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The Economic and Ecological Effects of Deforestation on the Nigerian Environment

L. N. Sambe[1*], C. O. Adeofun[2] and G. Dachung[3]

[1]Department of Social and Environmental Forestry, University of Agriculture, Makurdi, Benue State, Nigeria.
[2]Department of Environmental Management and Toxicology, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.
[3]Department of Forest Products and Production, University of Agriculture, Makurdi, Benue State, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

The increasing quest for economic development and demographic demand has led to rapid forest decline and degradation of the forests in Nigeria. Forests are lost yearly through the industrial, commercial and other urban-related activities. This is currently impacting on the environment and accelerating degradation and depletion of its forest cover and resources. Deforestation is an ongoing phenomenon in Nigeria and is becoming more pronounced with increasing population and urbanization. The effects of deforestation have led to a decline in forest cover, forest degradation, impoverishment of the soil and general deterioration in environmental conditions. However, the inestimable values of forests in promoting sustainable livelihood, industrial raw materials availability, food security, medicine and health care researches, cannot be over emphasized, hence the need for imbibing strategies for reversing the trend and promoting measures that could enhance sustainable management of Nigerian forests. Thus this review paper provides integrated insight into the strategies viable for reversing the deforestation trend and the effective management of the wide varieties of Nigeria's natural vegetation.

**Corresponding author: E-mail: leoskalisambe@yahoo.com;*

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1. INTRODUCTION

Deforestation constitutes one of the threatening global development challenges and also a serious long-term environmental problem facing the world and Nigeria today.

The forest is often perceived as a stock resource, a free good, with the land as something freely available for conversion to other uses without recognition of the consequences on its role of provision of environmental services, hence many forest ecosystems has been degraded into less diverse and stable ones [1].

The social and economic impact of deforestation has triggered the transformation of forested lands and represents the great forces in global environmental change and great drivers of biodiversity loss. The impact of people has been and continues to be profound. Forests are cleared, degraded and fragmented by timber harvest, conversion to agriculture, road-construction, human-caused fire, and in myriad other ways. The effort to use and subdue the forest has been a constant theme in the transformation of the earth, in many societies, in many lands, and at most times within the international, national, states and local government/communities circles [2].

According to Ogunwale [3], mankind's activities on the environment in his quest for development have resulted in a continuous and serious degradation of the ecosystem, thus pose a threat to both his present and future living. By destroying the forests we risk our own quality of life, gamble with the stability of climate and local weather, threaten the existence of other species and undermine the valuable services provided by biological diversity.

Deforestation is any activity that disrupts the natural ecology of the forest as a result of agricultural, social and economic activities carried out in the name of development [4]. It also affects economic activity and threatens the livelihood and cultural integrity of forest-dependent people by reducing the supply of forest products and causes siltation, erosion, desertification, drought and flooding [5]. Rapid deforestation is now a major problem affecting the daily lives of Nigerians through its effects.

For many developing countries like Nigeria in particular, forests represent an important resource base for economic development. If managed wisely, the forest has the capacity to provide a perpetual stream of income and subsistence products, while supporting other economic activities (such as fisheries and other agricultural activities) through its ecological services and functions which is the mainstay of the country economy, engaging over 70% of the population [6].

Scientists and researchers in Nigeria have drawn attention to the serious and mounting ecological problems associated with deforestation in the country. This concern dates back to many years before the 1930s when the United Nation (UN) sent a signal on the desert encroachments in sub- Saharan Africa. Since then, both policymakers and the general public have become aware of the fact that deforestation carries high opportunity costs in terms of the different economic and environmental benefits that the forest renders. Some of these opportunity costs are the loss of agricultural productivity, drought, desertification, erosion and climate change resulting from deforestation. Agriculturally, deforestation and conversion of forest to arable land has a drastic effect on soil properties. According to Ibrahim et al. [7], the principal effect of deforestation on chemical and nutritional properties of soil is related to a decrease in organic content. This leads to disruption of nutrient cycling mechanism as a result of the removal of deep-rooted trees, which has a serious effect on organic and nutrient content affecting agricultural productivity. Also, studies conducted from 1971 to 2005 revealed that there was a temperature increase in Nigeria by 1.10 C, compared to the global increase in mean temperature of 0.740 C. It was also found that in the same period the amount of rainfall in the country decreased by 81mm as against global average decrease of 52.8mm and these climatic changes had sharp effects on the agriculture [8].

According to Adeofun [9], the degradation of the forest ecosystem has obvious ecological effects on the immediate environment, but it may also affect distant areas. For instance, agricultural plains or valleys that depend upon forest highlands for their water may suffer flooding or drought as a result of the destruction of the forests. Genetic damages and losses of plants, animals and insects can also be serious and possibly permanent. According to Nzeh [2], the

economic and human consequences of deforestation include loss of potential wood and paper products among others which may then need to be imported and the loss of forest may run counter to what is for many developing countries the most urgent of all needs-fuelwood for cooking and heating.

The reliance on area expansion to meet the needs of the rapidly increasing human populations has resulted in increased deforestation resulting in serious environmental problems including erosion, loss of soil fertility, loss of medicinal plants and fruits, extinction of species, changes in climatic conditions, and displacement of indigenous people [10].

Deforestation poses a significant concern because of increased human encroachment upon wild areas, increased resource extraction and threats to biodiversity [11]. According to Abiola et al. [12], the anthropogenic activity of man is a serious factor depleting trees and affecting its significant proactive and regenerative capabilities, creating an avenue for desert encroachment. In Africa, almost all countries rely on the forest to meet basic energy needs. The share of wood fuels in African primary energy consumption represents on average 86% of total African energy consumption [13].

Forests in the tropics are being destroyed at an alarmingly high rate in recent years especially in Nigeria [14,15,16,17]. The FAO [18] reported that between 1990 and 2005 the loss of forests was highest in the tropics. It further stated that the net losses in this region averaged 6.9 million hectares/year between 1990 and 2005 and that the highest rate of conversion of forest land was in South America, followed by Africa.

In Nigeria, the rate of deforestation appears to have accelerated in recent years in spite of policy measures to stem the rate of deforestation, it has continued to increase at an alarming rate. For instance, Oseni, [18] and Aruofor, [1] estimated deforestation rate for the country at approximately 285,000 hectares annually. Ayala, [19] reported that between 2000 and 2005, Nigeria lost 5.7 percent of its primary forest as a result of deforestation which continues to increase at a rate of 3.8 percent, which is equivalent to 4,000 hectares per annum.

Popoola [20] stated that Nigeria losses 400,000 hectares of forest every year from continuous legal and illegal deforestation without corresponding afforestation or reforestation. Thus going by these figures, Nigeria has the highest rate of deforestation in the world. This trend thus describes deforestation as the major problem facing the forest ecosystem in this country.

The extent and the rate of deforestation in any particular location or region should be viewed in terms of economic, ecological and human dimensions. This is because forest degradation may in many ways be irreversible. In the short term, because of the extensive nature of the forest, the impact of activities altering their condition is not immediately apparent and as a result, they are largely ignored by those who cause them.

Thus the economic and ecological implications of these consequences of deforestation need to be highlighted. This will enable forestry policy makers and other stakeholders in the sector to be better informed about the implication of deforestation and seek innovative means and ways to combat deforestation.

1.1 Definition and Description of Forest and Deforestation

Different schools of thought have different concepts concerning forest. According to Dunster and Dunster [21] forest in the narrow technical sense is defined as a vegetation community dominated by trees and other woody shrubs, growing close enough together that the treetops touch or overlaps, creating various degrees of shade on the forest floor.

However, to the national forest inventories, forest is defined as “an area, incorporating all living and non-living components, that is dominated by trees having usually a single stem and a mature or potentially mature stand height exceeding two (2) metres and with existing or potential crown cover of overstorey strata about equal to or greater than 20%”. The fact that forest has been defined in many ways is a reflection of the diversity of forest and forest activities in the world and of the diversity of human approaches to the forest.

Meanwhile, a more concise definition was given by FAO [22], which stated that forest is land with tree crown cover (or equivalent stocking level/standing density) of more than 10% of the area. This may consist of either closed

formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest formations with a continuous vegetation cover in which tree crown cover exceeds 10%. Young natural stands and all plantations established for forestry purposes which have yet to reach a crown density of 10% are included under forest, as well as areas normally forming part of the forest, which are temporarily unstocked as a result of human intervention or natural causes but which are expected to revert to forest. Included are forest nurseries and seed orchards that constitute an integral part of the forest; forest roads, cleared tracts, firebreaks and other small open areas; forest in national parks, nature reserves and other protected areas such as those of specific scientific, historical, cultural or spiritual interest; windbreaks and shelter belts of trees with an area of more than 0.5 hectares and width of more than 20 meters; plantations primarily used for forestry purposes, including rubber wood plantations and cork oak stands.

Deforestation is basically the change of forest. It results from the removal of trees without sufficient replacement, which leads to a reduction in habitat, biodiversity as well as wood and quality of life. FAO [23] defines deforestation as the long-term reduction of the tree canopy cover below the minimum 10 percent threshold. UNFCCC [24], description has a different threshold, in which deforestation is defined as a measurable sustained decreased in crown cover from greater than 10-30 percent to less than 10-30 percent. In their definitions emphasis is put on the direct human-induced conversion of forested land to non-forested land. Indarto and Mutaqin [25], further outlines that land-use changing from forest to non-forest uses is counted as deforestation while temporary tree cutting where the forest is expected to regenerate is not considered as deforestation.

2. WORLD DEFORESTATION TREND

Extensive tropical deforestation is a relatively modern event that gained momentum in the 20th century and particularly in the last half of the 20th century. The FAO [22] report indicates considerable deforestation in the world during 1990-2010 but this was almost entirely confined to tropical regions [26]. Demand for agricultural land, timber, and other forest products, as well as a technological change in agriculture, significantly impact the mode and rate of transformation of forested areas. According to Professor Norman Myers, one of the foremost authorities on rates of deforestation in tropical forests, “the annual destruction rates seems set to accelerate further and could well double in another decade” [27]. However, extensive tropical deforestation is a relatively modern event that gained momentum in the 20th century and particularly in the last half of the 20th century. The FAO Forest Resources Assessment (FRA) 2001 and 2010 reports indicate considerable deforestation in the world during 1990-2010 but this was almost entirely confined to tropical regions [28,29]. A summary of deforestation during the decades 1990-2010 is given in Table 1. The Table show there was considerable deforestation in the world during 1990-2010 but this was almost entirely confined to tropical regions. Rowe et al. [30] estimated that 15 percent of the world’s forest was converted to other land uses between 1850 and 1980. Deforestation occurred at the rate of 9.2 million hectares per annum from 1980-1990, 16 million hectares per annum from 1990-2000 and decreased to 13 million hectares per annum from 2000-2010. The net change in forest area during the last decade was estimated at -5.2 million hectares per year, the loss area equivalent to the size of Costa Rica or 140 km^2 of forest per day, was, however, lesser than that reported during 1990-2000 which was 8.3 million hectares per year equivalent to a loss of 0.20 per cent of the remaining forest area each year. The current annual net loss is 37 per cent lower than that in the 1990s and equals a loss of 0.13 percent of the remaining forest area each year during this period. By contrast, some smaller countries have very high losses per year and they are at risk of virtually losing all their forests within the next decade if current rates of deforestation are maintained. Indeed some 31 countries do not even make the list because they have already removed most of their forests and even what remains is seriously fragmented and degraded.

South America with about four million hectares per year suffered the largest net loss of forests during the last decade followed by Africa with 3.4million hectares annually and the least Oceania with seven lakh hectares annually. Brazil and Indonesia had the highest lost of forest in the 1990s accounting for almost 40 percent of net forest loss. Brazil was the top deforesting country

Table 1. Countries with largest annual net loss of forest area, 1990-2010

Country	Annual Change 1990 – 2000		Country	Annual Change 2000 – 2010	
	1000/ha/year	%		1000/ha/year	%
Brazil	-2890	-0.51	Brazil	-2642	-0.49
Indonesia	-1914	-1.75	Australia	-562	-0.37
Sudan	-589	-0.80	Indonesia	-498	-0.51
Myanmar	-435	-1.17	Nigeria	-410	-3.67
Nigeria	-410	-2.68	Tanzania	-403	-1.13
Tanzania	-403	-1.02	Zimbabwe	-327	-1.88
Mexico	-354	-0.52	The Congo	-311	-0.20
Zimbabwe	-327	-1.58	Myanmar	-310	-0.93
Congo	-311	-0.20	Bolivia	-290	-0.49
Argentina	-293	-0.88	Venezuela	-288	-0.60
Total	**-7926**	**-0.71**	**Total**	**-6040**	**-0.53**

Source: Anon., (2010)

by area; the forests in Brazil are so extensive that this represents a loss of 0.4 percent per year. The forest area in North and Central America remained stable during the past decade. The forest area in Europe continued to expand although at a slower rate of seven lakh hectare per year during the last decade than in the 1990s with nine lakh hectares per year. Asia lost some six lakh hectares annually during the 1990s but gained more than 2.2 million hectares per year during the last decade. The five countries with the longest annual net loss of 2000-2010 were Comoros (-9.30%), Togo (-5.1%), Nigeria (-3.7%), Mauritania (-2.7%) and Uganda (-2.6%). The area of another wooded land globally decreased by about 3.1 million hectares per year during 1990 – 2000 and by about 1.9 million hectares per year during the last decade. The area of another wooded land also decreased during the past two decades in Africa, Asia and South America (26].

2.1 Deforestation Trend in Nigeria

The deforestation and degradation of Nigeria forest resources in indisputable. According to Federal Ministry of Environment, (FMEv) [31] between 1980 and 1990, the annual rate of deforestation averaged 3.5% and the forest area declined form 14.9 million ha.to 10.1 million ha which translates to the loss of 350,000 to 400,000 ha of forest land per annum for the country. The study carried by Forestry Management and Coordinating Unit (FORMECU) and the report by The Environmental Management Project (EMP) on vegetation and land use changes in Nigeria showed that undisturbed forest decreased from 2.9% of total land area of Nigeria in 1976/78 to 1.3% in 1993/95 – (decrease of 1,383,700 hectares); also the disturbed forest increased from 1.6% of total area of Nigeria in 1976/78 to 2.1% in 1993/95 – (an increase of 441,700) hectares. The report also revealed that the Riparian forest decreased from 0.8% to 0.6% - a decrease of 214,800 hectares within the same period [32].

FAO, [33] Global Forest Assessment reported that Nigeria's forests and woodlands, which currently cover about 9.6 million hectares, have been dwindling rapidly over the past decades. It stated that the country's current deforestation rate is estimated at 3.7% and one of the highest in the world. It further stated that between 1990 and 2015, Nigeria lost about 35% of its remaining forest resources and over 50% of another wooded land. This is an alarming trend that suggests that the assertion that the remaining forest area of the country would disappear in the next three decades might become a reality if steps and necessary initiatives are not taken to check this development [31].

3. FACTORS CAUSING DEFORESTATION IN NIGERIA

Deforestation which is the product of the interaction of many environmental, social, economic, cultural and political forces works differently in any given region. The combination of these forces varies from decades to decades, and from country to country. The agents of deforestation are those slash and burn farmers, ranchers, loggers, firewood collectors, infrastructure developers and others who are cutting down the forest.

According to Roper and Robert [34] deforestation is a process that involves a competition amongst different land users for scarce resources, a

process exacerbated by counter-productive policies and weak institutions. It creates wealth for some, causes hardships for others, and almost always brings serious consequence for the environment. Similarly, Pearce and Brown, [35] identified two main forces that affect deforestation. These are (a) Competition between humans and other species for the remaining ecological niches on land and in coastal regions. This factor is substantially demonstrated by the conversion of forest land to other uses such as agriculture, infrastructure, urban development, industry and others. (b) Failure in the working of the economic systems to reflect the true value of the environment. Basically, many of the functions of tropical forest are not marketed and as such are ignored in decision making. Additionally, decisions to convert tropical forests are themselves encouraged by fiscal and other incentives.

3.1 Expansion of Farming Land

The agricultural land expansion is generally viewed as the main source of deforestation contributing around 60 per cent of total tropical deforestation. Shifting agriculture also called slash and burn agriculture is the clearing of forested land for raising or growing the crops until the soil is exhausted of nutrients and/or the site is overtaken by weeds and then moving on to clear more forest. As the land degrades people are forced to migrate, exploring new forest frontiers increasing deforestation [36,37,38]. It is been often reported as the main agent of deforestation. About 60 per cent of the clearing of tropical moist forests is for agricultural settlement [27,39] with logging and other reasons like roads, urbanization and fuelwood accounting for the rest [40].

It has been estimated that about 140 million forest farmers occupy two million km^2 of the tropical moist forest and they are believed to have eliminated at least 100,000 km^2 of forest annually [9]. Out of the present tropical moist forest in Africa, about 400,000 km^2 are being utilized under the shifting cultivation practice of agriculture and this has accounted for forest loss estimated at about 40,000 km^2 per year.

In Nigeria it has been reported that large proportion of forest reserves located in different places in the country have been lost to rural expansion and agricultural activities [2]. For example, Umeh [41] reported that in Oyo State large areas of Ago Owa, Ife, Ogunpa dam plantations and Gambari forest reserves have been lost to farm settlement, industrial development and urbanization. He also stated that twenty hectares of Ogun river forest reserve were converted into fish-pond.

3.2 Deforestation from Developmental Projects

This is a powerful factor which has contributed largely to deforestation in Nigeria. Large areas of forest estates have been encroached upon and cleared by the government for other forms of land use. For example, in Enugu State it has been reported that large proportion of forest reserves located in different places like Ngwo in Udi Local Government Area and Ugwuoba of Oji-river Local Government Area, have been lost to rural expansion, agriculture activities and Power Holding Company of Nigeria, PLC (PHCN) national grid lines. Also, so many forest reserves have been deforested as a result of road construction. The impoundment of river Niger at Kanji also resulted into several hectares of forest lands being depleted. This is the situation in most forest estates all over the country with the trend been more in areas of high population density.

3.3 Forest and Other Plantations

Plantations are a positive benefit and should assist in reducing the rate of deforestation. The fact that plantations remove the timber pressure on natural forests does not translate eventually into less, but rather into more deforestation. Indeed, it is feared that agricultural expansion which is the main cause of deforestation in the tropics might replace forestry in the remaining natural forests [42,43,44]. The impact of timber plantations could thus turn out to be quite detrimental to tropical forest ecosystems [45]. Tree crops and rubber in particular plays a more important role in deforestation in Indonesia than subsistence-oriented shifting cultivation and about one-half of the plantations in the tropics are established on native forest cleared for the purpose [46]. In most cases, economic timber species and other forest products are cleared and burnt to prepare the site for plantation establishment through the artificial method of regeneration. It has been estimated according to Adeofun [9], that about 150,000 hectares of plantations have been established in Nigeria since 1978 through afforestation. This is as a result of the inability of the natural method of regeneration to cope with the rising demand for wood and wood products in the country. Thus,

afforestation can be said to be necessary evil since plantations of fast-growing species with shorter rotation ages have to be established in other to satisfy both the national and state wood demand.

3.4 Logging and Fuel Wood Collection

Logging does not necessarily cause deforestation but logging can seriously degrade forests [47]. Logging provides access roads to follow-on settlers and log scales can help finance the cost of clearing remaining trees and preparing land for planting of crops or pasture. Logging thus catalyzes deforestation [48]. A lot of timber species are removed or from both the reserved forest estates and the free areas without replenishment. Also, the general trend is that timber extraction is always far ahead of afforestation especially in Nigeria, hence this extraction and consumption trend will generate growing pressure to exploit the forest estate and the consequent deforestation and degradation [49].

Fuelwood gathering is often concentrated in tropical dry forests and degraded forest areas [50,26,40]. Fuelwood is not usually the major cause of deforestation in the humid tropics although it can be in some populated regions with reduced forest area such as in the Philippines, Thailand and parts of Central America. Fuelwood gathering was considered to be the main cause of deforestation and forest degradation in El Salvador [51]. In the drier areas of tropics, Fuelwood gathering can be a major cause of deforestation and degradation.

In many parts of Nigeria, forests are being destroyed as a result of widespread cutting of wood for fuel. This is more pronounced in the rural areas according to Nzeh and Eboh [52]. FAO [53], and National Bureau of Statistics (NBS) [54] statistics show that the rural dwellers depend on fuel wood for up to 75% of their total annual energy requirement.

3.5 Overgrazing

Overgrazing is more common in drier areas of the tropics where pastures degraded by overgrazing are subject to soil erosion. The ecosystem is subjected to unrestricted livestock grazing, with the nomadic herdsmen habitually looping the branches and tops of young trees to provide fodder for cattle [9]. Stripping trees to provide fodder for grazing animals can also be a problem in some dry areas of the tropics but is probably not a major cause of deforestation. Overgrazing is exacerbated by sociological phenomena called "the tragedy of the common." People share land but raise animals for themselves and try to enrich them by raising as many as they can. This leads to more animals than the land can support.

According to Aliyu et al. [55] most Fulani nomads in Akwanga area of Nassarawa State practice random grazing where most of the grasses are set on fire so that new ones could grow for their cattle to feed on, making it difficult for other plants to sprout. This practice has led to the extinction of various plants and thereby introducing foreign species that further impoverish the soil.

Animals remove the vegetation and winds finished the job by blowing away the topsoil, transforming grasslands into desert. When a herder was asked why he was grazing goats next to a sign that said “Protect vegetation, no grazing,” he said, “The lands are too infertile to grow crops—herding is the only way for us to survive” [56].

3.6 Fires

Fires are a major tool used in clearing the forest for shifting and permanent agriculture and for developing pastures. Fire is a good servant but is a poor master and can be used responsibly as a valuable tool in agricultural and forest management but if abused it can be a significant cause of deforestation [50,30]. Based on the data available from 118 countries representing 65 percent of the global forest area, an average of 19.8 million hectares or one percent of all forests were reported to be significantly affected each year by forest fires [57]. Deforestation due to road pavements in Brazil had also lead to higher incidences of forest fires [58,59].

In the dry season in Nigeria, the rainforest is very much prone to fire, continuous burning of the rain forest leads to derived grassland as most of the trees including their seedlings are destroyed. The rainforest region of Nigeria is relatively immune to fire than the Savanna in the wet season. The herdsmen and hunters do set fire to the forest in order to have fresh shoots for their animals and in order to drive out wild animals respectively. Taking into consideration the fact that it takes years for the forest to reach its climax, therefore, bush burning is a serious case of deforestation.

3.7 Mining

Mining is a lucrative activity promoting development booms which may attract population growth with consequent deforestation and is very intensive and very destructive [60,61]. The area of land involved is quite small and it is not seen as a major cause of primary deforestation, however, roads constructed to support the mining operations open up the area to shifting agriculturists, permanent farmers, ranchers, land speculators and infrastructure developers [62,63,64]. In Nigeria today, forests are being destroyed as a result of petroleum exploration, exploitation and oil spillage [65]. Mining of several minerals in Nigeria such as barite, tin, coal etc has led to the destruction of the forest and scarification of the landscape. If the wood is used as fuel in mining operations and it is sourced from plantations established for the purpose, it can cause serious deforestation in the region. On the other hand, mining can be labour intensive and take labour away from clearing forest.

3.8 Urbanization/Industrialization and Infrastructural Development

Expanding cities and towns require land to establish the infrastructures necessary to support growing population which is done by clearing the forests [66]. Tropical forests are a major target of infrastructure developments for oil exploitation, logging concessions or hydropower dam construction which inevitably conveys the expansion of the road network and the construction of roads in pristine areas [67]. The construction of roads, railways, bridges, and airports open up the land to development and brings increasing numbers of people to the forest frontier. Whether supported or not by the governmental programmes, these settlers have usually colonized the forest by using logging trails or new roads to access the forest for subsistence land [36,37,38]. The development of these infrastructure projects is of worldwide concern since tropical forest clearing accounts for roughly 20 per cent of anthropogenic carbon emissions destroying globally significant carbon sinks and around 21 per cent of tropical forests have been lost worldwide since 1980 [68].

3.9 Wars, Insecurity and Role of the Military

According to Mather, [60] and Sands, [61], military operations cause destruction as can be seen during the Vietnam War and more recently in the documented linkages between the civil war in Myanmar and the timber trade between Myanmar and Thailand. The authors also observed that the role of the powerful military in Brazilian politics are a major cause of Amazonian forest destruction. In Nigeria Northeast, the insurgents; Boko Haram took over the Sambisa Game Reserve and killed the forest guards in 2013 and the forest have since been invaded and taken over by the military. This has resulted in the degradation of the forest through the destruction for occupation and the conversion of the forest into a military base [69,70].

3.10 Tourism

National parks and sanctuaries beyond doubt protect the forests, but cautioned and improper opening of these areas to the public for tourism is damaging. Unfortunately, the national governments of tropical and sub-tropical countries adopt tourism for an easy way of making money sacrificing the stringent management strategies [71].

Eco-tourism and infrastructure development is taking place in this wilderness places causing deforestation especially deep in the forest [72]. This damage is caused either by the direct “pressure” exerted by tourists over the landscape, the flora and fauna or by other tourist sites built in the area, which does not put in good use the resources of the region and the main tourist attractions. The destructive effects of certain leisure activities are manifested basically by the incorrect use of the environment, and by a brutal intervention of humans in the natural landscape [73].

3.11 Deforestation Due to Ecological Factors

Ecological factors such as drought, erosion, wind throw etc are well-known agents of deforestation and they have claimed very large areas of our forest resource base. In areas where these conditions or factors are a severe drought for example has led to deforestation and subsequent desertification especially in the northern parts of Nigeria.

3.12 Indirect Causes of Deforestation

3.12.1 Overpopulation and poverty

According to Cropper and Griffiths, [74]; Kummer and Turner II, [75], Ehrhardt-Martinez, [76] and

Palo, [77], the role of population in deforestation is a contentious issue and as such the impact of population density on deforestation has been a subject of controversy. International agencies such as FAO and intergovernmental bodies generally believe that poverty and overpopulation are the main causes of forest loss and that they can help solve the problem by encouraging development and reduction in population growth. Conversely, the World Rainforest Movement and many other NGOs hold that unrestrained development and the excessive consumption habits of rich industrialized countries are directly responsible for most forest loss. They argued that overpopulation cause more pressure on forests but is not a problem exclusive to Third World countries because an individual in an industrialized country is likely to consume in the order of sixty times as much of the world's resources as a person in a poor country. The growing population in rich industrialized nations are therefore responsible for much of the exploitation of the earth and there is a clear link between the overconsumption in rich countries and deforestation in the tropics.

In Nigeria as in most third world countries, firewood constitutes the major source of fuel. The dependence of rural population (80% of the total population) on fuelwood for their energy needs and the inefficient utilization of fuelwood have contributed to the serious resource depletion which is more noticeable in the arid zone of the country. With the growing population in the country, more people require more food and space which requires more land for agriculture and habitation. This scenario is aggravated by the rampant, unusual and high cost of kerosene leading to a lot of pressure on the forests and also the prevailing customary land tenure systems in most parts of Nigeria, which vests ownership of forest lands outside forest reserves on the communities. Thus it becomes difficult to prevent people from cutting down the forest for firewood when there is no cheap and available alternative, this results in more clearing of forests [78].

Arguably increasing population is the biggest challenge of all to achieve sustainable management of human life support systems and controlling population growth is perhaps the best single thing that can be done to promote sustainability.

Poverty is undeniably responsible for much of the damage to rainforests. In tropical countries like Nigeria, pressure from human settlement comes about more from inequitable land distribution than from population pressure. In most cases, most of the land is owned by small but powerful elite which displaces poor farmers into rainforest areas and so long as these elites maintain their grip on power, lasting land reform will be difficult to achieve and deforestation continues unabated [79,80,81]. Therefore poverty is well considered to be an important underlying cause of forest conversion by small-scale farmers and naturally forest-dense areas are frequently associated with high levels of poverty. The population also often lacks the finance necessary for investments to maintain the quality of soil or increase yields on the existing cleared land [82]. Shifting cultivators at the forest frontier are among the poorest and most marginalized sections of the population. They usually own no land and have little capital and consequently no option but to clear the virgin forest. In Nigeria the population living in rural areas and poverty is enormous and a larger chunk of the population still live below the conventional accepted poverty line of US$1 per day [83]. Clearing for agricultural activities is often the only option available for the livelihoods of farmers living in forested areas and hence the uneven distribution of wealth affects deforestation [84].

3.12.2 Transmigration and colonisation schemes

Studies by Mather [60]; Colchester and Lohmann, [71]; and Levang, [85] have stressed that transmigration of people to the forest frontier whether forced or voluntary due to development policy or dislocation from war is the major indirect cause of deforestation. They maintained that dispossessed and landless people bring increased population pressure to the forest frontier and new migrants in the area increase demand for food and other agricultural products which can induce the farmers at the forest frontier to increase their agricultural production by expanding agricultural land by clearing the forests. The new migrants may not care for the conservation of the forests in their new home which further accelerates deforestation of the area.

3.12.3 Land rights, land tenure and inequitable land distribution and resources

The lack of land rights or absence property rights is one of the prevailing influences on

deforestation and forest degradation [86]. When cultivators at the forest frontier often do not hold titles to land and are displaced by others who gain tenure over the land they occupy, they are forced to clear more forest to survive [87]. Poorly defined tenure is generally bad for people and forests because unclear and insecure property rights may weaken incentives for land users and financial institutions to invest in sustainable land-use practices that reduce deforestation [88]. Insecure property rights promote deforestation by providing an incentive for landholders to clear forests, grow crops, and build structures to claim land [89]. In many countries, government have nominal control of forests which are too weak to effectively regulate their use while in frontier areas deforestation is common practice and legalized way of declaring claim to land and securing tenure [66]. The future of natural forests, forest reserves and protected forests, therefore, depend to a large extent on people's attitude in balancing the competing interests of their "natural rights" and "legal obligations" with their use of the environment [90].

3.12.4 Economic causes - development/and conversion value, fiscal policies, markets and consumerism

The relationship between development and deforestation is complex and dynamic. Several studies by Humphreys, [91]; Rudel et al. [92] and Ahrends et al. [93] have advanced views on the economic causes of deforestation. One point of view is that development will increase land productivity and thereby reduce the need to clear forests to meet food requirements. Another is that development will produce further capital and incentive to expand and clear more forest. The former may be the case when constrained by a fixed food demand. The latter may be the case when food demand may not be satisfied owing to a continuing export market and rising internal population with rising levels of consumption. It is also argued that richer farmers were better able to finance deforestation while a poor farmer can't afford to clear much forest. Conversely, through transfers, stronger credit markets and better opportunities for off-season employment can increase income as well as deforestation by small land holders. Land offering higher rents encourage quicker deforestation while higher prices for crops and lower prices for farm inputs also spur faster deforestation [48]. Wage increase can stimulate deforestation, technological innovations make farming more profitable either prompting the expansion of farms into the forest or attract new farmers to forest frontiers [94,95,96]. The increase in commodity price even when it is only temporary, tends to raise expectation about future prices, increasing the expected probability from land clearance and conversion to agriculture [97,98]. Many development policies have failed because they have supported either wittingly or unwittingly the development of those who already have land, power, influence and political clout. This further alienates the rural poor and puts the pressure back on the forests. Poor farm households or commercial loggers have little incentive to care about the environmental effects of their actions. According to Panayotou, [99] such unaccounted costs give rise to economic failures such as local market failures, policy failures and global appropriation failures. Market fails due to unregulated market economy which does not produce an optimal outcome. Hence prices generated by such market does not reflect the true social costs and benefits from resource use and convey misleading information about resource scarcity, providing inadequate incentives for management, efficient utilization and enhancement of natural resources. Policy failures or market distortions are a result of misguided intervention or unsuccessful attempts to mitigate failures resulting in worse outcomes. For instance, lack of respect of traditional land rights make property rights to forest land uncertain and could encourage short-term exploitation of forests rather than long-term sustainable use [100]. Global appropriation failures occur as in the case of tropical forests where the benefits of biodiversity conservation and the value of the genetic pool in developing new medicines, crops and pest control agents are poorly reflected in market allocations. For instance, it is argued that improved terms of trade for agricultural and forest product exports and higher real exchange rates make it more profitable to convert forests to other uses. This appears to confirm that tropical deforestation is caused by the drive for maximizing profits within the agricultural sector [101,102,103,104].

3.12.5 Undervaluing the forest

The failure in assigning a proper value to forests lead to degradation of forest ecosystems, or to abandonment of forest management, resulting in a consequent under provision of the service, with substantial economic and social losses to society. Neglect and under-valuation of forests

predisposes it to be cleared and it gains value only when they are cleared for obtaining legal title through 'improvement' for other land uses such as farming, industries and road construction. Where forest worth is appreciated, monetary values of commercial timber sales is the sole or predominant elements reported. Monetary value estimates often exclude the worth of forest functions in protecting biodiversity, water and soils, in capturing carbon, in providing livelihood opportunities outside the formal monetary economy [105]. The extraction of non-wood forest products also add value to the forest but it is not economical when compared to clearing options [106]. If the benefits from the environmental values could be paid for by the agents of deforestation, then the option to not clear would become more competitive. Alternatively, if the national governments value the environmental benefits, it could apply a tax or disincentives to clear. However, even though maintenance of the environmental services is essential for sustained economic development, deforesting nations usually have more immediate goals and are unprepared to take this step. The effective way of promoting forest cover will highly be depend on the competition of values among different land uses [107].

3.12.6 Corruption and political cause

The FAO identified forest crime and corruption as one of the main causes of deforestation in its 2001 report and warned that immediate attention has to be given to illegal activities and corruption in the world's forests in many countries [108]. Illegal forest practices include the approval of illegal contracts with private enterprises by forestry officers, illegal sale of harvesting permits, under-declaring volumes cut in public forest, underpricing of wood in concessions, harvesting of protected trees by commercial corporations, smuggling of forest products across borders and allowing illegal logging, processing forest raw materials without a license, bribery and patronage of figures to obtain concessions, favourable treatment through political allegiance, financing of political cronies and party operations [109,110,111]. In Nigeria the political climate has negatively affected the forestry sector development. For instance, a National Forestry Action Plan (NAFP) was first prepared in 1996 through a participatory approach that involved communities, CBOs, NGOs, Private Sector, and Civil Society, Local State and Federal Governments. The implementation of the NAFP was based on the assumption that donors would provide the required financial resources. Unfortunately, the political climate in Nigeria was not favourable till 1999 when a democratic government was established. The programme was therefore not implemented as conceived.

4. THE IMPACT OF DEFORESTATION ON THE ENVIRONMENT

According to Ogigirigi, [112] the impacts of deforestation on the environment are many and the most direct impacts are noticeable on the soil, hydrology and the atmosphere. This is because the major role of forest in the maintenance of environmental stability is in providing physical protection on the soil by interception thereby reducing the sticking force and frictional action of rain and wind.

4.1 Deforestation and Soil Erosion

Soil erosion is the most pronounced form of environmental degradation all over the country today which is directly linked to deforestation. Soil erosion is generally brought about by the action of water or wind when vegetation cover is removed such that all the physical protection offered by the vegetation is also removed. The continuous forest exploitation and removal of vegetation cover for various purposes has increased in intensity and rate with the population increase in the country so much to the extent that soil erosion has become so pronounced in many parts of the country. The direct impact on soil and accelerated run-off in areas without vegetation cover leads to serious soil erosion and the consequent development of extensive gulley which may extent over a very large area. Many examples of the gulley and sheet erosion have been reported in many parts of the country. Soil erosion usually reduces soil productivity, retards agricultural economy and destroys costly infrastructural facilities such as building and road networks due to constant deforestation.

Deforestation and placer mining along rivers cause an increase in siltation and sedimentation which can have serious consequences for downstream fisheries and for the capacity of downstream dams and reservoirs [113,114,115, 116,117,118].

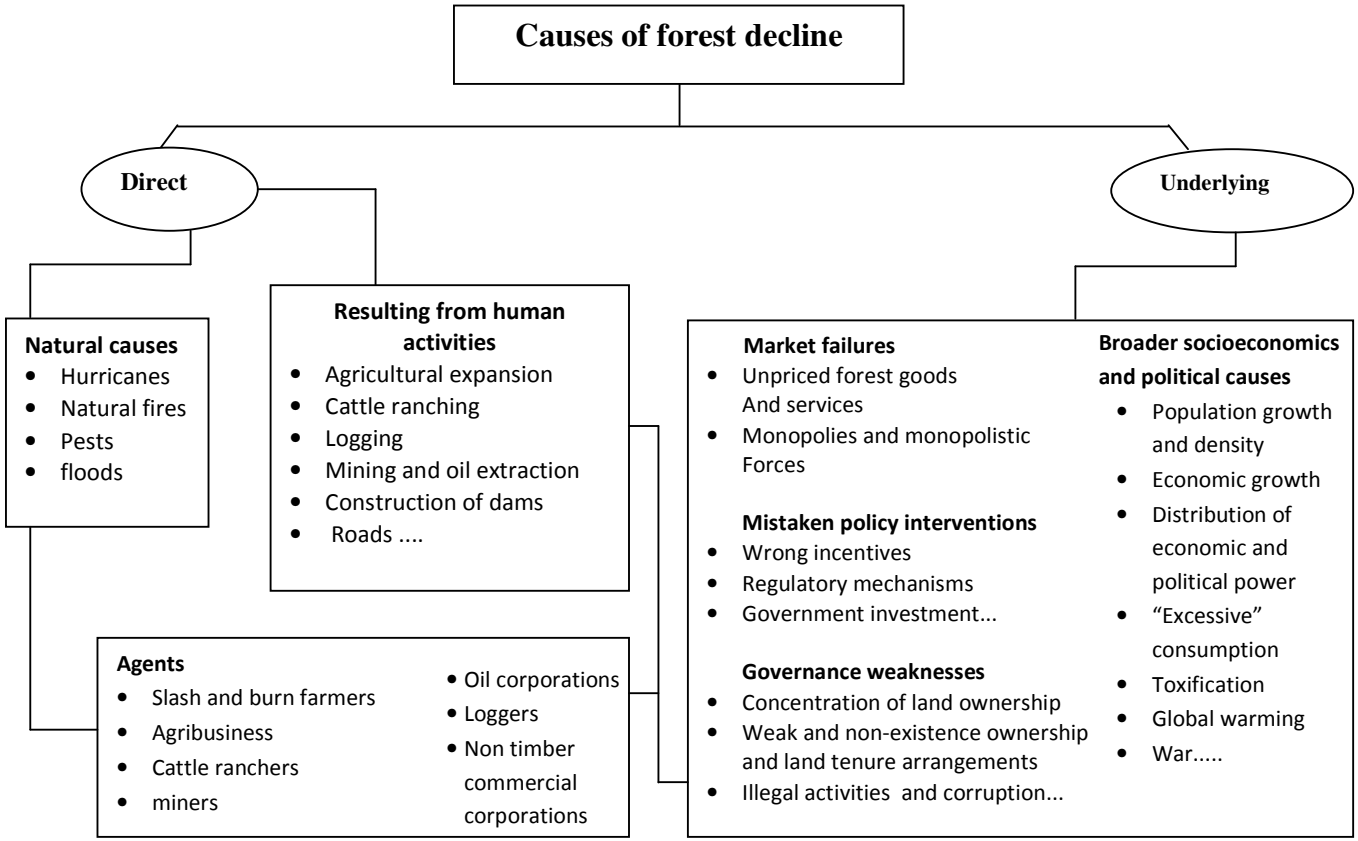

Fig. 1. Causes of forest decline
Source: Arnoldo, (2000)

4.2 Deforestation and Wind Erosion

In Southern part of Nigeria, coastal and gulley erosion are of greater importance. This is because these parts of the country have a long duration and high intensity of rainfall and hence erosion by water is more prominent. In the northern part of the country, however, erosion by wind is of greater significance in environmental degradation. The rapid rate of desert encroachment in this part of the country has been attributed to excessive deforestation resulting in exposure of dry sandy soils of the semi-arid zones to strong winds during the long dry seasons [119]. Deforestation and the consequent wind erosion in this region accelerates desert conditions typical of a moistureless environment, desiccating winds, drifting sand dunes and the extreme difficulty in establishing a thriving animal or plant life. These conditions constitute a precursor to desertification and its aftermath.

4.3 Impact of Deforestation on Water Resources

Deforestation impact on water resources is very important in view of the fact that it poses serious water resources problems resulting from the extensive destruction of watersheds. Removal of vegetation cover reduces interception of rainfall which varies from a few to as many as 50% of total annual precipitation. Deforestation will increase the rate and volume of run-off thereby resulting into increased stream flow which often gives rise to flooding and usually with disastrous consequences to life and property. Increased rate of run-off will also adversely affect recharge of underground water, and water storage capacities of water courses. This according to Enabor [120] is already evident along the River Niger and Benue and many other rivers in the savannah zone of Nigeria. The increased rate and volume of run-off arising from deforestation will increase the sediment load in the run-off water and its erosion power. This will eventually lead to sedimentation of surrounding water bodies, which after a long period will result to a progressive reduction in volume and depth of the water bodies until they become seasonal or eventually disappear [121,122]. Deforestation often leads to the permanent lowering of the water table, especially when such deforestation is permanent and irreversible such as in the case of the semi-arid regions of Nigeria. Deforestation arising from indiscriminate land clearing and bush burning in the savannah regions of Nigeria has been identified as factors aggravating the hydrological problems in these areas [9].

4.4 Deforestation and Atmospheric Conditions

There has been a global concern about the possible consequence of deforestation on atmospheric conditions. Many literatures have reported that the likely increase of carbon dioxide percentage in the atmosphere by up to 10% and a resultant increase in global temperature through the green house effect is a possible effect of total deforestation of all tropical rainforest.

Tropical forests are shrinking at a rate of about five per cent per decade as forests are logged and cleared to supply local, regional, national and global markets for wood products, cattle, agricultural produce and biofuels [123]. One of the most important ramifications of deforestation is its effect on the global atmosphere. Deforestation contributes to global warming which occurs from increased atmospheric concentrations of greenhouse gases (GHG) leading to a net increase in the global mean temperature as the forests are a primary terrestrial sink of carbon. Thus deforestation disrupts the global carbon cycle increasing the concentration of atmospheric carbon dioxide. Tropical deforestation is responsible for the emission of roughly two billion tonnes of carbon (as CO_2) to the atmosphere per year [124]. The release of the carbon dioxide due to global deforestation is equivalent to an estimated 25 per cent of emissions from combustion of fossil fuels [125].

4.5 Climate Change

The effect of climate change can be distinguished between microclimates, regional climate and global climate while assessing the effects of forest on climate especially the effect of tropical deforestation on climate [126]. Deforestation can change the global change of energy not only through the micrometeorological processes but also by increasing the concentration of carbon dioxide in the atmosphere [127] because carbon dioxide absorbs thermal infrared radiation in the atmosphere. Deforestation can lead to increase in the albedo of the land surface and hence affects the radiation budget of the region and has its implication for the general climate change [128,129,130].

For example, the negative impacts of deforestation are already measurable in the form of an increase in light intensity, air and soil temperatures and decrease in soil moisture and atmospheric relative humidity according to Woodall [131].

Deforestation affects wind flows, water vapour flows and absorption of solar energy thus clearly influencing local and global climate [48]. Deforestation on lowland plains moves cloud formation and rainfall to higher elevations [132] and disrupts normal weather patterns creating hotter and drier weather thus increasing drought and desertification, crop failures, melting of the polar ice caps, coastal flooding and displacement of major vegetation regimes. In the dry forest zones, land degradation has become an increasingly serious problem resulting in extreme cases of desertification [133]. Desertification is the consequence of extremes in climatic variation and unsustainable land use practices including overcutting of forest cover [134]. Global warming or global change includes anthropogenically produced climatic and ecological problems such as recent apparent climatic temperature shifts and precipitation regimes in some areas, sea level rise, stratospheric ozone depletion, atmospheric pollution and forest decline.

4.6 Water and Soil Resources Loss and Flooding

Deforestation disrupts the global water cycle with the removal of part of the forest, the area cannot hold as much water creating a drier climate. [117]. Water resources affected by deforestation include drinking water, fisheries and aquatic habitats, flood/drought control, waterways and dams affected by siltation, less appealing water-related recreation, and damage to crops and irrigation systems from erosion and turbidity [119]. Urban water protection is potentially one of the most important services that forest provides. Filtering and treating water is expensive however forests can reduce the costs of doing so either actively by filtering runoff or passively by substituting for housing or farms that generate runoff [48,135]. Deforestation can also result in watersheds that are no longer able to sustain and regulate water flows from rivers and streams. Once they are gone, too much water can result in downstream flooding, many of which have caused disasters in many parts of the world. This downstream flow causes soil erosion thus also silting of water courses, lakes and dams. Deforestation increases flooding mainly for two reasons. First, with a smaller 'tree fountain' effect, soils are more likely to be fully saturated with water. The 'sponge' fills up earlier in the wet season, causing additional precipitation to run off and increasing flood risk. Second, deforestation often results in soil compaction unable to absorb rain. Locally, this causes a faster response of stream flows to rainfall and thus potential flash flooding [48]. Moreover, deforestation also decrease dry season flows. The long-term effect of deforestation on the soil resource can be severe. Clearing the vegetative cover for slash and burn farming exposes the soil to the intensity of the tropical sun and torrential rains. Forest floors with their leaf litter and porous soils easily accommodate intense rainfall. The effects of deforestation on water availability, flash floods and dry season flows depend on what happens to these countervailing influences of infiltration and evapotranspiration- the sponge versus the fountain [117].

4.7 Decreased Biodiversity, Habitat Loss and Conflicts

According to Myers and Mittermeier, [136], forests especially those in the tropics serve as storehouses of biodiversity and consequently deforestation, fragmentation and degradation destroy the biodiversity as a whole and habitat for migratory species including the endangered ones, some of which are still to be catalogued. Tropical forests support about two-thirds of all known species and contain 65 per cent of the world's 10, 000 endangered species. Retaining the biodiversity of the forested areas is like retaining a form of capital until more research can establish the relative importance of various plants and animal species [134]. According to the World Health Organization, about 80 percent of the world's population relies for primary health care at least partially on traditional medicine. The biodiversity loss and associated large changes in forest cover could trigger abrupt, irreversible and harmful changes. These include regional climate change including feedback effects that could theoretically shift rainforests to savannas and the emergence of new pathogens as the growing trade in bushmeat increases contact between humans and animals [137].

The heavy fragmentation of this habitat has resulted in an intense human-elephant conflict causing not only in the loss of agricultural crops but also human and elephant lives. Mortality of about 50 persons and 20 elephants was reported

due to these severe human-elephant conflicts from this hotspot area annually [138,139].

A very important consequence of deforestation is the elimination of the gene pool, the permanent loss of valuable plant and animal genetic resources. Many plant species of importance such as valuable commercial species and source of pharmaceutical products are near extinction as a result of deforestation. Also, the destruction of wildlife habitat has drastically reduced animal populations and productivity such that many rare species are now threatened with extinction as reported by Roper [34].

In Nigeria, many trees, shrubs, herbs and assorted animals have been depleted while some are endangered. Mfon et al. [49] reported that several plant species have been overexploited especially those with edible seeds, nuts and kernels are now endangered. Most primates such as guenons, mangabeys, drills, chimpanzees and gorillas are now endangered [65].

4.8 Economic Losses

The tropical forests destroyed each year amounts to a loss in forest capital valued at US $ 45 billion [140]. In Nigeria the value of lost forest cover has been estimated at US$750 million annually at 1989 price [141]. By destroying the forests, all potential future revenues and future employment that could be derived from their sustainable management for timber and nontimber products might disappear.

4.9 Social Consequences

According to Colchester and Lohmann, [71] deforestation is an expression of social injustice with many social consequences often with devastating long-term impacts. The most immediate social impact of deforestation occurs at the local level with the loss of ecological services provided by the forests which intensifies with infrastructure development like construction of roads which results into frontier expansion often with social and land conflicts [142]. The valuable services afforded by forests such as erosion prevention, flood control, water treatment, fisheries protection and pollination functions that are particularly important to the world's poorest people who rely on natural resources for their everyday survival are lost.

5. STRATEGIES TO REDUCE DEFORESTATION

There are no general solutions and strategies of reducing deforestation, these will vary with region and will change over time. However, the ways must underpin improvement of the welfare of forest frontier communities. Any policy that exclude the other will not be successful and acceptable. Effective implementation of the strategies require cooperation, goodwill, stakeholder participation, development of management plans, monitoring and enforcement. The strategies should recognize the critical roles of national, state and municipal governments on one hand and on the other hand empower the civil society and the private sector to take a proactive role in reducing deforestation, often working in conjunction with government.

5.1 Reduce Poverty and Increase per Capita Incomes

The high incidence of poverty in Nigeria exacerbates deforestation. Iyang and Esohe [143] reported that about 45% of the country's teeming populace survives below the poverty line while Ja'afar – Furo [144] maintained that there is an established positive correlation between the level of poverty and utilisation of forest resources leading to deforestation and other exploitations. Thus Poverty reduction programmes are pivotal in reducing deforestation in the developing countries. The empowerment of local communities will help to curtail cutting down of trees as fuelwood for home consumption. The increase in per capita income and consequence increase incomes and literacy rates will reduce pressure on the remaining forests for new human settlement and land use change.

5.2 Promote Sustainable Management

The promotion of sustainable forest management must be sustainable ecologically, economically and socially. This entails the improvement of ecological values of the forest and the avoidance of degradation. The silviculture and management should not reduce biodiversity, but control soil erosion, soil fertility loss, and the maintenance of water quality on and off-site, and the safeguard of forest health and vitality [25]. This should however sustain both social and economic needs and for the management of environmental services. The cost of maintaining sustainable forest management has to be met by the

government. For instance, a study carried out by the Federal Ministry of Environment in 2010 stated that the capital need for afforestation, agroforestry and establishment of more forest reserves over a forty year plan would be $3.8 billion, $2.4 billion and $758.4 million respectively. How to meet this substantial budget remain a mirage especially in a face of dwindling oil revenue and mono economic debacle. This notwithstanding, the federal government National Forest Policy is geared towards ensuring sustainable forest management, promoting the participatory process of development, facilitating private sector – forestry development and adopting an integrated approach to forestry development. Government is currently embarking on a number of afforestation programmes. Under the guidance of the African Union Commission, Nigeria is keying into the project on the "Green Wall Initiative" in which a "green wall" of trees (40 million trees annually) will be planted across the dry-land area of Nigeria to not only push back deforestation and secure agriculture and livelihoods across the Sudano-Sahelian zone of the country, but also enhance the carbon sequestration of biological diversity resources in the region for climate change mitigation [145].

5.3 Reducing Emissions from Deforestation and Forest Degradation

Many international organizations including the United Nations and the World Bank have begun to develop programmes to curb deforestation mainly through Reducing Emissions from Deforestation and Forest Degradation (REDD) which use direct monetary or other incentives to encourage developing countries to limit and/or rollback deforestation. Significant work is underway on tools for use in monitoring developing country adherence to their agreed REDDS targets [48]. A global initiative designed to support developing countries to minimize their rates of deforestation is the Reducing Emissions from Deforestation and forest Degradation, plus conservation of forest carbon stocks, sustainable management of forests and enhancement of forest carbon stocks, known as REDD+ is ongoing in Nigeria. Nigeria's REDD+ progress and Readiness Preparation Proposal (R-PP) implementation cover the entire REDD+ process in Nigeria since 2010 and R-PP implementation (REDD+ Readiness Preparedness phase) since February 2015. The goal of the Programme is to enable Nigeria to contribute to climate change mitigation through improved forest conservation and enhancing sustainable community livelihoods. The implementation of the present Nigeria REDD+ Readiness Programme is in complete alignment with national efforts to address the challenge of deforestation and degrading forest resources in the country. The participation states are Cross River, Nasarawa and Ondo States [146].

5.4 Increase Area of Forest Plantation and Standard of Management of Protected Areas

Increasing the area of forest plantations by using vacant or unused lands and waste and marginal lands especially as roadside, along railway tracts, on contours, avenues, boundaries and on land not suited for agricultural production should have a net positive benefit.

The provision of protected areas is fundamental in an attempt to conserve. Protected areas alone, however, are not sufficient to conserve biodiversity. They should be considered alongside, and as part of, a wider strategy to conserve biodiversity. The minimum area of forest to be protected is generally considered to be 10 percent of total forest area. It is reported that 12.4 percent of the world's forest is located within protected areas biodiversity [26,136,59].

Forest Management in Nigeria today is mostly limited to government programmes. All the forest reserves, which form the bulk of the nation's productive forest, are under the management of the States or Local Governments. The forest outside forest reserves (free areas), where most of the wood products in the market comes from, are not put under any form of systematic management. The forest reserves have for sometimes been seriously neglected and have received little or no improvement in terms of investment and management [146].

The most serious impediment to sustainable forest management is the lack of dedicated forests specifically set aside for timber production. If the forest does not have a dedicated long-term tenure for timber production then there is no incentive to care for the long-term interests of the forest. FAO [22] found that 89 percent of forests in industrialized countries were under some form of management but only about six percent were in developing countries. If 20 percent could be set aside, not only could timber demand be sustainably met but buffer zones could be established to consolidate the

protected areas. This would form a conservation estate that would be one of the largest and most important in the world [28].

5.5 Encouraging Substitutes

For all purposes where tropical or other timber is used, other woods or materials could be substituted. Presently, Nigeria lacks adequate substitution for most forest products, for instance access to affordable cooking energy is beyond the reach of many Nigerians. The high cost and scarcity of kerosene and cooking gas encourage massive consumption of fuelwood and charcoal with their attendant forest depletion. Similarly, there are no alternatives for timber and wood consumption in paper manufacturing. For all-purpose where forest products are been used there is need for substitution, otherwise forest harvesting has to be commensurate with sustainable forest management especially afforestation [147].

5.6 Increase the Perceived and Actual Value of Forests

There are several ways of achieving increasing perceived and actual value of forests. Governments can impose realistic prices on stumpage and forest rent and can invest in improving the sustainable productivity of the forest. National and international beneficiaries of the environmental services of forests have to pay for such services [48]. There has been some success in devising schemes to collect payments for environmental services like carbon sequestration, biodiversity conservation, catchment protection and ecotourism. This success can further be more realized by integrating participatory mode of management with these collection schemes to ensure rights and tenure with equity in resource and benefit sharing for improving the livelihood of the rural poor who actually are the primary stakeholders of conservation and management.

5.7 Participatory Forest Management and Rights

In order for forest management to succeed at the forest frontier, all parties with an interest in the fate of the forest should be communally involved in planning, management and profit sharing. But forest ownership and management rights are almost always restricted and restrictions on ownership and use define alternative tenure systems [48]. Land reform is essential in order to address the problem deforestation. Moreover the rights of indigenous forest dwellers and others who depend on intact forests must be upheld. Therefore, the recognition of traditional laws of the indigenous peoples as indigenous rights will address the conflicts between customary and statutory laws and regulations related to forest ownership and natural resource use while ensuring conservation of forest resources by the indigenous communities. A means must be found to reconcile conservation and development by involving local/indigenous populations more closely in the decision-making process and by taking the interactions between 'societies' and forest resource more fully into account [148].

5.8 Increase Investment in Research, Education and Extension

Training and education of stakeholder's helps people understand how to prevent and reduce adverse environmental effects associated with deforestation and forestry activities and take appropriate action when possible. Research substantiates it and helps to understand the problem, its cause and mitigation. This is lacking due to paucity of funds and investments encourages this arena. There is a lack of knowledge and information in the general community about forests and forestry. Forest managers and those developing forest policies need to be comprehensively educated and need to appreciate the complexity of the interacting ecological, economic, social, cultural and political factors involved.

5.9 Improve the Information Base and Monitoring

Information on the global distribution of biodiversity and forest resources is inadequate. Knowledge of how much forest, where it is and what it is composed of is not always available. Basic information is needed for proper management a forest ecosystem. New remote sensing technologies make it feasible and affordable to identify hotspots of deforestation. Basic monitoring on the rate, location and causes of global deforestation should be prioritized along with the impacts of project and policy interventions [48]. According to Ademiluyi et al. [149], although there has been a worldwide increase in awareness and studies on land use and land cover change analysis in the last four to five decades, there is still an extremely low level of research attention on land use and land cover change studies in Nigeria. The second national

and the most current nation-wide database on Nigeria land use and vegetation was provided by the study carried out by Forestry Management and Coordinating Unit (FORMECU) in 1996. This call for an urgent need for proper geo-management of land; that is concomitant upon the availability of a detailed, accurate and up-to-date data.

5.10 Policy, Legislative and Regulatory Measures, Enforcement and Compliance

Laws, policy and legislative and regulatory measures should be effectively enforced and should be such that they encourages local people and institutional participation in forestry management and conservation along with safeguarding indigenous people's traditional rights and tenure with rightful sharing of benefits. Although Nigeria has well-articulated National policy, lack of political commitment and poor funding of the forestry sub-sector has rendered it ineffective for instance, the strategy to Increase the total area under sustainable forest management to 25% of the nation's land area by 2010 and to grant forest industries loans and grants to establish plantations to meet at least 60% of their raw materials' requirements has not translated in to reality. Other policy measures such as providing improved breeding of indigenous trees species, setting up of national forest fire service and capacity building and training of forest personnel in forest fire management, Promotion the development of cheaper and readily available alternatives to wood fuels, development of integrated land use plan, the establishment of grazing reserves to reduce wanton destruction of vegetation by humans and animals and to reduce outmigration, resuscitation and upgrade existing training and maintenance/workshop facilities in the country to enhance efficiency in wood conversion, treatment, preservation and maintenance of sawmilling equipment/tools, development and promotion of the use of alternative sources of energy e.g. coal briquettes, efficient wood stoves, solar energy, wind energy, biogas, etc, is a far cry from what is on ground. One fundamental problem at the national level is that though there is a comprehensive National Forest policy in Nigeria, the absence of a national forest legislation to give a legal backing to the forest policy in order to ensure its implementation is lacking. The lack of National Forestry Act in Nigeria has limited the effectiveness of forest policy in the country, the draft bill which is still in the office of the Attorney-General of the Federation [113].

According to Ijaiye and Joseph [150], legislative and regulatory measures at Federal and State levels in Nigeria provide for an impressive array of enforcement and compliance mechanisms. They include: permit, licence, certificate, inspection, search, seizure, arrest, sealing, notice of violation, notice of revocation of permit, revocation order, recourse to courts for civil penalties for violation, injunctive relief to require compliance, criminal sanctions for violations, citizen's suits to enforce the statutes in the absence of effective government enforcement. However, most of the enforcement strategies and mechanisms are not being enforced or implemented. For instance, the mechanism for acquisition and management of forest resources in terms of inventory of resources, allowable cuts, forest protection and health, use of forest harvesting tools and equipment and processing facilities, pre-harvesting inventory as well as production of and compliance with logging plans and safety guidelines, grading rules, quality control, certification, log tracking, adoption appropriate log transportation and haulage systems to minimise damaged in the residual stands, enforcement to plant and nurture a minimum of four seedlings for every one felled by tree takers, reduction of illegal forest activities through effective education, policing and forest protection are neither developed nor implemented.

To address both failures of law and failures of implementation, there the need to ensure that the correct laws and policies are in place on one hand and on the other, a summoned political will to work to implement the policy measures and enforce the law. This two-pronged approach to legal compliance is the only way to ensure that the full range of motivations, opportunities, and means to address deforestation in Nigeria.

5.11 Strengthen Government and Non-Government Institutions and Policies

Strong and stable government institution is essential to slow down the rate of deforestation FAO (2010). Environmental NGO's are contributing enormously towards conservation management. They have the advantage over government organizations and large international organizations because they are not constrained by government by bureaucracy and inertia. They

are better equipped to bypass corruption and they are very effective at getting to the people at the frontier who are in most need.

6. CONCLUSION

The surge of deforestation in Nigeria like most developing nations has threatened the continued supply of environmental resources and services. Understanding the processes of deforestation is vital for informing forest management and conservation policy and for an efficient targeting of interventions. This can be further addressed by community-based forest management which builds on political goodwill and strong community institutions. The control or reversal of deforestation can, therefore, be achieved by addressing the causal factors identified to be currently contributing to deforestation in the country. The promotion of alternative energy efficient and renewable sources should be encouraged to reduce the dependence on the use of firewood. Reducing deforestation would also require creating and strengthening inhibitors of deforestation such as protected areas and forest reserves as well as strengthening participatory forest restoration and protected area expansion programmes. It is imperative, therefore, that the country enhances the land use planning process in addition to identifying and implementing appropriate market-based instruments to mitigate harmful effects of development projects on forest resources. Other proposed measures include strengthening the existing procedures of environmental impact assessments and strategic environmental assessments particularly for developments targeted at the vulnerable areas. This should be accompanied by strengthening the monitoring and enforcement capacity of relevant conservation, environmental and land management agencies.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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