ENVIRONMENTAL CONSEQUENCES OF RAINFALL VARIABILITY AND DEFORESTATION IN SOUTHEASTERN NIGERIA

Ogbuene, E. B.
Centre for Environmental Management and Control (CEMAC)
University of Nigeria, Enugu Campus
E-mail: great.emmybrightmore@gmail.com or
emmybrightmore@yahoo.com

ABSTRACT

The study was a review of the environmental consequences of rainfall viability and deforestation in Southeastern Nigeria. Data on rainfall were collected from the archives of the Nigerian Meteorological Services, Oshodi Lagos, Enugu airport and Enugu State University of Science and Technology (ESUT) weather observatory. Time series analysis was utilized to establish long fluctuation pattern in rainfall over an extended period. Line graph, simple and multiple bar graphs were plotted with available rainfall data. The time series analysis disclosed secular trend, cyclical component and seasonal component of rainfall and associated environmental consequences. Also, the environmental consequences of rainfall variation and deforestation include soil erosion, flood disaster, decline in volume of stream, seasonal drought, increasing carbon emission. This no doubt results in deterioration and degradation of environmental quality. It then becomes expedient to apply adaptation measure, substantial planting of trees, and urgent development of forest and game reserve to mitigate this grave environmental hazard.

Keywords: *Environmental Consequences, Rainfall variability, Deforestation, Degradation, Adaptation measures.*

INTRODUCTION

Rainfall variability and deforestation constitutes a serious adverse socio-economic and environmental problem in Southeastern Nigeria. It has resulted into seasonal drought, flood, soil erosion, climate change, biodiversity loss among others (IPCC, 2004). Poverty and all forms of environmental as well as social unrests are on the increase in the study area. Rainfall variability and deforestation has made it almost very difficult for the people to embark on subsistence farming or forest product harvesting. This has compounded poverty situation in the area (Osagie, 2002; Adeguwon and Odekunle, 2006).

Deforestation is the clearance of naturally occurring forests by logging and burning. It is the permanent destruction of indigenous forests and woodlands. The term does not include the removal of industrial forests such as plantations of gums or pines. Deforestation has resulted in the reduction of indigenous forests to four-fifths of their pre-agricultural area. Indigenous forests now cover 21% of the earth's land surface (Tree Society, 2000, Hisham et al 1991). Up to 90% of West Africa's coastal rainforests have disappeared since 1900. In South Asia, about 88% of the rainforests have been lost. Much of what remains of the world's rainforests is in the Amazon basin, where the Amazon Rainforest covers approximately 4 million square kilometres. The regions with the highest tropical deforestation rate between 2000 and 2005 were Central America-which lost 1.3% of its forests each year-and tropical Asia. In Central America, two-thirds of lowland tropical forests have been turned into pasture since 1950 and 40% of all the rainforests have been lost in the last 40 years.

Several researches have revealed that Brazil has lost 90-95% of its Mata Atlântica forest. Madagascar has lost 90% of its eastern rainforests. As of 2007, less than 1% of Haiti's forests remained. Mexico, India, the Philippines, Indonesia, Thailand, Malaysia, Bangladesh, China, Sri Lanka, Laos, Nigeria, the Democratic Republic of the Congo, Liberia, Guinea, Ghana and the Côte d'Ivoire, have lost large areas of their rainforest as a result of deforestation. Several countries, notably Brazil, have declared their deforestation a national emergency. The consequences of current rate of deforestation are severe environmental problems (Alok, 2005, Frederick, Hugh, Hans-Jurgen and Mayaux, 2002; Pearce, 2001 and Ogbuene, 2010).

Rhett and Butler (2005) maintain that Nigeria has the world's highest

deforestation rate of primary forests according to revised deforestation figures from the Food and Agriculture Organization of the United Nations (FAO). It was observed that between 2000 and 2005 the country lost 55.7 percent of its primary forests. Nigerian forest is defined as forests with no visible signs of past or present human activities. Logging, subsistence agriculture, and the collection of fuel wood are cited as leading causes of forest clearing in the West African country. This has grave impact on the rate of rainfall variability in the area.

Wilson (1990), maintains that climatic factor of importance are precipitation and its mode of occurrence, humidity, temperature and wind, all of which directly affect evaporation and transpiration. Solar radiation has a linkage with evapo-transpiration and rainfall. However, constant deforestation disrupts evapo-transpiration and rainfall formation mechanism. These compound environmental problems, such as global warming, climate change, drought, flood, soil erosion, and gully expansion among others.

William and Philip (1999), agued that deforestation is a contributor to global warming and is often cited as one of the major causes of the enhanced greenhouse effect. Tropical deforestation is responsible for approximately 20% of world greenhouse gas emissions. Intergovernmental Panel on Climate Change (2000) opined that deforestation, mainly in tropical areas, could account for up to one-third of total anthropogenic carbon dioxide emissions. But recent calculations suggest that carbon dioxide emissions from deforestation and forest degradation (excluding peat land emissions) contribute about 12% of total anthropogenic carbon dioxide emissions with a range from 6 to 17%. Trees and other plants remove carbon (in the form of carbon dioxide) from the atmosphere during the process of photosynthesis and release oxygen back into the atmosphere during normal respiration.

Only when actively growing can a tree or forest removes carbon over an annual or longer timeframe, but the decay and burning of wood releases much of this stored carbon back to the atmosphere. In order for forests to take up carbon, the wood must be harvested and turned into long-lived products and trees must be re-planted. Deforestation may cause carbon stores held in soil to be released. Forests are stores of carbon and can be either sinks or sources depending on environmental circumstances. Mature forests alternate between being net sinks and net sources of carbon dioxide.

This released carbon through burning could result to acid rain and other associated environmental consequences (Rudel, 2005). Philip and William (2004) agued that flooding is a quite serious consequence of deforestation. Clearing the forest dramatically increases the surface run-off from rainfall, mainly because a greater proportion of the rain reaches the ground due to a lack of vegetation which would suck up the excess rainfall. "Tropical forests can receive as much rain in an hour as London would expect in a wet month, and a single storm has been measured as removing 185 tones of topsoil per hectare". In tropical regions where the forests are dense, flooding is not as serious a problem because there is vegetation to absorb the rainfall.

It is in areas of sparse vegetation that experience this problem. Hence, to avoid the disastrous effects of flooding, tropical forests need to remain dense and lush. IPCC (2004) has studied the inter-annual variability in climate of West African countries, and particularly the magnitude of rainfall variability and deforestation impact on human activities and comfort, including crop production, animal husbandry, carbon dioxide emission, building, construction, marketing, transportation, communication among others.

Rainfall marks the beginning of planting season, enables the farmers to commence their farming activities, but rainfall cessation interrupts their efforts and this result into huge socio-economic and environmental loss. The high rate of deforestation is linked to incidences of rainfall cessation. This condition makes agriculture a risky and non-lucrative profession in the area. It is important to note that early cessation of rain, shortens length of rainy season and reduces annual rainfall amount in the area. It is also observed that more frequent drought and persisting harmatan haze, increase temperature trends. This militates against human comfort index, biodiversity loss, soil moisture reduction, serious loss of water in various hand-dug shallow well.

Rainfall cessation is a major remarkable point in rainfall variability measuring index. It is among the major environmental problems that trigger off climate change. The issue of climate change, which is a global phenomenon, has been attracting international concern. Some countries are noted to be more vulnerable to the impact of climate change than others. Rainfall cessation is hence, identified as a major meteorological problem that is responsible for this current global disaster called climate change.

The water cycle is also affected by deforestation. Trees extract

groundwater through their roots and release it into the atmosphere through their leaves. When part of a forest is removed, the trees no longer transpire away this water, resulting in a much drier climate. It reduces the content of water in the soil and groundwater as well as atmospheric moisture. Deforestation reduces soil cohesion, so that erosion, flooding and landslides ensue. Forests enhance the recharge of aquifers in some localities. However, forests are a major source of aquifer depletion on most environments. Rainfall variability and deforestation are the major causes of climate change and other associated environmental problems as analyzed in this paper.

METHODOLOGY

The study concentrates on Southeastern area of Nigeria, which falls within the Guinea savanna vegetation zone, lies between the semi-arid north and wet southern part of Nigeria. The study area lies approximately between longitudes 60^{l} and 140^{l} E and latitude 70^{l} and 100^{l} N of the equator (see fig 1). Rainfall and temperature in the zone is largely seasonal and varies highly from year to year. The area records annual rainfall which ranges between 937.2 mm to 4251.9 mm, while mean temperature range is usually between 26.8 0C to 32.5 0C over the year. Two distinct seasons are observed, dry and wet. The dry season extends over a period of about 6 to 7 months, from October to March or April while the wet season extends over a period of about 5 to 6 months, from May to September. However, these meteorological conditions vary wildly and this is a factor of the present global climate change which results into land degradation and biodiversity loss. This then awakens the interest of this study.

Data on rainfall (for the period of 1902-2004, for Port-Harcourt, 1917-2005, for Enugu, 1975-2004 for Onisha, 1975-2004 for Owerri) were collected from the archives of the Nigerian Meteorological Services, Oshodi Lagos, Enugu airport and Enugu State University of Science and Technology (ESUT) weather observatory. The data obtained include: total volume of rainfall (mm) per annum and total monthly rainfall (mm). The Nigeria Meteorological Services used the Dines, Tilting and the British Standard rainguages to collect the rainfall data used in this study. The positions of these rainguages have not been tainted since the commencement of the record

keeping. Therefore, rainfall data may not have suffered from non-homogeneity. Data on the rate of tropical deforestation 1960 - 1990 were also generated from Global Feature Foundation 1998. This gives the study insight on rate of deforestation at the global level.

Time series analysis was utilized to establish long fluctuation pattern in rainfall over an extended period. This statistical tool can be defined as data values which are colleted, recorded or observed over successive increments of time (SPSS, 1990). For its effective application, there is need for decomposing and isolating of the various elements of analysis. This will help facilitate the forecasting processes.

Line graph, simple and multiple bar graphs were plotted with available rainfall data. This established variation in rainfall pattern over the years of analysis 1902-2004, for Port-Harcourt, 1917-2005, for Enugu, 1975-2004 for Onitsha 1975-2004 for Owerri). These were utilized to discuss environmental consequences of rainfall variability and deforestation in the study area. To understand the elements of time series analysis, there must be some consideration on the mathematical relationship among the various components such as monthly and the total annual rainfall. The most widely used model for time series decomposition is the multiplication model. In this model, the series are analyzed as the product of its components. It can be mathematically expressed as:

$Y = T \times C \times S \times I$ ---------- (1)

Where

- Y = Actual value of the variable of interest (total rainfall 1902-2004, for P.H Rivers State, 1917-2005, for Enugu, 1975-2004 for Onisha, 1975-2004 for Owerri).
- T = secular trend of rainfall
- C = cyclical component of rainfall
- S = seasonal component of rainfall
- I = irregular component of rainfall

(Source: Holdent, Peel and Thompson, 1993)

The various result of the analysis was presented in form of line and bar graph. The results disclosed rainfall variability, total rainfall over the years and estimated rate of deforestation.

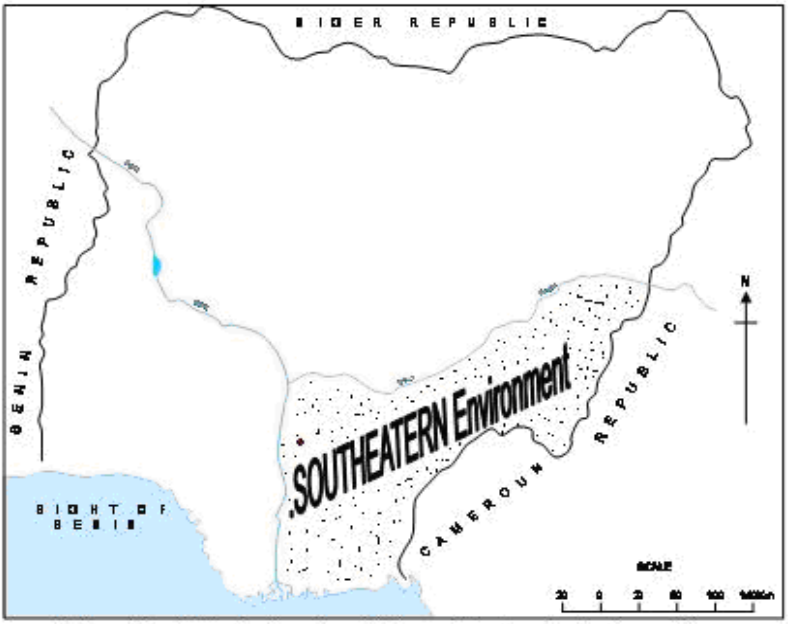

Fig 1a: Map of Nigeria Showing Location of Study Area (Southeastern Environment)

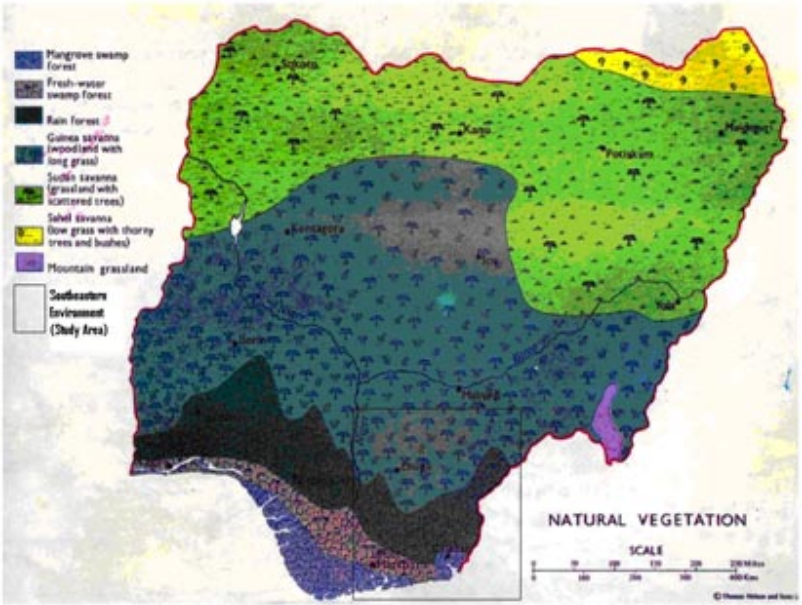

Fig 1b: Map of Nigeria Showing Natural vegetation and Southeastern Environment (Study Area)
(Source: Anika, 2010)

RESULTS AND DISCUSSION

The secular trend of rainfall (T) is a long term component that represents the rate of growth or decline in time series of rainfall over an extended period of time. The parameter analyzed in this study is rainfall (1970-2004) in Port-Harcourt, Enugu, Onitsha, and Owerri respectively. A trend line with a value of 2,500 mm of annual rainfall is regarded as maximum equilibrium rainfall point, while a trend line with annual rainfall of 1,500 mm is distinguished as minimum equilibrium rainfall point over the years of study. These various growth or decline in secular trend of rainfall are linked to environmental disaster which upshot flood and drought in the area.

The cyclical component of rainfall (C) was observed in the chart of time series analysis of rainfall above. This is a wavelike fluctuation around the trend line of rainfall. Any regular pattern of observation above or below the trend line is attributed to the cyclical component of the time series of rainfall. The peaks and the valleys above and below the trend line represent the cyclical component of rainfall.

Seasonal component of rainfall (S) which refers to pattern that repeats year after year was observed in the chart of time series of rainfall above. The circle points in the chart established a clear seasonal component of rainfall over these years of analysis. This could be disastrous since the area experiences uninterrupted excess rainfall or insufficient rainfall over an extended period of time, which may trigger off environmental problems such as flood, erosion, seasonal drought, desertification, poor soil moisture, climate change among others. It should be noted that the points in the chart that have rainfall values of 2,500 mm and above represents those years that record excess rainfall. On the other hand, the points with rainfall values of below 2,500 mm and above 1,500 mm represents those years that record moderate rainfall. Finally, the points with rainfall values of below 1,500 mm represents those years that record insufficient rainfall.

The graphs in fig . 3 and 4 reveals the rate of rainfall variability in southeastern Nigerian environment and estimated rate of deforestation in all tropical countries, Africa, Latin America and Asia. Rainfall variability and deforestation is a continuous process resulting in diverse environmental consequences such as flood, erosion, drought, desertification, increase carbon emission among others.

United Nations Food and Agriculture Organization (2005), estimates that although the Earth's total forest area continues to decrease at about 13 million hectares per year, the global rate of deforestation has recently been slowing. Still others claim that rainforests are being destroyed at an ever-quickening pace. Despite these uncertainties, there is a clear fact that destruction of rainforests remains a significant environmental problem in the area.

IMPACT OF RAINFALL VARIABILITY AND DEFORESTATION IN THE STUDY AREA

Rainfall variability and deforestation exposes the area to diverse environmental problems such as flood which is linked to excess rainfall. On the other hand, insufficient rainfall and constant deforestation triggers off drought and desertification which highly induce climate change and environmental degradation/deterioration. Anyadike (2009), opined that deforestation, over grazing, bush burning, and unplanned development have a grave impact on climate change and environmental sustainability.

Rainfall variability and deforestation has a serious impact on the condition of the environment and biodiversity loss/deterioration. Forest vegetation, wild life, soil fauna and flora depends on rainfall to flourish. The present environmental problems such as soil erosion, flood, drought, desertification among others, are triggered off by rainfall variability and deforestation. These constitute huge socio-economic and environmental losses to the country and the world at large. The current climate change which is a major global environmental problem borders on rainfall variability and deforestation. Oguntoyinbo (1981) opines that in the Sudan and Sahel Zone of Nigeria, the country's major livestock producing region and one of the important food and cash crops producing zones, drought and desertification constitutes severe hazards. This poses a great threat to the country's food security and wetland conservation.

Desertification result from the combination of drought and mismanagement of land especially from the disharmony between land use and management on one hand, and the soil and prevailing climate on the other (IPCC,1996). This study maintains that desertification, drought and flood are climatic phenomena which are triggered off by rainfall variability

and deforestation. Drought and desertification constitute serious problems on the Hadejia/Nguru/Kirrikissama wetland project for conservation of waterlands (Adejuwon, 2004).

Rainfall variability and deforestation compound the problem of soil erosion in the area. Soil erosion occurs under different climatic, geological and soil conditions in southeastern Nigeria. The two types of soil erosion are sheet and gully erosion, which occur in several part of the country. Gully erosion types are the more obvious forms of erosion in the study area. However, sheet erosion is more pernicious and highly detrimental due to the gradual, constant and uniform action, which ends up in the complete removal of the arable parts of the soil (Ofomata 1985). The study reveals that rainfall intensity, duration and amount are usually very high in southeastern environment, thus compounding the problem of erosion in the area. This is traced to constant deforestation and excess rainfall within the study area.

The highest concentrations of severe gully erosion in Nigeria are found in southeastern states: Anambra (with its famous Agulu-Nanka gullies), Enugu, Abia, Imo, and Akwa-Ibom. In these areas, gullies of over 120 meters in depth and up to 2 kilometers in width are not uncommon. Estimates of active gully erosion sites across the country put the total at 2000 active gullies (Adejuwon et al (2004).

In addition, excess rainfall and deforestation give rise to flooding and environmental degradation in the area. Survey in the study area revel that in mid - September, forty-two communities in Anambra West and East Local Government Areas, werecovered by the floods which displace an estimated 22,000 persons. Farmlands were destroyed and only few tubers of yam, cassava, rice and potatoes were salvaged. The consequences are severe food shortage and environmental resource deterioration in the area (United Nation Children's Fund, Nigeria, Oct. - Dec. 2007).

Another dangerous effect of Rainfall variability and deforestation is seasonal droughts which have led to serious reduction in soil moisture and volume of stream in the area. The plate below, as at the time of this survey, disclose the condition of stream in the area. It has resulted to biodiversity loss and other associated environmental consequences.

CONCLUSION AND RECOMMENDATIONS

Rainfall variability and deforestation constitute serious socio-economic and environmental consequences in the study area. The rate of deforestation and rainfall variability in the area is so high and little or no attempt is made on afforestation. Poverty and unemployment have also encouraged deforestation which is linked to rainfall variability and land loss/degradation. Considering the role of forest and biodiversity in climate regulation, erosion control, environmental sustainability, pollution control, carbon sink and environmental management system, the following recommendations were made to safeguard and control the situation. Urgent Development of Forest and Game Reserve within all the state in Southeastern Nigerian will help conserve biodiversity and control environmental problems such as erosion, flood, drought, desertification, pollution, among others.

Substantial planting of trees: Government should make it compulsory for every home in Southeastern urban environment to plant at list two trees. The ministry of environment should set up tree monitoring taskforce in the cities. These trees will help maintain human comfort index and urban climate.

Adaptation measures: Adaptation measures will be very significant due to variation in temperature, rainfall, water discharge regimes, surface and soil temperature which is triggered-off by deforestation as observed in the study. Broadly, these adaptations will include refinement of early warning system to enable timely remedial measure, effective water-use-strategies, adequate basin management and intensive research into evaporation, rain formation mechanism of the study area. A central adaptation approach therefore should be ecosystem management restoration activities such as afforestation, watershed rehabilitation and management, effective water harvesting and conservation.

Environmental impact assessment (EIA) should be compulsory to any type of development in the area. The process of identifying, predicting, evaluating the biophysical, social and other relevant impacts of development proposals prior to major decisions being taken and commitments made. Restoration and regulation of activities to ensure sustainable exploitation of environmental resource has to be given top priority in the area.

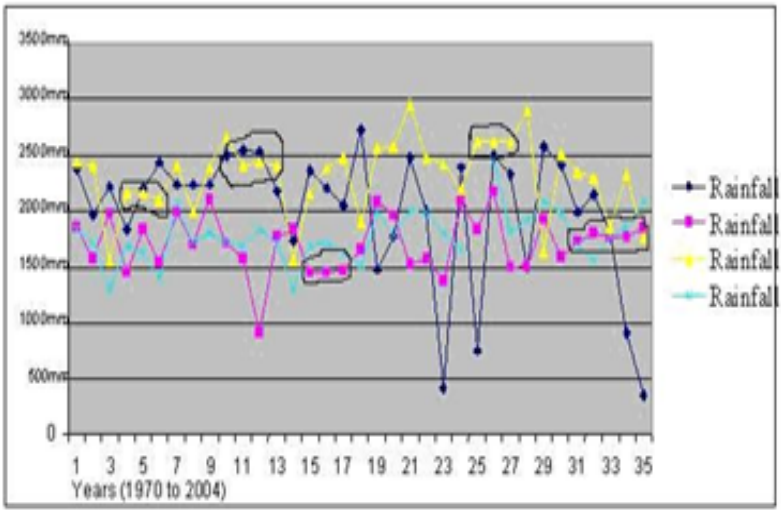

Fig 2: Time Series Analysis of Rainfall Variability in Southeastern Nigerian Environment (Source of raw data: NIMET, Lagos 2009)

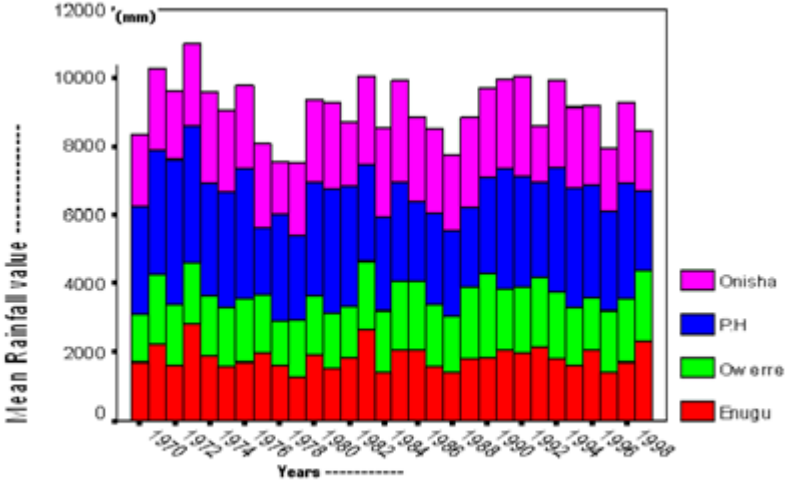

Fig 3: Component Bar Graph of Rainfall Variability in Southeastern Nigerian Environment (Source of raw data: NIMET, Lagos 2009)

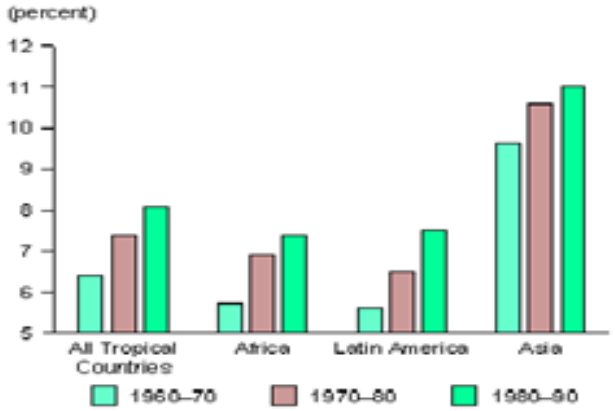

Fig 4: Estimated Rate of Tropical Deforestation (1960-1990) (Source: Global Futures Foundation, 1998)

Plate 3: Deforestation (emitting carbon dioxide and compounding environmental problems)

(Source: Global Futures Foundation, 1998)

Plate 1: Soil Erosion sites in Southeast Environs (resulting from rainfall variability and deforestation)

(Source: Authors field work, 2010)

Plate 2: Flood Disaster in Southeast Nigerian Environment (stimulated by excess rainfall and deforestation)

(Source: Anika, 2009)

Plate 2: Declining Stream in Southeast Environs (resulting from rainfall variability and deforestation)

(Source: Authors field work, March 2010)

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