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CHANGES IN SOME METEOROLOGICAL PARAMETERS IN THE NIGER DELTA REGION OF NIGERIA BETWEEN 1989 and 1996

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ABSTRACT

Changes in some climatic factors in five locations in the Niger delta region of Nigeria (long. 3^0E-9^0E and lat.$4^0$30'N-$5^0$20'N) have been examined with a view to identify the effect of climate change. Data from 1989 to 1996, used for the study were provided by the Meteorological records of the Nigerian meteorological services, Oshodi, Lagos. Results are presented in the form of composite graphs of monthly mean values, and show that all five locations share similar tropical humid climate. The parameters under study were almost all uniform during the period, except perhaps for Calabar and those locations that lie a little away from the coastlines where averages were slightly different. Monthly mean daily values in the area from 1989 – 1996 are: rainfall, 219.77mm; maximum temperature, 31.36^{0}C; Minimum temperature, 22.86^{0}C; Solar radiation, 11.924MJ/m^2; evaporation rate, 2.79mm; relative humidity at 9.00GMT, 80.90%; relative humidity at 15.00 GMT, 65.76%; sunshine duration, 4.06 hrs; cloud cover, 6.88 Oktas . Though a few distortions in the climatic factors coincided with the Pinaturbo volcanic eruption dimmed to have drastically lowered earth's average surface temperatures in 1991, the general pattern of climatic change seem to indicate consistent trend.

KEYWORDS: Niger-Delta, Composite, Pinaturbo, Meteorological-parameters

1.0 INTRODUCTION

The Niger delta is critical to the economy of Nigeria as it accounts for more 90 per cent of the total revenue generation in the country through oil exploration in particular. Uyigue and Ogbeibu (2008) report that the Niger Delta region is the bedrock of Nigeria's oil production. That since the discovery of oil in the region, oil exploration and exploitation have caused severe climate and environmental changes. As a result of oil exploration, a lot of economic activities including industrialization and urbanization are affecting not only the people's lives but the entire landscape and atmosphere constituents. According to Basil, 2001gas flaring has been in the front burner of Nigeria oil exploration since the colonial era with out commensurate measures to checkmate environmental degradation. Hence as the third largest oil producer in the world, Nigeria has become the largest gas flarer in the world . Environmental Rights Action (ERA) and the climate Justice Programme (CJP) (2005) systematically analyzed gas flaring in Nigeria and drew similar conclusions. This paper highlights the effects of atmospheric changes that have occurred on some meteorological parameters in the Niger Delta region between 1989 and 1996.

Ewona and Udo, (2008) Okpiliya et al, (2006) have already shown that climatic conditions affect both physical and emotional behavior and efficiency of those operating under it. It has also been reported that both rainfall and humidity pattern play a role in spatial distribution of vegetation. Changes in the Niger Delta environment and its ecosystem have also been observed by Stock, (2007), Uyigue and Agho (2007), Ashton – Jones, (1998), Awosika, (1995), Okali and Eleri (2004), Agbola and Olurin (2003) Onofeghara, (1990).

The occurrence of coastal erosion has been reported in the Niger Delta by Okoh and Egbon (1999). The report of Onofeghara, (1990) showed a rise in sea level along Nigerian coastal water. Goudie, (1989) pointed out that industrialization, deforestation; urbanization and tourism were among the strongest pathogenic indices that are capable of inducing changes in climatic factors. The Niger delta region has witnessed astronomical changes in almost all these areas of human activity. Carbon dioxide emission is a regular feature in the area especially coming from gas flaring, industrial activities, use of electric generators and automobiles. In 2007 a destructive tropical storm not common in this part of the world was reported in Port Harcourt coastal waters leaving many dead, (Port Harcourt, 2007). Port Harcourt is the regional headquarters for the petroleum industry in the region. It has a large petroleum refinery and several other manufacturing concerns, (Port Harcourt, 2007).

The Niger Delta is highly susceptible to adverse environmental changes caused by climate change because it is located in the coastal region of the world. Coastal regions of the world are already experiencing flooding due to rise in sea level. Amid the impact of climate change, the region is also faced with myriads of environmental problems resulting from oil exploration and exploitation activities. Reports on the environmental state of the Niger Delta are conclusive about the area becoming an ecological wasteland. Changes in rainfall pattern in the area have also been acknowledge in Oladipo (1995)

The flaring of gas has been practiced in the Niger Delta region for over four decades. Today there are about 123 flaring sites in the region (Energetic Solution Conference, 2004), making Nigeria one of the

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highest emitter of greenhouse gases in Africa. Carbon dioxide emissions in the area are among the highest in the world (Iyayi, 2004). Some 45.8 billion kilowatts of heat are discharged into the atmosphere of the Niger Delta from flaring 1.8 billion cubic feet of gas every day (Agbola and Olurin, 2003). Gas flaring has raised temperatures and rendered large areas uninhabitable. Between 1970 and 1986, a total of about 125.5 cubic meters of gas was produced in the Niger Delta region, about 102.3 (81.7%) million cubic meters were flared while only 2.6 million cubic meters were used as fuel by oil producing companies and about 14.6 million cubic meters were sold to other consumers (Awosika, 1995). Gas flaring and other oil exploration and exploitation activities have contributed significantly to the degradation of the environment in the region.

2.0 GEOGRAPHY OF THE AREA

The Niger Delta is located in the Atlantic Coast of southern Nigeria where River Niger divides into numerous tributaries. It is the second largest delta in the world with a coastline spanning about 450 kilometres terminating at the Imo River entrance. It is rich in biodiversity and is the largest and richest wetland in the world supporting large population of humans, flora and fauna. It has a highly diverse ecosystem (Iyayi, 2004).

Politically, the Niger Delta area cuts across nine states in southern Nigeria which include Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo and Rivers States as shown in Fig.1.

Fig. 1: Map of Nigeria showing states in the Niger Delta (Adapted from Iyayi, 2004)

3.0 MATERIALS AND METHOD OF STUDY

The data for nine monthly mean parameters namely, rainfall, maximum temperature, minimum temperature, solar radiation, evaporation rate, relative humidity at 9.00GMT, relative humidity at 15.00 GMT, sunshine duration, cloud cover, used for the study were supplied by the Nigerian Meteorological agency (NIMET), Oshodi, Lagos as monthly mean daily values between 1989 and 1996- a period of eight years. This period covered the period before and after the popular Pinatubo volcanic eruption believed to have lowered the earth's average temperature in 1991. This period was chosen to enable us ascertain the possible effect of Pinatubo volcanic eruption(one of the earth's greatest natural climatic modulators) on climate in this part of the world and the effect of local factors if any on climate change. NIMET, Oshodi is the official data archive for the Nigeria. Unfortunately, errors were observed in the area of entering the same data for two stations which

were sometimes in different geographical locations. Some data points were also completely omitted. In such a case, data rehabilitation is often employed, Callender, (1961) and Dougas and Heuer, (1985).

Data were screened for errors and consistency in two ways. First, a data point considered to be an outlier (i.e. one that is far higher or lower compared to the entire data set) is replaced by the average of the data preceding and after that point. And two, data set for a year found to be far lower or higher than other years have often been found to have been erroneously copied from the records of another station. Such data are often discarded out rightly. A common feature in data presentation is the occurrence of discontinuities when some data points are missing. Discontinuity in meteorological data is a characteristic feature in most recording stations in Nigeria. This is basically due to breakdown in measuring instruments without provision for immediate replacement. Sometimes too the movement of professional staff hinders the continuous record keeping of the station.

4.0 RESULTS AND DISCUSSION

4.1 Relationship between parameters

The relationship between various climatic parameters were presented in the form of composite graphs and studied for any evidence of change in trend or anomaly. Fig. 2 (a-i) shows composite graphs for maximum and minimum temperature, rainfall, evaporation, relative humidity, cloud cover sunshine duration and solar radiation. From the graphs we note that all five locations share similar humid climate perhaps except for a few data points which seem to stray away from a regular trend.

The results are presented in the form of composite graphs for all five locations, correlation analyses was also carried out to ascertain the extent of relationship. Consistent and high correlation values indicate that all five locations are affected by similar factors. A table of annual mean values was constructed. Sharp differences in the annual values between stations which are generally within one geographical area tells of the effect of local factors on the affected stations. The graphs are plotted together for ease of comparison.

Monthly mean daily values in the area from 1989 – 1996 are as follows: rainfall, 219.77mm; maximum temperature, 31.36^0C; Minimum temperature, 22.86^0C; Solar radiation, 11.924MJ/m^2; evaporation rate, 2.79mm; relative humidity at 9.00GMT, 80.90%; relative humidity at 15.00 GMT, 65.76%; sunshine duration, 4.06 hrs; cloud cover, 6.88 Oktas . From the graphs of figure 2 (a-i), we notice that there is no serious deviation from the common mean in the area for most of the parameters. This means that all the locations in the Niger delta region are affected by similar factors. The graphs show a very strong seasonal tendency as can be clearly seen from Figure 2.

From Figure 2 a, which is a rainfall composite, we note that rainfall pattern for monthly total rainfall for all five locations dropped from an annual monthly mean maximum of about 700mm to an annual monthly maximum of about 550mm between months 36 and 60 (i.e. 1992 and 1993), which is two years following the Pinatubo volcanic eruption that occurred in 1991. After this period rainfall pattern seem to have normalized as the annual monthly mean maximum value rose to about 700mm. This decrease can be attributed to the effect of pinaturbo volcanic eruption. Figure 2b seems to present a different picture as the monthly mean maximum temperature shows consistent decrease over the years under review as can be seen in Figure 2b. The world wide temperature dip in 1991 as reported by the IPCC seems to have lingered longer than expected. From figure 3 we observe that the volume of gas flared was on the increase during the period. We can therefore infer that gas flaring may have significant contribution to the lingering temperature dip in the area. Apart from rainfall and maximum temperature all seven parameters showed no relationship with the global effect of the volcanic eruption.

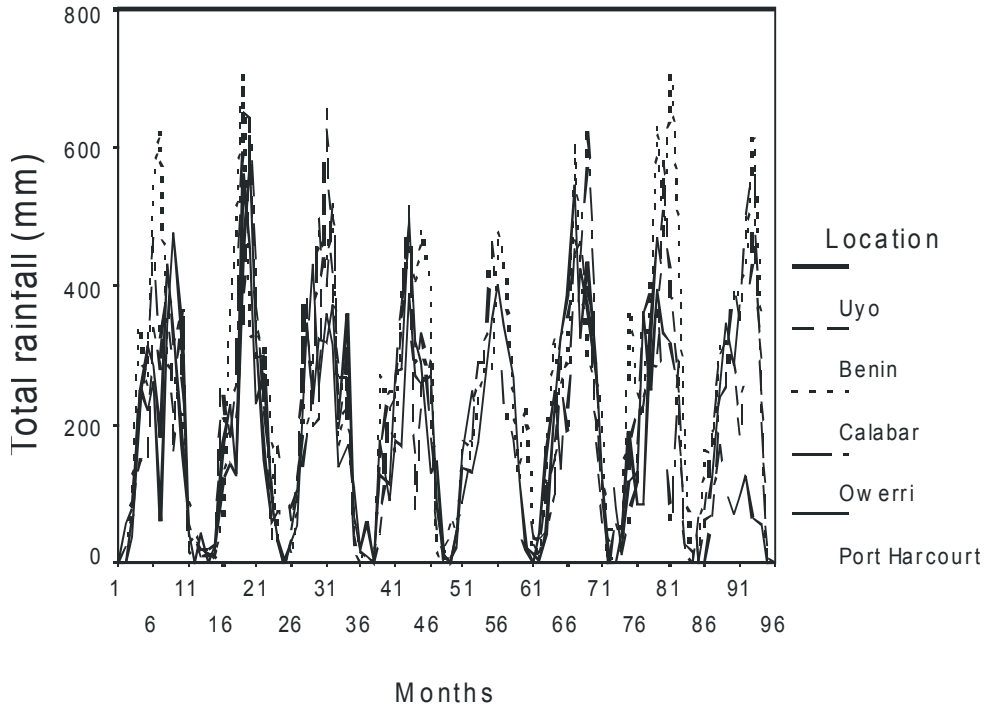

Fig. 2a: Composite for monthly mean daily total rainfall

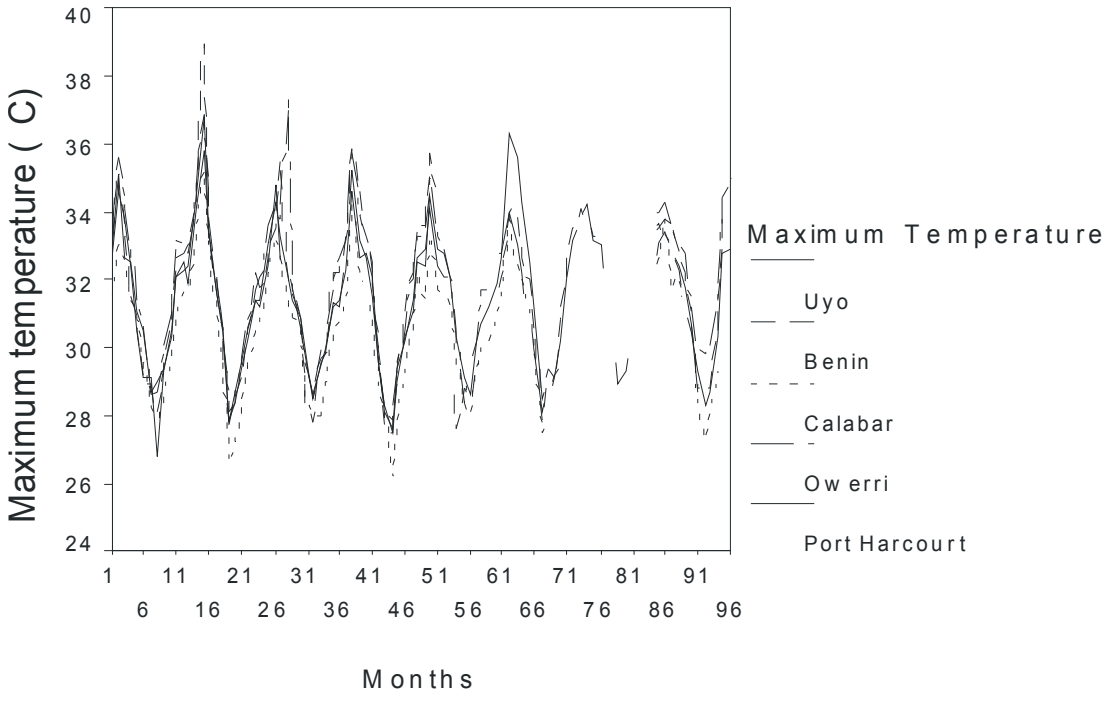

Fig 2b: Same as 2a but for maximum temperature

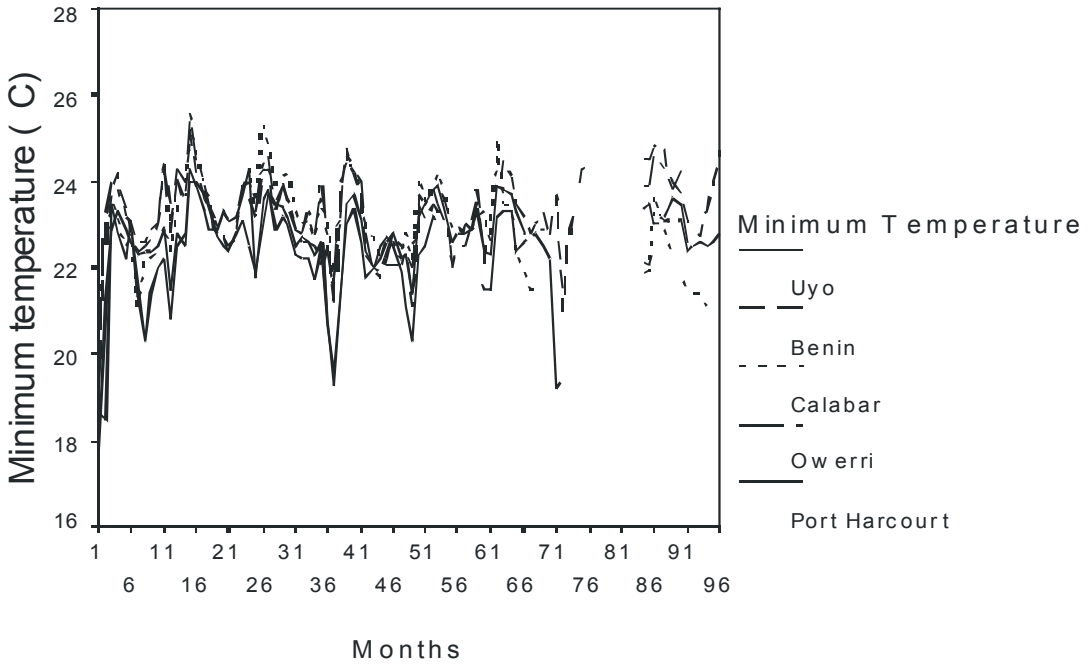

Fig. 2c: Same as 2a but for minimum temperature

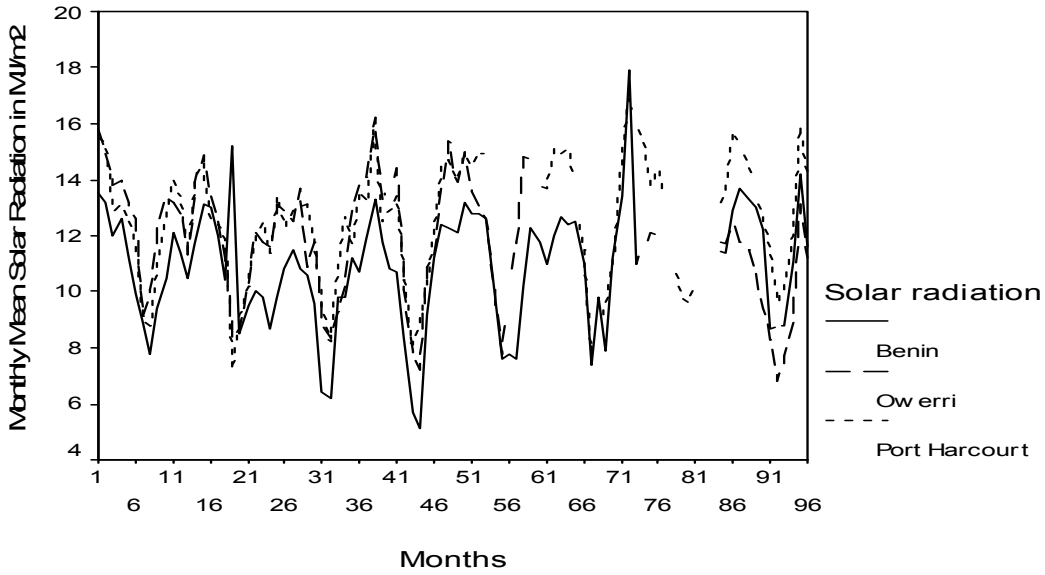

Fig. 2d: Same as 2a but for solar radiation

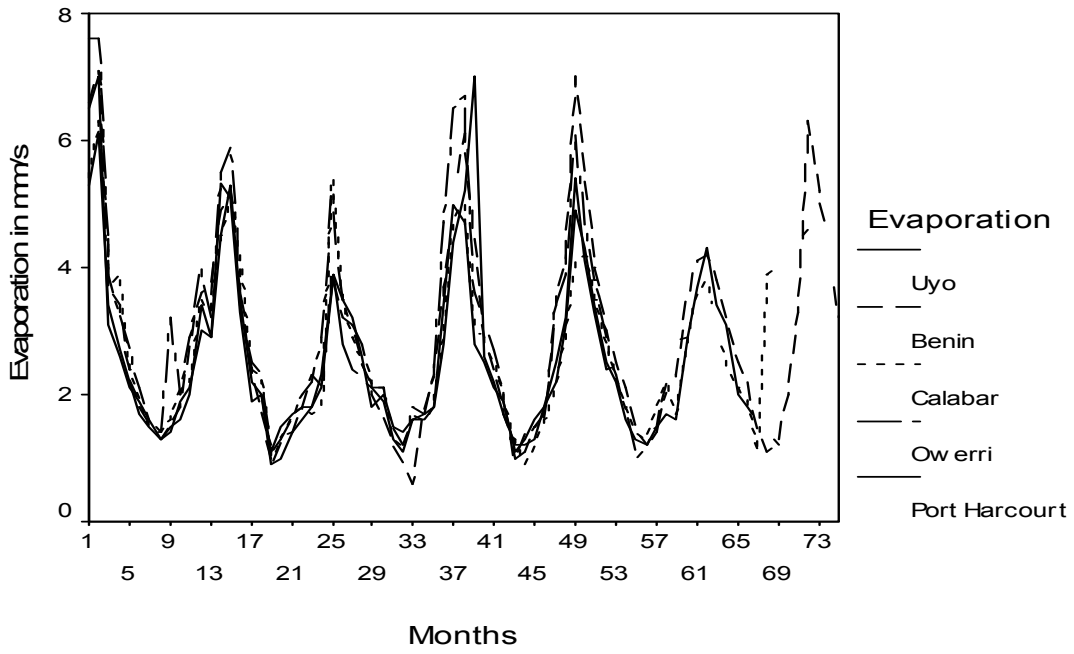

Fig. 2e: Same as 2a but for rate of evaporation

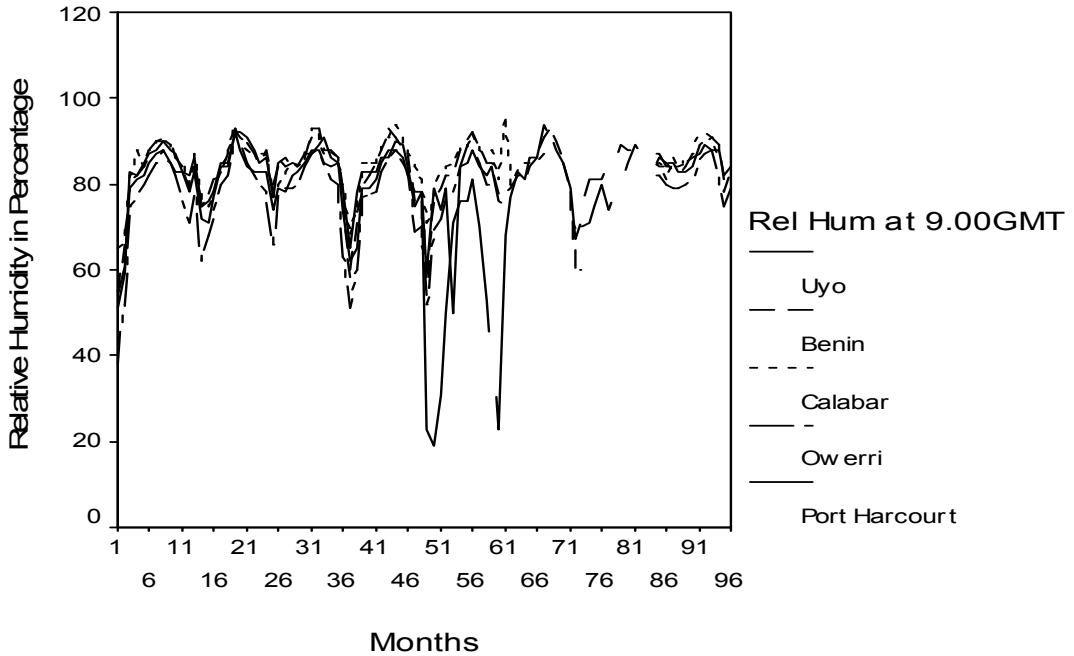

Fig. 2f: Same as 2a but for relative humidity at 9.00 hours GMT

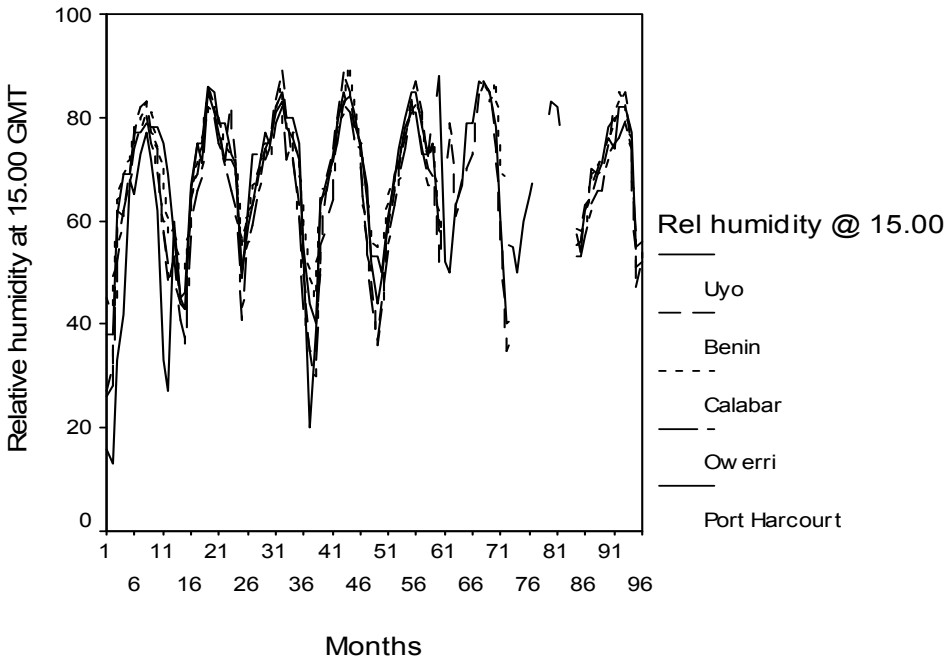

Fig. 2g: Same as 2a but for relative humidity at 15.00 hours GMT

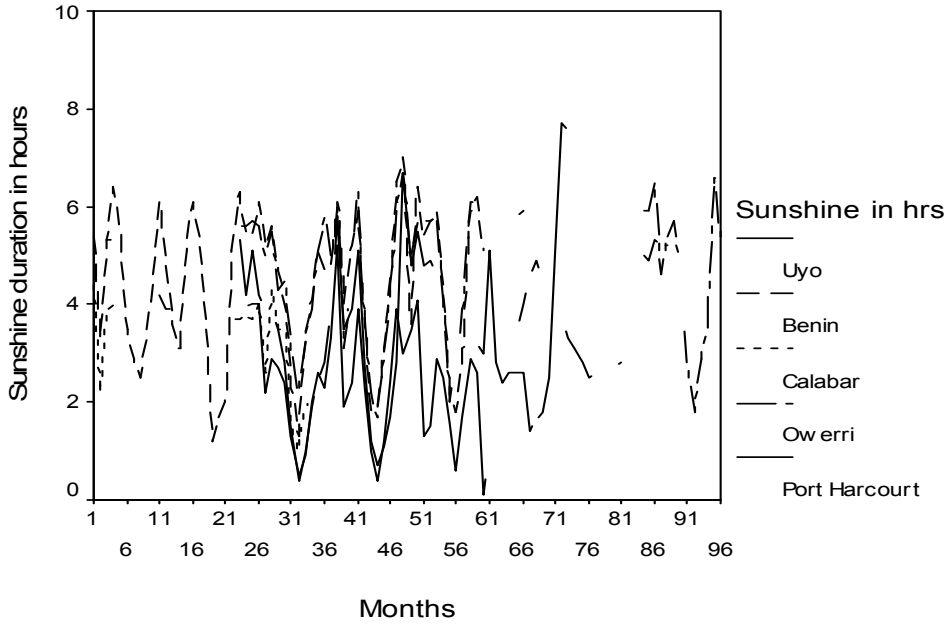

Fig. 2h: Same as 2a but for hours of bright sunshine

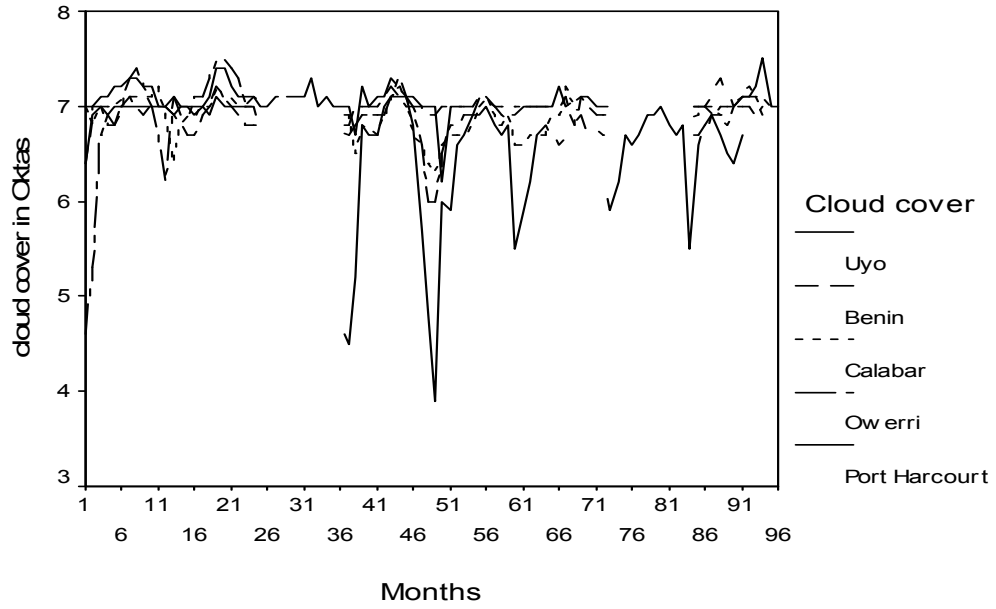

Fig. 2i: Same as 2a but for total cloud cover

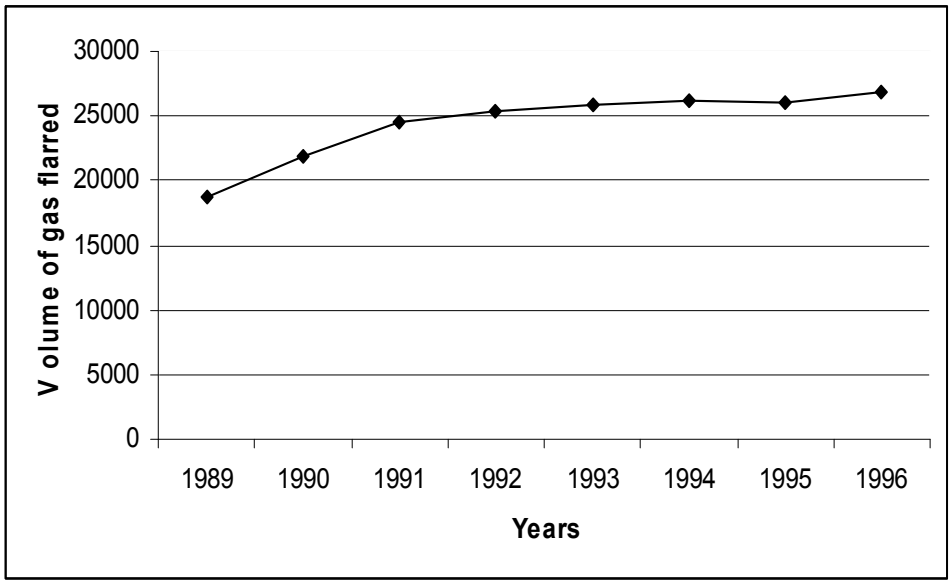

Fig.3: Composite for volume of gas flared.

4.2 **Average values**

Table 1 shows that the highest total monthly rainfall occurs in years with highest annual total rainfall for each location. This normally occurs in the months of June or July of every year. It follows then that for a particular year, the volume of rainfall in the months of June and July can be used to predict the total volume of rainfall in that year. Table 1 also shows that Calabar has the highest monthly total rainfall in the region which also has the highest annual total rainfall, while Port Harcourt maintains consistent lower values of rainfall in the region. Incidentally, this is the largest city in the region serving as the regional headquarters, with very high economic and industrial activities in the region. The city also witnesses the highest gas flaring activities in the world. The heat from the flares normally dispensed high up in the sky is capable of slowing down condensation processes which invariably reduces the total amount of rainfall.

Though rainfall and temperature values are relatively high in Calabar, evaporation rate seems to be low on the contrary. This agrees with Ewona and Udo (2008) that the climate of Calabar depends on more factors than is generally conceived. On the other hand, relative humidity values are consistent with the high rain regime of the area which are principally due to its proximity to the Atlantic Ocean. Annual total rainfall in the region seems to be decreasing and this conforms to global predictions.

Table 1: Summary of Monthly Mean Values of Meteorological Parameters in the Niger Delta Area: H= Highest, L =Lowest Values

LOCATION	Lat	Long	Rain H	Rain Av.	MaxT	MinT	Rad H	Rad L	Eva H	Eva L
UYO	5º 00'	7º 50'	560 Jul	234.5	36.8 Fe/Mc	18.5 Feb	N/A	N/A	7.0 Mar	1.1 Jul
BENIN	6º 20'	5º 37'	656 Jul	2608.17	35.9f-Mar	21.1 Jan	15.2 Jul	5.1 Aug	7.1 Feb	0.6 Sep
CAL	4º 55'	8º 20'	704 Jul	2821.94	35.2 Mar	20.5 Jan	N/A	N/A	6.3 Feb	0.6 Aug
OWERRI	5º 30'	7º 02'	650 Jul	2393.28	37.3 Ap	19.2 Jan	15.8 Jan	6.8 Aug	7.6 Jan/Feb	1.0 Jul
P/HARCRT	4º 45'	7º 00'	578 Jun	2012.8	35.8 Mar	17.7 Jan	16.9 Dec	7.9 Jul	7.0 Jan	1.0 Aug

LOCATION	Lat	Long	Hum9 H	Hum9 L	Hum15 H	Hum15 L	Sush H	Sush L	Cloud H	Cloud L
UYO	5º 00'	7º 50'	89 Jul	62 Jan	85 Jul	38 Jan	5.2 Feb	0.1 Dec	7.1 Jul	3.7 Jan
BENIN	6º 20'	5º 37'	93 Jul	55jan	89 Sep	27.0 Jan	7. Dec	0.2 Jul	7.2 Jul	6.4 Jan
CAL	4º 55'	8º 20'	94 Aug	65jan	90 Sep	13. Mar	9.5 Feb	1. Sep	7.2 Jul	6.3 Jan
OWERRI	5º 30'	7º 02'	89 Aug	38.Jan	83 Jul	21. Mar	6.7 Dec	1.7 Sep	7.5 Jul	4.6 Jan
P/HARCRT	4º 45'	7º 00'	92 Jul	19.Feb	87 Jul	13. Mar	7.7 Dec	1. Sep	7.4 Jul	6.2 Feb

4.3 Correlation of meteorological parameters between locations

Table 2: Summary of correlation values for similar parameters.

Parameter	Range of correlation coeficient
Monthly mean daily rainfall total	0.643 to 0.857
Monthly mean daily maximum temperature	between 0.461 and 0.976
Monthly mean daily minimum temperature	0.618-0.937
Monthly mean daily solar radiation	0.630-0.816
Monthly mean daily relative humidity @ 9.00GMT	0.537-0.962
Monthly mean daily relative humidity @ 15.00GMT	0.769-0.979
Monthly mean daily evaporation rate	0.880-0.972
Monthly mean daily sunshine duration	0.661-0.947
Monthly mean daily cloud cover	0.122-0.684

The correlation values shown in table2 are generally high except for cloud cover which depends more on local conditions like convectional air currents. These results tend to support the prevalence of convective cloudiness in this region earlier referred to in the study. We note that the climate in the region is affected by similar factors. For instance, rainfall in this region is the highest in the country even though these locations are not the only coastal-low latitude locations in the Country. Such high rainfall values have been attributed to the Adamawa relief which directly confront the warm moist air coming from the Atlantic Ocean towards the hinterland. Calabar in particular has the highest rainfall in Nigeria perhaps due to the additional influence of the Cameroon mountain ranges to which Obudu cattle ranch belongs.

5.0 CONCLUSION

The results of these studies show that variation in the climate of the Niger delta region depends principally on the environmental changes in the region more than it is affected by external forcing. Changes in the climatic factors in the region are not unconnected with major environmental changes in the vegetation, aerosol concentration in the air and general pollution caused by increased industrial activities and oil exploitation and gas flaring in particular as shown in figure 3. The low values of rainfall in Port Harcourt were gas flaring seems to be highest of the five locations point to the possible effect of pollution and environmental degradation on some meteorological parameters. Similarly, increasing rainfall regime in Calabar may be affected in part by wide spread tree and grass planting on lawns, walkways and roads in the urban city.

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