des données spatiales, notamment de sols, à l'utilisation des terres ainsi qu'aux procédures de prétraitement. En plus des données d'entrées, l'empirisme du modèle SWAT pourrait augmenter les incertitudes [35]. Malgré ces lacunes qui bien que nombreuses, le modèle a montré à travers les paramètres p-facteur et r-facteur, une bonne prise en compte des incertitudes. L'extraction des flux d'eau entrant dans le réservoir a permis d'obtenir les débits d'eau entrant dans le réservoir de la retenue de Issia (Figure 5).

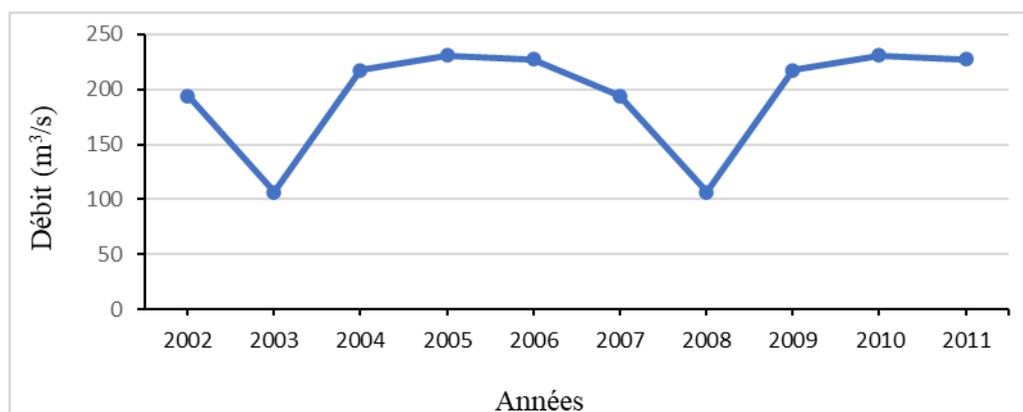


Fig. 5. Evolution des débits d'eau annuels entrant dans la retenue de Issia

Les flux d'eau entrant dans le réservoir de Issia, sur la période de 2002 à 2011 présentent un débit moyen interannuel de 1951,83 m³/s, soit une lame d'eau moyenne de 4 840,49 mm. Les débits d'eau annuelle entrant dans la retenue oscillent de 106,45 m³/s à 231,03 m³/s. A l'horizon 2050, les lames d'eau entrant dans le réservoir devraient baisser de 52 % (Figure 6).

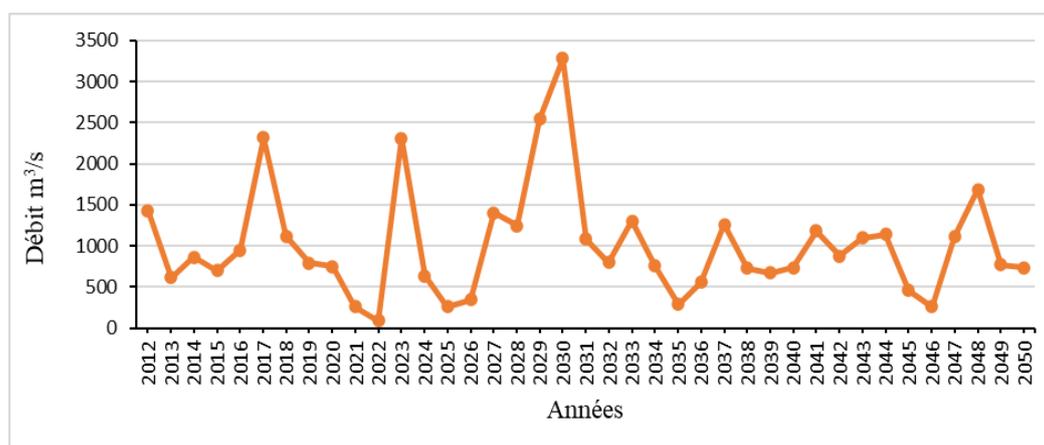


Fig. 6. Flux d'eau entrant dans la retenue de Issia

L'hydrographe prédictive des flux d'eau entrant dans la retenue de Issia présente deux tendances. La première tendance (2012 à 2032) est marquée par des débits qui oscillent entre 89,82 m³/s à 3 282,3 m³/s. Les lames d'eau entrant dans la retenue durant cette période sont ainsi estimées de 222,65 mm à 8 136,35 mm. La seconde tendance est celle de la période de 2032 à 2050. Elle est marquée par des débits d'eau entrant dans la retenue de Issia variant de 262,12 m³/s à 1 682,84 m³/s; soit des lames d'eau de 649,77 mm à 4 171,52 mm. De ces deux tendances, il est remarqué que les lames d'eau entrant dans le réservoir baissent de 52 %. Cette réduction des flux d'eau serait donc imputable à la conjugaison de l'anthropisation et du changement climatique qui ont pour corolaire l'augmentation de gaz à effet de serre tel que le CO₂.

4 CONCLUSION

Ce travail réalisé sur le bassin versant de la Lobo a permis d'évaluer l'incidence des actions combinées des activités anthropiques et du changement climatique sur les flux d'eau entrant dans la retenue de Issia. L'approche méthodologique mise en place a combiné télédétection et modélisation agro-hydrologique. L'approche par télédétection qui a reposé sur l'analyse diachronique des images Landsat 7 ETM+ (2008 et 2013) et Sentinelle-2 (2019) à travers la méthode de classification supervisée par le maximum de vraisemblance a permis de discriminer cinq (05) classes d'occupation de sol que sont: la forêt, la forêt dégradée, l'habitat et sol nu, la culture et jachère, et les plans d'eau. Les précisions globales obtenus pour les images classifiées de 2008, 2013 et 2019 sont respectivement 90 %, 92 % et 95,33 %. Les indices de Kappa de la matrice de confusion pour les trois images classifiées sont de 0,88; 0,9 et 0,94 respectivement en 2008, 2013 et 2019. Les cartes élaborées pour les

trois années ont permis d'identifier une évolution spatio-temporelle de l'occupation du sol. De 2008 à 2019, des taux moyen annuel de régression globale sont de 13,70 % pour la forêt, 10,49 % pour la forêt dégradée et de 1,29 % pour les culture et jachères. Dans la même période, il est remarqué une progression des habitats et sols nus (75,50 %) et eau (57,09 %). Il ressort que si aucune action n'est menée, il n'existera pratiquement plus de forêt sur le bassin versant de la Lobo d'ici 2050. La quantification des flux d'eau de la retenue de Issia a été réalisée à l'aide du modèle agro-hydrologique SWAT. Les critères statistiques et graphiques ont montré une bonne capacité du modèle à reproduire de manière satisfaisante les séries de débits à l'échelle mensuelle. L'analyse du bilan hydrique indique que le flux d'eau de la retenue baissera de 52 % par rapport aux flux actuels. Ces diminutions peuvent constituer une menace réelle pour la population de la localité de Issia les années à venir.

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Determinants of hygiene and sanitation in schools in the Nkafu quater, Kadutu health zone, Bukavu in South Kivu, DRC

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ABSTRACT: *Introduction:* For thousands of years humanity has been struck by epidemics, scourges. Schools determine in part the health and well-being of children by providing them with a healthy or unhealthy environment. In South Kivu, the population is confronted with insufficient drinking water, inadequate sanitation facilities, including public latrines, garbage cans, public dumps.

Methodology: This is a cross-sectional study involving 401 respondents including 384 students and 17 heads of schools. Data collection was done using the survey questionnaire and an interview guide. The data analyses were done with SPSS v23 software.

Results: The level of hygiene and sanitation practice is low (46.4%). This would be significantly associated with lack of access to water in schools, insufficient handwashing kits, non-drinkability of water used at school, absence of garbage cans and health days, non-washing of hands with soap before consuming food, non-participation in cleaning and maintenance, absence or poor quality of urinals in some schools, the non-separation of latrines for girls and boys, ignorance of the dangers of lack of hygiene and basic sanitation at school, poor construction of latrines, and non-washing of hands with soap after toilet ($p < 0.05$).

Conclusion: The practice of hygiene and sanitation remains weak and this must involve a collective awareness to find life-saving solutions in the training schools of executives.

KEYWORDS: Hygiene and sanitation, schools, Nkafu quater.

1 INTRODUCTION

For thousands of years humanity has been struck by epidemics and scourges. The literature and much careful research on small living organisms indicate that the major causes of the world's scourges are due to the lack of implementation and inadequacy of sanitation facilities in urban and rural areas [1]. In particular, we can note the hygiene in the school environment under this vision. Hygiene in schools can be defined as the set of measures designed to protect the health and safety of the people who attend them. Hygiene measures are all the more important as the school welcomes young children who constitute the age group of the population most exposed to the risk of infection [2].

In 2013, UNICEF reported a coverage rate of less than 50% for drinking water and sanitation in primary schools. While these figures give us a global view of challenges, they hide strong regional disparities. In addition, in equipped schools, the facilities are not always functional (maintenance errors) and do not always meet all the demand (over-attendance) [3]. Schools determine in part the health and well-being of children by providing them with a healthy or unhealthy environment. School water and sanitation facilities are increasingly considered essential to promote good hygiene practices and the well-being of children, but many schools have facilities that leave much to be desired [4].

In France, Doumont and Feulien (2013) show a negative perception of school sanitation: 88% of respondents find toilets smelly; 84% find them dirty; 83% confirm the absence of supervisors; 60% deplore the lack of toilet paper; 58% consider their number insufficient; 51% note the lack of closing at the doors; 46% think they are too far from the classroom. Stomach aches are common: 7% of students say they have it very often and 10% often; 9% of students feel embarrassed to do their work in middle school because they were unable to use the toilet in a timely manner [5]. In India, girls miss 5 days of school in a month (50 days a year) due to a lack of adequate protection during their periods and 23% of girls dropped out of school after they started menstruation [6]. In 2016, Ethiopia had 8.4 million children of primary school age. One in five primary schools had handwashing facilities, but only one in ten facilities offered handwashing facilities that were accessible to young children. Nearly nine out of ten primary schools had toilets, but less than half were accessible to young children [7].

In Zambia, a quantitative analysis of data collected from 10,000 schools found that the presence of improved sanitation facilities was correlated with a higher female-to-male enrolment ratio, as well as a reduction in repeated absences and drop-out rates, especially among girls [8].

The Democratic Republic of Congo is a country where the mortality rate is too high due to diseases of dirty hands that continue to increase on a large scale. Between 2013 and 2017, the DRC reported an estimated 151,000 cholera-related cases and 3,304 deaths. In 2018 and 2019, the number of suspected cholera cases was quite similar, but in 2019, the number of deaths decreased by 51% compared to 2018. Between January and early October 2020, the number of suspected cases and deaths decreased by 30% compared to the same period in 2019 [9]. In South Kivu, the population is now confronted with the insecurity caused by identified armed men, the insufficiency of drinking water, the total insufficiency of sanitary facilities, including public latrines, garbage can, public dumps.

In the schools of the Nkafu quater in Kadutu Health Zone, it is appropriate to observe several schools with degrading hygiene and sanitation systems that leave much to be desired. These schools are sometimes without latrines and if there are latrines, they are unsuitable, not having handwashing systems. This study aims to contribute to the promotion of good hygiene and sanitation conditions in schools in the Kadutu health zone in the city of Bukavu. Specifically, determine the level of hygiene and sanitation practices in schools in the Nkafu neighborhood in Kadutu Health Zone and determine the determinants associated with hygiene and sanitation in school settings in Kadutu Health Zone.

2 MATERIALS AND METHODS

2.1 STUDY FRAMEWORK

The NKAUFU is located in kadutu health zone in the city of Bukavu, South Kivu province, Democratic Republic of Congo. It is located between 2°28° and 2°33° south and on 28°49° and 28°53° east longitude. It is limited to the north by the coast of Lake Kivu, to the south by the road section of road No. 2 between the HERI KWETU center and ISTM/Bukavu to SOS; to the east by the KAHUWA river and the west by the WESHA river which separates the commune of Bagira from that of Kadutu. The area of 268.054,05m² is 268.05m². The hydrography of the NKAUFU district is characterized by its belonging to the Kivu basin with its main rivers which are the Weshatnd Kahuwa rivers. In every cell in the neighborhood there are ravines that are very important. We note the presence of that of the ISDR (Higher Institute of Rural Development of Bukavu) towards the general hospital, from TST to the clinic in Kadurhu towards Inga.

2.2 TYPE OF STUDY

We used a cross-sectional study Because it allowed us to describe the characteristics of the students attending the schools of the Nkafu quater, but also to describe the level of hygiene and sanitation at the level of these schools as well as the determinants associated with them in a reasonable time or in a short time.

2.3 STUDY POPULATION

It is made up of pupils and school authorities of the schools surveyed located in the Nkafu quater of Kadutu Health Zone.

2.4 CHOICE AND SIZE OF SAMPLING

2.4.1 SAMPLE SIZE

The sample size was calculated using Schwartz's formula that:

$$n = \frac{Z^2 \alpha \cdot P (1-P)}{d^2} = \frac{(1,96)^2 \cdot 0,5 (1-0,5)}{(0,05)^2} = \frac{3,8416 \cdot 0,5 \cdot 0,5}{0,0025} = \frac{0,9604}{0,0025} = 384,16 \approx 384 \text{ surveyed}$$

n= Sample

$Z^2 \alpha$ = Coefficient corresponding to the degree of confidence at 95% (equivalent to 1,96)

p= proportion on the use of hygiene and sanitation measures (we considered or retained a proportion of 50%) or 0,5 as the proportion was not known in view of the existing literatures in south kivu to date in relation to this theme)

d= Margin of error which is equal to 5%

Thus, in our study we investigated a total of 401 respondents, including 384 students and 17 school authorities.

2.4.2 SAMPLING TECHNIQUE

We used a systematic random sampling technique for students and comprehensive random sampling for school leaders involved in the study.

2.4.3 METHOD

We used the descriptive and analytical method because it allowed us to describe the different characteristics of the students surveyed and analytical because it helped us to determine the factors that are associated with hygiene and sanitation in the schools of the Nkafu quater.

2.5 TECHNICAL

2.5.1 THE DOCUMENTARY REVIEWS

This technique helped us to make a documentary review in different books, scientific journals, reports, websites corresponding to data related to hygiene and sanitation in schools in order to allow us to deepen the theoretical knowledge related to this subject of study.

2.5.2 SURVEY QUESTIONNAIRE

A survey questionnaire: both closed and open questions were sent to students and school leaders in the schools targeted by our research in the Nkafu quater of Kadutu Health Zone.

2.6 INCLUSION CRITERIA

All pupils regularly enrolled in one of the schools in the Nkafu district of Kadutu Health Zone;

- Be the head of the schools targeted by the study
- Agree to answer the questionnaire

2.7 EXCLUSION CRITERIA

- Pupils regularly enrolled in schools in Kadutu Health Zone whose schools are not in the Nkafu quater;
- Non-volunteers (pupils/school authorities) to participate in the study.

2.8 STUDY VARIABLES

- a. **Dependent variable:** Hygiene and sanitation practice in schools
- b. **Independent variable:** Socio-demographic characteristics; the level of hygiene and sanitation practices; diseases related to poor hygiene and basic sanitation in schools; factors associated with hygiene and sanitation in schools.

2.9 DATA ANALYSIS

We did the input mask, encoding, data analysis and table production using Microsoft Excel 2016 and SPSS version 23.0 software. First, we used the Odds Ratio (OR) to compare the study variables. Thus, we considered the difference to be significant when the p-value was < 0.05. The opposite showed that there is no statistically significant difference. Next, we did a logistic regression to determine an adjusted OR to identify factors associated with hygiene and sanitation in school settings.

2.10 ETHICAL CONSIDERATION

We obtained informed consent from pupils (with practical guidance from their teachers) and selected school leaders prior to data collection (before investigating them). Participation in this study was free and free of all forms of constraints. The data was collected anonymously and the confidentiality of the results was ensured.

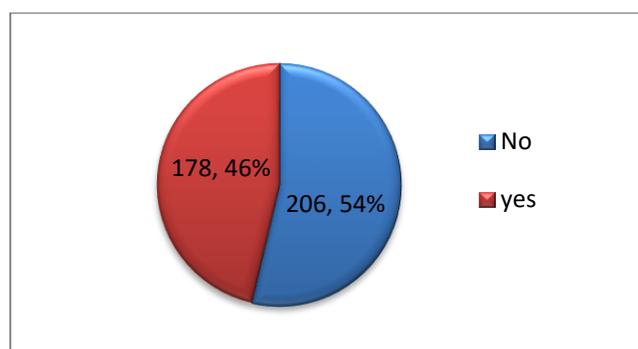
3 RESULTS

In this part, we present the different results found in the field related to the subject of study.

Table 1. Socio-demographic characteristics of respondents

Parameters	N=384	%
Age trache (medium, ±AND)	<i>16±3,8 years</i>	
10 -15 years	155	40,4
16-23 years	229	59,6
Sex		
Masculine	185	48,2
Feminine	199	51,8
Class		
1st year secondary school	2	0,5
2 nd year of secondary school	38	9,9
3rd year of the humanities	23	6,0
4th year of the humanities	78	20,3
5th year of the humanities	141	36,7
6th year of the humanities	102	26,6
Religion		
Catholic	131	34,1
Kimbanguist	11	2,9
Muslm	25	6,5
Protestant	208	54,2
Without religion	9	2,3
Type of school		
Tarpaulin Construction	1	0,3
Construction in wood	94	24,5
Construction in sustainable materials	231	60,2
Constructtion in semi-sustainable materials	58	15,1
Category of School		
Conventional (state-Church)	68	17,7
No conventional (State)	46	12,0
Private	270	70,3

It appears that most of the pupils surveyed were in the 16-23 age group with an average age of 16. Girls were in the majority than men with a sex ratio of 0.92 in favor of men. Most of the students interviewed were in Grade 5 followed by Grade 6 in the Humanities. Protestant and Catholic students were in the majority in the survey. The majority of students surveyed said their schools were built of sustainable materials. The students who were interviewed were more from private schools in the Nkafu quater of Kadutu Health Zone.



Graphic 1. Level of hygiene and sanitation practices in schools

The level of hygiene and sanitation practice was 46% of schools in the Nkafu district of Kadutu Health Zone Against 54% of the respondents had not admitted to having held a good quality of hygiene and sanitation within their schools. This shows that in the schools of the Nkafu district have the level of hygiene and sanitation is very low compared to hygienic conditions and basic sanitation.

Table 2. Determinants of lack of hygiene and sanitation in schools in the Nkafu quarter of Kadutu

Parameters	OR Adjusted	IC to 95%		P-Value
No access to water in the property	<u>0,2542</u>	<u>0,1662</u>	<u>0,3889</u>	<u>0,0000</u>
Lack of hand washing kits	<u>0,1261</u>	<u>0,0691</u>	<u>0,2301</u>	<u>0,0000</u>
No-potability of water used at school	<u>0,4177</u>	<u>0,2348</u>	<u>0,7429</u>	<u>0,0030</u>
Absence of garbage cans in schools	<u>0,1998</u>	<u>0,1291</u>	<u>0,3092</u>	<u>0,0000</u>
Absence of salubrity days	<u>0,3513</u>	<u>0,2311</u>	<u>0,5340</u>	<u>0,0000</u>
Bad conditions of latrine	<u>0,3763</u>	<u>0,2419</u>	<u>0,5854</u>	<u>0,0000</u>
No hand washing with soap before eating food at school	<u>0,2028</u>	<u>0,1291</u>	<u>0,3187</u>	<u>0,0000</u>
No participation in the cleaning and maintenance of the school	<u>0,1856</u>	<u>0,0985</u>	<u>0,3495</u>	<u>0,0000</u>
Lack of lessons at school on hygiene and sanitation	<u>0,0898</u>	<u>0,0286</u>	<u>0,2818</u>	<u>0,0000</u>
Bad quality of urinal	<u>0,2924</u>	<u>0,1087</u>	<u>0,7864</u>	<u>0,0149</u>
Absence of urinals in schools	<u>0,3311</u>	<u>0,2063</u>	<u>0,5313</u>	<u>0,0000</u>
No separation of girls 'and boys' latrines	<u>0,4715</u>	<u>0,2998</u>	<u>0,7414</u>	<u>0,0011</u>
Ignorance of the danger of poor hygiene and basic sanitation at school	<u>0,1725</u>	<u>0,0988</u>	<u>0,3011</u>	<u>0,0000</u>
The bad building of latrines	<u>0,2678</u>	<u>0,1568</u>	<u>0,4573</u>	<u>0,0000</u>
No hand washing with soap after toilet	<u>0,0671</u>	<u>0,0341</u>	<u>0,1322</u>	<u>0,0000</u>
Constant	*	*	*	<u>0,0000</u>

After multivariate analysis, we found that the poor and/or lack of hygiene and sanitation practices in school environments is significantly associated with different factors such as: lack of access to water in the establishment, lack of handwashing kits, non-drinkability of water used at school, absence of garbage cans in school environments, the absence of Celebrity days, the no-washing of hands with soap before consuming food at school, the no-participation in the cleaning and maintenance of the school, the absence of lessons at school on hygiene and sanitation, the absence of urinals in some schools and the poor quality of urinals, the non-separation of latrines girls and boys, ignorance of the dangers of lack of hygiene and basic sanitation at school, poor construction of latrines, and non-washing of hands with soap after toilet ($p < 0.05$).

4 DISCUSSION

4.1 THE PRACTICE OF HYGIENE AND SANITATION IN SCHOOLS

In this study, we found that the level of hygiene and sanitation practice in schools in the Nkafu neighborhood in Kadutu Health Zone was 46.4%. "Similarly for the leaders of some schools during our various conversations, they had felt that they carried out activities related to hygiene and sanitation in their respective schools but has a reliable frequency." These results are closer to those found by Serge in secondary schools in Bangui [9]. As well as Béatrice Tournonnias, Mélanie Ceran, and al. (2019) who find the same results found in the city of Zinder (Niger) [11]. It is good to show that among the factors that exert

the most influence on the quality of the environment is, among others, sanitation and hygiene at the individual and collective levels. Indeed, sanitation and hygiene are essential to the lives of human beings [12].

4.2 FACTORS ASSOCIATED WITH HYGIENE AND SANITATION IN SCHOOLS

After our field investigations, we found that the low level of hygiene and sanitation practices in schools is significantly associated with lack of access to water and no-potability of water used at school by schools ($p < 0.05$). This is in line with the statements of school officials *"The authorities of the schools surveyed have shown that they do not have access to water in their respective schools in most cases and they do not have taps within their schools. They said they also use tap water for consumption."* If OMS has stressed the importance of regulating water, sanitation and hygiene parameters in schools [13], it is shown that research will need to focus on improving the epidemiological quality of studies to isolate the effects of water and sanitation in schools [13]. In the study, it was noted that this low practice of hygiene and sanitation measures in schools is linked to the lack of handwashing kits in several schools ($p < 0.05$). This is in line with Serge in his study, which showed that many schools surveyed in the city of Bangui do not have shovels, rakes, wheelbarrows, plastic bins for classrooms, or garbage bins; even the broom that seems to be the least of things does not exist in some classrooms [10].

The absence of toilets in schools and the absence of health days were significantly linked to the low practice of hygiene and sanitation measures in schools ($p < 0.05$), however, *"the majority of schools in the Nkafu district have garbage cans to manage their waste, although health days for example in Salongo, sweeping, cleaning of the schoolyard are organized in some schools, other schools do not organize it."* said the heads of the schools concerned. Similarly in a similar study, we find, the author found the heads of the schools met had claimed that his latrines are at least cleaned regularly, some once a day, other 2 times a week and some in special circumstances such as the presence of excreta at the defecation hole. 81.8% of latrines are cleaned at least once a day, 9% of latrines are cleaned at least twice a week, and 9% in special circumstances [10]. The World Health Organization points out that dust and mold can cause respiratory diseases, asthma attacks and allergies. School premises must therefore be regularly and properly cleaned in order to preserve the health of the occupants [14]. Hence a responsible awareness in hygiene and sanitation is of great importance at the school levels.

We also found a significant influence between poor practice of hygiene and sanitation measures and non-washing of hands with soap before consuming food at school, non-participation in school cleaning and maintenance ($p < 0.05$).

In this study, the absence of lessons in school on hygiene and sanitation, the absence of urinals in some schools and the poor quality of urinals, the non-separation of latrines girls and boys, ignorance of the dangers of lack of hygiene and basic sanitation at school, poor construction of latrines, and non-washing of hands with soap after toilet ($p < 0.05$). This would further expose students and teachers to diseases of dirty hands. Diseases linked to unsafe water, lack of sanitation and poor hygiene represent a huge burden for developing countries. It is estimated that 88% of diarrhea diseases are due to the use of unsafe water and problems of sanitation and hygiene [15]. Many schools are located in communities where there is a high prevalence of diseases due to unsafe water consumption, lack of sanitation and hygiene, and where child-uvian malnutrition and other underlying health problems are common [16]. To determine the environmental factors that influence the state of health of students, the logistic regression model "Logit" was used, it appears from the analyses that the state of health of schoolchildren is explained at 62% by the following variables: the number of body washes per day, the cleaning of toilets, the number of tooth brushing per day, the health monitoring of women restaurateurs and the existence of drinking water facilities. These results are similar to those found in northeastern Benin that also seemed to most determine the health status of schoolchildren in northeastern Benin [17].

5 CONCLUSION

In sum, we found that the level of practice of hygiene and sanitation measures in schools is low in Kadutu Health Zone in Nkafu quater. This weakness would be significantly associated with the lack of access to water in the school, the lack of handwashing kits, the non-potability of the water used at school, the absence of garbage cans in school environments, the absence of health days, the non-washing of hands with soap before consuming food at school, non-participation in school cleaning and maintenance, lack of school lessons on hygiene and sanitation, absence of urinals in some schools and poor quality of urinals, non-separation of girls and boys latrines, ignorance of the dangers of lack of hygiene and basic sanitation at school, poor construction of latrines, and non-washing of hands with soap after toilet ($p < 0.05$).

RECOMMENDATION

In view of the results found, the involvement of all stakeholders in the education and promotion of the Congolese elite and the world in this field is of great importance in the promotion of health in schools.

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