

LAND DEGRADATION ASSESSMENT, IN THE PERI-URBAN AREA OF KADUNA METROPOLIS, NIGERIA

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ABSTRACT

This study assessed land degradation in the peri-urban area of Kaduna metropolis from the perspective of land use and land cover with the aim of ascertaining the role of these variables and to suggest on how to manage their existing nature and characteristic. Random sampling method was used to collect data from field observation, measurement and semi-structured interview which are summarized and analyzed using descriptive statistics and presented in the form of tables and photographs. The results indicated that the existing nature and characteristic of land use and land cover cannot be exonerated from contributing to ongoing land degradation in the area for the following reasons: first, 6% of the area is already degraded, second, low average values for surface cover index (12.7%), leaf cover index (11.4%) and tree density (40 trees/Ha), third, lost of vegetation biodiversity, fourth, absent of adequate conservation techniques to reduce the effects of crop farming and animal husbandry and lastly, evidence of problems already created by soil mining and refuse dumping. The situation in the study area calls for adequate land use and land cover planning, monitoring and management.

Keywords: conservation, degradation, environment, landuse, landcover.

INTRODUCTION

The maintenance of high quality environment is at the heart of human prosperity both in terms of economic and healthy living. But high quality environment has become the scarcest resource in the world. The issues are the same all over the world. The trend is one of decline in environmental quality, which environmentalists generally call degradation. Environmental degradation occurs in different parts of the world in different forms. It occurs mainly in the form of deforestation, erosion, desertification, massive flooding, global warming, wild fire and uncertain biochemical and hydrological cycles. For example, World Resources

Institute - *WRI* [1997] estimated that the whole world lost an average of 9,391,000 hectares of forest within ten years (1990 – 2000) to environmental degradation amounting to 0.2 percent of the world's land area. Another report by *Kapos* [2000] revealed that since the end of the last ice age, approximately half of the world's forest cover has been lost. The destruction of environmental resources can be blamed on man's insatiable quest for comfort, uncontrolled urbanization, industrialization, energy exploitation and agriculture.

One of the immediate results of such degrading activities is global warming. Global temperatures are now very high, much higher than in the years past, resulting in the melting of the ice in the Polar Regions, now swelling the oceans and causing flood with catastrophic outcome for man and properties. The recent perturbations in climate regime world over are partly attributed to degradation in the environment. Phenomena such as increasing intensity of El-Nino and the associated global warming are just few examples. Increase in frequency and high category of recent hurricanes in the United States of America (USA) and typhoon in Asia are already assumed to be some of the consequences of land degradation around the world.

The downward trend in the quality of the environment did not only affect the land cover. It equally affects other necessities of life like quality water and healthy atmosphere. Fresh water is increasingly being depleted or seriously threatened by excessive degradation of the environment and other factors. For example the Sahel in Africa and in the Middle East, fresh water is already a more critical commodity than energy resources. As a result, a *US Water News* [1991] headline stated, that "Next Middle East War May Be Over Water".

Indeed overuse and misuse of natural resources, pollution and rapid population growth combine to damage the environment and compromise health and living standards. As a result, virtually every country is at risk in one way or another. Unless man stop abusing the environment, the tendency of having the earth inch towards an unbalanced ecosystem is certain. Of particular concern to Nigeria as well as other developing countries is the identification of poverty as a factor of environmental degradation. What this implies is that the higher the poverty rating of a country, the more the environmental degradation and the more the suffering [*Green*, 1992].

In spite of all the efforts of both government and non-governmental agencies, the problem is particularly great in peri-urban areas of developing countries including Nigeria where land use for agriculture is intensive, vegetation cover is under immense pressure from animal husbandry and fuel wood collection, environmental pollution from solid waste generated, soil mining for physical development and expansion of settlement and infrastructure to meet social and

economic demands. When these forces merge together with poor agricultural practices and when the process continues for many years, the consequences on the environment is always enormous.

The degradation of any particular piece of land cannot be fully discussed without specific references to the nature and characteristics of the land use and land cover of the land. Land use, according to *Lillesand and Kiefer* [1987], are human activities associated with a specific piece of land, while land cover relates to the type of features present on the surface of the earth. As a result, there is urban use and residential use, as examples of land use. While examples of land cover include roof, pavement, grass and trees.

Knowledge of land use and land cover is therefore important for many planning and management activities concerned with the surface of the earth, particularly in relation to this study where land degradation is being examined with the overall objective to suggest better conservation techniques for land management. Such knowledge is also important in assessing the environmental impact of land use and land cover on the ecosystem and the socio-economic status (livelihood) of the dwellers. The need to do this constitutes the reason of this study which would help halt the degradation and ultimately enrich the environment for the benefit of all. A basic assumption of this research is that as land degradation increases in the study area, the socio-economic usefulness of the land diminishes. Therefore, a thorough knowledge of the causes of land degradation will enhance the formulation and implementation of effective remediation and mitigation measures.

The study area is the entire peri-urban area of Kaduna metropolis. The peri-urban areas of the city lie within a 500m corridor from the outskirts of the city. These zones are transition areas from rural to urban and they lack adequate infrastructure in comparison with the main city. The study area therefore circled the city and forms an irregular shape. It falls within latitudes $10^{\circ} 22' 00''$ - $10^{\circ} 40' 00''$ N and longitudes $7^{\circ} 20' 00''$ - $7^{\circ} 28' 00''$ E with the elevation ranging from 600m to 650m above mean sea level.

The approximate size of the study area is $24,000\text{m}^2$ (2.4 Ha). It falls within Igabi, Chikun, Kaduna North and South local government areas of Kaduna State, Nigeria (Fig. 1). A larger percentage of the northern part of the study area belongs to the Nigerian Defense Academy, the Nigerian Air Force, the old airport and the Nigerian Army. The area being a military zone excluded from the recent wave of physical development in the city. However, the area is not free from agricultural use [*Dogo, 2006*].

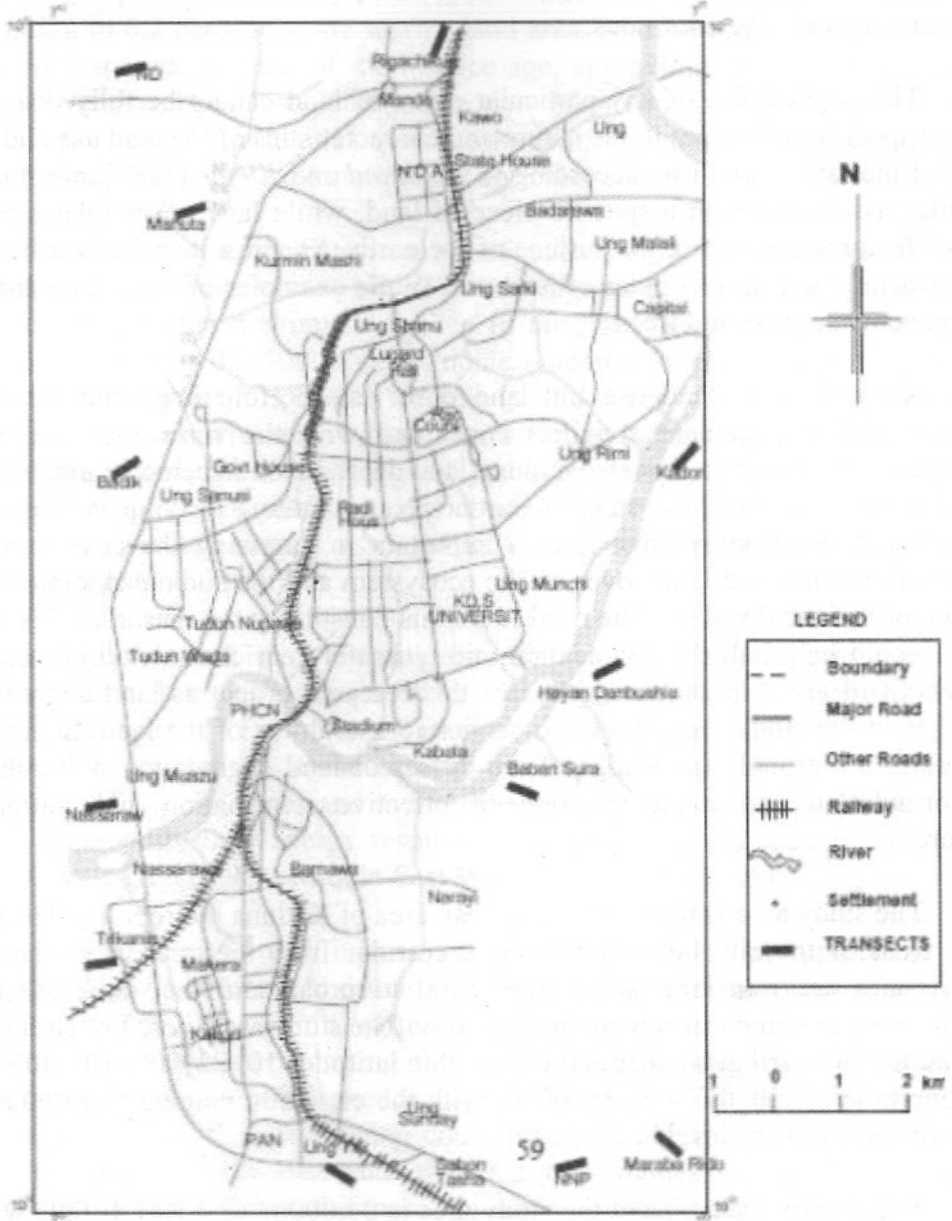


Figure 1. The area of study in The Kaduna State

The existing land use is predominantly agriculture, while the land cover is dominated by vegetation. The area's original vegetation is guinea Savanna, which has been replaced by cultured vegetation that is characterized by tall and short grasses with medium height trees interspersed within shrubs and herbs. River Gora

with six tributaries drains the northern area. The remaining parts do not fall in restricted environment like most of the northern part. As a result, both farming and grazing go on hand in hand. The vegetation is the same for both the northern and southern parts. River Kaduna and its tributaries drain the southern area. However, there is a section along the eastern part where the river creates a sharp boundary between urban land use and rural land use due to the absence of a bridge. However, a year after the fieldwork for this research had been completed; a bridge was being built over the river along the axis, however, this has not altered the land use situation. The trees are generally moderate in size, ranging from 5m to 15m in height and 15cm to 100cm in trunk diameter. The crops grown are mainly tubers (yams and potatoes), cereal (maize, guinea corn and millet) and vegetables (spinach, tomatoes, cabbage, onions etc). Cattle, goat and sheep grazed the vegetation from time to time.

Chance to avoid any kind of influence and for a proper representation of the study area. A base map was produced during the reconnaissance survey that served as the sample frame. From the sample frame, ninety six portions of 500m wide were created. These ninety six portions were numbered from 1 to 96. Twelve portions were then selected randomly. At each portion, transect of 50m wide and 500m long was randomly demarcated for the field observations and measurements (see Fig. 1).

The field measurement/observation were carried out using quadrant method and observation techniques accepted for standard fieldwork. On these selected transects, observation and measurement of land use, land cover, types of degradation, farming system, major crops planted, types and numbers of trees and conservation techniques are carried out. The semi-structured interviews on people's opinions on the existing conservation techniques and their effectiveness were conducted randomly on farmers found in the area. The interview was utilized to gather opinion from people who live and work on and around the study area. Some of the information that was sought for includes crop yield, types of land degradation, farming system, crop grown, land use, land cover, vegetation type, species and diversity, conservation techniques and farming problems.

Data processing involved various descriptive statistical tools such as means and percentages. The analysis entails the use of comparison and inferences while the discussion was focused on relating the result of the analysis with other results of the study and their implications toward sustainable environment. The discussions on land cover are based on field observations and measurements while land use information is derived from observation and scheduled interviews conducted with the farmers. Twelve (12) transects were used within the study area and using Figure 2 and the NNI formula by *Silk* [1979], the spatial distribution of the transects was computed to be 6.498. This value revealed that the transects are in

a near complete random distribution pattern and that the distribution of the transects within the study area is adequate in fulfilling the goal of the study by ensuring that the transects are chosen randomly.

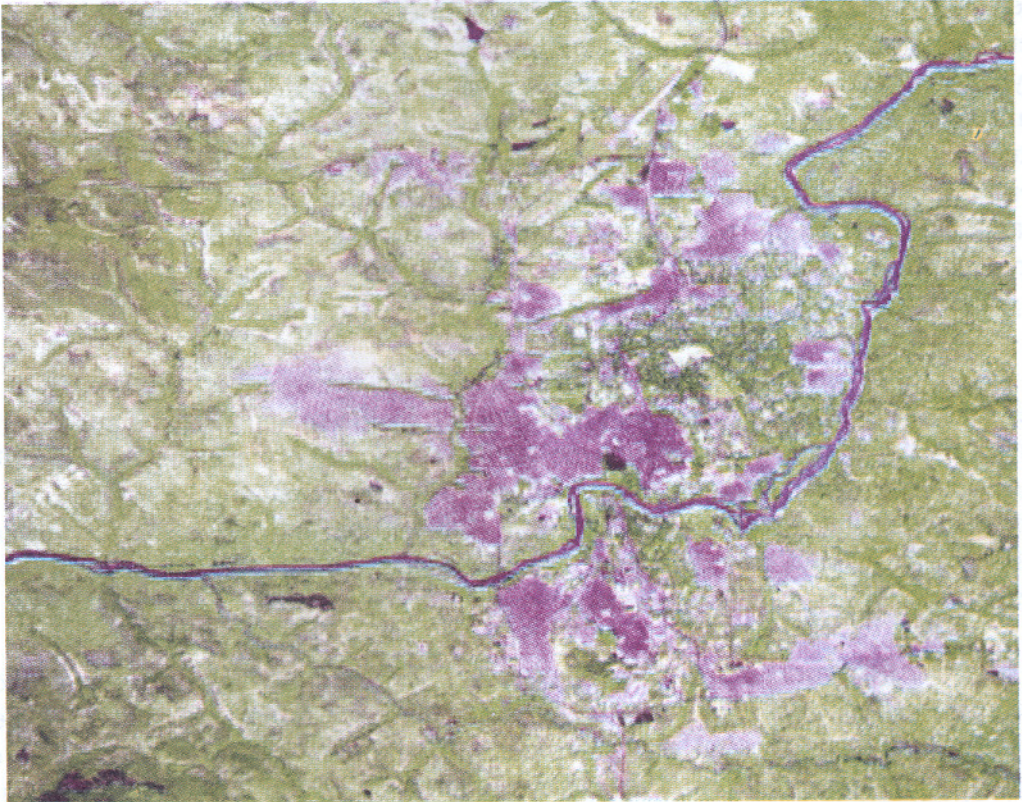


Figure 2. SPOT Satellite color composite Images of Kaduna Metropolis and its Peri-Urban Area

RESULTS AND DISCUSSION

Nature and Characteristics of Land Use

The nature of land use of Kaduna metropolis as a whole varies from one neighborhood to another. Indeed it varies from street to street as well as from house to house. The main reason is that developers and government officers do not follow master plan and this gives room to all kinds of building used for all sorts of purposes in a locality, leading to the development of an urban jungle or a slum [Adewuyi, 2005].

In the study area, the land use, as revealed from the field observation and measurements is generally for agriculture, forest, soil mining and refuse dumping

(Table 1). The major agricultural practice in the area is crop farming. In eleven out of the twelve transects, crop farming was practiced (Fig. 3). As a result, it can be generalized that the land use for the area is crop farming. Information from Table 1 further reveals that crop farming is basically rain fed and as a result, cultivation occurs only during the rainy season. Exception is however found along drainage channels where intensive crop farming through irrigation is practiced.

The major crops planted are maize, guinea corn, millet, sugar cane, cocoa yam and vegetables such as tomatoes, onions, cabbage, lettuce and spinach. These crops are grown for food and economic purposes although in small production scale.. This practice is also referred to as urban agriculture. On crop yield, two-third of the respondents agreed that crop yield had increased while one-third claimed they had not. Furthermore, over four-fifth of 62.5% of the respondents who agreed that the crop yield have increased, said that changes occurred in the last 15 years. Therefore, there is a correlation between changes in land cover, land use and crop yield.

As in other parts of northern Nigeria, crop farming goes hand in hand with animal husbandry. Even where land owners do not keep animals, *Fulani's* (animal bearers) do have access to the land. The study area is not an exemption to this practice. As a result, the peri-urban area of Kaduna metropolis is heavily grazed from the harvest period all through the dry season. Discussion with farmers as well as observation revealed that the farmers and the Fulani's normally go into symbiotic relationship where farmers provide crop residue as food for the livestock while the cow dung served as manure for crops. Consequently, the land of the study area is partly used for animal husbandry.

Another land use of the study area is forest. These are derived secondary forests made up of indigenous species as well as the exotic. These areas are forested because such lands are left to fallow and consequently, trees grow freely on the land. The last categories of land use are soil mining and refuse dumping. Soil mining takes place in one of the twelve transects. Information gathered from the interview revealed that 37.5% of respondents agreed that they excavate top soil. The soil is excavated to produce burnt red bricks for building of houses.

Refuse dumping is a common land use in the area (Fig. 4) and it occurs in two forms. First, human beings deliberately dump refuse on parcels of land due to proximity or availability of empty space. Second, refuse is dumped or scattered as a result of actions of wind and water. The wastes are mainly polythene and light weight objects that are not biodegradable. They are commonly found along drainage channels. However, refuse dumped by people are by far the most important and they occur randomly. The refuse content ranges from domestic waste such as paper, polythene, food, animal carcass, cloths, saw dust, plastics, to

industrial waste like chemicals and metals. Year after year, these dumps are partially cleared or are left to accumulate to swallow surrounding farmlands.



Figure 3. Photo showing crop farming



Figure 4. Photo showing refuse dumping in artificial pond

The dynamics of the changes in land use of the area show that 62.5% of the respondents agreed that there had been a change in land use in the last 20 years, while 33.3% agreed that there was no change and 4.2% said the question was not applicable. Of the 62.5% who agreed that there had been changes in land use of the area, 50% said the changes are from forest land use to agriculture while the remaining 12.5% said the change in land use is from grazing to farming.

Nature and Characteristics of Land Cover

The peri-urban area of Kaduna Metropolis has a distinct type of cover because the land use differs from that of the heart of the metropolis. Consequently, the major covers reflect the type of use and as a result, the covers for the area are trees, crops, grasses (Fig. 5), litters, shrubs and refuse. This implies that the area is not a built up area. Trees appeared in 11 of the 12 transects, grasses in all transects

while crops, shrubs, litters and refuse are not found in all transects (Tables 1 & 2). As a result it can be generalized that the main land cover for the area are trees and grasses.

Table 1: Summary of Results from Field Observation

Transect	Land use	Land cover	Types of degradation	Erosion types and number	Farming system	Major crops planted	Conservation techniques
TP 1 Rigachuku	Crop farming	Trees and crops	Sheet erosion and deforestation	Sheet – numerous	Crop and animal -rain fed	Maize and guinea corn	Crop residue left on farm
TP 2 NDA	Crop farming	Trees, crops, Grasses and litters	Sheet & gully erosion, deforestation and badland	Numerous sheet and one gully	Crop-rain fed	Maize and guinea corn	Use of fertilizer and crop residue
TP 3 Mahuta	Crop farming	Trees and grasses	Deforestation	NIL	Crop and animal -rain fed	Maize and millet	Use of fertilizer
TP 4 Badiko	Crop farming	Trees and crops	Flooding, Gully, pollution and refuse dumping	One gully	Intensive crop farming-Irrigation	Maize, rice, cabbage, tomatoes and lectus	Use of fertilizer, manure, raised beds and construction of water channels
TP 5 Nasarawa	Crop farming	Trees, crop and litters	Gully and excavation Pits	Two gully	Crop-rain fed	Maize	Use of fertilizer
TP 6 Trikania	Crop farming and refuse dump	Shrubs, grasses and refuse	Erosion, soil crusting, mining and refuse dump	Three gully	Crop-rain fed and irrigation	Maize, sugar cane, cocoa yam	NIL
TP 7 NNPC	Forest, crop and animal farming	Trees and grasses	Soil crusting and dumping of refuse	NIL	Crop and animal -rain fed	Maize, millet and guinea corn	Use of fertilizer and manure
TP 8 Maraba Rido	Crop farming	Trees, grasses and litters	Soil crusting and deforestation	NIL	Crop-rain fed	Maize and guinea corn	Use of manure
TP 9 Baban Sura	Crop farming	Trees	Erosion, badland and sandy deposit	Five sheet And rill	Crop-rain fed	Maize and guinea corn	Use of fertilizer and crop residue
TP 10 Hayan Danbushia	Crop farming	Trees, grasses and litters	Deforestation	NIL	Crop and Plantation-rain fed	Maize, millet, guinea corn and Soya-beans	Use of crop residue
TP 11 Television	Crop farming Soil mining Refuse dump	Grasses and refuse	Soil mining, erosion, Refuse dumping and Bush burning	One gully and 42 burrow pits	Crop-rain fed	Maize, guinea corn, sugar cane and cocoa yam	Ridging across slope
TP 12 Kadore	Forest	Trees, grasses and litters	NIL	NIL	NIL	NIL	Litters allow to remain on the ground

Table 2, show the values of the proportion of cover of tree, grass, litter and tree density per transect. Table 2 further reveals that the Surface Cover Index (SCI) in the transect ranges from 2.17% to 52.6%, while areas covered by litter in the transect ranges from 4% to 96%, Leaf Cover Index (LCI) range from less than 1% to 63%. The overall proportion of the types of trees in the area which was classified along indigenous and exotic species revealed that the ratio is generally 3 to 7 (380: 840) for the total peri-urban area while in the transects studied the ratio is from 1:1, to some cases where it is 1:0 in favor of indigenous species. The density of trees in transects equally varies. The number ranges from one per transect to 313 per transect.

Table 2: Summary of Land Use and Land Cover Characteristics

Transect	Area Degraded (m ²)	Area Degraded (%)	SCI (%)	Tree Crown Fullness (%)	Area Cover By Litter (%)	Tree Density Per Transect	LCI (%)	Ratio of Types of Exotic Indigeno us to Exotic Trees	Types of Exotic Trees
TP 1	0	0	11.60	48	78	17	1.4	1:1	Mango, Guava, Cashew
TP 2	4166.00	16.66	2.27	53	25	16	1	1:4	Mango
TP 3	0	0	20.00	25	42	1	<1	Only 1 palm tree	Palm
TP 4	195.70	0.78	52.60	75	4	121	10	1:12	Mango, Guava, Kola
TP 5	132.65	0.53	1.83	80	25	77	6.2	1:10	Mango
TP 6	1571.21	6.28	1.67	70	40	17	1.4	1:7	Mango
TP 7	221.79	0.89	2.00	70	40	239	19	1:30	Mango, Guava, Cashew
TP 8	0	0	3.50	74	90	209	17	1:2	Mango, Guava
TP 9	3383.89	13.54	19.60	75	44	79	6.3	1:1	Mango, Palm
TP 10	945.00	3.78	33.50	67	37	127	10	1:1	Mango, Guava, Cashew, Oranges
TP 11	6006.70	24.03	2.17	59	35	4	<1	All indigeno us	NIL
TP 12	0	0	2.33	96	96	313	63	1:1	Mango
Total	16,622.94	66.49	153.07	792	556	1220	137.3	380:840	
AVG./trans ect	1,385.25	5.54	12.76	66	46.33	101.67	11.44	3:7	

$$\text{Overall Degradation Rate} = (\text{Total Area Degraded} / \text{Total Area}) * 100$$

$$= (16,622.94 / 300,000) = 0.0554 = 6\%.$$

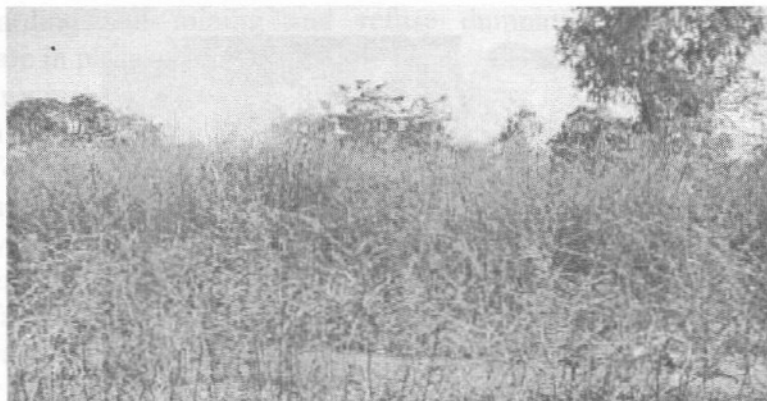


Figure 5. Photo showing the grass cover

The tree species found in the study area are diverse in nature. For the exotic species, the major trees are mango, guava, cashew and orange while examples of indigenous species found in the area are *tamarind* tree, locust bean, shea butter, *maringa*, baobab and many more as shown by Figure 6. The interview conducted and the field observation revealed that the farmers as well as the people living around use the trees for the following functions; economy (selling, as asset and collateral), wood fuel for energy, and food for man, for medicines (traditional herbal medicine) as shown in Figure 7, for provision of shade, wind break and shelter belt. Other uses are for ash, manure and as animal feeds.

Results from the interview revealed diverse responses on the dynamics of the vegetation cover of the area. It clearly revealed that 47.9% of respondents agreed that there had been an increase in the number of trees in their farms. Another 35.4% of the respondents reported that there had been a reduction in the number of trees, while 4.2% said there was an increase in grasses. However, 8.3% said there had been a reduction in trees but increase in grass and finally 4.2% said there had been losses of both trees and grasses in the area.



Figure 6. Photo show different types of trees in the study Area

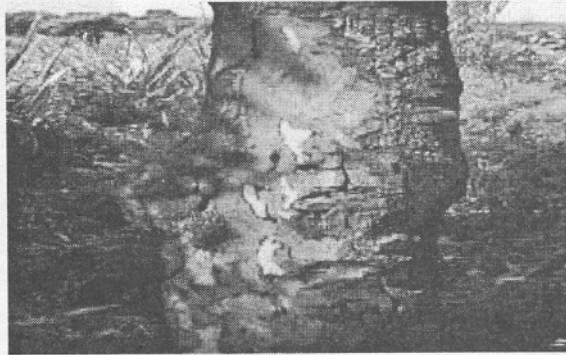


Figure 7. Photo show the use of tree bark for local medicine

Implications of the Results

Humans are the major determining force in global environmental change through various land uses [Adewuyi, 2008]. According to Okin [2002], land use is a major factor of soil erosion in particular and land degradation in general. Of all types of land use, crop cultivation and grazing have been the major contributors to land degradation [Puigdefabrégas and Mendizabel, 1998]. Their study revealed that cultivation of land increases erosion by water. Quine *et al.*, [1994] added that fivefold increases in water erosion rates occurs on cultivated land. Similarly Banin and Fish [1995] reported that irrigation agriculture could contribute more significantly to the salt content of soils leading to lowered long-term productivity rates. Like in crop cultivation, Albaladejo *et al.*, [1998] recorded significant decreases in both soil organic carbon content and stable aggregate and an increase in bulk density from areas subjected to heavy grazing.

In the light of the results of various studies already mentioned on land degradation, crop farming and grazing contributed significantly to land degradation and do not seem not to be the best land use practices for sustainable development without suitable conservation techniques. Consequently, if proper care is not taken crop cultivation and grazing form the major causes of land degradation anywhere including this study area. For example, from Table 1 it was noticed that transect that were used mainly for crop farming experienced various degradation problems and have more erosion types and number. It was also observed that the conservation techniques employed by the farmers targeted only soil nutrient enrichment only to increase crop yield through the application of fertilizer, manure and crop residue leaving other environmental problems such as erosion, loss of biodiversity and flooding being unattended to. Similarly, the type of agriculture practiced in the study area which is mainly crop farming and some level of animal husbandry required a better approach to guarantee sustainable development.

Regarding soil mining and refuse dumping, where no conservation techniques are in place as observed in the field, they are really an immense problem for the environment. For instance, soil mining in the area has led to loss of surface soil rich in organic material, distortion of the land surface morphology, gully erosion, deforestation and flooding. The consequences of indiscriminate dumping of refuse have been over-flogged by many studies. The effect on the environment in the study area is not different from what has been mentioned in many studies. However, another dimension of the problem that was discovered was the loss of space for farming and loss of productive man-hours to clearing and sorting of waste. It was discovered that farmers now lose part of their farmland to waste. Particularly notorious are the non biodegradable wastes such as cellophane, polythene, plastic and metals. The other new but major problem is the loss of productive man hours now dedicated to the clearing of waste (*noma leda*) which take up to two weeks to clear about 200m² at the beginning of every planting season. Mostly affected are farms along the river banks.

In Figure 8 (left) shows a parcel of farm land before the waste on it was sorted, while right photo shows another farmland that the waste had been sorted but is still dotted by waste all over which are retained in the soil and are mostly non-degradable. Forest covers in the area are secondary forest, mostly of exotic trees, very scant and are all on lands where the owners have prevented their use. As a result, the future of these forests is in doubt and their contribution to sustainable environment cannot be guaranteed since they do not belong to government neither is there any land use and land cover master plan for the area.

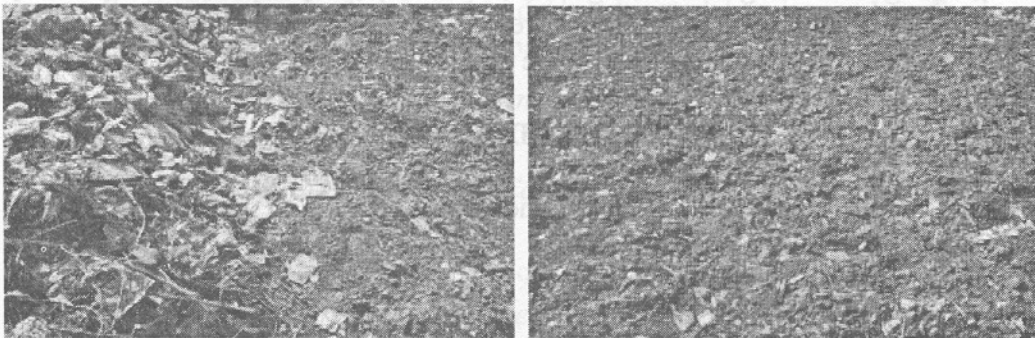


Figure 8. Photos shows a parcel of farm land before the waste on it was sorted (left), and farm land dotted with waste after sorting (right).

In summary, the existing nature and characteristic of land use and land cover cannot be exonerated from causing land degradation in the study area based on the following arguments: first, a situation where areas' suffering from degradation covers about six percent of transects areas is a bad indicator that the environment is not well managed, second, from Table 2 the average values of the surface cover index (12.7%), leaf cover index (11.4%) and tree density (40

trees/Ha) are too low for any form of sustainability of a good environment for a long time, third, the effects of soil mining and refuse dumping are already creating environmental problems for more than a single generation because their impact cannot be solved within a short time, fourth, a situation where the major land uses are farming and animal husbandry without any adequate conservation and where the evident of their effects on the environment are obvious is a major problem. Finally, the study area is losing its vegetation biodiversity with the taking over of the vegetation by few exotic species from numerous indigenous species.

CONCLUSION

The situation in the study area calls for adequate land use and land cover planning, monitoring and management to avert serious environmental problems now and most especially in the future when the problems may have escalated if the current trend continued. From the policy angle, the challenge is on the state and local government ministries and department and the land users to begin to use and view the environment as a resources that has to be utilized in a sustainable manner, otherwise its quality will continue to diminish and this will affect every one of us individually or collectively in many ways either medically, socially, economically or politically. From the technical perspective, it is better to begin to use agro-forestry method of agriculture to reduce the negative effect of crop farming alone, and to improve the biodiversity among other benefits to the environment and the farmers. Lastly there is an urgent need to immediately stop all form of soil mining, refuse dumping and to begin to manage water resources properly. This study firmly believes that if these recommendations are followed degradation will be arrested and more land will be made available to the users.

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