International Journal of Innovation and Applied Studies
ISSN 2028-9324 Vol. 8 No. 2 Sep. 2014, pp. 800-812

http://www.ijias.issr-journals.org/

Spatial dynamics and modeling of wetlands degradation by remote sensing: The case of the small valley Adjarra in the lower valley of Ouémé (Ramsar Site No. 1018, south - east of Benin)

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ABSTRACT: After registration of four of its wetlands to Ramsar sites for protecting them, Benin still experiencing a degradation of the environment across wetlands. Those in the lower valley of the Ouémé in general and the valley Adjarra in particular are under increasing anthropogenic pressure. The objective of this paper is to characterize the spatial dynamics and model the degradation of the valley Adjarra. The methodology is a geographical approach based on sampling, photo - digital interpretation, automatic detection and change mapping and modeling. The results show that the spatial dynamics of the landscape contributes to the degradation of the valley. It is characterized by the growth of urban areas (64.83%) of marshy grassland (619.18%), the gallery forest (249.00%), semi-deciduous forest (74.42%), plantations (231.18%), crops and fallow (516.14%), and regression of water (43.39%), dense forest (57.33%) and crops and fallow under palm trees (93.68%) now converted into plantations. The most important changes in the landscape are made in the dense forest and the least important in cultivated fields and fallow under palm trees. The increase in crop fields and fallows and agglomeration is regressive factors in dense forest. At the gallery forest and forest semi - deciduous, it is rather the regression occupancy rate of water and the crops and fallow land under palm trees behind the progression of these units. Thus, in the valley of Adjarra rate variation of vegetation is explained by changes in those of water, fields of crops and fallow crop fields and fallow under the palm trees and cities. This critical situation the degradation of the valley is particularly felt in the dense forest.

KEYWORDS: wetlands, valley Adjarra, anthropogenic pressures, modeling, remote sensing, occupancy changes, degradation.

1 INTRODUCTION

The frequency and impact of floods and fires have increased dramatically over the past 50 years, partly due to changes in ecosystems [1]. Croplands, pastures and forests that occupy 60% of the surface of the Earth are gradually exposed to threats of increased climate variability and longer term climate change [2]. In terms of perspective, the climate will become both wetter and drier. Forecasts increasing climate extremes Africa announced that by 2020, 75 to 250 million people will be exposed to water scarcity due to climate change. [3] Wetlands, transition areas between the terrestrial environment and the aquatic environment (ecotones) are particularly affected. In this area, water is the main factor controlling the environment and the associated plant and animal life. They cover less than 9% of the global land area and provide hydrological functions, biological, ecological and cultural. These ecosystems provide many services to local populations: timber resources, water resources, food resources, medicinal plants... The phenomena of destruction and degradation of wetlands have accelerated over the past decade. Several studies have confirmed the threat growing increasingly they are being [4] and [5]. Currently, the resource requirements are increasingly increased especially in relation to wetlands and a growing population, facing an alarming impoverishment.

In Benin, wetlands are concentrated in the south where 50% of the population over 10% of the national area live with less than 150 inhabitants per km² [6] and rarely relatively high densities. This situation justifies an anthropogenic pressure on surrounding ecosystems experiencing progressive degradation.

To protect its biological resources including wetlands, Benin Republic has acceded to several international conventions, including one that is specific to this study, the RAMSAR convention. The Ramsar Convention is an intergovernmental treaty on Wetlands, signed in Ramsar, a city in Iran 2 February 1971 [27]. To have ratified this Convention (24 January 2000), Benin has a duty to ensure that the ecological characteristics of each site listed. In addition, he was responsible for promoting the use of wetlands through national development plans and the creation of nature reserves in registered or unregistered sites. To date, four of its wetlands are registered Ramsar sites of international importance: Site No. 1017 Valley Mono - Couffo West Benin; Site No. 1018 low Ouémé Valley, East - Benin; Site N ° 1668 W complex; Site No. 1669 wetland Pendjari River [8]. Despite this, the loss of large areas of natural formations deserves special attention especially to scale moist areas constituent unit of wetlands.

The main objective of this study is to characterize the spatial dynamics and model the degradation of the small valley Adjarra, a wetland in the lower valley of Oueme.

Specifically, it will investigate and characterize the spatial dynamics from 2000 to 2013; identify changes and to model the degradation of the small valley.

To achieve these objectives, several assumptions are made: the small valley Adjarra is characterized by a spatial dynamic; changes in the landscape of the valley are critical for its degradation; levels of degradation are varied.

The study area, the small valley Adjarra is located south-east of Benin in the borough of Menedjonou (Municipality of Adjarra). This landform is a shred of the Sakété-Pobè tray which has a small and narrow lying on the watershed Yewa depression. It is characterized by swamps and crossed by several rivers, including the Adjarran River which is a natural border between the Republic of Benin and the Federal Republic of Nigeria. [9] The study area is the part of the valley Adjarra, situated in Benin between 6° 28' 52, 06'' and 6 ° 32' 14, 3'' north latitude, 2° 41' 39, 5'' and 2° 43' 07, 1'' east longitude. It covers an area of 17.91 km^2 and is covered by a sub-equatorial climate with two rainy seasons (March-July and September-December) and two dry seasons (December to March and July to September). Soils are waterlogged, low slope and tropical lateritic. The vegetation consists of gallery forest, dense forest and semi - deciduous forest under anthropogenic influence crop oil palm, raffia palm, timber plantations and energy service.

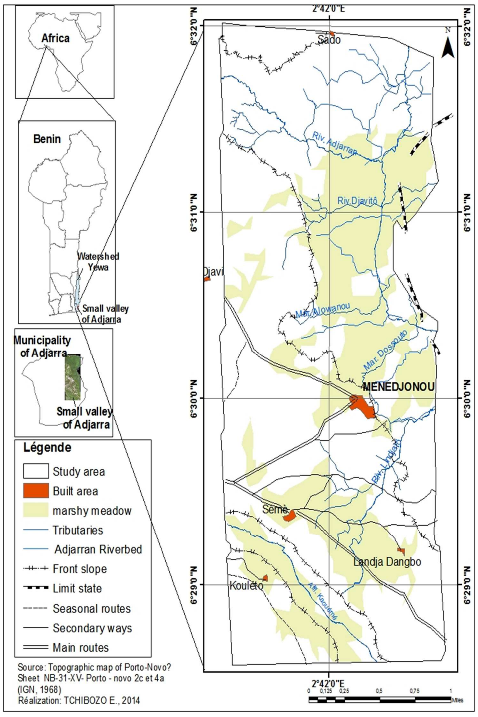

Figure 1a: Geographical location of the study area

Source : Image Landsat 8, OLI, Earthexplorer,

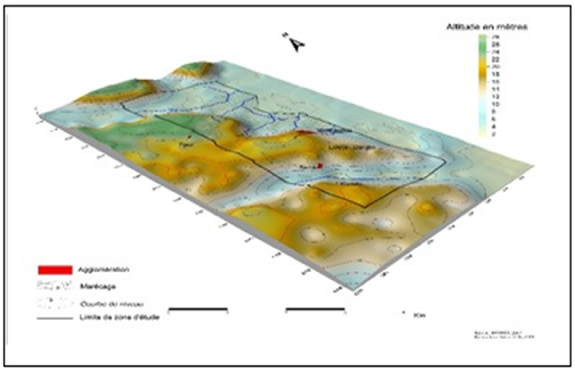

Figure 1b: Relief of the small valley Adjarra

Photo 1: Lindja –Tokpa landing

Figure 1 : Présentation du secteur d'étude

2 MATERIALS AND METHODS

2.1 MATERIAL

The material used is composed of a GPS receiver, a laptop, software, scanner and printer. The data collected from satellite images, topographic maps, attribute data extracted from the third census of population and housing [10], planimetric surveys and still photography in the field. Their main characteristics are shown in table 1.

Table 1. Main characteristics of the data collected.

N°	Data	Main characteristics	Scale/ Resolution	Source and year
1	Landsat 7 image, Radiometer ETM+	Spectral bands 0,45-0,52 µm ; 0,53-0,61 µm 0,63-0,69 µm, 0,78-0,9 µm 1,55-1,75 µm ; 2,09-2,35 µm 10,4-12,5 µm; 0,5-0,68 µm	30 meters	GLCF, 06/2000
2	Landsat 8 Image, LDCM/ OLI Radiometer	0,43-0,45 µm ; 0,45-0,51 µm 0,52-0,60 µm ; 0,63-0,68 µm 0,85-0,89 µm ; 1,56-1,66 µm 1,36-1,39 µm ; 2,1-2,3 µm 0,52-0,9 µm (panchromatic)	30 meters 15 meters	USGS, 09/2013
3	SPOT – XS Image	Spectral bands (0,50 - 0,59 ; 0,61- 0,69; 0,79 - 0,90 µm	20 meters	IGN - Benin, 11/ 2006
4	Shuttle Radar Topography Mission (SRTM3)	Digital Elevation Model	90 meters	2000
5	Topographic map of West Africa	NB-31-XV-sheet Porto - Novo 2c and 4a	Scale: 1/50 000, raster scanned with 200 dpi	IGN - Benin, 1968
6	Planimetric survey (GPS) and shooting photographic	Garmin GPS coordinates UTM-31N WGS 84 Datum	Precision 7m	Fieldwork, november 2013

Source: Monographic of Adjarra 2006 [11] completed by field survey 2011.

2.2 METHODS

The methods consist of sampling, digital photo -interpretation assisted image classification, detection and automatic mapping of change and modeling.

2.2.1 SAMPLING OF THE VALLEY ADJARRA VILLAGES VISITED IN THE FIELD

The sampling method adopted is non-probabilistic and purposive. The size of the representative sample is obtained by systematic sampling of the parent population (general population of the borough of Menédjonou). This sample meets the following criteria:

- be located in the valley Adjarra village
- have an agricultural ≥ 1.5 ratio.

The frequency of this representation with respect to the parent sample is p = 0.20. Σ its standard deviation is 0.01%. The confidence interval is considered 0.19 ≤ p ≤ 0.20.

2.2.2 ASSISTED IMAGE CLASSIFICATION BY DIGITAL PHOTO - INTERPRETATION

The raw images are corrected from bitter field surveys using GPS and recognized on topographic maps and satellite images. In this intermediate step of image processing, a database of planimetric data was obtained. She served for segmenting scenes Landsat 7 and Landsat 8 to get breaks in the image on the valley Adjarra. These images were then cut undergone treatment by visual improvement to enhance the contours of the different targets of interest (water, vegetation, crops and plantations). Assisted image classification is performed by the maximum likelihood criterion. The results are evaluated by calculating the error matrix and the Kappa number. The study of spatial dynamics is performed by diachronic analysis from the results of the photo - the automatic interpretation and mapping of Landsat 7 ETM + (06/2000) and Landsat OLI 8 (12/2013).

2.2.3 AUTOMATIC DETECTION AND MAPPING OF CHANGES

Cuts of satellite imagery scenes on the valley study were treated with visual enhancement software (ERDAS Imagine), segmentation, classification and identification of changes with the software ENVI 4.7, ENVI EX produce maps. These are obtained by vectorization of the classified image (raster). Spatial analysis was conducted by studying the topological relationships and the achievement of spatial queries using Arc Map 10.1 software. The classes generated by supervised image classification and vectorization are compared to those recognized on thematic maps collected to assess the impact of human activities on the valley Adjarra [12]. The changes are identified from the results of classification. The major advantage of this approach is its ability to provide a matrix of change (transition matrix). Change detection based on the results of image classification is based on the classified images to produce information about the change. This is done from the post-classification comparison of ENVI software - EX 4.8.

2.2.4 MODELING THE DEGRADATION OF THE VALLEY

To model the degradation of the valley Adjarra, factor analysis was performed using SPSS software. A study of bivariate Pearson correlation is applied from with statistical attributes derived from mapping the land. Several matrices are generated and the variance of land classes is appreciated. Factorial components are extracted by the principal component analysis of SPSS software [13].

3 RESULTS

3.1 SAMPLING OF THE VALLEY VILLAGES VISITED IN THE FIELD

The district Menédjonou (Adjarra) nine districts of villages and cities (Alladako, Djavi, Gbangnito, Gbéadji, Gbéhamey, Lindja - Dangba, Menédjonou, seeded and Tchakou), five of which are actually located in the valley of Adjarra (Djavi, Lindja - Dangba, Menédjonou, Sown and Tchakou). In this series, those who meet the criteria of representativeness, plus set out in the methodology, and are Djavi Menédjonou (table II).

Table 2. Areas of villages and cities sampled for direct observation in the borough of Menedjonou

District housing the valley Adjarra	Areas of villages and town of the borough of Menedjonou	General Population (hbts.)	Agricultural population	general Population / Agricultural population	Villages / neighborhoods located in the third valley Adjarra	Areas of villages sampled for direct observation in the field
Menedjonou (13959 habitants)	Alladako	1864	1517	1,23	-	-
	Djavi	2698	1796	1,5	Djavi	Djavi
	Gbangnito	1898	798	2,38	-	-
	Gbeadji	1486	906	1,64	-	-
	Gbehamey	640	608	1,05	-	-
	Lindja - Dangba	1528	1142	1,34	Lindja - Dangba	-
	Menedjonou	1687	920	1,83	Menedjonou	Menedjonou
	Seme	1429	1150	1,24	Seme	-
	Tchakou	729	602	1,21	Tchakou	-
Total	9 districts of towns and cities/villages	13959	9439	13,42	5610	2716

Source: Terms of villages and urban neighborhoods, Oueme Department, INSAE - DED, May 2004 [14], adapted.

The cumulative size of the population of these two areas is equal to 2,716 people, or 20% of the total population of the district Menédjonou. These areas are drained by several rivers and inhabited mainly by Nagos the Adjaranou and Torinou (table III).

Table 3: Stand neighborhoods sampled villages and towns in the valley Adjarra.

District harboring the valley Adjarra	Areas of villages and towns sampled	Stand of the small valley	River backwaters
Menedjonou	Djavi	Nagos, Ajarranou, Torinou,	Daloutokpa, Dêloutokpa, Deblatokpa, Datinto.
	Menedjonou		Adjarran, Dossoutokpa, Aguidi

Source: Terms of villages and urban neighborhoods, Oueme Department, INSAE - DED, May 2004[14], adapted

3.2 THE MAPPING OF THE SPATIAL DYNAMICS FROM 2000 TO 2013

3.2.1 VALIDATION OF ASSISTED IMAGE CLASSIFICATION

Classifications have achieved values of 99, 4 and 99, 6 for the overall accuracy of the confusion matrix and the values of 0, 97 and 0, 98 kappa. This index allows to remove the portion of chance or subjectivity of the agreement between the techniques [15]. From the foregoing, it can be concluded that the results are statistically classifications made valid and acceptable.

3.2.2 THE SPATIAL DYNAMICS FROM 2000 TO 2013

The results of the spatial dynamics of landscape from 2000 to 2013 are shown in figure 2.

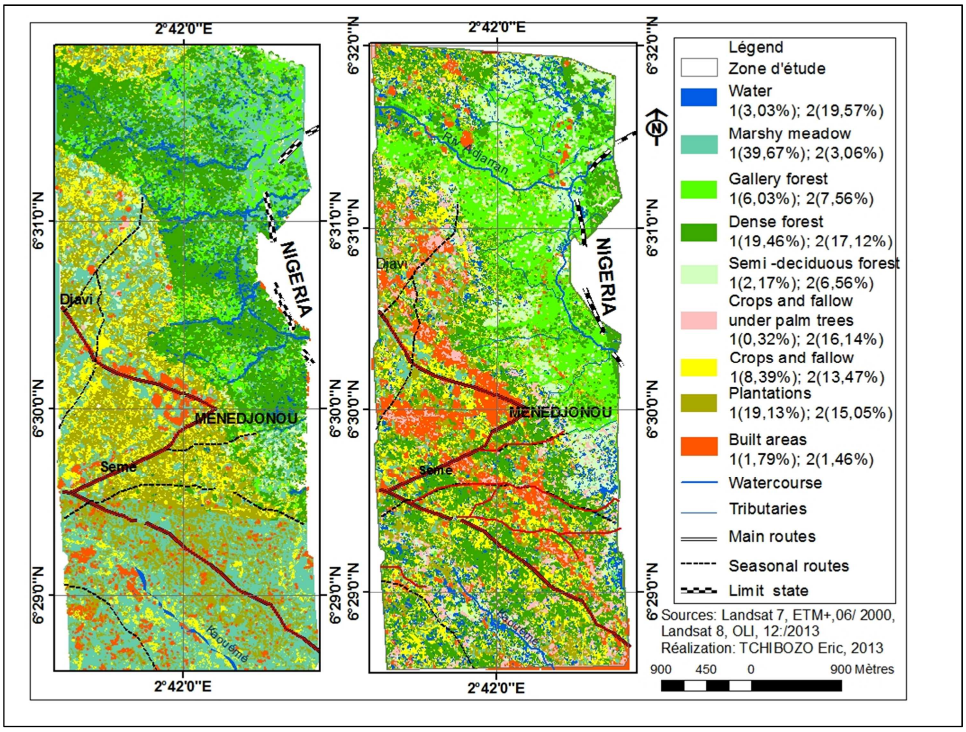

Figure 2: Map of land cover of small valley Adjarra (2000 et 2013)

Source : Image Landsat 8 ; OLI, Earthexplorer, 2013, interpreted

The analysis of the maps can remember the following:

In 2000, urban areas (1.45%) were poorly represented on a wet landscape water (27.98%) and marshy grassland (2.19%) with a low coverage of natural vegetation (32, 93%). The latter concentrated in the east of the study area is still within the depression of the valley and dominated by dense forest (21.14%) which is readily distinguishable from the gallery forest (5, 55%) and semi - deciduous forest (6.24%). The relatively large farming Centre - west and north-west of the valley and less in the South, consisted of plantations (10.23%), fallow crops palms (22.67%) and crops and fallow (2 , 54%). These were little noticed in the landscape of the valley.

In 2013, the occupancy rate has evolved agglomerations of 1.45% to 2.39%, an increase of 64.83% compared to that observed in 2000. Islands of habitat are now structured by many pathways that indicate sites of urbanization. Throughout the study site, building density gradually decreases from the center to the north - west and central south-east. The landscape became less humid with a decline of 43.39% occupancy water and a significant increase in the marshy meadow rose from 2.19% to 15.75%, a significant increase (619.18%). Despite this situation, which could be explained by the period of data collection (the dry season), characterized by lower rainfall and increased temperature (December), stagnant flood waters are still visible especially in the north - east, south - east and South in the bed of the tributary Kaouémé. The coverage of all of the natural vegetation has become more important and is currently 39.89%. The dense forest has decreased substantially 57.33% and migrated south and north - west of the study area where the combined pressure of agriculture and natural risks of flooding is greater. Gallery forest has more on interfluves became the dominant formation of the landscape with a rate from 5.55% to 19.37%, an increase of 249.00%. The forest semi - deciduous relatively larger around the valleys rose 74.42%. She currently draws a discontinuous belt around the depression of the valley which is currently sparser.

Centre - west and south - east of the valley, agricultural activities have become more visible on the riverbanks, in the bed of the river and Adjarran around the track to show the extent of human activities. The relative pressure plantations whose occupancy rate increased by 231.18% and the crop and fallow that have experienced an increase of 516.14% with the loss of crops and fallow land under palm trees which fell 22 we note 67% to 0.15% (figure 3).

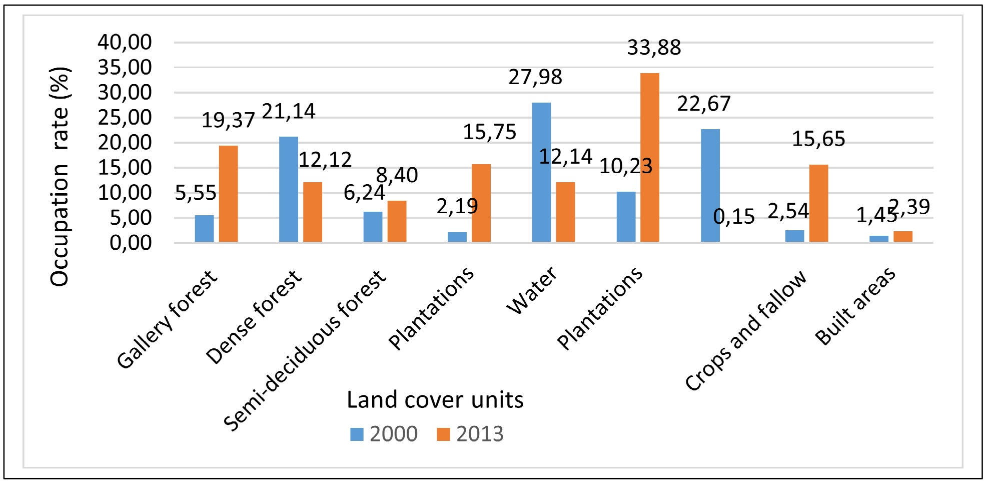

Figure 3: Comparative histogram occupancy units

Source: Image Landsat 8, OLI, Earthexplorer, 2013, processed statistically

Thus, in the valley of Adjarra spatial dynamics, studied from 2000 to 2013 is characterized by the progression, regression, stability and change of land use units. The increase is observed on the gallery forest, semi-deciduous forest, marshy grassland, plantations, crops and fallow and towns. Regression is obtained on the water (with localized flooding beds valleys) and the dense forest while crop fields and fallow under palm trees have undergone a change with significant conversion (figure 2).

3.3 CHANGES IN THE LANDSCAPE

Spatial dynamics from 2000 to 2013 has generated several changes in the landscape (table IV).

Table 4: Transition matrix of spatial dynamic (2000 to 2013)

Dynamic of land cover (%)	FG	FD	FSD	Mg	W	Pl	CFP	CF	Ag
FG	**41,22**	2,10	3,35	68,03	12,33	0,006	**2,13**	1,54	0,16
FD	2,67	**20,97**	0,51	8,53	3,77	36,98	**8,28**	16,01	14,32
FSD	29,23	0,63	**43,51**	**6,54**	0,00	0,66	**7,40**	**5,43**	0,16
Mg	**8,33**	0,56	**6,54**	**0,05**	0,00	**8,69**	**0,47**	1,51	**1,51**
w	22,40	**53,39**	1,92	7,82	**78,17**	2,97	**3,29**	7,09	11,50
Pl	0,25	5,59	0,12	**22,65**	3,45	**45,11**	**34,75**	15,73	22,73
CJP	3,46	3,25	43,41	**40,36**	2,28	10,64	**36,78**	7,09	2,15
CJ	0,76	13,01	0,63	14,07	0,00	2,80	**4,40**	**45,67**	17,02
Ag	0,01	0,50	0,01	1,50	0,00	0,83	**2,50**	5,36	**31,96**
Total 2013	108,33	100,00	100,00	169,55	100,00	108,69	100,00	105,43	101,51

Legend:

Changements	**Stability**	**Regression**	**Progression**

FG- Gallery forest, FD-Dense forest, FSD-Semi-deciduous forest, W-Water, Pl- Plantations, Mg- marshy grassland (CFP- crop and fallow under palm trees, CF- crop and fallow, Ag-Built areas

Analysis of the table shows that the most important changes are observed in dense forest (which lost 53.39% of its occupancy rate in favor of the water) and the marshy grassland (which received a contribution of 40.36% of crop fields and fallow under palm trees). Fields of crops and fallow land under palm trees gave way in turn 34.75% of their occupancy to plantations also increased significantly with a contribution of 8.69% of the swampy meadow. The least significant changes are noticed on the crop fields and fallow under palm trees and agglomerations (who left respectively 0.47% and 1.51% of their occupancy in the marshy grassland and urban areas). Stable landscape units are water (78.17%), crop fields and fallow (45.67%), plantations (45.11%) and forest semi - deciduous (43.51%). Marshy meadow is the least stable formation with a rate of 0.05%. In figure 4, the changes identified are located northeast of the depression in the center and southeast of the bank - west valley. Regression is more visible on the south bank - west valley. The increase is especially noticeable in localized depression in the east and south of the small valley Adjarra.

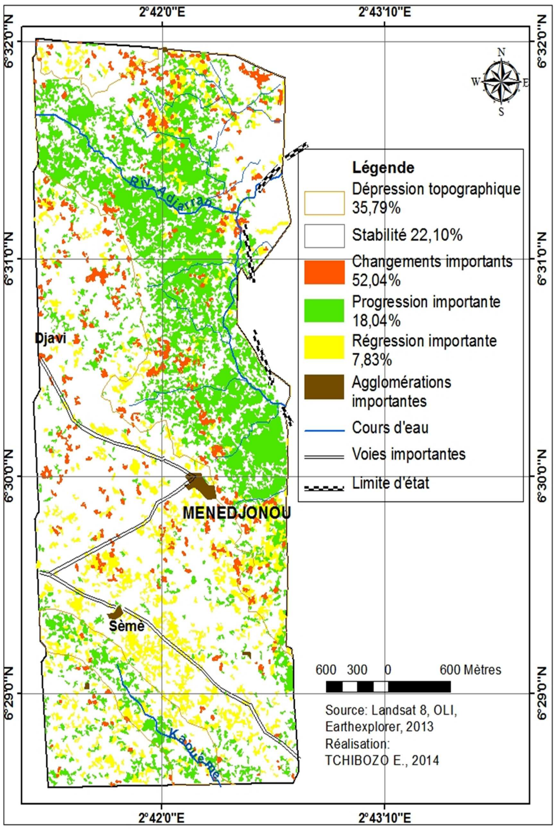

Figure 4: Map changes in the small valley Adjarra

Source : Image Landsat 8 ; OLI, Earthexplorer, 2013, interpreted

Photo1: Cultures et jachères sous palmiers

Photo 2: Cultures et jachères

Photo 3: Exploitation forestière

Source : Tchibozo E., 2014

Thus, in the small valley Adjarra, spatial dynamics generated several changes in the landscape. Some courses have received contributions to improve their occupancy rates while others have lost some of their original area. Cases of stability are also observed in certain formations.

3.4 MODELING OF DEGRADATION OF THE SMALL VALLEY ADJARRA

Several studies have shown that with the increase of human activities related to agriculture and urbanization, natural formations decrease. In depression Adjarra, only dense forests and water meet this known trend. Despite the relative intensity of activities and fallow crops (which increased by 516.14%) and plantations (which increased by 231.18%), the occupancy rate of the gallery forest, semi - deciduous and marshy grassland increased (figure 1). To understand this situation, a factor analysis was performed. The results obtained are shown below.

Table 5: Correlation matrix of spatial units from 2000 to 2013 (after factor analysis)

		S_FD	S_FG	S_FSD	S_E	S_PM	S_CJP	S_CJ	S_Pl	S_Ag
Corre-lation	S_FD	1,000	-0,008	0,049	-0,087	-0,045	-0,019	0,096	0,003	-0,060
	S_FG	-0,008	1,000	-0,014	-0,021	-0,028	-0,021	-0,015	-0,009	-0,020
	S_FSD	0,049	-0,014	1,000	-0,036	0,049	-0,043	-0,029	-0,009	-0,041
	S_E	-0,087	-0,021	-0,036	1,000	0,013	0,263	-0,043	-0,032	0,122
	S_PM	-0,045	-0,028	0,049	0,013	1,000	0,023	0,015	0,014	-0,007
	S_CJP	-0,019	-0,021	-0,043	0,263	0,023	1,000	-0,020	-0,028	-0,025
	S_CJ	0,096	-0,015	-0,029	-0,043	0,015	-0,020	1,000	-0,023	-0,034
	S_Pl	0,003	-0,009	-0,009	-0,032	0,014	-0,028	-0,023	1,000	-0,014
	S_Ag	-0,060	-0,020	-0,041	0,122	-0,007	-0,025	-0,034	-0,014	1,000
Sig. (1-tailed)	S_FD	1	0,447	0,215	0,078	0,234	0,379	,058	0,480	0,163
	S_FG	0,447	1	0,408	0,366	0,324	0,365	,406	0,440	0,373
	S_FSD	0,215	0,408	1	0,282	0,215	0,244	,320	0,442	0,252
	S_E	0,078	0,366	0,282	1	0,415	0,000	,240	0,299	0,023
	S_PM	0,234	0,324	0,215	0,415	1	0,357	,405	0,408	0,456
	S_CJP	0,379	0,365	0,244	0,000	0,357	1	,375	0,327	0,341
	S_CJ	0,058	0,406	0,320	0,240	0,405	0,375	1	0,356	0,289
	S_Pl	0,480	0,440	0,442	0,299	0,408	0,327	,356	1	0,408
	S_Ag	0,163	0,373	0,252	0,023	0,456	0,341	,289	0,408	1

a. Determinant = 0,878

Legend : S_FD - dense forest area; S_FG - gallery forest area; S_FSD - Area semi - deciduous forest; S_E water-Aire; S_Pm - marshy grassland area; S_CJP - Area under crops and fallow palm; S_ CJ - Aire crops and fallow; S_Pl - Children plantations; S_Ag - Area cities
***Source**: Factor analysis of unit areas of occupancy (after image interpretation and mapping)*

The analysis of the correlation matrix (table V) reveals a weak correlation between natural and anthropogenic landscape formations. In this series of values, relationships dense forest with water (-0.087) on the one hand and with crops and fallow (0.096) on the other hand, are characterized with a significant rate of 7.8% the first and the second 5.8% (significant for a standard 5%). The table shows that the marshy meadow induces a negative correlation of - .045 with dense forest. Water maintains a positive correlation of 0.263 with crops and fallow land under palm. The relationship with the water is also visible agglomerations. This explains that if water increases these last two spatial units follow the same trend. Figure 1 and Table IV, showed a complete conversion of crops and fallow land under palm plantations therefore a decline in the water. This regression of this unit could be explained by higher centers. Indeed, the dense forest maintains a negative correlation (-0.60) with the city. This indicates a decrease in dense forest with increasing the city. From these findings, we can understand that with the decline of water and increase the marshy grassland and cities, the dense forest decreases. The threat of human activities and natural hazards related to flooding is low for the gallery forest and forest semi - deciduous. Agglomerations show no significant correlation with both natural formations (figure 5)

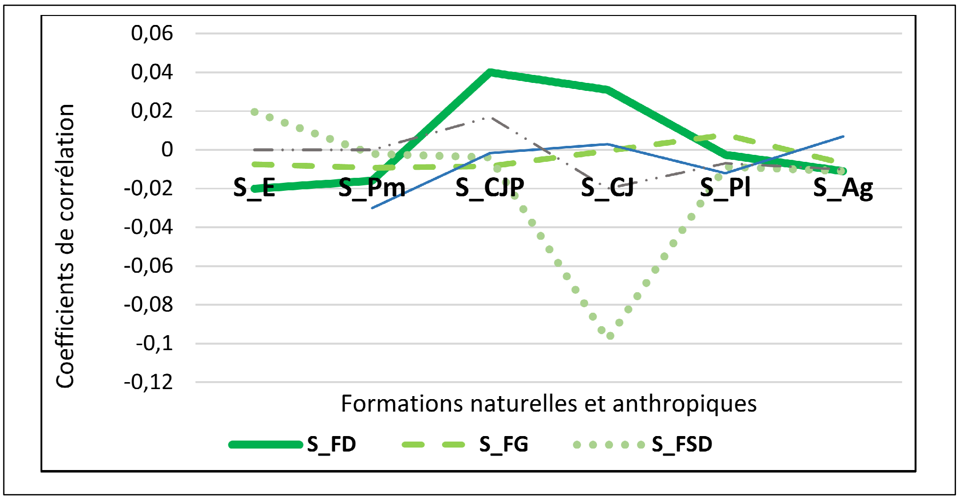

Figure 5: Interpretation graphic of correlation of natural and anthropogenic formations in small valley Adjarra

Source : Source : Image Landsat 8 ; OLI, Earthexplorer, 2013, interpreted

Factorial components are extracted by the principal component analysis. Of the nine variables of occupation of the landscape, both components are extracted. The initial eigenvalues and sums of squares selected factors are also determined. The results obtained in this step are shown in table VI.

Table 6: Total variance explained areas of spatial units from 2000 to 2013 (after factor analysis)

Total Variance Explained					
Component	Initial Eigenvalues			Extraction Sums of Squared loadings	
	Total	% of variance	Cumulative %	Total	% of variance
1	1,349	14,987	14,987	1,349	14,987
2	1,098	12,196	12,196	1,098	12,196

***Source**: Factorial analysis of unit areas of occupancy (after image interpretation and mapping)*

The analysis of the table shows that the variables have different weights, in proportion to their variance. Variable considered in the total information if the variance is high. In the table the largest variance is relatively low with 14, 987 and to the first component 12, 196 for the second. This explains a hierarchy of occupancy in the landscape dynamics (table VIII).

Table 7: Component Matrix of Factorial Analysis of Spatial Unit Areas (2000 - 2013)

	Component	
	1	2
S_E	0,755	,186
S_CJP	0,623	,474
S_FSD	-0,211	0
S_PM	0	0
S_CJ	-0,238	0,557
S_FD	-0,386	0,537
S_Ag	0,341	-0,373
S_Pl	-0,111	-,233
S_FG	0	-,198

***Source**: Factorial analysis of unit areas of occupancy (after image interpretation and mapping).*

Table 8: Component Matrix after Factorial Analysis Rotation of Spatial Unit Areas (2000 - 2013)

	Composante	
	1	2
S_CJP	0,782	0
S_E	0,695	-0,348
S_Pl	-0,235	-0,105
S_FG	-0,188	-0,100
S_PM	0	0
S_ FD		0,660
S_CJ	0,180	0,578
S_Ag		-0,506
S_FSD	-0,121	0,184

Source: Factorial analysis of unit areas of occupancy (after image interpretation and mapping).

In table VII, two components extracted by par Principal Component Analysis Method. In table VIII, the same method used with Kaiser "Varimax » Rotation Normalized. The convergence of rotation is getting after three iterations. The extraction of the factorial axes helped build the graph eigenvalues of factor analysis and diagram in space after rotation of the main components of landscape units from 2000 to 2013 (figure 6, figure 7).

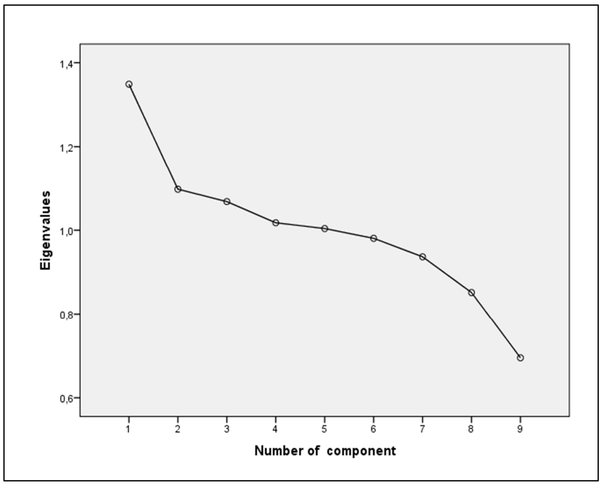

Figure 6: Eigenvalues of Factorial Analysis

***Source**: Factorial analysis of unit areas of occupancy (after image interpretation and mapping).*

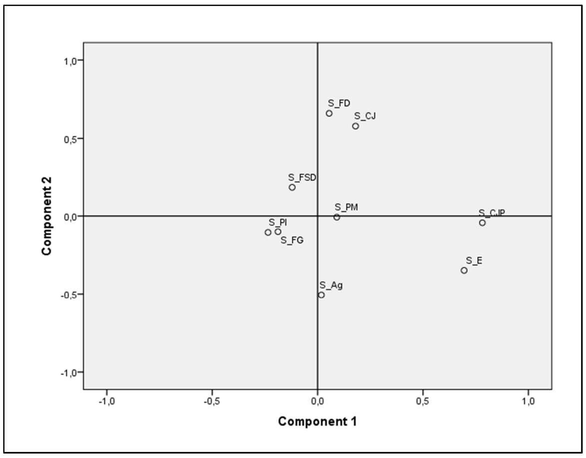

Figure 7: Component Plot in Rotated Space after Principal Component Analysis

***Source**: Factorial analysis of unit areas of occupancy (after image interpretation and mapping).*

The interpretation of figure 6 explains that the highest values are on the first two components extracted by principal components analysis. In figure 7, the axis 1 represented by component 1 in the matrix components (table VI), considers 14.987% of the variance and represents the best gallery forest (0.00), the marshy grassland (0, 00), crops and fallow land under palm (0.623), plantations and water (0.755). It is manifested by a linear function F (x) = 0.623 + 0.755 S_CJP S_E; S_CJP where is the area of crops and fallow under palm and S_E is the area of water. Area 2, represented by component 2 holds 12.196% of the total variance and expressed best represents the dense forest (0.537), crops and fallow 0.557), semi-deciduous forest (0.000) and cities (- 0.373). The factorial axis 2 is represented by a linear function F (x) = 0.537 + 0.557 FD CJ - 0.372 Ag; S_FD where is the area of dense forest, S_CJ is the area of crops and fallow and S_Ag is the area of settlements. Diagram of components in space after rotation, we can deduce that the growth of crops and fallow and agglomeration are regressive factors in dense forest. Indeed, 0.557 unit crops and fallow and 0.372 sinter plant are likely to degrade 0.537 unit dense forest. Regression of water and crop and fallow under palm trees contributes to the progression of the semi -

deciduous forest and gallery forest in the landscape of the valley Adjarra. From the foregoing, it can be concluded that the variation of vegetation of the valley Adjarra is explained by variations in water, crops and fallow fields, crop fields and fallow land under palm trees and cities.

Thus, human activities influence the dynamics of the landscape of the valley. This situation is characterized by the intensity of agricultural activities, increasing the marshy meadow, the decline in occupancy of the water and the regression of the dense forest are crucial for the degradation of the valley Adjarra. Gallery forest and semi-deciduous forest are not influenced by anthropogenic activities. Their relatively larger increase at the gallery forest could be explained by the soil conditions of the valley Adjarra, related relief to moisture, insolation and temperature. The decline in water could also be explained by the decline in rainfall and temperature increase during the month of December when the picture was taken (figure 1a). This critical situation the degradation of the valley is particularly felt in the dense forest.

4 DISCUSSIONS

This study is carried out on the spatial dynamics and modeling of degradation of wetlands by remote sensing. The results are consistent with those of several authors. In his study of the environment, [16] argues that the abuse potential of natural Adjarra and degradation of the forest ecosystem. The present study showed that the degradation of the dense forest is explained by the increase in crop fields and fallow fields and conversion of crops and fallow under palm plantations. Decreasing water and increasing the marshy meadow in the valley can be explained by the dry season characterized by lower rainfall and increased temperature. Flooding of some beds of depression confirms the observations [3] according to which the Adjarra knows rainy disturbances that lead to changes in production cycles. In studies on wetlands issues Oueme Department, the PROGEL showed that depression Adjarra space encompassing the valley Adjarra has low development, watershed degradation by water erosion the filling of water hyacinths and anarchic occupation of space by human settlements. [18] The existence of the threat of human activities identified by this study confirms environmental degradation declared by the PROGEL. About ECOPLAN 2004 cited by [18], agglomerations of Adjarra have experienced significant growth from 1968 to the present day. This increase in urban occupation is explained by the natural increase of the population and strong migration. The dynamics of land from 2000 to 2013 studied in the valley Adjarra confirms this statement.

Thus, from the foregoing, we can say that the results of this study support existing information published by several authors over the valley and of some interest to intervene effectively on adaptation strategies to climate change. The limitations of this study are related to the diachronic approach used to assess a complex and multiple land use dynamics. Although the results express the reality on the ground, it would have, in addition to two dates (2000 and 2013) analyze another way to highlight potential interruptions and changes to search separately and compare, in different natural areas.

5 CONCLUSION

The valley Adjarra, wet and fragile area, unfavorable to the principle occupation is occupied by human activities. The dynamics of the land is characterized by higher centers (64.83%), the marshy grassland (619.18%), the gallery forest (249.00%), forest semi-deciduous (74.42%), plantations (231.18% and crops and fallow (516.14%), the regression of water (43.39%), and the dense forest (57.33%) with a conversion of crops and fallow land under palm plantations. the most significant changes are made on the dense forest and the least important on cultivated fields and fallow under palm trees and cities.'s most stable units of occupation valley Adjarra are water, crop fields and fallows, plantations and forest semi -. deciduous fields of crops and fallow under palm trees and fields of crops and fallow are crucial for the degradation of the dense forest. this training decreases with the decrease of water and increase the marshy meadow to degrade the valley's. The gallery forest and semi-deciduous forest are not influenced by anthropogenic activities.

Thus, the valley Adjarra is threatened by anthropogenic activities especially agriculture and urbanization. The impact of these activities is reflected by changes in the landscape that are expressed by the destruction of the rainforest, the decline in the occupancy of the water and the progression of marshy grassland and anthropogenic formations rates.

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