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Ecological implications of land use dynamics: the case of oluwa forest reserve in Southwestern Nigeria

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This paper examines the extent of resource use and the level of degradation consequent upon land use. Three distinctive trends were observed in terms of forest and land cover dynamics. These are forest degradation, deforestation and regeneration. The paper integrated a topographical map of 1969 and satellite imageries from Landsat MSS 1972, and Landsat TM 1991 and 2000 with ground truthing and socio-economic surveys to assess changes in forest resource use and land cover in Southwestern Nigeria. Results from this study suggest that human induced conversions and modifications of land cover are directly related to loss of biodiversity and this will have negative impact on the ecological setting. The paper therefore stresses the need for conservation and sustainable management of forest resources.

Keywords: land use; forest resources; human activities; degradation; planning; sustainable development

Human occupation of forests dates back to 25,000-40,000 years ago in Southeast Asia and the Pacific, 10,000 years in the Amazon and perhaps 3,000 years in Africa (Poore and Sayer, 1991). Changes were brought about when people moved from China to Southeast Asia, and from Europe to Africa and South America (Williams, 1990). Williams (1990) reported that from around 1600 the tropical forests were altered radically by the introduction of new crops and new methods of exploitation. Forests were cleared to made way for cash crops such as rubber in Malaysia and Indonesia, coffee in Brazil, tea in India and China, sugar cane in the Caribbean, cocoa and kolanut in Nigeria, tobacco and oil palm in Asia. In Nigeria, Ola-Adams (1981) reported that approximately 2,000 hectares of the western edge of Ogbesse Forest Reserve had been cleared and replaced by permanent agriculture. He further revealed that in some other areas of high forests, several areas of the forest estate reserves are being de-reserved for the establishment of agricultural crops. He further pointed out that in the current efforts to diversify the country's economy, large areas of the high forest zones are being cleared and planted with food and tree crops. He indicated for instance, that 45,845 ha were planted with food crops; 10,000 ha for oil palm; 73,000 ha for cocoa and about 140,000 ha for rubber plantations (Ola-Adams, 1981).

The main causes of forest destruction, as a result of land use, are well known. The studies of Myers (1984), Gradwohl and Greenberg (1988), Poore (1989), Repetto (1990), Salami et al (1999) and Orimoogunje (2005) are particularly revealing, while Palo's (1987) analysis indicates the complexities and interactions.

The effect of land use on Nigerian forest is aptly indicated by the fact that in 1897 there were 60 million hectares of forests and woodlands as against 9.6 million hectares of forests and woodlands in 1985 (Nwoboshi, 1986). In other words, there is a loss of over 50 million hectares in less than 100 years. Between 1981 and 1985 closed forest was being converted at the rate of 5% per year in Nigeria (WRI, 1987). The socio-economic implications of these deforestation processes are quite disturbing. Acute shortage of both industrial timber and fuel wood are already observable, while deforestation is also robbing us of numerous shrubs and herbs of food and medicinal value, as well as valuable plant genetic resources (NEST, 1991; Abe, 1995; Adesina, 1997; Orimoogunje, 1999; 2000; 2005). The loss of biodiversity and genetic resources is represented by 484 species in 112 families compiled by Gbile et al (1981) and listed as endangered plant species. Therefore, this study

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sets out to provide some information on processes of forest reserve transformation in Oluwa Forest Reserve and the resulting derivatives in this part of Nigeria.

Materials and Methods

Study area

The study reported here was carried out in Oluwa Forest Reserve, a part of Southwestern Nigeria. It is lying approximately between latitudes 6° 37' and 7° 20 north and longitudes 4° 27 and 5° 05 east (See Figure 1). The area is part of the western plains and ranges of Nigeria with much of it lying approximately between 300 and 600 metres above the sea level (Iloeje, 1981). Most rivers and streams draining this area arise from the southern part of the study area. Notable among the rivers are Oni, Oluwa, Ominla and Owena. The climate of the study area can be described as humid tropical environment (Fosberg, et al, 1961; Garnier, 1961). Mean annual rainfall ranges from 1,200mm to 1450mm and temperatures are high throughout the year with a mean of about 27°C and an annual range of about 3°C. The natural vegetation of the area is the tropical rainforest characterized by emergents with multiple canopies and lianas. Some of the most commonly found trees in the area include Melicia excelsa, Afzelia bipindensis, Antiaris africana, Brachystegia nigerica, Lophira alata, Lovoa trichiliodes, Terminalia ivorensis, T. superba, Triplochiton scleroxylon, etc. However, the natural vegetation of the area, with the exception of the areas devoted to forest reserve, has now been reduced to secondary regrowth, forest thickets and fallow regrowth at varying stages of development or replaced by perennial and annual crops (Osunade, 1991). These perennial crops include cocoa, kola and citrus.

Methods

The data used for this study was generated from the Topographical Sheet of 1969 at a scale of 1:250,000 (which served as base map), Landsat MSS 1972, Landsat TM 1991 and 2000 coupled with intensive ground truthing. The study area was demarcated on the map and grided into 5 km x 5 km, which gives 25 square grids out of which 10 square grids were selected using the table of random numbers. Each grid was again grided into 1km x 1km out of which 10 were again selected randomly. Ten quadrats of 40m x 25m were demarcated from each of the selected 1 km x l km grids for vegetation analysis. One hundred quadrats were selected altogether. This quadrat size falls within the range of quadrat sizes suggested by Weshoff and Maarel (1978) and which has been used by Aweto (1978), Ekanade (1985), Adejuwon and Adesina (1988), Salami (1995) and Orimoogunje (2005) for vegetation sampling in the tropics. All tree species occurring in each quadrat were identified and recorded.

The final maps were however drawn at a scale of 1:250,000 so that they could be easily related to the topographical base map of 1969 covering the area. Digital image processing was carried out using Multipscope 3.0 Software Package. Land uses were identified and classified from the Landsat imageries based on colour, texture, shape and size using the Integrated Land and Water Information Systems (ILWIS) 3.4 software. The classes of training sites include: the arable crop cultivation, tree crop cultivation, exotic tree plantation, dense forest and settlement/open space. The maximum probability algorithm was used for final classification.

The mathematics of the maximum likelihood decision rule, which was applied, has been explained by Tatsuoka (1971). The result of the classification of 2000 Landsat TM imagery was validated with ground truthing of the study area. The precision was above 90%, showing that the classification method was reliable. Furthermore, the inventory of fauna was extracted from the one compiled by the foresters in order to ascertain the level of degradation. The nature, history and socio-economic aspects of land use in the study area were investigated through a questionnaire administered to the farmers (350 in number).

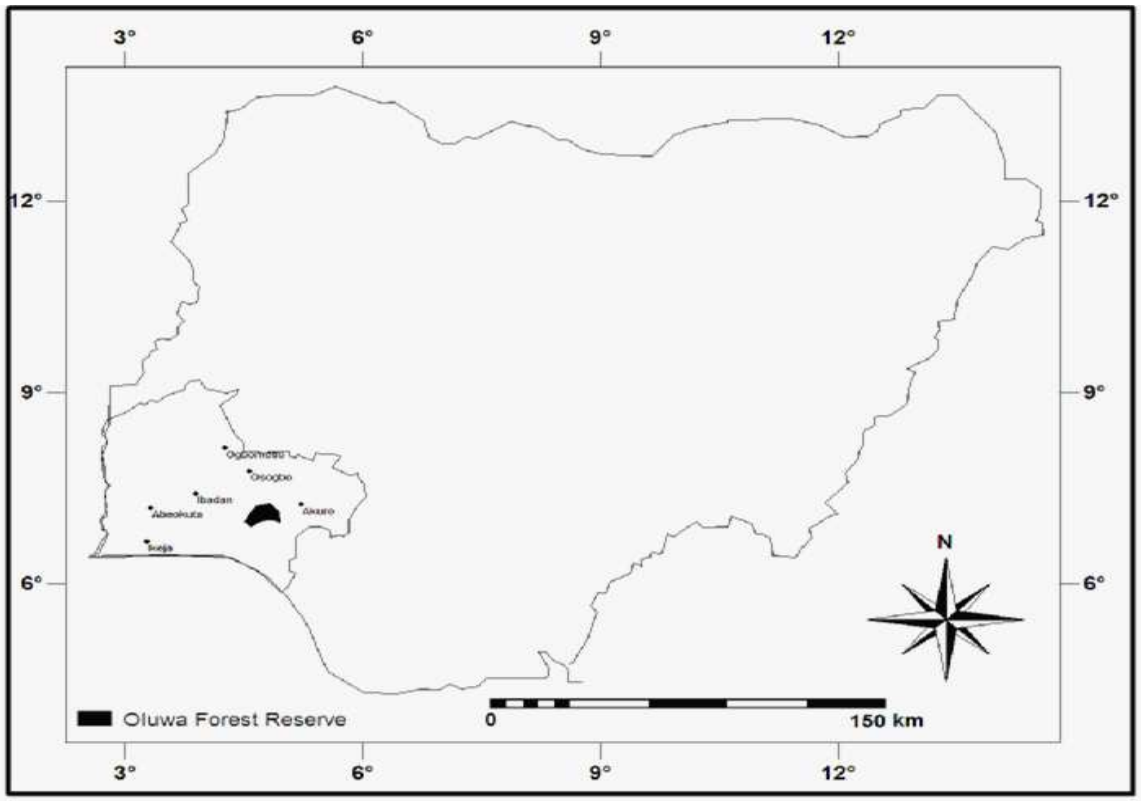

Figure 1: The study area in Southwestern Nigeria

Results and Discussion

Table 1 shows the result of image processing of the main land use and cover types for the three periods considered in the study area, while Figure 2 displays these land cover/use types in various forms. Table 1 shows that in 1969 the forest reserve was almost in the original state i.e. the area had not been much disturbed by human occupation. This may be due to the fact that population at that particular point in time was manageable and cocoa lands in other places were still not only productive but available. Furthermore, not many people probably knew about the existence of the Forest Reserve. Lastly, there was probably stricter control of the Forest Reserve by government agencies at that time.

Table 1 also shows that in 1991, 30.14% of the area was under exotic tree plantation (mainly Gmelina arborea and Tectona grandis), 59.99% of the study area was under dense forest and 2.97% was under tree crops (e.g. cocoa and kolanut), 1.45% under arable crop cultivation while 5.45% was under settlement/open space.

Furthermore, the table shows that by 2000 the proportions of exotic tree plantation and dense forest had been reduced to 12.06% and 10.49% respectively while the proportions of the arable crop cultivation, tree crop cultivation and settlement had increased considerably to 30.44%, 30.28% and 16.73% respectively. All these may be due to the fact that the rural poor have very few options. There are few prospects for off-farm employment in either the urban centers or the rural areas. For those opportunities that do exist, there is intense competition for the few jobs available. Illiteracy further limits the options of many because they do not have the basic tools needed to pursue other economic alternatives to subsistence farming.

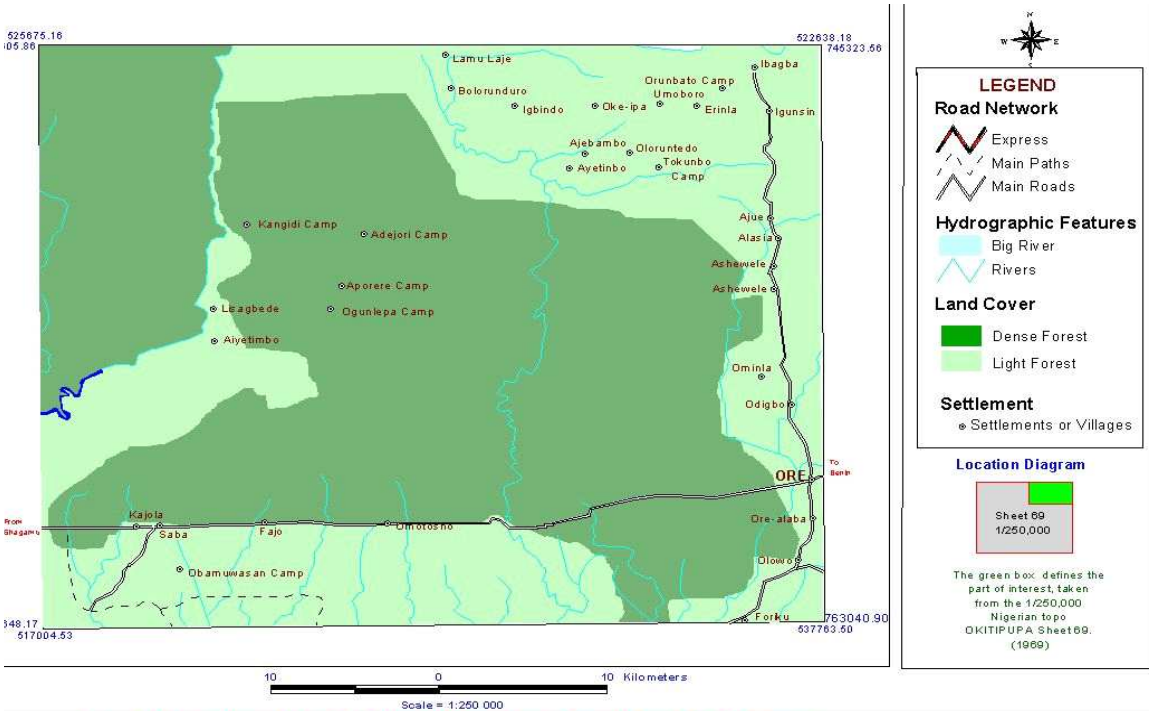

Figure 2: Land use Map of Oluwa Forest Reserve as at 1972

In some cases, people migrate from the neighbouring states to the forest frontier in search of a more prosperous and secure life (see Table 2). From the results in Table 1 two groups of land use changes were identified. The first group includes those land use types whose areal extent had increased between 1972 and 1991 and between 1991 and 2000. The land use types whose areal extent had increased between 1972 and 1991 included the exotic tree plantation from 49,034.40 hectares in 1972 to 55,683 hectares in 1991; settlement/open space from 4,932.60 hectares in 1972 to 10,056 hectares in 1991; arable crop cultivation and tree crop cultivation from zero in 1972 to 2,671 hectares and 5,505 hectares respectively. Similarly, arable crop cultivation increased from 2,671 hectares in 1991 to 56,229 hectares in 2000; tree crop cultivation from 5,505 hectares in 1991 to 55,943 hectares in 2000; and settlement/open space from 10,056 hectares in 1991 to 30,911 hectares in 2000. In sum total, these land use types have grown tremendously in areal extent in the study area.

Table 2 shows that many of the dwellers are non-indigenes that migrate from neighbouring states, occupying 80% of the total population, with Kogi State halving the total population and the remaining 50% shared between the indigenes (20%) and non-indigenes (Oyo 12%; Osun 10%; and Delta 8%). Hand-in-hand with poverty comes food insecurity and chronic undernourishment. With few alternatives available to them, the rural poor look to the forests as a short-term solution to their economic problems.

Arable crop cultivation has shown the most spectacular growth. The areal coverage was 2,671 hectares in 1991, which increased to 56,229 hectares by 2000. This land cover unit increased by more than 21 times its coverage in 2000. This trend may be expected because most of the people in the study area are migrant farmers looking for fertile soil. For instance, about 50% of the people interviewed were mainly arable cultivators who engaged in the cultivation of cassava, maize, cocoyam, banana and plantain. This may also be due to the fact that there is a shortage of land outside the forest reserves as a result of population increase.

Tree crop cultivation has also increased by more than 10 times its areal extent from 5,505

hectares in 1991 to 55,943 hectares in 2000. This was supported by the outcome of the questionnaire analysis. For instance, 75% of the people interviewed at Bagbe, Igunsi, Asewele, Gbekelu and Ago-kabiyesi are mainly cocoa farmers while 65% of the people interviewed at Lamu, Laje and Laoso are both cocoa and plantain cultivators.

Table 1: Areal coverage of land use types in the study area between 1972 and 2000

Land Use Type	1972		1991		2000	
	Area Extent (Ha)	% of Total	Areal Extent (Ha)	% of Total	Areal Extent (Ha)	% of Total
Dense forest	130,774.00	70.79	110,826	59.99	19,383	10.49
Exotic tree plantation	49,034.40	26.54	55,683	30.14	22,276	12.06
Arable crop cultivation	-	-	2,671	1.45	56,229	30.44
Tree crop cultivation	-	-	5,505	2.97	55,943	30.28
Settlement/open space	4,932	2.67	10,056	5.45	30,911	16.73
Total	184,741	100.00	184,741	100.00	184,741	100.00

The interview also reveals that about 60% of the people interviewed at Nirowi area were taungya farmers. They combine banana and plantain cultivation with Tectona grandis and Gmelina arborea planted by the Forestry Department, Ondo State on the same plot. This has taken over a substantial part of the forest reserve. The pattern of growth exhibited by settlement in the area is consistent with the observable pattern in many parts of the world (Areola, 1994: Wildgen, 2004). This pattern is influenced by many factors one of which is that the vast majority of dwellers are poor to average income earners who depend on agriculture solely as their source of sustenance. More so, many of the dwellers are non-indigenes that migrate from neighbouring states such as, Osun, Oyo, Delta, Ondo and Kogi (see Table 2).

Table 2: Farmers origin

Origin	Frequency	%
Ondo	70	20
Osun	35	10
Oyo	42	12
Delta	28	08
Kogi	175	50
Total	350	100

The second group of land use changes in the study area included those whose extent of coverage had decreased. In 1972, dense forest occupied 130,774 hectares but decreased to 110,826 hectares in 1991 and 19,382 hectares in 2000. This trend was consistent with what had been described for many forest reserves in Nigeria (e.g. Ola-Adams, 1981) and other parts of the world (Williams, 1990). The exotic tree plantation had also decreased from 55,683 hectares in 1991 to 22,276 hectares in 2000. In Nigeria, agriculture has destroyed many forested areas. Ola-Adams (1981) reported that approximately 2,000 hectares of the western edge of Ogbesse Forest Reserve had been cut over and replaced by permanent agriculture. It appears that many forest reserves are being de-reserved by illegal incursion in order to pave the way for the establishment of both tree and arable crops as exemplified by this study and many other studies (Ola-Adams, 1986; Salami, 1995).

Harcourt (1992) reported that the commodity, which was generally considered to be of greatest economic value in the tropical rainforest, is timber. As a result of lumbering activities in the forest reserves, many of the valuable trees have been removed. This has led to a decline in the areal coverage by dense forest class cover. The pattern of decline exhibited by the exotic plantation class cover is consistent with the observable pattern in many parts of South Western Nigeria (e.g. Salami, 1995). It was revealed by the Department of Forestry, Ondo State, that no other exotic plantation has been established apart from those established between 1980 and 1996, whereas their products are in high demand. For example, teak is always in demand for electrictypoles while gmelina is mainly in demand for paper production.

Ecological Implications of Forest Reserve Transformation

The study area, which falls within the tropical rain forest, was once described by White (1983) as an area consisting essentially of continuous stands of varied trees with canopies varying in height from 10 to 50 metres. He further revealed that the crowns of individual trees overlapped each other and are often interlaced with lianas. This description was of the past status of the study area but not the present state. Plates 1 and 2 show the present status of the study area. Changes have occurred because of human activities including shifting cultivation, permanent cultivation and logging in the study area. The on-going conversion of the natural rainforest cover into different agricultural land uses creates negative impacts on soil resources and stability of the environment.

The high forest is highly variable with regard to species composition and stocking. Hall (1977) suggested that the variation could be associated with soil differences and stated further that the use of ferralitic soil for intensive plantation establishment was not advisable unless adequate precautions are taken to compensate for substantial nutrient removal from the cycle during harvest.

Orimoogunje (2005) examined the inventory of the fauna population of the study area compiled by the forester and found an absence of monkey on the list. This indicated, according to Gbile et al (1981) an absence of original forest, as monkeys are good indicators of original forest. The forest workers further showed that Buffalos and antelopes were also at the point of extinction in the study area. This showed that the problem of forest destruction was directly related to loss of biodiversity.

Other leading direct causes of forest conversion and degradation in the study area, revealed by the administration questionnaires, apart from the advancement of agricultural frontiers and subsequent use of land by subsistent farmers, include: (i) widespread poverty, unequal distribution of income, high population density and growth rates which serve as exacerbating factors; (ii) large-scale commercial logging and timber extraction; (iii) conversion of forests to perennial tree plantations and other cash crops; (vi) large-scale colonization and resettlement projects like the Ondo State Afforestation Project in the centre of the reserve; and (vii) demand for land by shifting cultivators, small-scale farmers and landless migrants. These findings correlated with those from other locations (Hecht and Cockburn, 1989; Myers, 1984).

In the study area, agriculture has destroyed many forested areas (see Plates 1 to 4). The area of farmland within the study area covered 56,229 ha for arable crops cultivation. Farming encroachment into the Oluwa Forest Reserve accounted for 30.28% in 2000. Indiscriminate burning of the natural forest in the area has led to depletion and destruction of natural forest as could be seen from Plate 4. According to Ola-Adams (1981), the dangers of losing genetic diversity are greatest in the high forest ecosystems where there is great diversity of species and where forest destruction is more rapid. Ekanade (1991) reported that this might affect the ground surface albedo. Clayton (1958) demonstrated the possibility of a total degradation of the forest reverting to a grassland ecosystem as a result of tree crop cultivation which might encourage weed infestation and appearance of grasses. Already, many plant species known to be endemic in this part of the world have become endangered or in some cases extinct. This fact was supported by Federal Environment Protection Agency's (FEPA, 1992) finding that gave a list of 484 species of plants as endangered in Nigeria. This figure could be on the increase as a result of the intensification of human activities in the forest reserves.

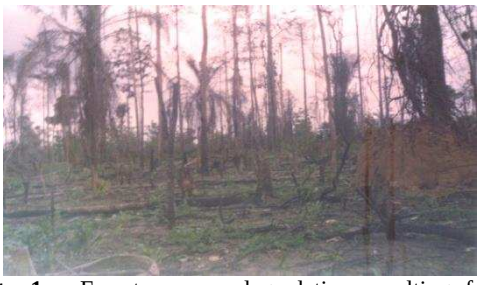

Plate 1: Forest reserve degradation resulting from arable cultivation (present state)

Plate 2: Fallow land within the forest reserve

Plate 3: Forest degradation resulting from arable cultivation and fuel wood production

Plate 4: Forest destruction by bush clearing and burning

Conclusion

This study shows that Oluwa Forest Reserve is under serious threat by human activities. The evidence of this includes the loss of about 84% of the forest reserve to human activities especially agriculture. The resultant effects of this are loss of biodiversity and genetic resources; loss of protection which plants give to soil and possibly increasing carbon dioxide which may have implications for the environmental warming crisis. Furthermore, the impacts of man in expansion of farm holdings and establishment of villages and hamlets in the reserve have contributed to reducing the extent and luxury of plant cover in the reserve and indeed, threatening the survival of the whole forest reserve as an important ecological unit in Southwestern Nigeria. With the findings of this study, there is need to intensify efforts by Government to control further incursion through the development of strategies and plans that will bridge the gaps in the conservation effort; while effective mechanisms should also be developed to harmonize cross-sectoral policies related to forestry. In this regard, a participatory approach in the management of forest reserves should be adopted involving the communities around the forest reserves, the State and other stakeholders. This will ensure commitment of the communities in the protection and sustainable management of the forest resources in the reserves. The local population should be enlightened as to the consequences of deforestation. In the case of the Oluwa Forest Reserve, the Ondo State Government should urgently initiate measures to empower the Department of Forestry and Wildlife to be in control of the reserve without interference from the other Government parastatals.

References

Abe, J.O. (1995) Community participation in forestry development in Nigeria – Osun State experience. In: Odunoye, E.A., Akinsanmi, F.A. and Bamidele, A.O. (eds) Forestry and the Small-scale Farmer. Proceedings of the 24th Annual Conference of the Forestry Association of Nigeria held in Kaduna, Kaduna State.30th October to November, 1995.

Adejuwon, J.O. (1971) Agricultural colonization in twentieth century in Western Nigeria: Distribution and vegetation characteristics. Journal of Tropical Geography, **39** 1-10.

Adejuwon, J.O. and Adesina F.A. (1998) Components of cover changes in Tropical Africa: Nigeria experience. Ife Social Sciences Review, **15** 1, 147 – 161.

Adesina F.A. (1997) Vegetation degradation and environmental changes in the tropics. Ife Research Publications in Geography, **6**: 1 & 2, pp. 68-78.

Areola, O. (1994) "The Spatial Growth of Ibadan City and its impact on the Rural Hinterland". In Filani, M.O. Akintola, F.0. and Ikporukpo, C. O., (eds): Ibadan Region Rex Charles Publication in association with Connel Publications, Ibadan, Pp. 72 – 84.

Aweto, A.O. (1978) Secondary succession and Soil Regeneration in a Part of the Forest Zone of Southwestern. Nigeria Unpublished PhD. Thesis, University of Ibadan, Nigeria.

Bilsborrow, R.E. (1994) Population development and deforestation: some recent evidence. In: Population, environment and Development, edited by the United Nations (New York: U.N.) pp. 117-134.

Clayton, W.D. (1958) Secondary vegetation transition to savanna near Ibadan, Nigeria. Journal of Ecology **46** 217-238.

Ekanade, O. (1985) The Impact of Cocoa Cultivation on Soil Characteristics in Southwestern Nigeria. Unpublished PhD. Thesis, Department of Geography, University of Ife, Ile-Ife, Nigeria.

Ekanade, O. (1991) Degradation of the physical elements of the rural environment resulting from tree crops cultivation in the Nigeria cocoa belt. Singapore Journal ofTropical Geography. **12** 82 – 94.

Federal Environment Protection Agency (FEPA) (1992) Transition to sustainable Development in Nigeria. FEPA, Abuja.

Fosberg, F.G., Garnier, B.J. and Kuchler, A.W. (1961) "Delimitation of humid tropics". Geographical Review, **51** 333 – 339.

Garnier, B.J. (1961) Mapping the humid tropics – climatic criteria. Geographical Review, **51** 339 -346.

Gbile, Z.O., Ola-Adams, B.A., and Soladoye, M.O. (1981) List of Rare Species of the Nigerian Flora. Research Paper (Forest Series) No. 47. Forestry Research Institute of Nigeria, Ibadan.

Gradwohl, J. and Greenberg, R. (1988) Saving Tropical Forest. Earth scan, London.

Hall, J.B. (1977) Forest types in Nigeria: An Analysis of pre-exploitation forest enumerate-ion data. Journal of Ecology, **65** 187 – 199.

Hecht, S. and Cockburn, A. (1989) The Fate of the Forest. London: Verso.

Iloeje, N.P. (1981) A New Geography of Nigeria. Longman, England 201 pp.

Myers, N. (1984) The Primary Source: tropical forests and our future. Norton, New York.

NEST (1991) *Nigerian's Threatened* Environment: A National Profile. NEST, Ibadan.

Nwoboshi, L.C. (1986) "Meeting challenges of the deforestation in Nigeria, through effective reforestation". In: Oguntala, A.C. (Ed.). The Challenges of Deforestation in Nigeria. Proceedings of the Forestry Association of Nigeria Conference, pp. 225-239.

Ola-Adams, B.A. (1978) Dry matter production and nutrient contents in a stand of Coppiced Cassia siamea Lam. in Ibadan Fuel Plantation. Nigeria Journal of Science **12** (1 and 2) 293 – 301.

Ola-Adams, B.A. (1981) Strategies for conservation and utilization of forest genetic resources in Nigeria. The Nigerian Journal of Forestry Vol. **II:** 2: 32 – 39.

Orimoogunje, O.O.I. (1999) An Assessment of Management Strategy of Forest Reserves in Osun State, Nigeria. Unpublished M.Sc. Thesis, Department of Geography, Obafemi Awolowo University, Ile-Ife.

Orimoogunje, O.O.I. (2000) Vegetation: A sustainer being endangered. Paper Presented at National Conference on Environmental Education held at Ekiadolor College of Education between 15th and 17th November, 2000.

Orimoogunje, O.O.I. (2005) The Impact of Land Use Dynamics on Oluwa Forest Reserve in Southwestern, Nigeria. Unpublished Ph.D. Thesis, Department of Geography, Obafemi Awolowo University, Ile-Ife.

Osunade, M.A.A. (1991) Agricultural change by supplanting process in a traditional farming system. International Journal of Ecology and Environmental Sciences, **17** 201 – 209.

Poore, M.E.D. (1989) No Timber without Trees. Earth scan, London.

Poore, D. and Sayer, J. (1991) The Management of Tropical Moist Forest Lands: Ecological Guidelines, 2nd edition, IUCN, Gland Switzerland and Cambridge, UK. 76pp.

Repetto, R. (1990) Deforestation in the tropics. Scientific American **262** (4) 18-24.

Salami, A.T. (1995) Structural Changes in Vegetal Cover in Ife and Ede Regions of Southwestern Nigeria between 1963 and 1993. Unpublished PhD. Thesis, Department of Geography, Obafemi Awolowo University, Ile-Ife.

Salami, A.T., Ekanade, O. and Oyinloye, R.O. (1999) Detection of forest reserve incursion in Southwestern Nigeria from a combination of multi-date aerial photographs and high-resolution satellite imagery. Int. Journal of Remote Sensing Vol. **20,** No. 8, 1487 – 1497.

Tatsuoka, M.M. (1971) Multivariate Analysis Techniques for Educational and Psychological Research. (John Wiley: New York).

Westhoff, F. and Maarel, E. Vander, (1978) "The Braun-Blanquet Approach", in R.H. Whittaker (Ed.) Classification of Plant Communities. The Hague, pp. 287 – 399.

Wildgen, J.K. (2004) "Urban Planning Applications for Large Scale Imagery". A Paper presented at College of Urban and Public Affairs, University of New Orleans, New Orleans.

Williams, M. (1990) Forests. In: Turnere, B.L., Clark, W.C., Kates, R.W., Rechard, J.F., Matthews, J.T. and Meyers, W.B. (Eds.). The Earth as Transformed by Human Action. Global and Regional Changes in the Biosphere over the Past 300 years. Cambridge University Press, Cambridge, pp. 179 – 201.

World Bank (1991) Forest Sector Policy Paper. The World Bank. Washington, D.C.

World Resources Institute (WRI) 1987) World Resources 1987. Basic Books New York.