



Review paper

Men Implications of deforestation on climate change in Nigeria: a theoretical assessment

Akpan G.P.¹, Bashar A.K.² and Kaoje T.S.²

¹Department of Geography and Environmental Management, University of Ilorin, Ilorin, Nigeria

²Kebbi State College of Basic and Advanced Studies, Yauri, Kebbi State, Nigeria
godisgood885@gmail.com

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Abstract

Deforestation is the loss of forest by removing the vegetation by man for agriculture, animal grazing, urban and industrial development. Deforestation has great impact on the developing countries as tropical forest is being converted into other land use types. Biodiversity, fauna and flora are being destroyed and the natural environment is degraded resulting to severe impact and contributing immensely to climate change. Deforestation promotes the release of carbon stored in plants and soils and significantly alters the energy budget of the earth system. The normal weather pattern is mostly disrupted leading to hotter and drier weather thereby increasing drought occurrence and desertification. African countries are noted as the most vulnerable region of the world where deforestation has impacted negatively on their environment and Nigeria has the highest record of annual net loss of its forest. This paper ex-ray the implications of deforestation on climate change in Nigeria. The review is based on content analysis exploring evidence from secondary data and field survey. Types and functions of forest as well as causes of deforestation have been extensively discussed. Approaches for combating deforestation in Nigeria have been identified. There include environmental education and enlightenment, increase of protected areas, agroforestry programmes, reforestation and afforestation initiative among others.

Keywords: Deforestation, forest, afforestation programme, reforestation, agriculture.

Introduction

The relevance of forest cover in providing environmental benefits such as soil conservation, energy balance, biodiversity preservation, climate change mitigation and agriculture sustainability cannot be overemphasized¹. The forest resources have undergone severe degradation for many years, accurate statistics on the level of the world's rainforest destruction has always been elusive. However, it is worthy to note that large area of the tropical rainforest is lost to destruction due to anthropogenic activities and the rate at which these forest are destroyed is on the increase despite activities of many environmental activists calling for global action on deforestation.

Inyang and Esohe² reported that 87% of the total carbon emitted in Nigeria is through deforestation. The release of carbon dioxide (CO₂) into the atmosphere impede the reflection of solar radiation back to space. This gas is reflected back to the earth therefore exacerbating temperature rise and causing global warming. It has been reported by scientists and environmentalists that deforestation is one of the major drivers of climate change. In fact, the impacts of climate change are occurring faster than what many scientists first predicted. Over 75 percent of carbon is emitted from industrial sources like

burning of fossil fuels among others. However, 20 to 25% of carbon is traceable to deforestation and is mostly in the tropics³.

Deforestation is the removal of forest of vegetation by man for the purpose of agriculture, animal grazing, urban and industrial development among others⁴. Deforestation poses serious environmental threat to developing countries of the tropical region. This is so because, the tropical forests are being removed, reduced and degraded⁵ leading to biodiversity lost and greenhouse effect⁶.

Deforestation is also seen as a process whereby the forest cover is removed in order to convert the land to a non-forest used⁷. It is an activity that involved clearing or thinning of the forests by man for agriculture or industrial purposes⁸. Deforestation and its effects are not readily acknowledged by many people in Nigeria especially the illiterate ones, although this activity is happening within their neighborhood. The cutting down of trees and removing forest cover increase the release of carbon stored in trees and soil into the atmosphere thereby increasing air temperature and other climatic anomalies⁹. Also, deforestation increases soil erosion, as well as reduces precipitation and induces other climate extremes including floods¹⁰. When forest is cleared, it affects the entire cycle because forest provide carbon sink thereby reducing the carbon and other greenhouse gases, thus preventing its negative impacts on the atmosphere.

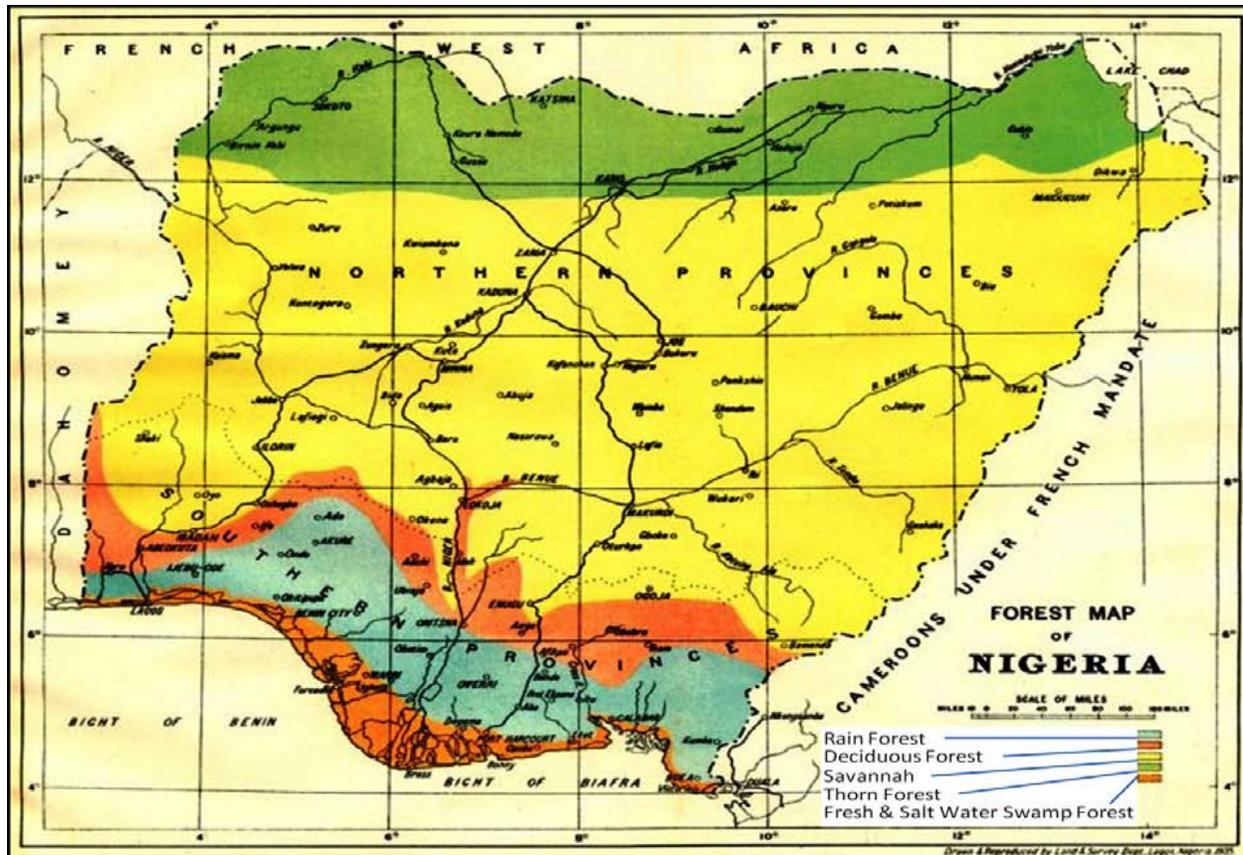


Figure-1: Forest Classification of Nigeria¹⁰.

Environmentalists and numerous scientists have come to terms with the reality of deforestation noting that the greatest percentage of CO₂ in the atmosphere is exacerbated by removing the forest cover^{11,12}. Models predict deforestation as the driving force for global warming and the experiment postulates afforestation programme in the tropics as a panacea for global temperature increase due to the fact that forest cover provide effective carbon sinks to the environment⁹.

The term climate change can therefore be regarded as a shift in the mean weather conditions over long period of time¹³. The occurrence of change in the average weather conditions which includes average temperature, precipitation, wind and other climatic elements for many decades is therefore termed Climate change. These changes according to Anon¹⁴ can be driven by dynamic process which include variation in radiation intensity and anthropogenic activities or human-induced deforestation. However, the most general definition of climate change is given as a significant variation in the statistical properties of the climate system over a long period of time. Fluctuations and climate extremes over a short period or decades do not portray climate change^{15,16}.

This paper therefore attempts to assess the implication of deforestation on climate change in Nigeria with the view to proffering mitigation strategies to its impact.

Types of Forest

According to Olagunju¹⁷, Forest are grouped into different types based on selected criteria as mentioned below: i. Based on spontaneity: natural and artificial forest ii. Spontaneity: natural and man-made or artificial forest iii. Anthropogenic influence: primary/secondary forest iv. Foliage longevity: Fresh evergreen /self-renewing ephemeral forest v. The broadness of leaves: broadleaf trees, mixed forest vi. Geographical location: temperate forest, sub-tropical and tropical moist forest, sub-tropical and tropical dry forest vii. General appearance: old growth and second growth. viii. And lastly the most dominant species. Generally, forest is classified into three broad groups viz: coniferous forest, temperate deciduous forest and rain forest.

Coniferous Forests: The coniferous forest vegetation is characterized by flesh evergreens and the dominant trees are noticed for growing needles instead of leaves, cones instead of flowers. Annual rainfall in the coniferous forest vegetation is between 300mm to 900mm. However, due to low temperature of the coniferous forest (-40°C and 20°C), the trees are able to survive by growing needles instead of leaves and the needle leaves can withstand the cold environment and survive the harsh condition of climate. Coniferous forests are found in Canada, Europe and United states. These regions are characterized by

cold, and the type of precipitation is snow fall in the winters and the summer is warm humid.

Temperate Deciduous Forests: The temperate deciduous forest has low temperature ranging from -30°C and 21°C . Annual rainfall is between 750mm and 1500mm. The vegetation in the temperate deciduous forest is characterized by broadleaf trees. This is due to the fact that the trees are influenced by four prominent seasons of the temperate climate. For instance, most remarkable is the change in color of leaves in autumn, fall off in the winter and regenerate during spring. This vegetal adaptation enables it to withstand harsh winter season by being inactive due to the extreme low temperature exhibited during this season. Temperate deciduous forests are found in Eastern United States, Europe, Asia, Japan and Canada.

Rain Forests: Rain forest has temperature ranging between 20°C and 25°C and high annual rainfall of 2000mm and 10,000mm. As the name implies, this forest experience rainfall all year round and the vegetation in this forest include vines and palm trees. Globally, area covered by rainforest is less than 2 percent of the earth and almost 50 percent of all animal and plant inhabit the rainforest. Almost all rainforest lie near the equator. There are the rainforest of Africa, Southeast Asia and South America.

Functions of the forest

Forests perform several functions especially the strategic role it plays in the sustainability of the earth and the support of human and animal existence. Forests have many functions medicinal, economic and environmental. Olagunju¹⁷ identified different functions of the forests and categorized them as follows:

Environmental function of the Forest: i. The protection and conservation of biodiversity, ii. Climate and weather elements (precipitation, temperature, relative humidity among others) are moderated by forest, iii. The forest protects the earth from the negative effect of carbon dioxide (carbon sequestration), iv. Protect the soil against erosion and leaching.

Socio-cultural and economic function of the Forest: i. Increase soil fertility thereby enhancing food security, ii. Herbal and medicinal products are gotten from the forest, iii. Provide fuel wood for domestic/industrial uses, iv. Forest resources provide income and employment for the people, v. Raw materials are made available for industries from the forest. vi. Forest resources also serve as a means of national revenue and foreign exchange earnings, vii. Forest provide sacred site for both religious and cultural activities, viii. Forest are also used for shooting movies, it is aesthetic in nature and provide avenue for sporting activities.

Implications of Deforestation on Climate Change

The removal of vegetation significantly contributes to climate change in several dimensions. Environmentalists reported that

the loss of forest and land use change account for about 23 percent anthropogenic CO_2 emissions. This percentage makes up about 17 percent of over 100 years global warming effect of the entire greenhouse gas emission. This is a serious and disturbing scenario considering the fact that major stake holders are not doing much to curb the rate at which deforestation is perpetuated especially in Africa and other developing regions.

Deforestation affects global energy through the alteration of micrometeorological processes and sporadic increase in carbon dioxide concentration in the lower atmosphere¹⁸. This greenhouse gas therefore absorbs thermal infrared radiation and prevents the radiation from escaping into the outer space thereby increasing the air temperature beyond normal threshold. In addition, deforestation exacerbate the effects of albedo of the land surface affecting energy budget¹⁹⁻²¹. Water vapor flows, wind flows and solar energy absorption are significantly influenced by the impact of deforestation which directly affect local and global climate²². Cloud formation and rainfall are partly the function of vegetation. However, deforestation on the low land can move these climatic elements to a higher elevation resulting in low precipitation²³.

When forests are removed, normal weather patterns are disrupted. This can create hotter and drier conditions which in turn accelerate the effect of drought and desertification process leading to crop failure, displacement of major vegetation regimes and other climatic extremes²⁴. Climate variability as witness today is a direct repercussion of deforestation and unsustainable land use practices. The apparent anthropogenic induced climate change which leads to temperature anomalies, precipitation fluctuations and extremes in some areas, sea level rise, atmospheric pollution and depletion of stratospheric ozone layer, forest decline are the "forcing" climate change.

The rate at which the tropical forests are shrinking is alarming, for instance, in every 10 years period, 5 percent of the forest are lost to logging for wood supply, cattle grazing, agriculture and biofuel production¹⁴.

Lawrence and Vandecar²⁵ argued that the need to articulate agriculture and forestry management together is imperative. This is because tropical forest is important in regulating climate variability, thus provides tropical agricultural sustainability and productivity. It is essentially necessary to note that forest conservation and protection are critical aspect of agricultural planning and development. Furthermore, destruction of forest through deforestation couple with climate change will endanger crop production and livestock farming. The risk posed to global food security due to human-induced climate change is eminent if the current rate of deforestation is not addressed. Nevertheless, if trees are planted to replace the ones cut down, they will soak up CO_2 as they grow thereby reducing greenhouse gas in the atmosphere. It is reported that the plants and other land-based forest resources soak up about one third (1/3) of all CO_2 added to the atmosphere annually²⁶.

Deforestation affects the global atmosphere in different ways. The increase atmospheric concentration of greenhouse gasses (GHG) brings about rising global mean temperature as part of the consequences of deforestation. This is because primary forest provide terrestrial sink for carbon dioxide. When this essential function is not performed due to deforestation, the global carbon cycle will be destabilized thus increases the concentration of carbon dioxide in the atmosphere. For example, studies reported that over 2 billion tons of carbon is emitted into the atmosphere as a result of tropical deforestation²⁷. Carbon dioxide released due to global deforestation is virtually equal to 25 percent of emission from combustion of fossil fuel²⁸. This statistic is worrisome and calls for urgent remediation.

Global Deforestation Perspective

The declaration of international year of forest in year 2011 has provided impetus and greater awareness to global forests vulnerability. The importance of forest cover cannot be overstressed. These environmental benefits of forest include maintaining hydrological cycle of the earth system, mitigation of climate change, soil conservation and biodiversity protection among others²⁹. In addition, forest resources also provide numerous economic benefits. For instance, over 145 countries are involved in logging for timber production³⁰ for commercial purposes. The current environmental crisis on the account of incessant and high level deforestation calls for concern³¹.

The last half of the 20th Century has witness increase tropical deforestation activities. It was reported by FAOFRA, 2001 and 2010 that unimaginable global deforestation activities occurred during 1990–2015. However, the tropical regions of the world were the worst affected¹⁵ (Table-1). This corroborated the submission by Rowe et al.³² that over 15 percent of world forested areas were converted to other land use type in 1850 and 1980.

The rate at which global forests are destroyed is alarming. Available statistics show that deforestation was at 9.2 million hectares annually from 1980–1990. Similarly, from 1990–2000, 16 million hectares of forest was removed and in 2001 and 2015, the global forests declined to just 13 million hectares per annum. Most unfortunately, the deforested area in the past 10 years is recorded as -5.2 million hectares annually. This figures represent 140km² of forest lost per day. Nevertheless, this estimate was smaller compared to the reported case between 1990 and 2000 which statistical records show that 8.3 million hectares of forest was lost annually. This is equivalent to 0.20 percent loss of forested area per year.

Presently, the global annual net loss of forest is 37 percent. This is lower than the deforestation rate that occurred in 1990s and equivalent to 0.13 percent loss of the forested area annually during this period. However, this statistics indicate that smaller and low income countries loss more forest annually and may likely loss their forest in the next 10 years if the present rate of

deforestation is not urgently reduced (Figure-2). This is in clear contrast with the developed countries with low deforestation rate. Indeed it is sad to note that some 31 countries of the world do not have forest therefore do not make the list of countries with forest because they have removed virtually all the forest leaving the regenerated forest fragmented.

Table-1: Change in forest area by region and sub-region, 1990-2015³¹.

Regional/Sub-regional	1990 - 2000		2001 - 2015	
	1000ha/year%	1000ha/year%	1000ha/year%	1000ha/year%
Eastern and Southern Africa	-1841	-0.62	-1839	-0.66
Northern Africa	-590	-0.72	-41	-0.05
Western and Central Africa	-1637	-0.46	-1535	-0.46
Total Africa	-4067	-0.56	-3414	-0.49
East Asia	1762	0.81	2781	1.16
South and Southeast Asia	-2428	-0.77	-677	-0.23
Western and Central Asia	72	0.10	131	0.31
Total Asia	-595	-0.10	2235	0.39
Russian Federation (RF)	32	n.s.	-18	n.s.
Europe excluding RF	845	0.46	694	0.36
Total Europe	877	0.09	679	0.07
Caribbean	53	0.87	50	0.75
Central America	-374	-1.56	-248	-1.19
North America	32	n.s.	188	0.03
Total North and Central America	-289	-0.04	-10	0.00
Total Oceania	-41	-0.02	-700	-0.36
Total South America	-4213	-0.45	-3997	-0.45
World	-8327	-0.20	-5211	-0.13

Nigeria Deforestation Perspective

Over the years Nigeria has lost her forests to deforestation due to anthropogenic activities. FORMECU reported that 1976/1978 and 1993/1995, the natural forest (excluding plantations) shrubs/grassland have decreased from 23,439,000ha, this represents 26% of the Nigeria forest to 15,097,000ha (16.6%)³³. Available record indicates that since 1990, about 6.1million

hectares (35.7%) of forest cover has been removed. The diverse biodiversity and the ecosystem of Nigeria forest resources are endangered. Old forests are disappearing at a very fast rate. For example between 1990 and 2005, Nigeria lost a significant 79 percent area of its forest due to agriculture. Logging, livestock grazing and forest fires among others. Similarly, from 2000 upward, Nigeria has continue to loss an average of 11 percent of its natural forest annually. Furthermore, in 1990, the rate of forest lost double, making Nigeria a severe environmental crisis region. It is worthy to note that this loss of forested land in Nigeria is mostly human-induced or anthropogenic in nature (Table-2)³⁴.

The case of deforestation in Nigeria is very pathetic, in fact Nigeria is distinguished for recording the highest rate of deforestation of its natural forest in the world³⁵. The rate at which the forested land cover of Nigeria is removed is put at over 3.5% annually indicating a loss of about 350,000 to 400.000 hectares of forest annually (Figure-3)³³. Recent reports indicate that forest occupy about 92.377km² (10%) of Nigeria. This is actually lower than the recommended 25 percent by Food and Agriculture Organization of the United Nation (FAO). The action by which the forest reserve are being de-reserved by government is not helping the present situation. Over the years, the state forest Department has not been able to curb the frequent request from the forest estate for forest land to be used for the establishment of agricultural crop cultivation. This unfortunate situation portrays a picture that forest estate was intended to be preserved for other economic activities as

increase in demands for de-reservation is rising all over the country. Ola-Adams *et al.*³⁶ noted that in Nigeria, 64 species of forest resources are vulnerable, 14 species are endangered and 9 species are critically endangered. This scenario is very unfortunate considering Nigeria’s abundant natural resources endowment with no articulated effort by policy makers for the preservation of these forest resources.

NACGRAB/FDA corroborated this by submitting that most significant reason for cutting trees in the reserved areas is due to state Department of Forestry negligence. This department has relegated their core mandate of forest management practices since 1970s. The lack of effective management practice by forestry department has rendered forests to be seen as infinite resources for anyone to plunder without regulative guidelines for the harvest of forest resources.

This findings was supported by Oduntan *et al.*³⁷, that forested areas under protection as surveyed in Ogun state (Yewa division) are endangered by anthropogenic activities with variation in levels of impacts and severity.

Courses of deforestation in the Nigerian environment

In order to save the forest from continuous destruction, the need to know why these forests are being destroyed is imperative. Deforestation is caused by both natural and anthropogenic activities (Figure-4).

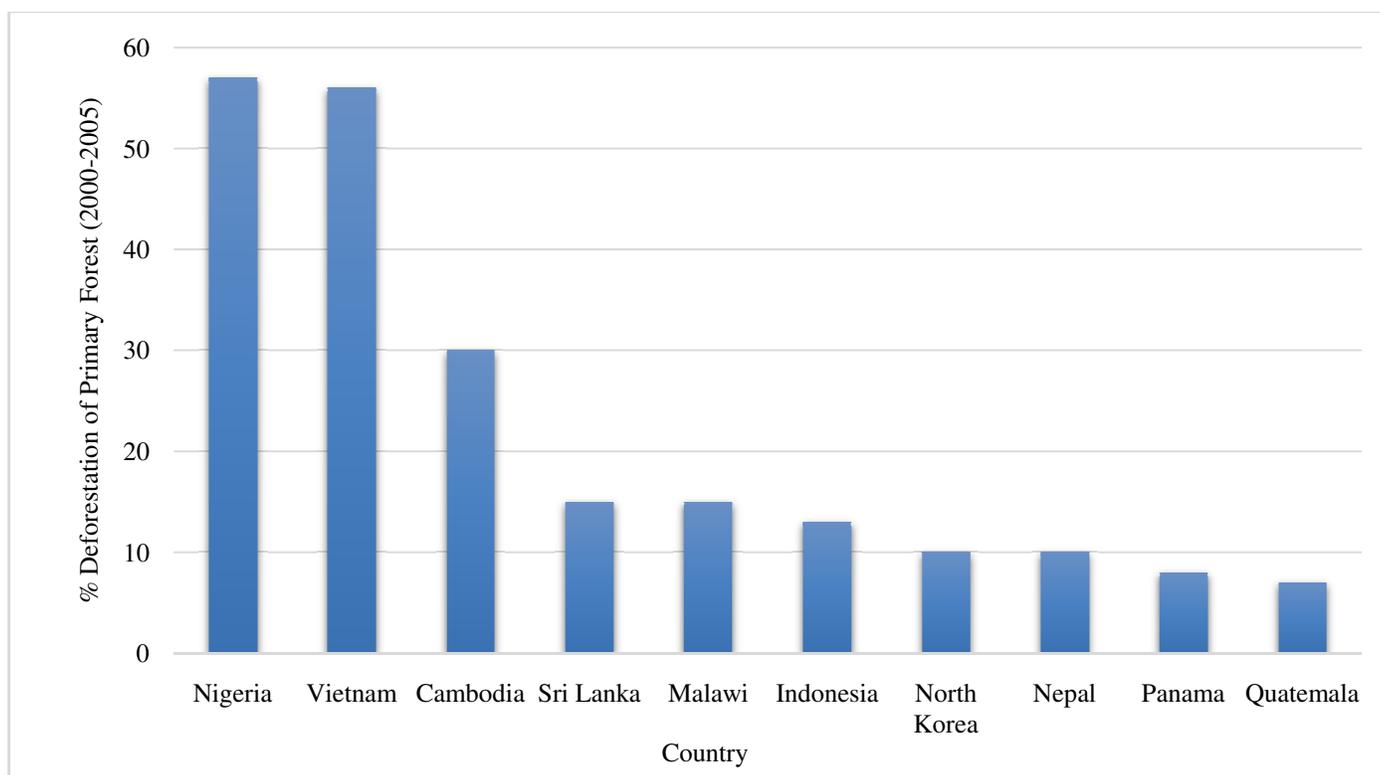


Figure-2: Countries with the Worst Deforestation Rate of Primary Forest (2000-2005)⁴⁶.

Table-2: Some Causes of Deforestation in Various States of Nigeria³⁴.

	Timber Extraction		Large scale agric		Shifting cultivation		Fuel wood extraction		Annual Fire	
	No. of states	%	No. of states	%	No. of states	%	No. of states	%	No. of states	%
Major Cause	6	27.3	19	84.4	13	59.0	12	54.6	9	40.9
Minor Cause	10	45.5	3	13.6	7	31.9	6	27.3	10	45.5
Non- Cause	3	3.6	0	0	2	9.1	3	13.6	3	13.6
Non-Response	3	13.6	0	0	0	0	1	4.5	0	0
Total	22	100	22	100	22	100	22	100	22	100

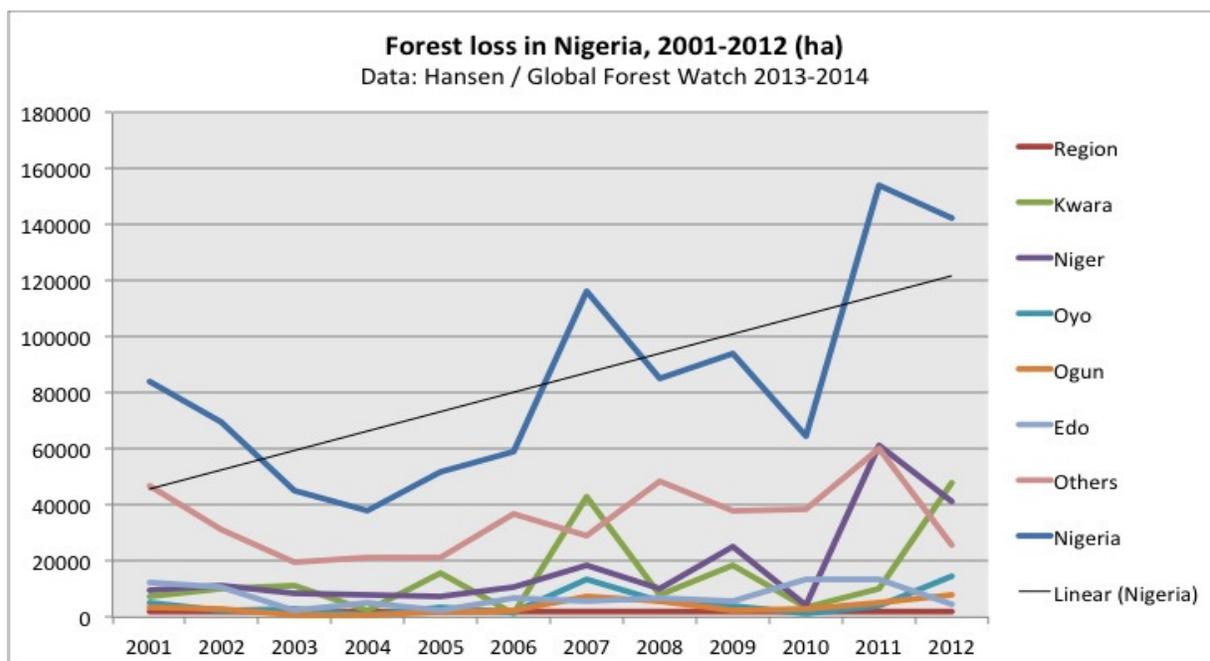


Figure-3: Forest Loss in Nigeria, 2001 – 2012(ha)³⁸.

Natural causes

Volcanic Activity: Volcanic eruption is one of the natural causes of deforestation. The lava flowing out during eruption burns the forest destroying the trees, animals and other ecological organisms that contributes to the healthy growth of the ecosystem. In addition, the gases released can kill wildlife and other microorganisms. Most importantly is the poisonous nature of the carbon dioxide released during volcanic activities. It is observed that greenhouse gas like carbon dioxide forms deadly sink areas when release from volcanic vents. The abundance of CO₂ and lack of the presence of herbivores increase the toxic evergreen plants in the area. Herbivorous animals are attracted to the grass which asphyxiate the animals by the toxic. In 1999, it was reported that lava flows in Cameroon destroyed sections of virgin rainforest. Also there is evidence that Rica destroyed the rainforest³⁵. According to Peter³⁸, massive environmental degradation and destruction was

recorded due to volcanic eruption at the mountainous Mkomon district of Kwande Local government of Benue state.

Fire: Forest fire contributes to the destruction of forest leading to natural or human-induced deforestation. When forest is burnt, ground vegetation, shrubs, saplings and other smaller trees in the ground level are destroyed and eradicated while the big trees in the upper canopy are spared. The weaker trees in the forest floor are removed by fire. Also forest that is stressed by extreme climatic condition like drought and dry spell are vulnerable to forest fire. A typical example is the fire that occurred in the great Bornean in 1982–83, the fire destroyed more than 9 million acres (3.6 million hectares) of forest area of Kalimauta in Indonesia. It has been reported also that over half of the Amazon rainforest is vulnerable to forest fire during dry spell and extreme droughts.

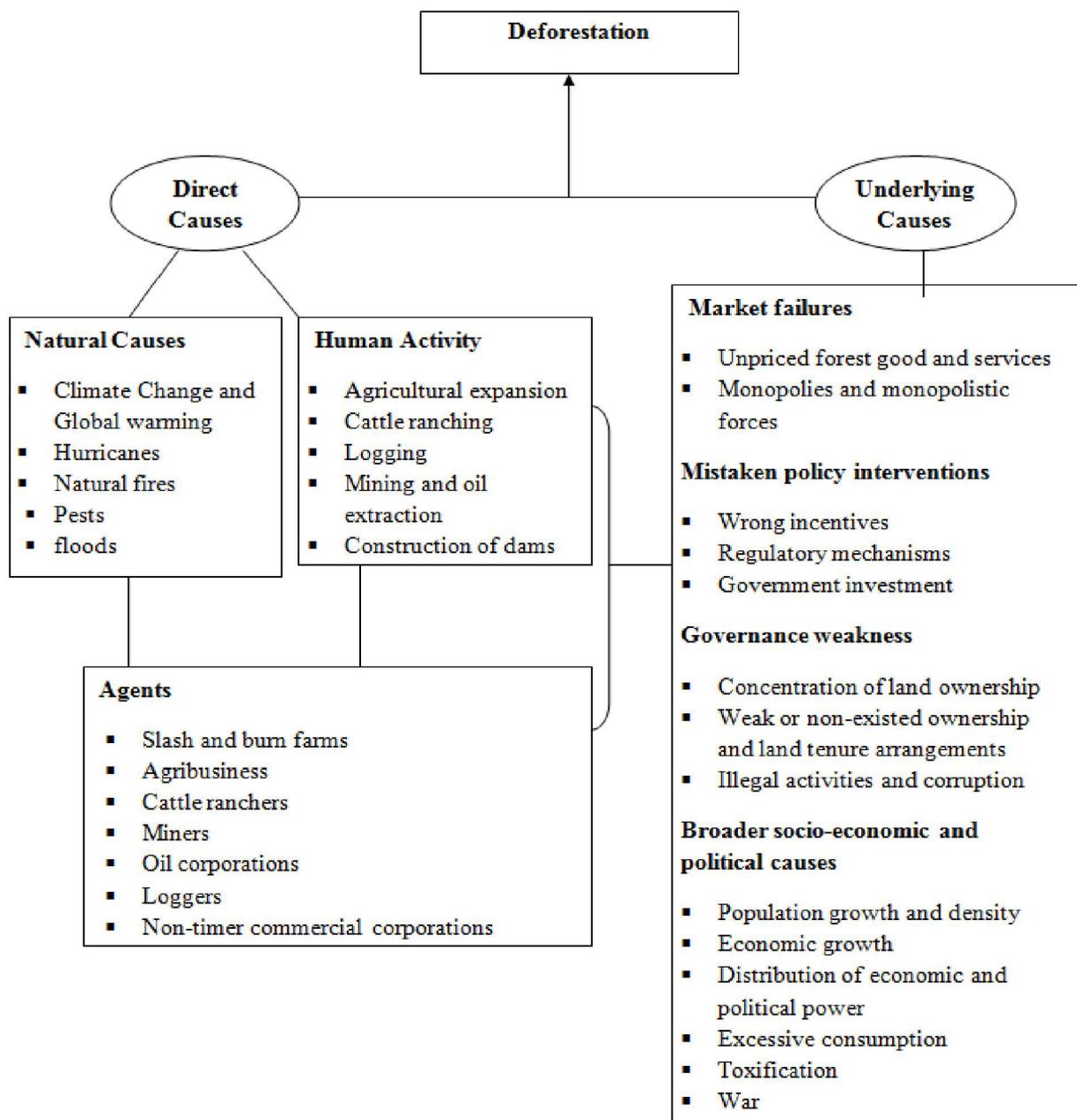


Figure-4: Direct and Underlying Causes of Forest Decline¹⁸.

Tropical Storm: Tropical storms are severe and rapidly spinning wind system characterized by a low pressure at the center accompanied by heavy rainfall. Example of tropical storm are cyclonic storm, hurricane and typhoon among others. Tree fall in the forest can lead to dozens of trees falling alongside with the trees attached to them by lianas. In some regions, larger tropical storms such as hurricanes can destroy a large forest land and recovery may take many years from hundreds to thousands of years.

The 1880 storm of northwestern part of Peninsular, Malaysia destroyed an extensive forest area of Kelanian. Recovery from

such natural disaster is often prolong. It is expected to take at least 250 years or more for Luquillo Montane forest in Puetto Rico to recover from Hurricane Hugo of 1989³⁵.

Drought: Drought is one of the environmental disasters that occur due to prolong period of dryness and complete absent of rainfall in an area for a long period of time. Drought affect vegetation by weakening the plant and exposing the vegetation to moisture stress to a point where the plants become susceptible to disease and other negative environmental factors. Drought is partially caused by human activities like removal of forest cover. However, drought can occur naturally, though driven by

climate change. El Nino periodically causes drought in Asian and American tropical rainforest. El Nino was identified as the culprit behind the great Bornean fire of 1982 – 1983 and 1997 – 1998. Drought occurs frequently in the arid and semi-arid region of Africa and northern part of Nigeria with severe impact on the vegetation of these regions.

Anthropogenic or Human Activities

Logging and fuel wood: Logging is a process of cutting down trees for timber or fuel wood. Though logging especially selective cutting of matured trees does not cause deforestation but can have significant effect on primary forests³⁹. It is noted that logging activities in Asia is said to be quite intensive and is the leading cause of deforestation in that region. Logging however serves as catalyze to deforestation²³. Logging for firewood is viewed as one of the major causes of deforestation and forest degradation in El Salvador⁴⁰. Similarly, logging for fuel wood increase deforestation and forest degradation in drier part of Nigeria (Savannah belt of Nigeria)⁴¹. According to FAO⁴², cutting of trees for fuel wood accounts for 61% of total removal and most of the fuel wood is for charcoal production.

Agricultural Activities: Agriculture promotes deforestation in many ways. Many trees are fell down during farm preparation for crop production. Animal grazing, shifting cultivation, slash and burn agriculture are ways of destroying the forest. For example over 60% of the forested areas in the tropics are cleared for agriculture like crop production, plantation farming and livestock grazing¹⁵. It is reported that shifting cultivation has affected more than one half of tropical forest. For instance, shifting cultivation was greatest in Asia with about 30 percent deforestation rate. However, over 15 percent of the impact of shifting agriculture is recorded in the whole tropical world.

Overgrazing: Overgrazing entails exposing pasture to intensive grazing by livestock such that sufficient recovery period is not possible. This can cause the destruction of forested land and the ecosystem can be degraded significantly. Overgrazing occur frequently in drier area of the tropics were pasture overgrazed by livestock are degraded and are susceptible to soil erosion.

The destruction of forest through overgrazing has turned large areas of Qinghai province in China into a desert. Overgrazing has changed the large grasslands in the north of Beijing and in Inner Mongolia into desert³². Overgrazing has made the forest Savannah of Nigeria susceptible to desertification.

Mineral resources exploration and mining: Minerals like crude oil, coal among others are explored and mined with considerable impact on the forest. The process of mineral exploration and mining are very intensive and destructive to the environment^{43,44}. Mining is always done in a small area of land and it is not seen as a major cause of primary deforestation. Mining is a lucrative activity promoting development booms

which may attract population growth with consequent deforestation.

Though mining may involve a small land area, however, the implication on forest resources is enormous. Mining promotes development which serves as a pull factor thus encouraging population growth in the destination region with its potential consequent of deforestation. Mining accelerate deforestation, for instance the deforestation rate exacerbated by mining activities in Guyana from the year 2000 to 2008 increased 2.77 times according to evaluation report by the World Wildlife Fund, Guianas⁴⁵. Furthermore, mining in Philippian couple with logging are among the major activities that contributes to the countries decline in forested area from 17 million hectares in 1934 to a meager 3 million in 2003 (82% decline)⁴⁶. Similarly, it is reported that about 2000 hectares of tropical forest in the municipality of Coahuayana in Michoacan, South-western Mexico will be completely destroyed by Iron mineral mining planned by the Italo- Argentine Mining Company³¹. The mining of oil in the Niger Delta region of the south-south, coal mining of South-east, gold and lead mining of northern part of Nigeria, all play a devastating role and promote deforestation activities in the regions.

Corruption and political cause: Food and Agriculture Organization (FAO) report of 2001 submitted that forest crime and corruption are the major cause of deforestation in many countries⁴². Illegal contracts are approved by forestry officers, unauthorized sale of harvesting permits, under-declaring volumes cut in public forest, under pricing of wood in concession are some of the corruption activities perpetrated by government officials. Forestry department also aid and abate crime by allowing cutting of trees in protected areas illegally and smuggling of forest products and resources into other countries without proper authorization and documentation^{47,48}. This illegal activities increase deforestation process especially in developing countries of the world.

Urbanization / Industrialization and Infrastructural Development: Urbanization which is the expansion of towns or cities for residential and industrial purposes increase the process of deforestation remarkably. City expansion requires extensive land for infrastructural development necessary to support population growth. This infrastructural development is achieved by removing the forest cover through deforestation^{43,44}. The forests in the tropics are vulnerable and are mostly the major target of infrastructural development and industrialization especially for hydropower dam, oil exploitation and construction of road network among others. According to Kaimowitz and Angelsen⁴⁹, these developmental endeavors are done in pristine areas thereby destroying the virgin forest and forest resources.

Urbanization and infrastructure development account for high rate of deforestation in developing countries. Construction of roads, bridges, railways, industrial zone and air ports among

others brings about population increase through migration from the rural area to the newly developed towns. It is worthy to note that new settlers are most likely to colonize the forests by logging for timber, clearing the land for agriculture and new road to access the forest in order to explore and utilized the forest resources⁵⁰⁻⁵². The development of these infrastructure projects are of worldwide concern, since tropical forest clearing accounts for roughly 20 per cent of anthropogenic carbon emissions destroying significant carbon sinks and around 21 per cent of tropical forests have been lost worldwide since⁵³. This has great repercussion on climate change

Combating Deforestation in Nigeria

Consensus effort is required to combat and reduce deforestation in Nigeria. This could be possible by collaborative endeavor of individuals at the community level, policy makers, organizations, governments and non-governmental agencies and all critical stakeholders. Combating deforestation in Nigeria can be effective and accelerated through methods that embrace environmental awareness, deforestation preventive approaches, sustained tree planting or afforestation activities and effective enforcement among others. Therefore Combating deforestation in Nigeria can be achieved through the following:

Environmental Education and Enlightenment programmes: Environmental education will provide the platform for understanding of human interactions and how the environment is influenced and impacted by anthropogenic or human activities such as agriculture, deforestation, construction and grazing. The overall impending environmental catastrophe will be minimized if enlightenment campaign is undertaken by both government, non-governmental organizations and environmentalist. Such laudable endeavors can help to inculcate and infuse stewardship ethics which will indirectly awaken the sense of responsibility in terms of managing environmental resources (forest) appropriately. Furthermore, environmental enlightenment of all stakeholders starting from the grassroots and the local people will systematically discourage and prevent inimical environmental tendencies such as deforestation, cultivation along slopes, overgrazing, logging and bush burning among others. The outcome of environmental awareness through education and enlightenment will enable individuals, community and the country to be conscious of the negative effects of deforestation on their immediate environment.

Increase of Protected Area (forest Belt): The efforts by government to protect and preserve vulnerable areas from deforestation in Nigeria is recognized. For instance, in the year 2000, the then President of Nigeria, Olusegun Obasanjo instructed the Ministry of Environment to establish green belt stretching from Kebbi State in the North-West to Borno State in the North-East, Ayuba et al⁵⁴ in an effort to halt the encroaching desertification process in the region. However, in recent years, desert encroachment is fast eroding the forested land of the

north due to deforestation and government is not doing enough to protect these vulnerable areas.

The emphatic protection and preservation of areas vulnerable to deforestation is vital and necessary in any effort to protect the ecosystem and biodiversity^{55,56}. There is therefore the need for the protection of forests area that are highly vulnerable in order to confront the menace of deforestation and prevent human deleterious impacts in such volatile region.

Agroforestry programmes: Agroforestry involve planting of trees among crops or pastureland. In order word, the combination of agriculture and forestry for effective land management is agroforestry. This method (agroforestry) is highly advantageous in the sense that forest area will increase and dependency on primary forest will be drastically minimized. In addition, this practice is beneficial in terms of soil management and conservation. Also soil holding capacity against erosion is enhanced and soil fertility improvement is achieved⁵⁶. Agroforestry practice should be encouraged especially in the northern region of Nigeria due to its vulnerability to desertification, drought and other environmental disasters that affect the forested land.

Reforestation and Afforestation Programme: This process involves replanting of trees to replace the deforested ones. Reforestation and afforestation are vital avenue by which depleted forest resources are restored. Afforestation and reforestation are important ways of combating deforestation. Some African countries including Nigeria have used this method to reclaim degraded forest. For example, in Nigeria, the forest belt was created through tree planting effort by the government in the northern part of the country. The need to also plant trees along contours, boundaries, road side, railway tracts and important non-forested areas are great effort towards reducing the negative effect on the primary and established forests.

Policy and enforcement: Effective policy and enforcement will combat deforestation in Nigeria. Food and Agriculture Organization⁴² opined that about half of the present tropical forest depletion could be curbed if government in the countries with deforestation menace are determined to tackle this problem. In Nigeria charcoal production has reduced the tropical rain forest to more than half. The need for comprehensive policy formulation that will curb charcoal production, timber logging, bush burning and negative agricultural practices is imperative. Effective legislation and enforcement mechanism is required. In addition, the need to develop new environmental policies and modification of the existing ones for greater effectiveness and efficiency is urgently needed in order to combat deforestation in Nigeria. Most importantly, the political will to enforce environmental friendly policies is very critical. Also such policies and legislations should endeavor to encourage the community for effective participation in forest protection advocacy and forest

management. This community based participation in forestry management and conservation should be tailored along safeguarding indigenous people's traditional rights and tenure with rightful sharing of benefits.

Conclusion

The continuous destruction of forest resources through deforestation especially in Africa in general and Nigeria in particular is taking critical dimension and calls for urgent attention by both international and local consensus for effective forest management, protection and preservation. The various environmental, socio-cultural and economic functions of forest are endangered by anthropogenic endeavors resulting to deforestation and biodiversity degradation. It should be noted that deforestation is in the increase in Nigeria due to high level of poverty and lack of goodwill by policy makers and government institutions for effective policy enforcement and regulations.

Nevertheless, deforestation could be tackled through structured strategies such as environmental education and enlightenment programmes, increase protected areas, reforestation and afforestation programmes among others.

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