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FUEL WOOD CONSUMPTION AND SPECIES DEGRADATION IN SOUTH-WESTERN NIGERIA: THE ECOLOGICAL RELEVANCE

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ABSTRACT

The continuous dependence of man on fuel and service wood has resulted in serious degradation of the fragile forest ecosystem. Therefore, this study evaluated the sources and patterns of fuel wood and examined the rate of consumption in the study area. This was with the aim to assess the ecological implications of fuelwood consumption on species degradation. The study utilized both, primary and secondary data. Information was extracted from topographic map on the scale of 1: 50,000 and satellites imageries that cover the study area. Questionnaire administration, field observation and weight measurement of fuel wood were carried out. The results showed that the sources of fuel wood for domestic cooking were forest, nearby bush and abandoned farm while the sources of domestic energy were fuel wood (61.17%), charcoal (27%), kerosene (10%), electricity (1.33%) and gas (0.5%). Fuel wood for small scale industries were: forest (49.23%), farmland (34.62) and fallow land (16.15%). The trend of fuel wood consumption was on the high side from 1995 to 2011, it was 58% in 1995, 70% in 2000, 82% in 2005 and 92% in 2010 and 2011 respectively. Many valuable economic tree species such as *Triplochiton scleroxylon*, *Nesogordonia papaverifera*, and *Cordia* spp. are near their extinction. Animals such as antelope, wolf and fox are going into extinction while monkey, grasscutter, hare, rabbit were endemic in the study area. The study concluded that the patterns of fuel wood use and fuel wood saturation presents a great danger for biodiversity products and services.

Keywords: Ecological implication; fuelwood consumption; species degradation; sustainable environment.

INTRODUCTION

FAO (2011) and May-Tobin (2011) revealed that up to 2 billion people depend on forest goods such as fruits, game meat, fibers and fuelwood to meet their basic needs. Mead (2005) and FAO (2011) claimed that fuelwood harvesting in developing countries is so important that it rivals other sources of industrial energy such as electricity, principally among poor people in rural areas. Salim & Ullsten, (1999) reported that 58% of the energy supply in Africa comes from fuelwood and charcoal and this percentage in Latin America and Asia, though lower, is 15% and 11% respectively, and thus cannot be neglected as a potential source of ecosystem disturbance.

The survival of rural dwellers and urban poor depends on finding enough wood to cook their meal which at present constitutes the main source of cooking fuel for over 76% of the Nigerian population (UNDP, 1998). According to Specht *et al*. (2015) environmental damage from fuelwood harvesting can be significant if too many people depend on too few forested areas and the ecosystem services they deliver.The United Nations Development Programmes (UNDP) (1998) figures for 1993 showed that Nigeria consumed 262,783 metric tonnes of fuel wood. This is a lotcomparing to the volume recorded for South Africa (7,210 tonnes) and Thailand (3, 5313 tonnes). The dependence on fuelwood is rising in Nigeria while it has virtually ceased in South Africa and Thailand. A study from Ethiopia, which considered regrowth, harvesting of fuelwood and fuelwood consumption, revealed that on a local scale the harvest is three-times the annual allowable cut (Gebreegziabher, *et.al*., 2011). At the present rate of fuel wood consumption and cutting, we may soon convert our forests to savannas and grasslands (Agagu, 2009). Many tropical biodiversity hotspots (Bouget *et al*., 2012; Myers *et al*., 2000) represent such a scenario where human population rely on vanishing, reduced and fragmented forests to meet their demand for fuelwood, land for agriculture and production of animal protein (Peres *et al.,* 2010; Ruger *et al*., 2008). De Montalembert & Clement (1983) reported that fuel wood meets about 90% of energy need in South of Sahara Africa and Latin America. Oyebo (2006) revealed that in Nigeria, about 350,000 to 400,000 hectares of forest are being lost per annum due to the demand for food, energy and fodder, and also through illegal logging and non-replacement of the natural vegetation. However, the environmental impacts of fuelwood consumption are somewhat neglected by both, authorities and conservationists, probably because this activity constitutes a cryptic and chronic disturbance thought to be of a less concern in the face of other major causes of biodiversity loss such as deforestation due to land use shifts (Bensel, 2008; Puyravaud *et al*., 2010).

Ekanade & Orimoogunje (2012), Asifat (2012) and Specht, *et.al*. (2015) have established that people's dependence on fuel-wood as primary source of energy is increasingly popular in developing countries such as Nigeria. This is as a result of rapid population growth and rise in fuel price of kerosene and natural gas (Asifat, 2013). Many people cannot afford to use fossil fuels and more importantly the erratic nature of electricity in Nigeria has increased the use of fuel-wood. Meanwhile, fuelwood consumption for various purposes is causing serious deforestation problems in Nigeria (Asifat, 2013). Also, pressure on forest especially in the tropical world, to provide economic resources have been increasing rapidly as a consequence of burgeoning population in the region. This has led to unabated deforestation, which has been recognized as one of the major drivers of biodiversity loss as well as a threat to the existence of the global ecological problem (Salami, 2006). Furthermore, the rise in the use of wood to meet domestic and commercial needs has culminated in deforestation leading to loss of biodiversity, loss of soil fertility through loss of nutrients, drainage of previously moist forest soil, dramatic increase in temperature extremes, more desertification, more carbon dioxide, resulting in increase in global warming and climate change (Ojonigu *et al*; 2010). Nguon (2013) revealed that the pressure on forests is particularly high in Ethiopia, due to expansion of agriculture and other large-scale investment programs. In the long-term perspective, deforestation in Ethiopia has been steadily increasing at alarming rates. According to FAO (2010) estimates, the total area of natural forests in 1990 was 15.1 million ha and was reduced within 20 years to 12.3 million ha. Accordingly, Ethiopia has lost 140,000 ha of natural forest annually, and fuelwood collection played an important role in the process (Feleke, 2002; Haile, *et.al*, 2009; FAO, 2010; Gebreegziabher, *et.al*, 2011; Nguon, 2013).

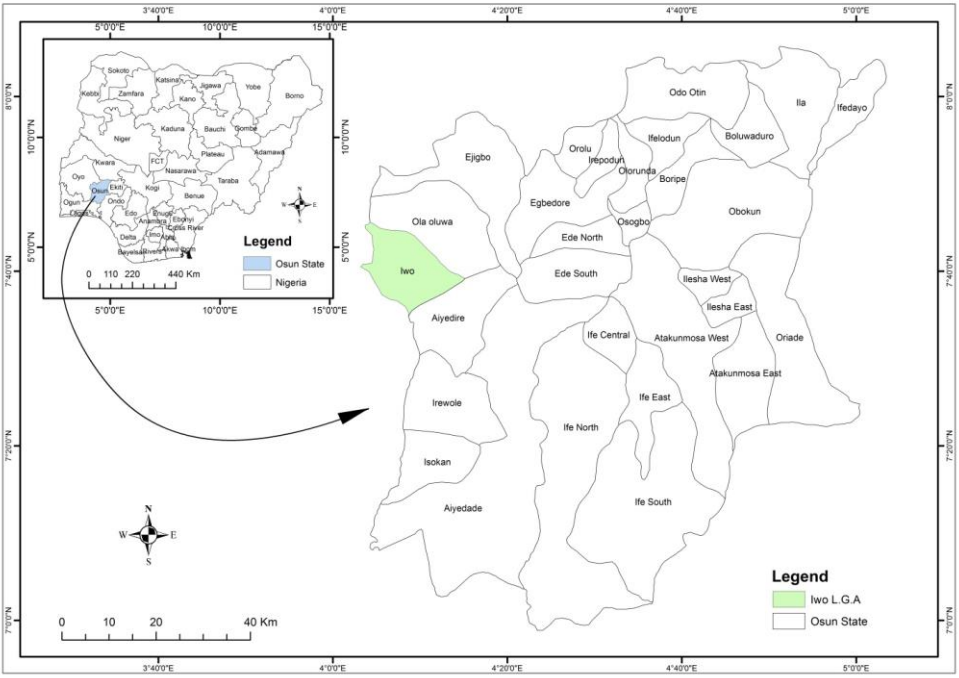
It is obvious from the foregoing that this study is very vital in order to improve our knowledge about the extent and impact of fuelwood collection and consumption; and to know the extent to which specific plant communities have been depleted of wood conversion for fuel purposes and the extent of possible impacts of these in the study area. It will also shed light on whether the ecosystem processes subsequently fail in the nature of unregulated firewood businesses, especially small commercial suppliers; the role of state forestry agencies in the firewood industry and the effects of firewood harvest in state forests; and the local variation in fuelwood consumption. This comes down to the facts that the general lack of information limits our ability to draw firm conclusions about the spatial variation of firewood collection. For remedial work cannot be implemented until more is known. For a sustainable ecological setting and balanced function of the ecosystem there is a need to assess the current situation regarding fuelwood consumption and production in the study area. Therefore, it is obvious that fuel wood consumption is resulting in a visible and alarming rate of degradation of our environment causing great environmental damage to natural resources with specific reference to flora and fauna and this needs urgent attention by all the stakeholders involved in environmental management.

MATERIALS AND METHODS

Study Area

The study area is Iwo Local Government Area which covers approximately 245 km^2 located in the Southwestern Nigeria. It lies roughly between latitudes $7^0 33^1$ and 7^0 52^1N and between longitudes 4^0 02^1 and 4^0 18^1E (Fig. 1). The total population of the study area is 217, 275 people (NPC, 2006).

Fig. 1: Nigeria showing Osun State inserted



The climate of the study area is of the humid sub-equatorial type. It is characterized by high humidity and substantial rainfall. This climate is mainly controlled by two prevailing air masses, namely; the tropical maritime and the tropical continental. The rainfall distribution of the area is characterized by the double maxima regime; the two periods of maximum rainfall are June/July and September/October. The mean annual rainfall ranges from 1200mm to 1450mm. Temperatures are high throughout the year with no pronounced seasonal variations. The mean annual temperature is about 27^0C while the annual range does not exceed 6^0C. Another important climatic element is the relative humidity which is usually high throughout the year as a result of dominant influence of the tropical maritime air mass. The study area is mainly Guinea Savannah but the north western and central part is dominated by forest reserve with valuable trees species. The savannah boundary of the study area is covered with tall grasses and short trees. The dominant species of the climbing plants are lianas which are clustered and entangled, making accessibility and exploitation of big trees very difficult. Valuable trees found in this area are *Melicia exclesa*, *Triplochiton scleroxylon*, *Nesogordonia papaverifera*, and *Cordia spp* etc. There are two forest reserves in the study area and these are the Oba Hill forest and Iwo Forest reserve. The soil in this area belongs to the highly ferruginous tropical red soils associated with basement complex rock. As a result of dense humid forest cover in the area, the soils are generally deep and are of two types; deep clayey soils formed on low smooth hill crests and upper slopes; and the more sandy hill wash on the lower slopes. Soil degradation and soil erosion are generally not serious but considerable hill wash is recorded along the slopes of the hills.

Methods of Data Collection and Analysis

Both, primary and secondary data sources were used for this study. The Primary data include the use of Global Positioning System (GPS) to obtain the geographic coordinates of the sampled settlements and locations of human activities such as the cassava flakes (*gaari*) industries, charcoal processing industries, bakeries and other facilities of relevance to the study. Questionnaire administration coupled with field observation and weight measurement of fuel wood were carried out. The questionnaires were in two folds. The first set of questionnaire was used for household information focusing on energy source; rate of fuel wood consumption; alternatives to fuel wood consumption; awareness of the negative implication of fuel wood consumption and health implications. The second set of questionnaire was for commercial fuel wood users, that is, small scale industries such as food vendors, bakeries, cassava and charcoal processing industries followed by in-depth interview to confirm and augment responses from respondents. Weight measurements were also used to measure the weekly household fuel wood consumption. This was carried out with the aid of a hand balance instrument using the stated formula below;

$$\frac{Wwb + Wwc - Wwl}{Npp} \qquad \text{---------- equ (1)}$$

Where:

Wwb - Weight of wood at the beginning of the week;

Wwc - Weight of wood collected during the week;

Wwl - Weight of wood left by the end of the week

Npp - Number of people in the household

For those people collecting fuel wood once per week (i.e. at the beginning of the week) the stated formula below was adopted;

$$\frac{\text{Dfc multiplied by 7days}}{\text{Npp}} \qquad \text{---------- equ (2)}$$

Where:
Dfc means Daily fuel wood consumption;
Npp means Number of people in a household

The Secondary data were sourced from Topographic map on the scale of 1: 50,000 and satellite imageries (Landsat TM 1986 and 2000), which show the forest reserves located within the study area. 600 questionnaires were administered. Five wards were systematically selected from the fifteen existing wards. Street listings were carried out for the five wards selected in which six streets were systematically selected. Then, house listing was carried out and 120 questionnaires were administered to 120 households selected through systematic random sampling of each ward. Total enumeration was adopted for commercial fuel wood users since there were not many of them. Data collected were analyzed using descriptive and inferential statistics.

RESULTS AND DISCUSSION

Land use/ land cover Analysis of the Study Area

Table 1 is the outcome of Landsat Image analysis that covers the study area and shows the spatial extent of land use/land cover types of the study area in 1986. It is evident from the Table that intensive agriculture constituted the most extensive land use/land cover type, accounting for 50,640.85 hectares (52.32%) of the total area, followed by grassland covering 37,117.25 hectares (38.35%). Forest reserve occupied 54, 77.79 hectares, amounting to 5.66% of the total area. Whilst urban core, urban periphery, dam and natural water body accounted for 2,604.36ha (2.69%), 712.96ha (0.74%), 47.68ha (0.05%) and 182.78ha (0.19%) respectively.

Table 1: Land use/Land covers Areal Extent in 1986

Category	Area (Ha)	%
Dam	47.68	0.05
Forest Reserve	5,477.79	5.66
Grassland	37,117.25	38.35
Intensive Agriculture	50,640.85	52.32
Urban core	2,604.36	2.69
Urban periphery	712.96	0.74
Natural Water body	182.78	0.19
Total	**96,783.67**	**100**

Source: Image Analysis of Landsat TM 1986

Table 2 is the outcome of Landsat Image analysis that covers the study area as at 2000 and shows that intensive agriculture maintained its dominance over other land use/land cover types but receded to 50,468.51ha (52.15%). Also, forest reserve decreased to 3,059.61ha (3.16%). However, grassland, urban core, urban periphery and dam increased in areal extent to 37,975.53ha (39.24%), 3,354.79ha (3.47%), 1,684.77ha (1.74%) and 59.04ha (0.06%) respectively. In contrast, the total area covered by natural water body decreased to 181.42ha (0.19%).

Table 2: Land use/Land covers Areal Extent in 2000

Category	Area (Ha)	%
Dam	59.04	0.06
Forest Reserve	3059.61	3.16
Grassland	37975.53	39.24
Intensive Agriculture	50468.51	52.15
Urban core	3354.79	3.47
Urban periphery	1684.77	1.74
Natural Water body	181.42	0.19
Total	**96783.67**	**100**

Source: Image Analysis of Landsat TM 2000

Table 3 presents the change in land use/land cover between the Landsat image analysis of 1986 and 2000. According to the table, the pattern of changes between the periods revealed that forest reserve declined in the area at 3.15% per annum. This suggests that anthropogenic activities have been encroaching upon the area initially covered by the forest reserve. This trend may be dangerous if allowed to continue and in the near future the forest reserve may be totally lost to other land use/land cover types which may have serious implications for species diversity in the study area. In the same manner, intensive agriculture lost a substantial part of its total area to other land use/land cover types particularly grassland at the rate of 0.024% per annum. This indicates the extension of the desertification process or rather modification of the area under transitional zone between forest region and guinea savanna but this is triggered by the persistent cultivation of the area. Dam increased in total area covered between the periods by 23.83%, suggesting an annual increase rate of 1.70%. This may be attributed to the increasing demand for safe drinking water by residents of the major and minor urban in the area. However, the area covered by the natural water body decreased at the rate of 0.014% per annum. The table further reveals that urban core and urban periphery encroached on other land use/land cover types at the rates of 2.06% and 9.74% respectively per annum. The expansions of these settlements have encroached on intensive agriculture and grassland. This suggests a strong tendency for losing more of the area under intensive agriculture to urban expansion if the trend remains unabated (Orimoogunje, 2014). Consequently, this poses a serious threat to food security and aggravation forest depletion and species degradation in the area.

Table 3: Land use/Land covers Change and rate of Change between 1986 and 2000

Category	Change between 1986 and 2000		Average rate of Change	
	Ha	%	Ha/yr	%
Dam	+11.36	+23.83	+0.81	+1.70
Forest Reserve	-2,418.18	-44.15	-172.73	-3.15
Grassland	+858.28	+2.31	+61.31	+0.17
Intensive Agriculture	-172.34	-0.34	-12.31	-0.024
Urban core	+750.43	+28.81	+53.60	+2.06
Urban periphery	+971.81	+136.31	+9.74	+9.74
Natural Water body	-0.36	-0.20	-0.026	-0.014

Source: Image Analysis of Landsat TM 1986 and 2000

Socio-Economics Analysis

Socio-economic survey of the study area revealed that most of the logs used as fuel wood and charcoal come mainly from Oban and Iwo Forest Reserve, nearby farmland and the neighbouring state. Table 4 reveals that fuelwood, with 367 (61.2%) respondents, is the major source of domestic energy in the study area according to the level of consumption in the selected wards. This finding corroborates National Planning Commission study of 2004 in which it was discovered that 80% of Nigerians who are mostly rural dwellers depend solely on fuel wood for their energy requirements.

In the same way Agagu's (2009) studies revealed that fuel wood constitutes the main source of fuel for cooking by over 76 % of the Nigerian population. It is evident from Table 4 that charcoal is the next dominant source of domestic energy in the study area, with 162 (27%) respondents, followed by kerosene stove with 60 (10%) respondents. The Table reveals further that gas and electricity are not commonly used in the study area. It was noted that fuel types differ slightly depending on the economic status of the household. It was identified during the study that wood was the primary source of fuel for 61.2% of those households surveyed.

Table 4: Source of Domestic Energy

Ward	Fuel wood	Charcoal	Kerosene	Gas	Electricity
Oke-Adan 2	83	23	13	0	1
Molete	59	37	21	0	3
Isale-Oba 1	61	45	11	1	2
Gidigbo	76	31	9	2	2
Oke-Oba 1	88	26	6	0	0
Total	**367**	**162**	**60**	**3**	**8**

Source: Author's field work

Household Fuel wood Consumption

Table 5 shows the rate of fuelwood consumed by 28 household surveys within two weeks of survey to five different houses in five different streets in the study to ascertain the actual quantity of fuelwood that will be used by each household. Of the household surveyed, Nike Bello Street has the least volume of fuelwood consumed, that is, 3.25kg/per/week; Olumodan Street has the highest volume of fuelwood consumed (6.4kg/per/week). This is followed by Oke-Ifa (6.17kg/person/week) while Oke-Afo household consumed 5.43g/person/week. In order to ascertain the actual volume of wood consumed, the survey was repeated in the second week and there is a slight variation in the level of fuelwood consumption. For instance, Dawodu streets where the surveyed household consumed 6.33kg/person/week have increased by 0.67kg, Oke-Afo and Oke-Ifa have also increased by 0.28kg and 0.16kg respectively. In all, the 28 surveyed households consumed 158kg and 165kg in the first and the second week respectively. On average fuelwood consumed in the area sampled put together will be 5.64kg/person/week for the first week and 5.89kg/person/week for the second week. This is very high consumption comparing to countries such as Mexico and Gambia with 1.05kg/person/week.

Table 5: Household fuelwood consumption per week

S/N	Street Address	Wk1 (kg/wk)	Wk2 (kg/wk)	Population in the house	Week 1 (kg/wk)	Week 2 (kg/wk)
1	Nike Bello	13	13	4	3.25	3,25
2	Dawodu	38	42	6	6.33	7.00
3	Oke- Ifa	37	38	6	6.17	6.33
4	Oke-Afo	38	40	7	5.43	5.71
5	Olumodan	32	32	5	6.40	6.40
Total		**158**	**165**	**28**	**27.58**	**28.69**

Source: Semi-structure questionnaires

Rate of Commercial Fuel wood Consumption in the Study Area

The small scale industries that make use of fuelwood as a source of energy for their various commercial activities in the study area include locust beans processing industry, hides and skin, charcoal production, cassava processing industries and bakeries and food canteens. All these small scale industries were identified and interviewed. According to Morgan (1978), the third world countries, particularly in the rural areas, continue to rely mainly on traditional fuels. The most important one is fuel wood, used not only for cooking, heating, and traditional crafts, but also in a growing number of new industries and trades.

Table 6 shows that out of 11 charcoal producers interviewed, 6 of them sourced their wood from the forest; 2 from farmland that are nearby while 3 sourced from abandoned fallow land. It is also evident from the Table that out of 66 bakers interviewed 28 of them sourced for the fuelwood from the forest, 23 sourced their own from farmlands, meaning they are being supplied by farmers who see stand of trees on their farmland as an obstruction while 15 depends on fallow land abandoned by farmer for their own source of fuelwood. 53 cassava processors were also identified and interviewed. Out of this 53 cassava processors 30 sourced their fuelwood from forest; 20 from farmlands and 3 from fallow land respectively. In total, the percentage of businesses that sourced their wood from the forest was 29.23% and from farmland and fallow land was 34.62% and 16.15% respectively. This finding gives credence to Morgan (1978) claiming that the fuel wood supply of south-western Nigeria is obtained mainly from the clearance of forests for cultivation or, from savannah woodland regrowth on farmland fallows.

Table 6: Source of Fuelwood for Small Scale Industries in the study area

Industry	Forest	Farmland	Fallow Land
Charcoal production	6	2	3
Bakery	28	23	15
Cassava processing	30	20	3
Percentage	**49.23**	**34.62**	**16.15**

Source: Semi-structure questionnaires

Quantity of firewood consumed per week

The total of 92 small scale industries surveys were conducted in the study area (see Table 7). Table 7 shows that 31 covered bakery industry, 30 covered cassava processing, 8 covered Food canteens operators, 10 covered locust bean and leather processing while 3 covered charcoal production.

A full load of Dyna truck contained 2,200 tonnes of fuelwood. With regard to 31 bakery industries surveys 6 bakers used quarter load of Dyna truck (550 tonnes each), 25 bakers used half load of dyna (1,100 tonnes each) per week. In total 31 bakers used 14 loads of Dyna truck (30,800 tonnes) per week for bread production. Of the 30 cassava processing industry surveyed, 26 of them used 13 loads while 4 of them used 4 loads. In total the 30 cassava processors used 17 loads of Dyna truck per week which is the highest consuption in the study. Table 7 also reveals, that 10 respondents each covered hides and skin and locust bean processing and both used two and half load of Dyna truck per week for their activities while 3 respondents covered charcoal production and this used 12 loads of Dyna truck for charcoal production in a week.

Table 7: Quantity of Wood Consumed per week by Small industries in the study area

N0	Industry	$^1/_4$ Load	$^1/_2$Load	1 Load	4 Loads	Total/wk(ton)
31	Bakery	3,300	27,500	-	-	30,800
30	Cassava Processing	-	28,600	8,800	-	37,400
08	Food canteen	550	4,400	2,200	-	7,150
10	Locust bean processing	5,500	-	-	-	5,500
10	Hides and skin processing	5,500	-	-	-	5,500
03	Charcoal producers	-	-	-	26,400	26,400

N.B: 1 Load equals 2,200 tonnes (2, 200, 00 kg)

IMPLICATION OF THE STUDY

Dresen *et.al*, (2015) have established that the ecological implications of fuelwood use largely depend on the method of fuelwood harvesting. When carried out on a sustainable basis, fuelwood harvesting provides benefits, like the reduction in the probability of forest fires, reduction in forest pests and diseases, and even the acceleration of tree growth (i.e., acting like a selective pruning) to local forests (Orimoogunje, 1999). Over-harvesting of fuelwood, on the other hand, leads to a wide range of local and global environmental impacts, including forest degradation, loss of biodiversity leading to soil erosion, changes in nutrient cycles, and emissions of greenhouse gases. This is supported by Table 8 below which reveals that wood removal for fuelwood components lead to deforestation (58.83%), loss of valuable species (18.80%), loss of soil fertility (5.50%), increased in windstorm (2.70%) and global warming (1.83%) respectively.

Focus Group Discussion (FGD) and personal observation during the ecological surveys revealed that there has been considerable decrease in the vegetation cover in the study area in terms of number and species diversity. In fact, all the indigenous trees noted for the area, such as *Melicia exclesa*, *Triplochiton scleroxylon*, *Nesogordonia papaverifera*, and *Cordia* spp. have disappeared and the whole area is currently dominated by exotic species such as *Gmelina arborea, Tectona grandis*, etc. Figure 2 below shows species currently typical for the forest reserve, monospecies.

Table 8: Respondents Perception on Environmental Impacts of Fuelwood

Negative Impacts of Fuelwood	**Frequency**	**Percentage**
None	74	12.33
Deforestation	353	58.83
Loss of valuable wood species	113	18.8
Increased occurrence of windstorms	16	2.70
Loss of soil fertility	33	5.50
Global warming	11	1.83
Total	**600**	**100**

Source: Semi-structure questionnaires

Fig. 2: Exotic species
– *Gmelina arborea (an exotic species) with shrubs undergrowth*

The surveys also revealed that animals such as antelope, wolf and fox had gone into extinction while monkey, grasscutter, hare, rabbit were endemic in the study area. This was confirmed by the forester and the rangers who kept a list of species that are threatened and endemic in the study area. Over 90% of the respondents were of the opinion that this decrease was due to the removal of trees for fuel, charcoal production and agricultural purposes. Consequently, deforestation and its associated effects such as soil erosion, flood, nutrients depletion, decreasing rainfall and temperature rises were being experienced in the area for a few years and at a threatening rate as confessed by the respondents. At least 60% of the respondents claimed that there has been scarcity of tree species within their surrounding and the forest reserve in the past 7 years.

It was identified that both, fuelwood shortages and seasonal variations had affected the majority of respondents in the study area. Of the respondents surveyed, 47.5% stated that they had suffered fuelwood shortages over the past 3 years, while 52.5% agreed that they had suffered fuelwood shortages over the past 1 year, thus documenting the increase in fuelwood shortages over the past year. 65% of the respondents' households agreed that seasonal variations affect the availability of fuelwood they have access to. Some of the reasons adduced for this is that fuelwood is scarce during the rainy seasons but relatively available during the dry season. It was discovered that more wood is available during the dry seasons when farmers are preparing their farmland for rainy season and that they used more wood due to its availability. It is evident from the field survey that the most commonly used trees for fuel in the study area were *Anogeissus leiocarpus* 54.5%, *Blighia sapida* 34.1%, *Cinnamomum aromaticum* 29.5% and *Bridelia micarantha* 18.2% (Table 9). The respondents revealed that these species are favoured for fuel because of their attributes such as calorific value, smokiness and long-lasting flame. Some of the respondents admitted, specifically the charcoal producers, that brittle branches, a fast drying time and flammability were important factors taken into consideration when selecting fuelwood species.

The implication of Table 10 on the environment was that *Anogeissus leiocarpus*, *Blighia sapida*, *Cinnamomum aromaticum*, and *Bridelia micaratha* may go into extinction in that order, if this demand continued to be high without any mitigation strategy in place. The summary of these findings is that the trend of fuelwood consumption is on the high side and the implication of this portrays serious danger for the ecological setting of the study area. For instance the per capital fuelwood consumption rate in the study area is 0.00101 tonne (1.01 kg) per person per day equivalent to approximately 477,475 tonnes (477,475,000 kg) a year. It also revealed that lack of awareness among the respondents to own or manage a fuelwood supply of their own or to protect the environment because only 11% of the respondents engaged in afforestation activities while 89% did not see the reason why they should engage in these activities.

Table 9: Species preferred by Small Scale Industry

Species		**Percentage**
Ayin	*Anogeissus leiocarpus*	54.5
Isin	*Blighia sapida*	34.1
Cassia	*Cinnamomum aromaticum*	29.5
Ira	*Bridelia micarantha*	18.2

Source: Semi-structure questionnaires

Table 10: Tree Species by order of Preference by Consumers

Charcoal production	**Bakery**	**Cassava processing industry**
Anogeissus leiocarpus	*Anogeissus leiocarpus*	*Anogeissus leiocarpus*
Blighia sapida	*Bridelia micarantha*	*Blighia sapida*
Cinnamomum aromaticum	*Blighia sapida*	*Cinnamomum aromaticum*
Bridelia micarantha	*Cinnamomum aromaticum*	*Bridelia micarantha*

Source: Semi-structure questionnaires

CONCLUSION

In summary, the picture that emerges from these findings showed that the study area is under a serious threat by human activities. The evidence of which include the loss of about 3.15% of the forest resources annually to human activities especially fuelwood consumption and agriculture with antecedent result of loss of biodiversity and genetic resources, loss of protection which plants give to soil and increasing carbon dioxide which have complicated environmental warming crisis. The survey indicated that all the respondents used fuelwood as their main source of energy for their domestic cooking, even the small scale industries were not left out in this process. The majority of the respondents' in the study area still use the traditional 3 stone stoves although alternate sources are available. This clearly indicates the general public lacks awareness of fuel-efficient stoves and the importance of conserving the study area's natural resources. Almost all the respondents claimed to collect their fuelwood directly from the bush or buy it from the local market, which also comes from the bush. This poses a serious danger for animal habitat and genetic diversity in the study area. Furthermore, very few farmers according to the study are actively involved in tree planting and management of fuelwood species on their farms. Although 11% actually managed trees specifically for fruit production and fuelwood consumption, none were involved in woodlot development. The patterns of fuelwood use, in terms of the amount and type of fuelwood demand, preferred tree species, and fuelwood saturation, show important socio-economic variations. It is therefore evident from the findings of this study that efforts have to be made to inform farmers about fuel-efficient stoves, to conserve fuelwood and about other ways to develop on-farm fuelwood production and woodlots. Finally, it is obvious from this study that fuelwood consumption has done more harm than good to the environment. Therefore, there is need to embark on public enlightenment of sustainable fuelwood use so that people will engage in sustainable forest management and own their source of fuelwood production which will minimize pressure on valuable trees of economic and ecological importance. Charcoal producers should also be encouraged to embark on massive afforestation while energy saving stove should be introduced and encouraged in the study area.

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