Journal of Research in Forestry, Wildlife&Environment Vol. 8(2):157 - 170
http://www.ajol.info/index.php/jrfwe

jfewr ©2016 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Mvrèse et al..2016

EFFECTS OF LAND COVER CHANGE ON RANGELAND VEGETATION IN W BIOSPHERE RESERVE, BENIN REPUBLIC, WEST AFRICA

***[1]Myrèse C. A.; Mireille S. T.; [1]Dan, B.S.C;[1]Marcel R.B. H. [1]; and [1]Brice S.**

[1] Laboratory of Applied Ecology, Faculty of Agronomic Sciences, University of Abomey-Calavi, 01 BP 526, Cotonou, Benin
Corresponding author:myrese86@yahoo.fr*; **Phone:**(+229) 96 60 25 10.

ABSTRACT

Due to the rapid increase in population, land cover has changed in Benin. Because of this, the management approach adopted by most developing countries in Africa for biodiversity conservation was the development of protected areas. But these areas were located where poverty and insufficient employment opportunities determined the population's needs and activities hence, protected areas' vulnerability increased. This study focused on land cover change evaluation inside the W Biosphere Reserve (WBR) in Benin during these last decades. For this purpose, three maps, taken in 1989, 2000 and 2013 were interpreted using the software Arc Gis 10.1. Dynamic area proportion values were calculated and transition matrices were elaborated. Results showed that land cover has changed considerably and these changes were mostly observed in the periphery of the hunting zone where settlements, farms and fallows were noticed and in high proportions in 2013 than in 1989 and 2000. Concerning natural vegetations, the savannahs increased from 1989 to 2000 and were the most represented land cover type in 2013 while dense forests, gallery forests and woodlands decreased in the same period. Our results highlights, the necessity to study the dynamics in floristic composition of the area in order to assess change in floristic composition and to redefine with actors the best management practices which will allow the protected areas to assume their main role of biodiversity conservation.

Key-words: Land cover, Maps, Dynamics, Change, Benin Republic.

INTRODUCTION

Land cover is the result of a complex process and can be defined by the biophysical state of the earth's surface andsubsurface, including biota, soil, topography and groundwater (Turner, 2002; Lambin et al., 2003; Lepers et al., 2005) while land use refers to the transformation of land cover to desired human purposes (Houessou et al., 2013). Over the last few decades, land use/cover is undergoing drastic change. This change is to accommodate the rapidly growing population as observed currently by Mondal et al., (2012). The world's population is estimated to reach 8.9 billion in 2050 (Lutz et al., 2001).

This rapidly increasing population has led to increasing land requirement for agriculture and urbanization, heightening the clearance of forests. At the beginning of the twentieth century, the world's forest cover was estimated at 5 billion hectares and has reduced to 2.9 billion hectares nowadays (Issiaka, 2012). These declined forests are mainly concentrated in developing countries (DeFries et al., 2007; FAO 2010). From 1990 till today, the loss of forests in developing countries has averaged 13 million hectares per year (Lester, 2009). Steppes, savannas and grasslands also experienced a rapid decline, from around 3200 million hectares in 1800 to 2700 million hectares in 1990 (Ramankutty et al., 1999; Goldewijk, 2001).

The management approach adopted by most developing countries in Africa for biodiversity conservation has been the development of protected areas (Lambi et al., 2012). These areas were established throughout the world, sequel to land cover conversion in degraded ecosystems and the consequent habitat loss. Therefore, protected areas are considered as areas (forest, land and water) dedicated for biodiversity conservation through local laws and legislations. These areas serves as representative lands of biodiversity preservation for current and future generations (Pimm et al., 2001; IUCN, 2005) and constitutes an appropriate balance between land cover changes and needs to preserve other ecosystem services.

Many protected areas around the world are likely to undergo increasing pressures, depending on the land use and socioeconomic dynamics of the regions in which they are located (DeFries et al., 2005). The maintenance of ecological functions of protected areas is not static through time. Wittemeyer et al., (2008) observed an accelerated human population growth around protected areas in developing countries in Africa. These areas are located in densely populated regions where poverty and insufficient employment opportunities exist; indicating that the local human population relies on local resources for food and energy

needs (DeFries et al., 2007).This situation increases protected areas vulnerability.

Knowing trends on land use and land cover change in protected areas remains a great concern to sustainably design and conservation strategies for the management of protected areas (Clerici et al., 2007; Flamenco-Sandoval et al., 2007). In Benin, previous studies have assessed land cover change and demonstrated its impacts on natural's ecosystems which become degraded. For instance, in the central part of Benin, Oloukoi et al. (2006) showed that land cover regression is about 59.4% from 1978 to 1998. Adi et al. (2013) analyzed temporal dynamics of landscapes in the Sudanian zone of North Benin. And Houessou et al. (2013) investigated how land use and land cover change in two sites with different land use intensity around the W National Park. Their findings showed a rapid decline in land cover around the protected areas and a deforestation rate of 7.63%-15.13% outside the reserve. Thus, this study focused on changes in land cover within the hunting zone of Djona and addressed the following scientific questions: *(i)*: What change happened in the vegetation coverin the last two decades? *(ii)*: Is the periphery of the hunting zone most affected than the other parts of the study area? *(iii)*: Does the population's activities affect the land cover of the protected area?

METHODS

Study area

This study was carried out in the W Biosphere Reserve (WBR) in Benin, which covers 563.280ha and is located between 11°20'-12°23'N and 2°04'-3°05'E. The WBR is subdivided into three zones: core area, hunting and buffer zones. The hunting zone constitutes especially our study area (figure 1). It's an area devoted to hunting and safari tours. Agriculture, domestic livestock grazing, wood harvesting and non timber products extraction are excluded from that zone. But these prescriptions were not followed by populations surrounding the hunting zone and vegetation is highly

degraded giving way in some places to mosaic systems.

According to White (1983), the WBiosphere Reserve (WBR) belongs to the regional centre of Sudanian endemism and is characterized by a single rainy season (from May to October) and a single dry season (from November to April). Data related to the weather characteristics for the period 1980-2010 was taken at Kandi-Asecna, (2010). Thus, the average annual rainfall for the period from 1980 to 2010 is 979.19 mm. For the same period, the average annual temperature is about 28.21°C with 16.83°C minima value in December and 39.26°C in April for maxima value. The relative humidity is highest in august (81%) and lowest in February (26%).

Various soils are distinguished: minerals soils, little mature soils, tropical ferruginous soils and minerals soils with gley (Avakoudjo et al., 2014). Highly degraded land, called *bowé,* was also observed in this area (Padonou et al., 2014). The vegetation is mainly composed of woodlands, fallows, tree and shrubs savannas (Ahoudji et al., 2014).

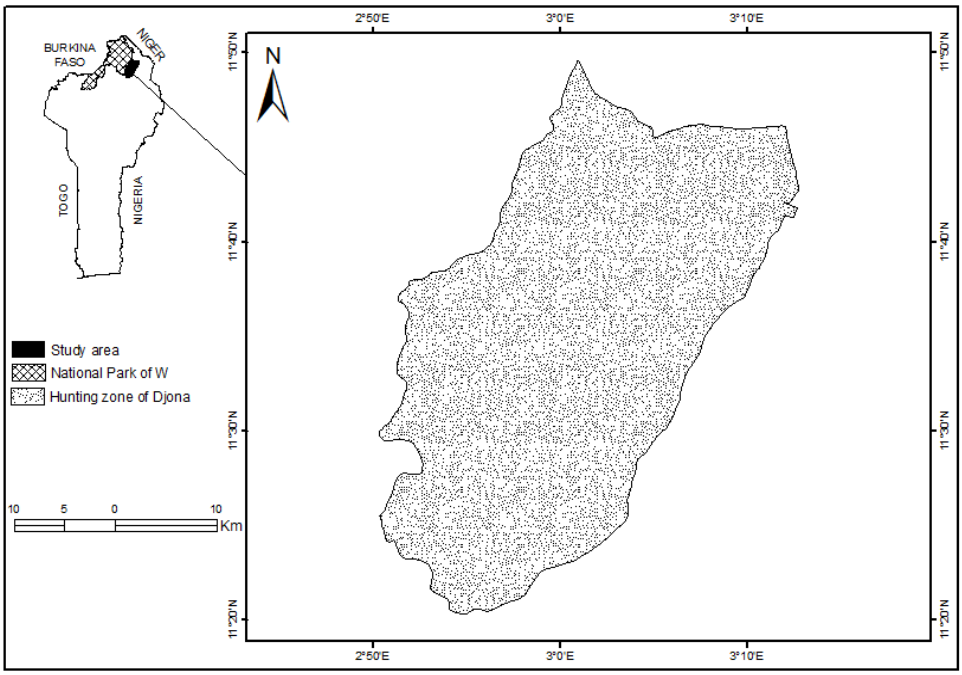


Figure 1: Localization of the study site, the hunting zone of Djona-part of the W Biosphere Reserve (Benin).

Data collection

Three maps, taken in 1989, 2000 and 2013 were interpreted. All images were acquired from landsat images, at the "Centre National de Télédétection (CENATEL)". The three maps of the W Biosphere Reserve were clipped to obtain maps of the hunting zone of Djona, using the software Arc Gis 10.1.

Data analysis

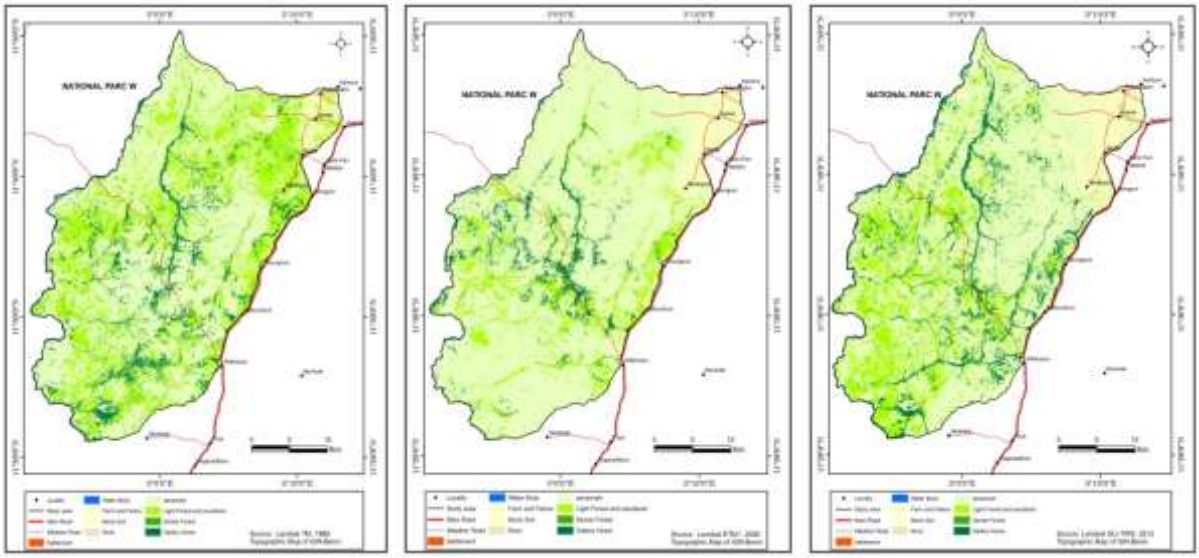
Based on the land cover/use classes' maps, we grouped the different land cover types. Land covers dynamics is evaluated with determination of proportion of each land cover type and the realization of dynamic graph with excel. The transition matrices were elaborated for the periods 1989-2000; 2000-2013 and 1989-2013.

RESULTS

Land covers types in the study area

Land cover maps of 1989, 2000 and 2013 showed six land cover types: settlements, farms and fallows, savannahs (woody, trees and shrubs, woody), woodlands, dense forest and gallery forest. Land cover map of 1989 (figure 2a) showed that savannahs (57.71 %) followed by woodlands (30.01%) were the most dominant land cover types comparatively to the others. Farm and fallows and settlement were the less represented land cover types (1.25% and 0.01% respectively as proportions values) in 1989. The land cover map of 2000 (figure 2b) showed that savannahs were the most dominant land cover type with 76.31% as proportion value. It's followed by woodlands and gallery forest land cover types. In year 2000, farms-fallows and settlements proportions' increased and passed respectively to 3.26 and 0.02%.

In 2013, land cover map (figure 2c), we remarked that the more dominant land covers were savannahs (62.19%) and woodlands (21.21%). We also noticed that farms and fallows were represented with 5.33% proportion value and settlement with 0.07%.



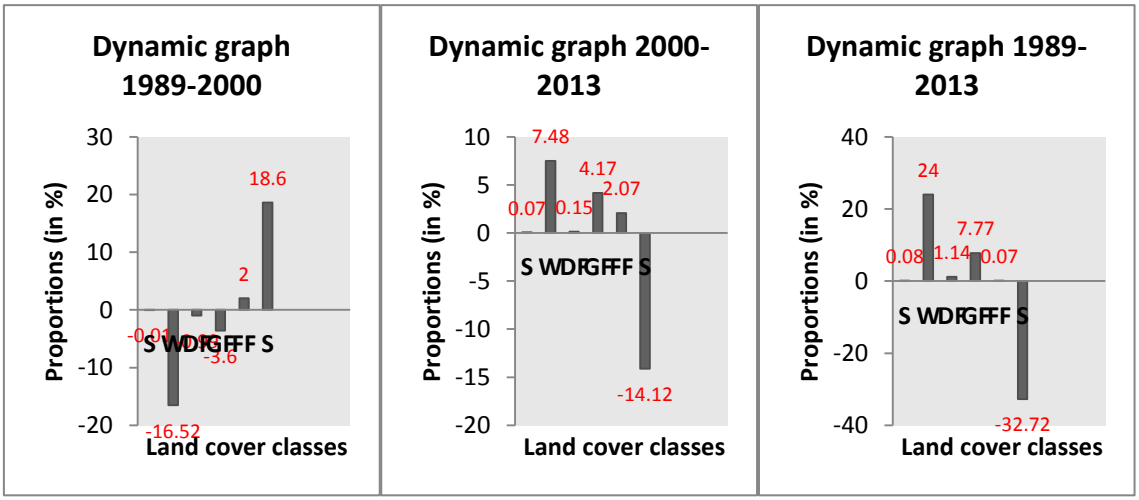
(a) (b) (c)

Figure 2: Land covers maps for 1989 (a), 2000 (b) and 2013 (c).

Myrèse *et al.,* ***dynamics for 1989-2000; 2000-2013 and 1989-2013***

We observed for 1989, 2000 and 2013 that the most represented land cover types were savannahs and woodlands. Dynamics values graphs presented on figure 3 showed that from 1989 to 2000, the savannahs increased to 76.31% while woodland land cover decreased drastically and from 30.04 to 13.52%. At the same time, settlement proportions doubled and to 0.02% as farms-fallows land cover type increased to 3.25%.

Dynamics of land cover types from 2000 to 2013 showed the increase of all land cover types without savannahs land cover type which decreased (with -14.12 as dynamic proportion value). From 1989 to 2013, we observed on dynamic change in land cover in the settlement; farm and fallow proportions increased in respective proportions of 0.06 and 4.08. Savannahs land-cover type increased while woodland, dense forest and gallery forests decreased.



(a) (b) (c)

Figure 3: Land cover dynamics from 1989 to 2013 at the hunting zone of Djona (WBR)

Legend: St: settlements; W: woodlands; DF: dense forest; GF: gallery forests; FF: farms and fallows; S: savannah.
(a): Land cover change in the Hunting zone of Djona in WBR from 1989 to 2000; (b): Land cover change in the Hunting zone of Djona in WBR from 2000 to 2013 and (c): Land cover change in the Hunting zone ofDjona in WBR from 1989 to 2013.

Transition matrices

The transition matrices of land cover in the hunting zone of Djona for 1989-2000, 2000-2013 and 1989-2013 were presented in Table 1. From 1989 to 2000, dense forest was moderately degraded in woodlands, savannah, farms and fallows. In the same time, woodland was also lower degraded in savannah and in farms and fallows. Transition matrix for 2000-2013 showed the same trend. On transition matrix of 1989-2013 we observed in 2013 that gallery forest was degraded in farms and fallows. Dense forest land cover type was degraded mostly in woodland, moderately in savannah and lower in farms and fallows. For this period, woodland degraded moderately in savannah and lower in farms and fallows. Savannah land cover type in 2013 was degraded in farms and fallows.

Table 1: Transition matrices of land cover in the Hunting zone of Djona for 1989-2000; 2000-2013 and 1989-2013.

	Gallery forests	Dense forest	woodlands	Savannah	Farms and fallows	Settlements	Total areas (Km^2)
Gallery forests	105.77	0	0	0	0.80	0	106.60
Dense forest	0	0.92	7.71	3.65	0.55	0	12.86
Woodlands	0	0.15	90.17	249.78	14.13	0	354.5
Savannah	0	0	38.39	631.26	14.11	0	683.43
Farms and fallows	0	0	0	4.96	9.59	0	14.74
Settlements	0	0	0	0	0	0.18	0.18
Total area 1989 (km^2)	105.77	1.07	136.27	889.66	39.36	0.18	**1172.31**
Gallery forests	85.23	0	0	0	20.54	0	105.77
Dense forest	0	0.93	0.03	0.08	0.02	0	1.07
Woodlands	0	2.55	86.46	43.46	3.79	0	136.27
Savannah	0	0	179.97	675.88	33.22	0.61	889.66
Farms and fallows	0	0	0	9.95	29.16	0	39.36
Settlements	0	0	0	0	0	0.18	0.18
Total area 2000 (km^2)	85.22505	3.483	266.456	729.3721	86.73075	1.0395	**1172.31**
Gallery forests	85.23	0	0	0	21.31	0	106.78
Dense forest	0	0.70	7.32	3.40	1.41	0	12.86

woodlands	0	2.78	259.14	65.37	26.54	0	354.50
Savannah	0	0	0	656.18	27.59	0	683.43
Farms and fallows	0	0	0	4.42	9.45	0.82	14.74
Settlements	0	0	0	0	0	0.18	0.18
Total area (km^2)	85.23	3.48	266.46	721.50	86.73	1.04	**1172.31**

DISCUSSION

Land cover types

This study investigated the land cover and land use change around W Biosphere Reserve in Benin and highlighted change occurring in this area especially in the hunting zone of Djona. Our results showed that the most represented land cover types for these tree years were savannas followed by woodland. From 1989 to 2013, areas of some of land covers such as dense forest and gallery forest were reduced and degraded mostly into woodlands, savannahs and lower in farms and fallows. When in the same time woodlands were degraded in savannahs and farms and fallows. Savannahs land cover type was also moderate degraded in farms and fallows and settlements. Then, farms and fallows area increase from 1989 to 2013. These observations underlined changes induced in vegetation and highlight the evidence of land conversion and land use change inside the protected area. This corroborates with (Houessou et al., 2013) who observed changes in land cover outside the protected area.

Land covers dynamic

The presence of settlements, fields and fallow land cover typeswas considered as human intrusion in the protected area. We noticed that these two land cover types were particularly located within the periphery of the hunting zone, characterized by the proximity of

population's activities and livestock breeding. These regions are also characterized by transhumance from Niger, Nigeria and Burkina Faso. We can deduce that farms and fallows and settlements land cover types were induced by the shift and burn agricultural practice in this area. This is consistent with previous studies (Lambin et al., 2003; Wood et al., 2004) which concluded that human practices and agriculture remains the principal factors inducing land cover change in sub-Saharan Africa.

Our results showed that dense forests, gallery forests and woodlands land cover types proportions decreased from 1989 to 2013. This highlights that without agricultural activities, others factors also induced change in land cover. According to Brink and Eva, (2009) the main drivers of land cover change were both natural and human. However, the perceived driving forces could vary in the same region and from one region to another (Lykke, 2000). Land use in a protected area as "grazing" induced change in vegetation cover. High grazing intensity explained also the conversion of land covers. This is consistent with Issiaka, (2012) who showed in Sahel regions that grazing is one of important factors inducing changes in land cover.

CONCLUSION

Our results on land use/cover change in the hunting zone of Djona in W Biosphere Reserve in Benin confirmed all of the three hypotheses and we can retained that, globally, land use has changed considerably in the last decades. The most represented land cover type was savannas formations and the periphery of this area was the most affected by the installation of farms and agricultural purposes. This situation affected natural resources. Our research highlights, the necessity to redefine with actors best management practices in order to preserve natural resources and to permit to protected areas to assume their main role which was to protect biodiversity.

ACKNOWLEDGEMENTS

We acknowledged the laboratory of Applied Ecology and the International Foundation of Science (IFS) whichfinanced this study and all experts and reviewers which contribute to the scientific evaluation of this paper.

REFERENCES

Adi, M., Sinsin, B., De Cannière, C. andBogaert, J. (2013). Anthropisation et dynamique des paysages en zone soudanienne du nord Bénin. Tropicultura. 31: 78-88.

Ahoudji, M.C., Teka, O., Axelsen, J. andHouinato, M. (2014).Current floristic composition, life form and productivity of the grasslands in the hunting zone of Djona (Benin).Journal of Applied Biosciences. 78: 6753-6762.

Avakoudjo, J., R. Glèlè-Kakai, V. Kindomihou, A. Assogbadjo and Sinsin, B (2014).Farmers' perception on the donga phenomenon and implication for adaptation strategies by locals in the sudanian Benin. Laboratory of Applied, Ecology report, University of Abomey-Calavi, Cotonou, Benin.

Brink, A.B. and Eva, H.D. (2009). Monitoring 25 years of land cover change dynamics inAfrica: A sample based remote sensing approach. Applied Geography.29: 501-512.

Clerici, N., Bodini, A., Eva, H., Gregoire, J.M., Dulieu, D. and Paolini, C. (2007).Increased isolation of two Biosphere Reserves and surrounding protected areas (WAP ecological complex, West Africa).Journal for Nature Conservation. 15: 26-40.

DeFries, R., Hansen, A., Newton, A.C. and Hansen, M.C. (2005).Increasing isolation of protected areas in tropical forests over the past twenty years.Ecological Applications. 15: 19-26.

Defries, R., Hansen, A., Turner, B.L., Reid, R. and Liu, J. (2007). Land use change around protected areas: management to balance human needs and ecological function. Ecological Applications. 17: 1031-1038.

Food and Agriculture Organization (FAO) of the United Nations. (2010). Global Forest Resources Assessment 2010: Final Report. FAO FORESTRY PAPER 163 pp.

Flamenco-Sandoval, A., Ramos, M.M. and Masera, O.R. (2007). Assessing implications of land-use and land-cover change dynamics for conservation of a highly diverse tropical rain forest. Biological Conservation. 138: 131-145.

Houessou, L., Teka, O., Toko, I., Lykke, A.M. and Sinsin, B. (2013). Land Use and Land-cover change at "W" Biosphere Reserve and its surroundings areas in Benin Republic (West Africa). Environment and Natural Resources Research. 3(2): 87-101.

Goldewijk, K.K. (2001). Estimating global land use change over the past 300 years: the HYDE database.Glob.Biogeochem.Cycles. 15(2): 417–34.

Issiaka, I.M. (2012). Land-use and land-cover change in Semi-Arid zone: the case of Waro-Souloulou area in Goulbi Maradi watershed in the Republic of Niger. Environment and Natural Resources research. 2(1): 47-62.

International Union for Conservation of Nature (IUCN) (2005).Benefits beyond boundaries. Proceedings of the Vth IUCN world parks congress. The World Conservation Union, Durban.

Kandi- Agence pour la Securité de la Navigation en Afrique et à Madagascar (Kandi-Asecna) (2010). Données pluviométriques

Lambin, E.F., Geist, H.J. and Lepers, E. (2003). Dynamics of land-use and

land-cover change in tropical regions. Annual Review ofEnvironment and Resources. 28: 205-241.

Lambi, C.M., Kimengsi, J.N., Kometa, C.G. & Tata Sunjo, E. (2012).The management and challenges of protected areas and the sustenance of local livelihoods in Cameroon.Environment and natural resources research. 2(1): 10-18.

Lepers, E., Lambin, E.F., Janetos, A.C., Defries, R., Achard, F., Ramankutty, N. and Scholes, R.J. (2005). A Synthesis of Information on Rapid Land-cover Change for the Period 1981-2000. BioScience. 55: 115-124.

Lester, R.B. (2009). Eco-Economie, une autre croissance est possible, écologique et durable. Edition du seuil, Chapter 3.

Lutz, W., Sanderson, W. and Scherbov, S. (2001). The end of world population growth.Nature. 412: 543-545.

Lykke, A.M. (2000). Local perceptions of vegetation change and priorities for conservation of woody savanna vegetation in Senegal.Journal of Environmental Management. 59: 107-120.

Mondal, A., Arniban, M., Subhanil, G., Sananda, K., Sandip, M. andRajarshi, D. (2012).Decadal-scale vegetation dynamics of Kolkata and its surrounding areas, India using fuzzy classification technique.Environment and natural resources research. 2(4) : 18-29.

Oloukoi, J., Mama, V.J. and Agbo, F.B. (2006).Modélisation de la dynamique de l'occupation des terres dans le département des collines au Bénin. Télédétection. 6: 305-323.

Padonou, E.A., Fandohan, B., Bachman, Y. andSinsin, B. (2014). How farmer's perceived and cope with bowalization: a case study from West Africa.Land Use Policy. 36: 461-467.

Pimm, S.L., Ayres, M., Balmford, A., Branch, G. and Brandon, K. (2001).

Can we define Nature's end? Science. 233: 2207-2208.

Ramankutty, N. and Foley, J.A. (1999).Estimating historical changes in global landcover: croplands from 1700 to 1992.Glob.Biogeochem.Cycles. 13(4): 997-1027.

Turner, B.L. (2002). Toward integrated land-change science: Advances in 1.5 decades of sustained international research on land-use and land-cover change. In Steffen W, Jäger J, Carson DJ, Bradhsaw C (eds). Challenges of a Changing Earth. Berlin: Springer. pp 21-26.

Wittemyer, G., Elsen, P., Bean, W.T., Burton, A.C.O. andBrashares, J.S. (2008).Accelerated Human Population Growth at Protected Area Edges.Science. 321: 123-126.

White, F. (1983). Vegetation of Africa: a descriptive memoir to accompany the UNESCO AETFAT UNSO vegetation map of Africa: UNESCO, Paris.

Wood, E.C., Tappan, G.G. and Hadj, A. (2004). Understanding the drivers of agricultural land use change in south-central Senegal.Journal of Arid Environments. 59: 565-582.