



THE ROLE OF AGROFORESTRY IN CLIMATE CHANGE MITIGATION

Sangotoyinbo, O. A. Fadoyin, A. S. Omoghie, E. S. and Adebajo, A. E.

*Forestry Research Institute of Nigeria, Moist Forest Research Institute,
P.O.Box 2444, Benin City, Edo State, Nigeria.*

Corresponding Author: Sangoguns2002@yahoo.co.uk/ 08060709897

Abstract

The massive forest destruction does not only exacerbate the depletion of Nigeria resources but also the ecosystem's diversity. Climate change is one of the most important global environmental threats with serious implications on food security, natural ecosystem, water supply and health. Climate change represents one of the greatest environmental, social and economic threats facing the planet. This global phenomenon is more strongly felt by the people living in developing countries especially in Africa, specifically in Nigeria due to their reliance on natural resources. This paper examines the extent of deforestation in some of the developing countries in Africa, contributions of deforestation to climate change effects, consequences of climate change to the immediate environment and the causes and the effects of climate change on the environment. The paper also describes some of the Agroforestry projects with potentials to can mitigate the adverse effect of climate change.

Key words: *Ecosystem, Environment, Climate change, Deforestation and Agroforestry*

Introduction

Agroforestry is a sustainable land management system which combines production of crops, forest trees and animals simultaneously on the same unit of land and applies management practices that are compatible with the local population (Kings 1996 and Barret, 2002). Forests are large area of land covered with trees and brush that grow thick. Forests have also played a critical role in the survival of human population (UNEP, 2002). Its function in maintaining global food production cannot be over-emphasized but, the greatest roles of forest which cannot be physically quantified is the protection and conservation of the global environment. Global forest destruction exacerbated by inappropriate government policies, increase in population, urbanization, fire-outbreak and over-exploitation are responsible for the negative impacts of climate change on both human welfare and the environment (Sangotoyinbo *et al.*, 2010b). If an urgent attention is not taken, the global environment is in a serious danger.

Deforestation, through indiscriminate felling of economic tree species, is a major cause of climate change. It has in many ways served as a threat to sustainable forest resources management. It has created wealth for some, causes hardship for others and almost brings serious consequences on the environment. FAO (1983) reported that in the 80s about 400 hectares of forest and woodland out of every 1000 hectares suffered from deforestation on annual basis. The remaining forest area in Nigeria will likely disappear by 2020, if the current rate of depletion continues unabated. The southern rainforest which covers only 2 percentages of the total land area in Nigeria is being depleted at an annual rate of 3.5 percent. Large scale deforestation of the south, particularly in the low forest area has resulted in a number of other problems including sheet and gully erosion, flooding as well as siltation of rivers that sometimes constitute the only source of water for domestic use. In northern Nigeria alone, the annual deforestation of woodland run to about 92,000 hectares while the whole country consumes about 50 to 55 million cubic meter of wood annually (UNSN, 2001).

Climate change has taken a centre point in the midst of diverse threatening environmental challenges facing the planet earth now. It is arguably the most threatening environmental problem of our time, stimulating discourses vis-a-vis the causes, long term effects, as well as how to forestall the lingering and frustrating impacts. The effects of climate change is more pronounced in African societies because of its geography, its sole dependence on agriculture and its generalized incapacity to cope and adapt to climate extreme (FAO, 2003; Bolaji-Olatunji *et al.*, 2010).

Climate Risk Management and Adaptation (CRMA, 2008) defines climate change as any significant change in climate over time whether due to natural variability or because of human activity. Climate change is a change in global weather patterns. Climate change has cumulative effect on natural resources and the balance of nature (NEST, 2004). This in turn affects agriculture. The total average impact of climate change may be positive or negative depending on the climate scenario (Apata *et al.*, 2009). Even with this situation, indigenous peoples have very weak approach towards tackling climate change effect. Hence mitigating climate change is therefore crucial for developing countries.

The issue of climate change is receiving so much global attention because of the projected impacts on the biodiversity which now contribute to environmental problems mankind faces as we enter 21st century. Climate change cannot be aptly described until we have good understanding of what is meant by the very dynamic phenomenon called climate. Climate can be defined as the synthesis of weather at a given location or area over a period of at least thirty years (Ayodele, 2003) described it as representing a generalization of weather condition over an area. This is measured by changes in all features associated with weathers such as world pattern, rainfall, temperature and storms, more aptly, global climate change means change in the climate of earth as a whole (Anon, 2007).

Extent of Deforestation in Africa

Rainforests are being destroyed by uncontrolled logging or conversion to farmlands at alarming rate (Plate 1). Urgent action is required to halt this trend and preserve these forests for the benefit of local communities and for the good of the world.



A



B

Plate1: Deforestation of rainforests through (A) Conversion to farmland and (B) logging

According to Sanwo (2005), 70% of the total timber extracted in high-forest states in Nigeria is stolen, with no records kept. The state forestry departments have been unable to protect the forest estate adequately from extensive encroachment. Harvesting of industrial wood is done by mill operators, by independent registered loggers and, in many cases, by poachers. Plate 2 shows the massive exploitation of economic hardwood species of the tropical rainforest ecosystem of Nigeria. Table 1 Revealed the List of African Countries and the Number of Extinct and Endanger Hardwood Tree Species



Pate 2: Massive extraction of timber from Nigeria's tropical rainforests.

Table 1: List of African Countries and Number of Extinct and Endanger Hardwood Tree Species

S/N	COUNTRY	EXTICNT	SPP	ENDANGERED SPP	TOTAL
1	Cameroon	1	355		356
2	Cote d' Ivore	2	105		107
3	Gabon	—	108		108
4	Ghana	—	117		117
5	Kenya	—	103		103
6	Madagascar	—	281		281
7	Mauritius	2	88		90
8	Nigeria	2	171		173
9	South Africa	3	74		77
10	Swaziland	1	11		12
11	Tanzania	2	240		242

Source: IUCN 2008 Red List Categories

Contributions of Deforestation to Climate Change

The major causes of climate change are human activities (anthropogenic) and deforestation is playing a crucial role. Deforestation could be defined as the total or partial removal of vegetation cover for a particular purpose. It means a complete change from forest to agriculture urbanization or desert. Others include any area that has been logged even if the cutting was selective (Cunningham and Cunningham 2002). According to Kio (2000) the term 'Deforestation' denotes the complete clearing of natural tree formation (high forest and savanna) for agricultural particularly shifting cultivation and other uses.

The rate of deforestation in Nigeria in the last three decades had been so rapid as a result of relative improved standard of living. This had led to erection of several structures and other forms of constructions within the metropolis .One of the big cities that has witnessed such a rapid urbanization is Ibadan, the capital of Oyo State (the second largest city in Africa of Lat.7 23N and Long 3 56E).Imagine the city which experience mean annual temperature of 24-28 about 20 years ago recorded 30-35 (FRIN, 1999).These changes no doubt have greatly modified the overall environmental condition of the city. The city which had 7-10 well protected forest reserves between 1960 and 1980 has lost almost all the reserves; those that remained consist of newly grown coppices. Some of these forest reserves in the city had witnessed one form of degradation or the other, these are; Igbo Agala forest reserve, Alalubosa forest reserve, Eleyele watershed management, Ajibode forest plantation, Onigambari forest reserve etc.

Illegal felling, over exploitation, industrialization and urbanization, agricultural practices, etc. have rendered most of our forest estates deforested. Forest plays a critical roles in sustaining the health of environment by mitigating climate change, conserving biological diversity, maintaining clear and reliable water resources, sustaining and enhancing land productivity, protecting coastal and marine resources and providing low cost and renewable energy. However, the forest cover in Africa has been diminishing steadily since 1980s (FAO, 2005). Some of the ways in which deforestation contributes to climate change are narrated below:

Agriculture: Crop Production

Total clearing and destruction of many virgin land and forest to provide land for food crop, tree plantations or livestock production is taking place unabated in developing countries.Most of this farm produce are exported to industrialized countries while the local populace are hungry and are sufferingthe impacts of different environmental hazards. Between 1900 and 1980, about half of the forest in developing countries was cleared for agriculture (World Bank, 1978). In Nigeria, the clearing of land for farming accounts for over 80% of the total area deforested annually (Alaje et. al. 2012)

Population Growth

Population of the earth was estimated at 3.7 billion in 1970, and twenty-five years later ()1995, it went up to 5.1 billion. Ninety percent of population growth was within the developing countries (Ausbel, et al. 2004). Also, it has been discovered that Nigerians is consuming between 1.9kg and 4kg per day per capital of fire wood depending on household size. When applied to the country's population currently put to about 140 million, the country consumes about 266 million kilograms of wood daily (The Guardian, Friday, April 18, 2008). The destruction of forest trees due to population growth has contributed greatly to the occurrence of climate change because more carbon IV oxide would be released into the atmosphere because there are no enough trees to sequestrate the gas.

Urbanization and Industrialization

This involves the construction of roads, companies, public and private buildings, dams and religion centre. The construction of new roads has a profound impact on the forest. Road construction is considered to be one of the

main causes of deforestation. Forest is also encroached upon by industrial and residential development as population grows and cities extend outward. All these led to the disappearance of economic trees which in turn causes climate change.

Forest Fire / Bush Burning

World Bank (1991) reported that fire outbreaks occur more frequently in the forest estate during the later part of the dry season that is between November and March. In this period, the litters on the forest floor are dried with high combustibility which makes the litters to burn with ease. Fire is caused by many factors but the greatest culprit in the forest fire is man. About 99% of fire outbreak is caused by man, either deliberate or carelessness, misplaced priority or ignorance. Fire can also occur naturally through thunderstorm (Sangotoyinbo, 2002). Forest fires have ravaged most of our forest reserves and plantations, and some of the economic tree species have been destroyed. Each year, fire engulfs millions of hectares of forest worldwide (Toyinbo *et al.*, 2009). This massive loss of forest trees has really contributed to the occurrence of climate change globally.

Poverty Level

It has been reported that 1.3 billion people (about one fifth of the world population) are living in abject poverty with an income of less than \$1 per day. The poorest people are often forced to meet short-term survival need at the cost of long-term sustainability. The poor will be desperate for fuel wood and crop land to feed himself and his family which will lead to deforestation and latter cause climate change. The poor cannot afford the price of kerosene or gas for cooking.

Ignorance

Ignorance also contributes lots to deforestation rate because some rural dwellers do not know the implication of deforestation even there are many urban illiterates who do not know the importance of trees in their environment. They see forest as a threat therefore, destroying it has nothing to cost them and this will eventually lead to climate change.

Over Exploitation

Over exploitation of forest resources is predominant in developing countries especially in Nigeria. Logging activities (Legal and Illegal felling). Exploitation of charcoal, fire wood, chewing stick, wrapping leaf and medicinal plants have contributed largely to the deforestation of forest areas, which is the major cause of climate change in our environment (Sangotoyinbo *et al.* 2010a : Alaje *et al.* 2012). Climate change is a global challenge and an issue of great concern in almost all continents in the world today. This change is attributed to directly or indirectly to human activities that alter the composition of the global atmosphere and which is in addition to the natural variability observed over comparable time periods, (Adeoti, 2009). Nigeria is one of the countries expected to be most affected by the impacts of climate change through sea level rising along her coast line intensified desertification, erosion and flooding disaster and general land degradation (Babalola, 2012).

Consequences of Climate Change

Desertification: Desertification or desert encroachment refers to gradual extension of the desert into area where hitherto there were no deserts. Desertification may be through natural processes or human activities. The natural process includes weathering and action of winds. The human activities include destruction of vegetation through mining, settlement and urbanization (Prince, 2002 and Otegbeye, 2000).

Global Warming: Globally, average temperature are expected to increase between 1.5° c to 6.1° c (2.7° F to 11° F) in the next hundred years. Global warming refers to persistent increase in global temperature generated from the greenhouse gases. This is a direct resultant effect of ozone layer depletion due to the absorption of ultraviolet radiation to the earth surface. This is a most serious phenomenon that causes climate change. Global warming causes rises in the sea levels as the ice caps melt due to the high temperature which resulting in the uprising on the volume of water beyond the river bank. The end point of this is flood which destroy farmland, displaces people, cause food insecurity and loss of biodiversity (Cunningham, 2002).

Ozone Layer Depletion: A global environmental concern is the depletion of atmospheric ozone layer, traceable to be lofting of chemicals used for refrigeration, fire retardation, aerosol propulsion and forest clearing. These greenhouse gases as they escape react with the ozone layer thereby poking holes on it. This allows direct penetration on the ozone layer by ultraviolet rays that are harmful to man and the functioning of the ecosystem on the land and sea, such radiation increase has serious implication on human health. It causes skin cancer, cataracts and alters man's immune system and blindness to animals (Daniel, 2006).

Greenhouse Effect: The change in energy quantity is very importance because the atmosphere selectively longer wavelengths. Most solar energy comes in the form of intense high energy light or near infrared

wavelengths. This short wavelength energy passes relatively easily through the atmosphere to reach the earth surface. Re-emitted energy from the earth's warmed surface is lower intensity, longer-wavelength in the far-infrared part of the spectrum. Atmosphere gases, especially carbon-dioxide and water vapour block much of this long-wavelength energy, holding it in a lower atmosphere and letting it leak out of the space slowly. This terrestrial emitted energy provides most of the heat in the lower atmosphere. However, too much greenhouse effect caused by burning of fossil fuels and deforestation, may cause harmful to environment changed (Cunningham, 2002).

Loss of Biodiversity: Biodiversity loss according to Animashaun (1995) is a concomitant of series of interdependent man-induced processes which include population growth, expansion of cultivated land and soil deterioration with their implications on the ecosystem. Loss of biodiversity is usually presented as an environmental problem, but underlying causes are essentially social, economic and political. For instance, the excessive and unsustainable consumption of resources by a small but rich minority of the world's poor and hungry in a desperate bid for survival have destroyed or over exploited habitats world-wide. According to Faries et al (1998), no environmental crisis will have more lasting effect than the loss of biological diversity. Increase in temperature resulting in rise in sea level could cause submergence of low lying communities such as most settlement in Nigeria's Atlantic coastline from Lagos to Niger Delta. Ojo (2007) expressed the fear that Lekki and Ajah (in Lagos state) Warri and Port Harcourt are some of the major cities that could also be adversely affected because 0.2 meter rise in sea level could lead to displacement of 200 villages and about one to two million people in the Niger Delta.

Some Agroforestry Projects That Curb Climate Change

Shelterbelt Establishment or Management:

Shelterbelt is a large-scale multi-storey strips or block of trees planted to protect area such as farmland and buildings from the influence of wind storm. The use of shelterbelt is common in areas affected by massive movement of sand and particles called SAND DUNE. When shelterbelt is established in a single row in small scale, it is regarded as WIND BREAK. Sand dune fixation has been successfully carried out in the northern parts of the country (arid areas) such as Kano, Sokoto and Maiduguri in form of Shelterbelt Management.

Erosion Control Programme

It is globally identified that millions of hectares of cultivated land are lost to agricultural production each year because of soil degradation caused by soil erosion (FAO, 1992). An investigation of land degradation in Kastina State revealed the existence of large tracts of bare land devoid of top soil due to sheet erosion and gully erosion and too severe sheet erosion on the farmland (Odunze et al, 1998). Post erosion survey conducted on land revealed that erosive forces leave behind wide deleterious effects other than simply washing away the top soil and its nutrients. The presence of tree cover minimizes the erosive force, prevents the excessive sun intensity which can cause increase evaporation again the presence of litter fall can also increase the amount of soil organic matter thereby improves or increases the soil fertility in the area hence, encourages agricultural farming. According to FEPA (1999) eight percent of the total land area of Nigeria is under severe sheet, rill, and gully erosion spread around the country. Egboka (1999) reported that almost every town in Anambra, Enugu, Ebonyi, Imo, and Abia states is continuously devastated by water erosion.

Coastal Conservation with Tree Planting

The coastal population is estimated at about 25 million people and concentrated in large coastal cities like Calabar, Lagos, Port Harcourt and Warri. Coastal erosion is a prevalent phenomenon along the entire Nigeria coastline (Awosika and Folurunsho, 2006). In the riverine area, coastal is perennial source of water supply to mankind, they also serve as natural habitat for many aquatic animals. Wetland storage of flood water is worth an estimated 3 billion to 4 billion dollar per year. Wetland also improves water quality by acting as natural water purification removing silt and absorbing nutrient and toxin (Cunningham et al, 2005). It is the straight line planting of tree species that are used to prevent the water dryness in rivers, ponds and lakes to guide against the over-flowing of water at the river bank and to prevent the expansion of water bodies and coastal erosion caused by tidal winds and also to protect some of these aquatic animals. The types of trees that are normally used for this task are; *Moringa olivera*, *Sesbania species*, *Leucaenia species* and *Coco nucifera*.

Agricultural Land Reclamation

Many lands have been degraded and become unproductive and wasted due to some economic development activities, such as; mining, irrigation, agricultural activities etc. Change in land scale hydrology has made some soils salty. Planting of trees can be used to rehabilitate the area. In Indian, farmers are using *Terminalia* species to reclaim saline area while some arable crops can still be planted together in order to solve the problem of food insecurity. The saline tolerant species are; *Penamia pinata*, *Albizia lebbeck*, *Prosopis gulfifera*, *Terminalia arjuna*, *Pinus carribea* (World Bank, 1989; Onyema et al, 2008).

Avenue Planting and Homestead Planting of Trees

Different types of economic tree species are planted by the road sides, by the entrance of a building and within the surrounding of a house. These trees serve many purposes such as reduction of noise of pollution caused by

industrial machines or heavy vehicles. The trees absorb the poisonous atmospheric gasses and even carbon dioxide which causes climate change, the trees serve as wind break for prevention of wind storm that damages building, arable crops for household consumption and also properties. They perform recreational and beautification values. The trees can also be economic trees which can be used as timber or as food crops for household consumption such as *Moringa oleifera*, *Terminalia catapa*, *Adansonia digitata*, *Anacardium occidentale*, *Eucalyptus species*, *Tectoniagrandis*, *Gmelina arborea*, *Hura crepitans*, *Magnifera indica*, *Azadirachta indica*, *Dacryodes edulis*.

Conclusion and Recommendation

Climate change is disrupting human beings, animals, plants and the environment in every continent, according to an unprecedented study that reveals the extent to which climate change is already affecting the world's ecosystems. The great implications of these effects on biological, social and economic well-being of man are also obvious. As animals and plants extinction goes on, it is unequivocal that man's ability to sustain on these life forms will be affected. Livelihood activities like hunting, production of plants and animals, harvesting of forest products, and marketing among others will become extremely difficult and most cases impossible. Aside deforestation, other daily activities of man (use of automobiles and machines, disposal of agricultural waste, e.t.c) have a great impact in depleting the ozone layer which thereafter causes climate change. Agroforestry practices happen to be one of the best biological ways of mitigating climate change and will also promote the food production on sustainable basis. It is therefore recommended that all the mitigation measures enumerated and discussed should be absolutely followed and implemented by both government and individuals in order to maintain clement and conducive environment for present and future generations.

References

- Agboka, B.C.E (1999): The Hydrological Water Cycle: A Sustainable Holism of Technological Cum-Socio-economic Environment. Inaugural Lecture, Nnamdi Azikwe University, Awka, Nigeria May 19, 1999. Page 46.
- Cunningham, W.P. and Cunningham, M.A. (2002): Principle of Environmental Science Inquiry and Applications, University of Minnesota.
- Daniel, V. K. (2006): Animals and their responses to climate. *In Journal of Animal Husbandry* 3, 122
- Dunn, J.E (1992): An Agroforestry Handbook: A field guide for extension workers in the humid forest Zone of Nigeria. An ODA assisted forest project Calabar. Page 4. Food and Agricultural Organization (1979): High Forest Development in Nigeria. The indicative Inventory of High Forest in Southern Nigeria, 1973-1977. Technical Report 1, F.ONR/71/546. Report Prepared for the Government of Nigeria. Page 381. FAO (1983): Forestry and Food Security. FAO paper No.90, Rome. Pp.1-74. Food and Agricultural Organization (1991): Fighting Hunger; N0 47. FAO, World Food Day Publication. Page 9.
- FAO (2003): Global Forest resources Assessment. FAO, Rome Paper 140.
- Federal Environmental Protection Agency (1999): National Policy on the Environment (Revised Edition). Abuja, Nigeria Reduction in Developing Countries. Food and Agriculture Organization of the United Nation, Page 43.
- Forestry Research Institute of Nigeria (1999): Data Report from Metrological Garden.
- International Union for the Conservation Nature (2008): Red list Category, Summary Country Totals (Animals; Plants) 2008 IUCN List. Tables: 6a and 6b. IUCN. Physician for Social Responsibilities. 2003. Degree of Danger. How Smatter Energy Can Protect Our Health in California. Washington DC. Page 10.
- Oduze, A.C; A.B. Momodu and S.A. Daddari (1998): A Report on Investigation of Land Degradation in Kastina State, Nigeria, Report Prepared for Ministry of Agriculture and Natural Resources, Kastina State, Institute of Agricultural Research, Ahmadu Bello University, Zaria. Page 37.
- Sangotoyinbo, O.A (2002): The Effect of Deforestation on the Environment in Ibadan Metropolis. HND Project submitted to the Department of Forestry Technology, Federal College of Forestry, Jericho, and Ibadan. Page 28.
- Sangotoyinbo O.A. (2010): Deforestation: A Threat to Sustainability of Forest Resources Management in Nigeria. Proceeding of African Regional Conference on Sustainable Development, Volume 4, Number 4, June 8th-11th 2010. Delta State University, Abraka, Nigeria.
- Sangotoyinbo, O.A.; Alaje, M.A.; Idumah, F.O.; Jayeoba, W.A.; Odefadehan, O.O. and Pitan, O.O. (2010b): Deforestation: A Threat to Sustainability of Forest Resources Management in Nigeria. Proceedings of the Fourth African Regional Conference on Sustainable Development
- Sanwo, K. (2005): Effects of pilferage and biopiracy on the development and harnessing of renewable resources in Nigeria. National Research Network on Pilferage in Agriculture, College of Agricultural Sciences, Yewa Campus, Ayetoro, Ogun State, Nigeria
- United Nation Environmental Programme (2002): African Environmental Outlook, Past, Present and Future Perspectives, Page 4.