Global Journal of Environmental Sciences. Vol. 4, No. 2, 2005,: 139 - 145
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AN ANALYSIS OF RAINFALL PATTERNS IN NIGERIA

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(Received 8 December 2004; Revision accepted 25 February, 2005)

ABSTRACT

The paper is designed to study the rainfall patterns and its implications in Nigeria. Rainfall data from 28 stations for the period of 1970 – 2002 were collected from the Nigeria Meteorological Station, Lagos. While the vegetation map of Nigeria between 1973 and 1995 forms the basis of biodiversity change analysis. The results among others show that rainfall decreases from 1350 mm (1941–1970) to 1276 mm (1970–2002). While there is a general decrease in rainfall in Nigeria, the coastal area is experiencing slight increase. Apart from the general southward shift in rainfall patterns, the duration has also reduced from 80-360 (1941-1970) to 40-280 (1970-2002) rainy days per year. This has created ecological destabilisation and altered the pattern of the vegetation belt especially in the northern fringes of the country. The rainfall pattern has also enhanced wind erosion/desertification, soil erosion and coastal flooding in the north, east and coastal areas of Nigeria respectively. With these impacts, the paper therefore recommends some adaptive and mitigation measures that could help to revert the current situation.

KEYWORDS: Changing Climate, Vegetation belts, Rainfall Pattern and Shift.

INTRODUCTION

The on-going changing climate with its associated global warming had been observed to have impacted and will continue to affect the rainfall pattern of different parts of the world (Bello, 1998 and Adebayo, 1999). The impacts will be increase, decrease or total shift in rainfall amount, duration and intensity (Odjugo, 1999, 2000 and Olaniran 2002).

Rainfall fluctuation, variability and abnormalities have been noticed by many researchers in Nigeria (Ayoade, 1973, Olaniran 1985 and 1991, Adefolalu 1986, Afiesimama, et. al., 1999,). The impact of rainfall anomalies has been linked to the occurrence of drought and desertification (Adefolalu, 1988, Yawe, 2000 and Yugunda, 2002).

It is noted above that much attention has been placed on rainfall fluctuation and anomalies in Nigeria but the rainfall pattern has been grossly overlooked. In the light of the above review, one is tempted to ask the following questions. What has been the pattern of rainfall in Nigeria? Is there any evidence of changing climate based on the rainfall pattern? What are the implications of on-going rainfall patterns in Nigeria? This paper is set to provide plausible answer to these questions. To do this effectively, the first section looks at the materials and methods used. While the second section focuses on the results and discussions, the third and fourth sections address the implications and conclusions respectively.

MATERIALS AND METHODS

Rainfall data between 1970 and 2002 for 28 weather stations in Nigeria were collected from the Nigeria Meteorological Station, Lagos. The Stations are shown in figure 1. The rainfall data from these stations were computed into averages and plotted in a map of Nigeria using Isohyet. The outcome is compared with the work of Oguntoyinbo (1978) and Olaniran (2002) who studied the rain trend and distribution in Nigeria between 1941–1970. These maps form the base maps and with these the differences in rainfall pattern within the two periods were determined. The topographical map sheets and vegetation maps of Nigeria between 1973-1995 were collected from the Department of surveying, Ministry of Land and Surveys and the Federal Ministry of Agriculture and Natural Resources. The last vegetation map used was that of 1995 because that is the most recent available in Nigeria. With these maps the impacts of climate on vegetation changes were monitored and mapped out.

RESULTS AND DISCUSSION

The pattern of rainfall is seasonal. While it is double maximal in the south, it is single peak in northern Nigeria (Fig.1). It is obvious from figures 1a and b that the line dividing the double peak from the single peak has shifted southward between 80-150 km within the past 33 years and the line is now clearly below Lat. 9^0N of the equator.

As shown in Fig. 2a, rainfall has generally being on a decline in Nigeria over the years. Prior to 1970, a higher proportion of the rainfall totals was above normal (Oguntoyinbo, 1978 and Afiesimama, et.al., 1999). This condition noticed then still continued until 1980 when drastic decline sets in (fig. 2b). Between 1980 and 2002, or for the period of 23 years, only 8 years (35%) were either normal or above normal while the remaining 15 years (65%) were clearly below normal (Fig. 2b) The decadal rainfall decreased from 1354 mm (1971–1980) to 1255 mm (1991–2000). This implies that there is a decrease of 99 mm (7%) in rainfall amount between the two decades.

Although there is a general decrease in rainfall in Nigeria, the study also reveals that while there is a decreasing trend in rainfall in northern Nigeria, the southern coastal area is experiencing slightly increasing rainfall (Figures 3a and b). This is a clear depiction of an evidence of global warming. So many studies have shown that global warming will bring about more rainfall in most coastal regions and aridity to most continental interiors (IPCC 1995, Akitikpi 1999, Odjugo 1999,). Coastal areas receiving rainfall above 2900 mm have shifted from the shoreline for between 100–120 km inland. Calabar and Warri that were below 2900 mm (1941-1970) are now slightly above 2900 mm, while Okitipupa and Ondo axis that were receiving rainfall below 2000 mm are now above 2000 mm. The Isohyet of 2000 mm although shifted eastward from

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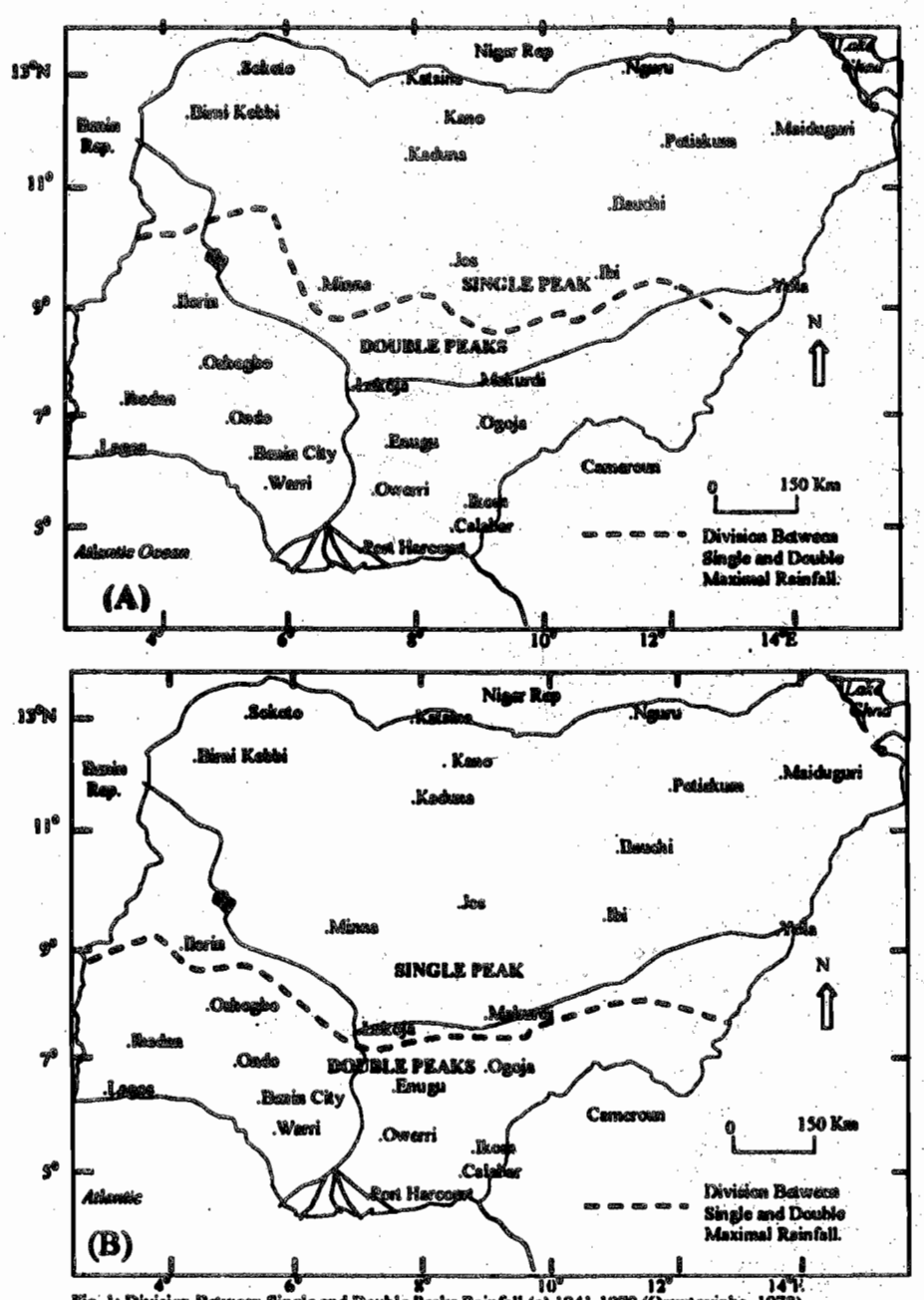


Fig. 1: Division Between Single and Double Peaks Rainfall (a) 1941-1970 (Oguntoyinbo, 1978) and (b) 1970-2002

Lagos axis for about 100 km, it is observed to have shifted interior-ward with the deepest trough in Ondo region.

On the contrary, the 500 mm isohyet before 1970 was not found in Nigeria (Fig. 3a). By 2002, this Isohyet has drifted southward by 150 km in the Lake Chad region and westward by 950 km, almost taken over the entire northern fringes of the country (Fig.3b). The 1000 mm Isohyet shifted southward by between 60-120 km. Also worthy of note is the 1200 mm Isohyet that engulfed the Jos plateau prior to 1970. This has shifted entirely off the Plateau zone down south, a distance of about 300 km (Figures 3a and b).

The study also observed that both the length of rainy season and the number of rain days is decreasing nation wide. This decrease in the length of rainy season ranges between 2 and 3 months. Oguntoyinbo (1978) noted that the on-set of rains below 6°N of the equator in Nigeria was late February and ceases in December, but this study observed that rains hardly established until late March and ends in November. In the North (Lat. 10°N and above) the on-set of rains was early May and ends in October, but now, the rains come in late June and by September, the dry season has set in.

Based on the changes on the number of rainy days, Oguntoyinbo (1978) noted that rainy days range between 80 and 360 days per year in the extreme north east and Niger-Delta coastal areas respectively, while the average for the period of study (1970 – 2002) stands at 40 (north eastern Nigeria) and 280 days (Niger Delta coastal areas). This implies that rainy days have dropped by 50% in the north-eastern region, and 22% in the Niger Delta coastal area. Another key finding is that, although, there is a reduction of 22–50% of rainy days, rainstorm increased by 38% in Nigeria south of 8°N while it was 6% between 8°N and 14°N.

Another prominent change in rainfall pattern of southern Nigeria is the gradual shift in the short dry season (commonly referred to as August break) period from August to July. Oguntoyinbo (1978) noted that the short dry season is prominent in the month of August. But for the past 33 years (1970 – 2002), the short dry season occurred in July for 21

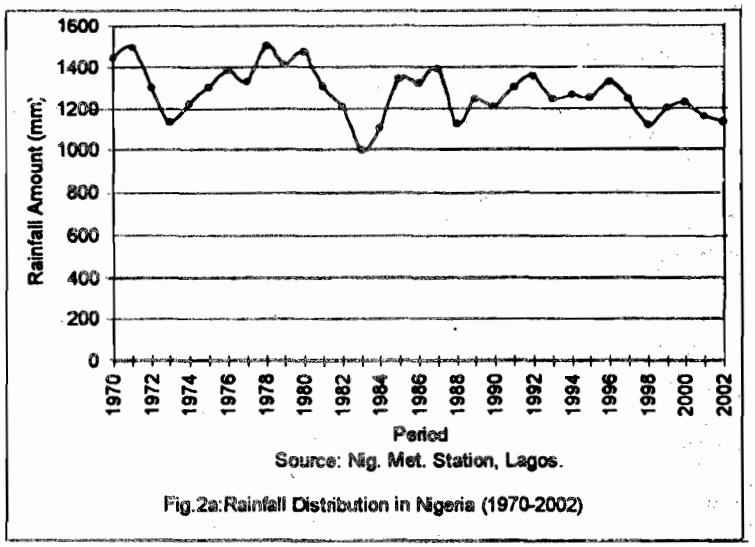
years (64%) while in August it was only 12 years (36%). The characteristic heavy rainfall experienced in August only in northern Nigeria is being experienced in most years in southern Nigeria.

Implications of the Rainfall Pattern

The implications of the present rainfall pattern especially the increasing intensity of rainfall (rainstorms) is the frequent cases of flooding in the coastal areas being currently experienced (Umoh, 2002, Ogundebi, 2004). While this aggravate the incidence of soil erosion in the eastern Nigeria, the northern part of the country with ever decreasing rainfall has resulted to series of droughts, wind erosion and the encroachment of the desert. This agrees with the findings of (Adebayo, 1999 and Odjugo and Ikhuoria 2003).

The increasing rainfall in the coastal area and the expected sea level rise due to global warming and the melting of the polar ice will further worsen the coastal flooding whereby the salt water will intrude into the current freshwater areas. This is expected to change the vegetation structure or biodiversity composition of the coastal wetland. Oladipupo (2002) revealed that the coastal wetland of Nigeria is expected to extend inland-ward by between 175 and 240 km if the sea level increases by 1m in 2100. Odjugo and Ikhuoria (2003) noted that the Sahara desert is encroaching into the country at on annual rate of 8 km. The encroaching desert due more to decreasing rainfall has led to ecological destabilisation and a southward shift of the Sahel Savanna (Fig.5).

As shown in fig. 5a, only the north eastern fringe of Nigeria covering Kukawa (Borno State) and Geidam (Yobe State) was occupied by Sahel Savanna in 1975. By 1995, this has extended westward to Sabon Birni (Sokoto State) leading to loss of Sudan Savanna biodiversity and replaced by that of Sahel Savanna (Fig. 5b). This region almost corresponds with the 500 mm isohyet (Fig. 3b). The derived Savanna is also observed to have shifted southward into the tropical rainforest. Although only Sahel and the derived Savanna have major vegetation belt shift as at 1995, other belts have been so depleted and prone to change. The drastic reduction in rainfall since 1995 and increasing population, urbanisation and deforestation must have created a reasonable change. This will further be studied when more recent satellite imagery is available. The reduction in the number of rainy days and length of rainy season must have forced farmers in extreme north as noted by Akonga, (2001) to change from the production of guinea corn to millet, cowpea and short duration groundnut. Moreover, Odjugo and Ikhuoria (2003) also noted that aridity occasioned by reduced rainfall has caused the



Source: Nig. Met. Station, Lagos.

Fig.2a:Rainfall Distribution in Nigeria (1970-2002)

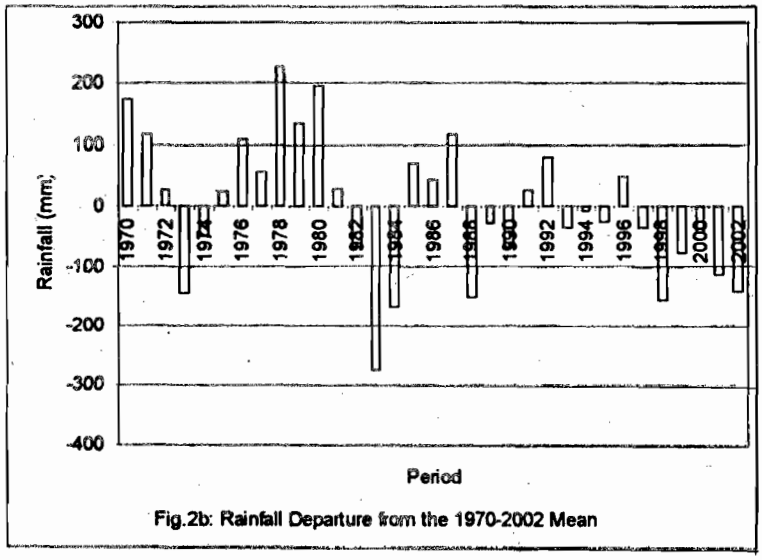


Fig.2b: Rainfall Departure from the 1970-2002 Mean

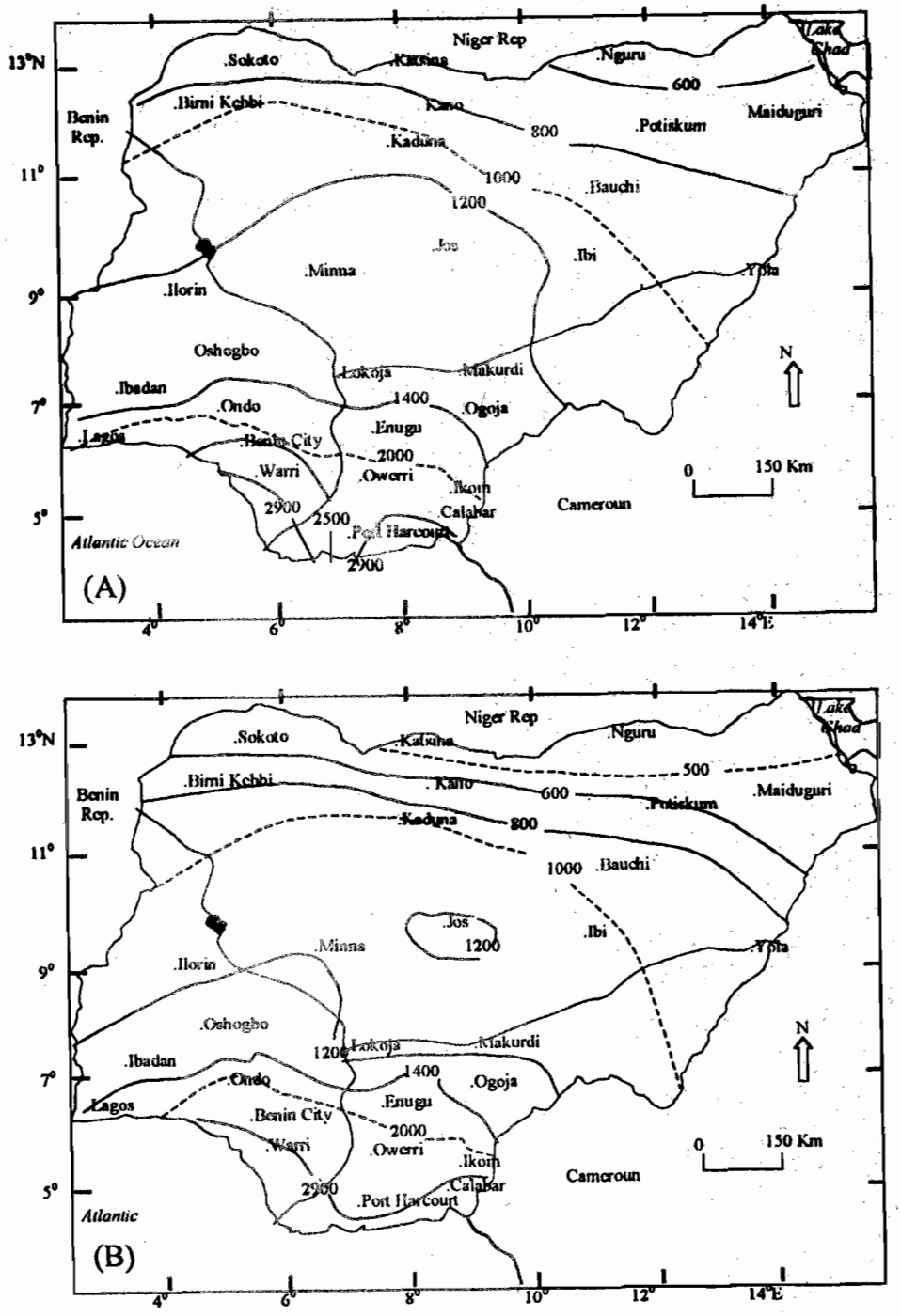


Fig. 3: Spatial pattern of rainfall in Nigeria (a) Between 1941-1970 (Olaniran, 2002) and (b) Between 1970-2002

migrating sand dunes from Sahara desert to bury large expanse of arable lands in northern fringe of the country. This has resulted to scarcity of arable land in the affected communities.

The ecological destabilisation and disappearance of vegetation occasioned by reduced rainfall and increasing temperature will continue to manifest negatively in other areas like drying up of rivers, lakes, and reduction in the level of ground water table. For example, the size of Lake Chad decreased from 16884 Km^2 in 1972 to only 304 Km^2 in 2000 (NCRS, 2003). Moreover, the changing rainfall pattern if continued, will definitely lead to massive relocation of people and activities. For example, the drying up of rivers will lead to relocation of dams and hydroelectric facilities. Also, settlements, people and industrial plants will be relocated to avoid either inundation occasioned by coastal flooding or aridity due to excessive decline in rainfall.

To reverse these negative implications, the rainfall pattern should be normalised and this will suppress the increasing temperature. To do this effectively, all the factors or forces that cause the changing climate should be reverted. These include clean development mechanisms through the application of renewable energy sources, drastic reduction of green house gas emissions, enhancement of terrestrial ecosystem by encouraging afforestation and discouraging deforestation. Such afforestation and reafforestation programmes should be human–related involving all stakeholders while deforestation could be discouraged by

reducing the price of kerosene and cooking gas and change from, or reduce drastically the current reliance on wood to iron and aluminium in our building and furniture constructions. Serious reduction in the price of kerosene will drastically limit the use of firewood for domestic fuel thus, conserving the natural vegetation. Creation of public awareness programmes on the importance of biodiversity conservation on rainfall regimes together with the enforcement of existing laws and regulations on forest resources exploitation should be rigorously pursued.

The changing rainfall pattern requires proper adaptation whether short or long term while mitigation measures are being put in place. Those in northern Nigeria have to adopt drought resistant crops by growing millets that requires low rainfall amount and short duration rather than Guinea corn and maize. Areas that have been taken over by sand dunes and abandoned by farmers could be converted to organised and well-monitored cattle ranching. Irrigation projects should be developed and underground water should be harnessed in addition to the current practice of surface waters (rivers and lakes).

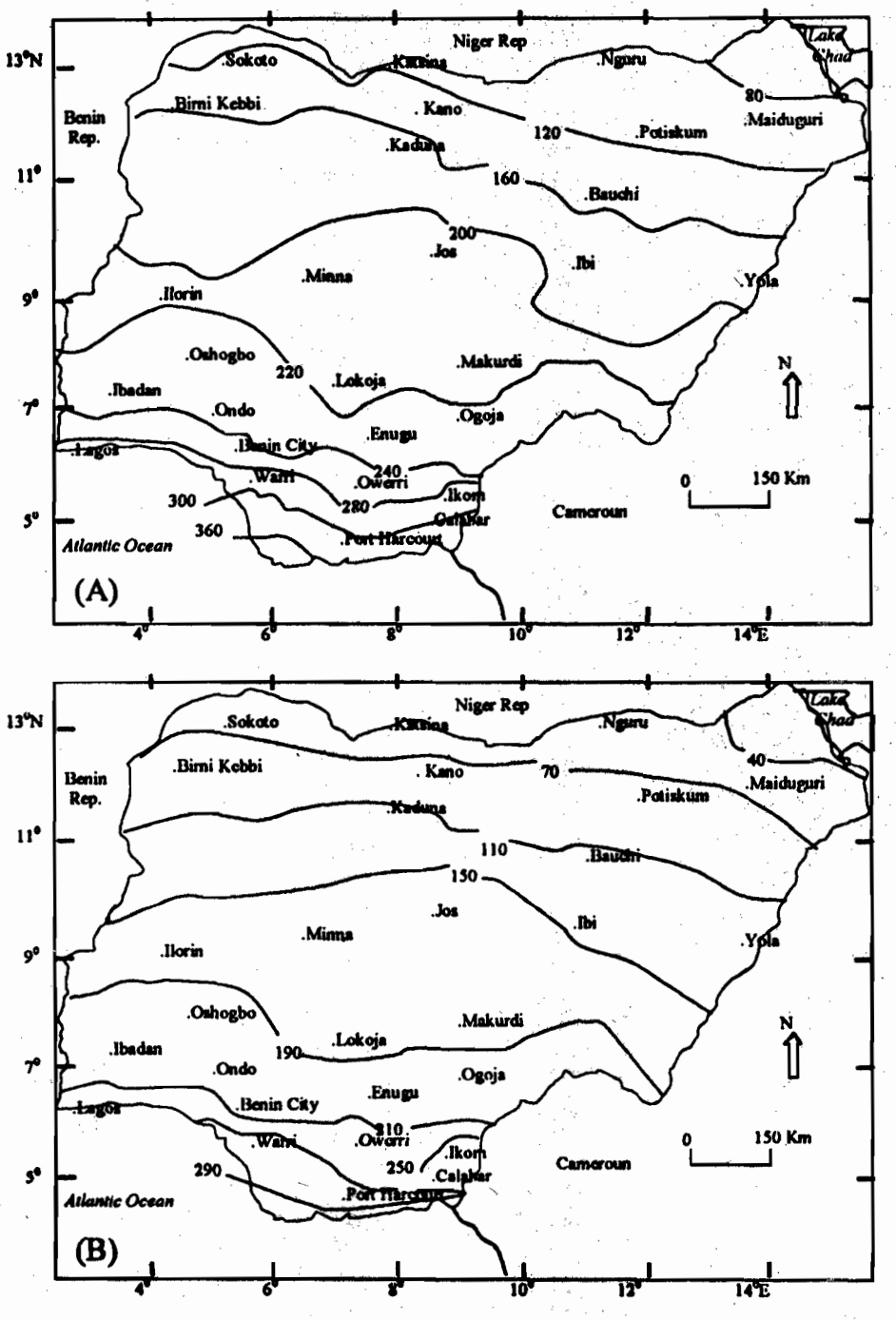


Fig. 4: Spatial pattern of rainy Days in Nigeria (a) Between 1940-1970 (Oguntoyinbo, 1978) and (b) Between 1970-2002

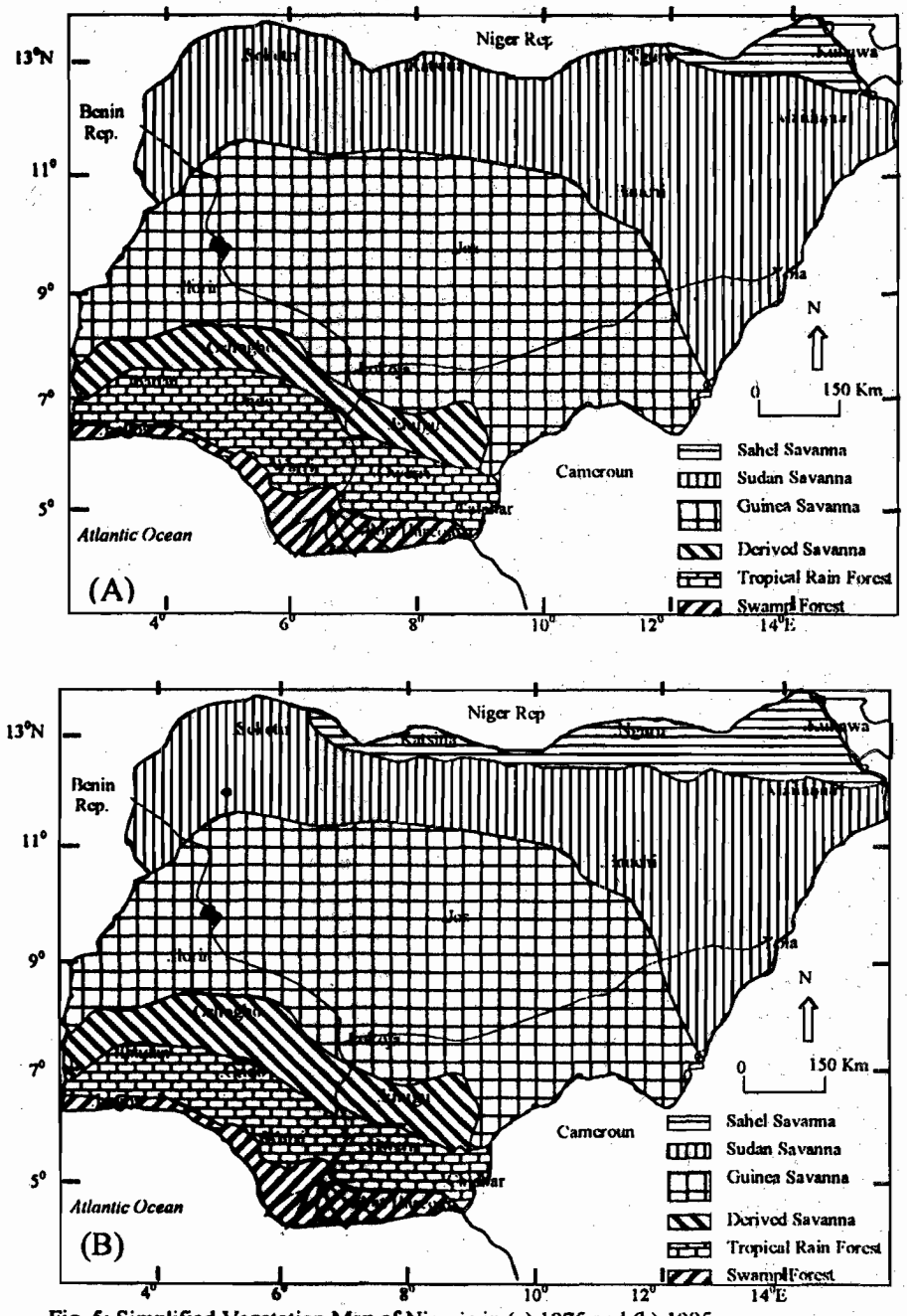


Fig. 5: Simplified Vegetation Map of Nigeria in (a) 1975 and (b) 1995

CONCLUSION

The paper established the fact that rainfall amount and duration is generally declining in Nigeria, but the coastal area has been experiencing slightly increasing rainfall amount. These rainfall characteristics have led to a drastic shift in rainfall pattern throughout the entire country. A tremendous general downward shift with the exception of the coastal areas that experiences slight upward shift is now the current pattern. This clearly shows that Nigeria as a region is currently experiencing the known characteristics or features of global warming and changing climate.

The changing pattern of rainfall has impacted negatively on not only the biodiversity, but also the hydrological cycle with its associated features and majority of Nigerian populace, through change in farming systems, types of crops produced and in some cases relocation. The rainfall pattern for the past 33 years has sent enough signals for the government to take proper measures both in short and long terms to revert the trend. Else we will be seeing our natural heritage of rich biodiversity being gradually lost and converted to desert or desert like condition.

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