NIGERIA AMMA UNIVERSITY OF CALABAR

CLIMATE CHANGE, INTERANNUAL AND INTERSEASONAL VARIATIONS OF TEMPERATURE, HUMIDITY AND RAINFALL DYNAMICS IN SOUTHEAST NIGERIA

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4TH AMMA INTERNATIONAL CONFERENCE, 2 – 6 JULY 2012
TOULOUSE, FRANCE

INTRODUCTION

- **The relationship between climate change and weather elements such as temperature, humidity and rainfall is of utmost importance especially, when considering the fact that slight perturbations in climate can cause incredible changes in these weather elements.**
- **The IPCC Fourth Assessment report (AR4, 2007) had predicted that at a confidence level >90%, there will be more frequent warm spells, heat waves and heavy rainfall especially in the tropical humid environments.**
- **West African monsoon (besides the Asian/Australian monsoon) is a seasonal phenomenon with devastating impacts especially during the peak months (June-September, November-January) ranging from thunderstorms, coastal flooding, desertification, removal of rooftops by strong winds, destruction of economic trees, destruction of human lives, disruption of agricultural activities such as fishing and farming, landslides, intense gully erosion etc.**
- **Recent studies in Nigeria have shown that the extent of relationship between seasonal changes and agronomy (Sowunmi & Akintola , 2010; weather elements and climate change (Odjugo, 2010) and potential/ predicted changes in climatic conditions are alarming(IPCC ,1997; Ahmad & Ahmed, 2000; IPCC, 2001; NEST, 2003; Hengeveld *et al.*,2005; Odjugo, 2010) and remarkably consequential.**

METHODOLOGY

Study Area: Calabar is a coastal city in Nigeria with a population of about 500,000 and more located at Latitude 4° 59' 36" N and Longitude 8° 19' 05" E. Unlike other coastal cities (Lagos, Warri, Bonny, Port Harcourt etc), Calabar lies close to the Cameroon mountain in the east and is markedly influenced by the monsoonal climate reversals.

Data Collection/Analysis

Monthly data on rainfall, air temperature, humidity and wind in Calabar were obtained from the Nigerian Meteorological Agency (NIMET), Calabar and the Geography Department (Yearly Weather Report), University of Calabar, Nigeria. The collected data covered 2002- 2010 period. Mean monthly data were computed for the climatic factors (humidity, rainfall , temperature and wind). Statistical analyses were done to establish the inter-annual and inter-seasonal trends, the strength of the linear relationship between the variables and to develop time series models for the area.

Fig. 1: Map of Nigeria showing Calabar, the study area

RESULTS/ FINDINGS

The mean values of rainfall, humidity and temperature for the period 2002-2010 are presented in Table below. Values ranged from 3830 to 7320mm per month (rainfall), 81.83 t0 85.42 % (humidity) and 25.98 – 27.45 oC (temperature) respectively.

Table 1 : Minimum, Maximum, Mean and standard Deviation for Rainfall, Humidity and Temperature in Calabar, Nigeria

	Rainfall (mm)				Humidity(%)				Temperature(°C)			
Year	Min	Max	Mean	stdev	Min	Max	Mean	stdev	Min	Max	Mean	stdev
2002	0.0	23.60	7.32	6.47	80.0	90.0	83.25	3.52	20.80	29.0	26.72	2.19
2003	1.0	15.10	5.83	4.907	79.0	90.0	84.0	3.44	26.60	29.60	27.45	0.83
2004	0.10	9.10	4.73	3.34	83.0	90.0	85.42	2.27	25.50	29.70	27.45	1.28
2005	1.0	15.30	6.92	4.46	72.0	90.0	82.75	4.63	25.10	29.10	26.85	1.04
2006	0.0	24.50	8.12	6.30	82.0	88.0	84.17	1.70	24.00	28.90	25.98	1.38
2007	0.0	11.20	6.64	3.20	76.0	93.0	84.50	5.0	24.70	28.90	26.06	1.28
2008	0.0	8.80	5.27	2.97	81.0	87.0	83.17	1.47	25.20	30.10	27.18	1.55
2009	0.0	10.40	3.83	3.43	79.0	84.0	81.83	1.27	23.30	28.10	26.65	1.41
2010	0.0	24.50	6.06	4.41	79.0	84.0	81.83	1.40	24.50	29.80	26.76	1.57

Rainfall (mm) = Value x 100

RESULTS SUMMARY

Results showed that:

- **There was increased frequency in the falling of rain accompanied by devastating effects (storms and flooding) during the period.**
- **The mean annual rainfall in Calabar increased from 4000mm/yr (Nigeria Climate,2004)) to 6060mm/yr in this study. Distribution is high (2002) and low (2010), mostly unimodal.**
- **The mean annual relative humidity is high (> 80%) and is responsible for dryness and heat felt in the region , even at night time. Distribution is irregular pattern**
- **The mean annual temperature appears to be stable probably mediated by the occurrences of frequent rains.**
- **Low but significant correlations existed between RF/H, r= 0.353, P < 0.01 ; RF/T, r= - 0.348, P < 0.01 and H/T, r = -0.192, P < 0.05. Indicates the influence of external factor (climate change).**
- **Average Wind speed /intensity occurred between 0.35 – 0.50m/s at the hinterland but approaches 1.2m/s and more during periods of thunder storms.**
- **Wind rose diagrams describing wind percentage frequency distribution were dominantly NW and SW contrary to the conventional North easterly and Southwesterly winds.**

RAINFALL DISTRIBUTION 2002-2010

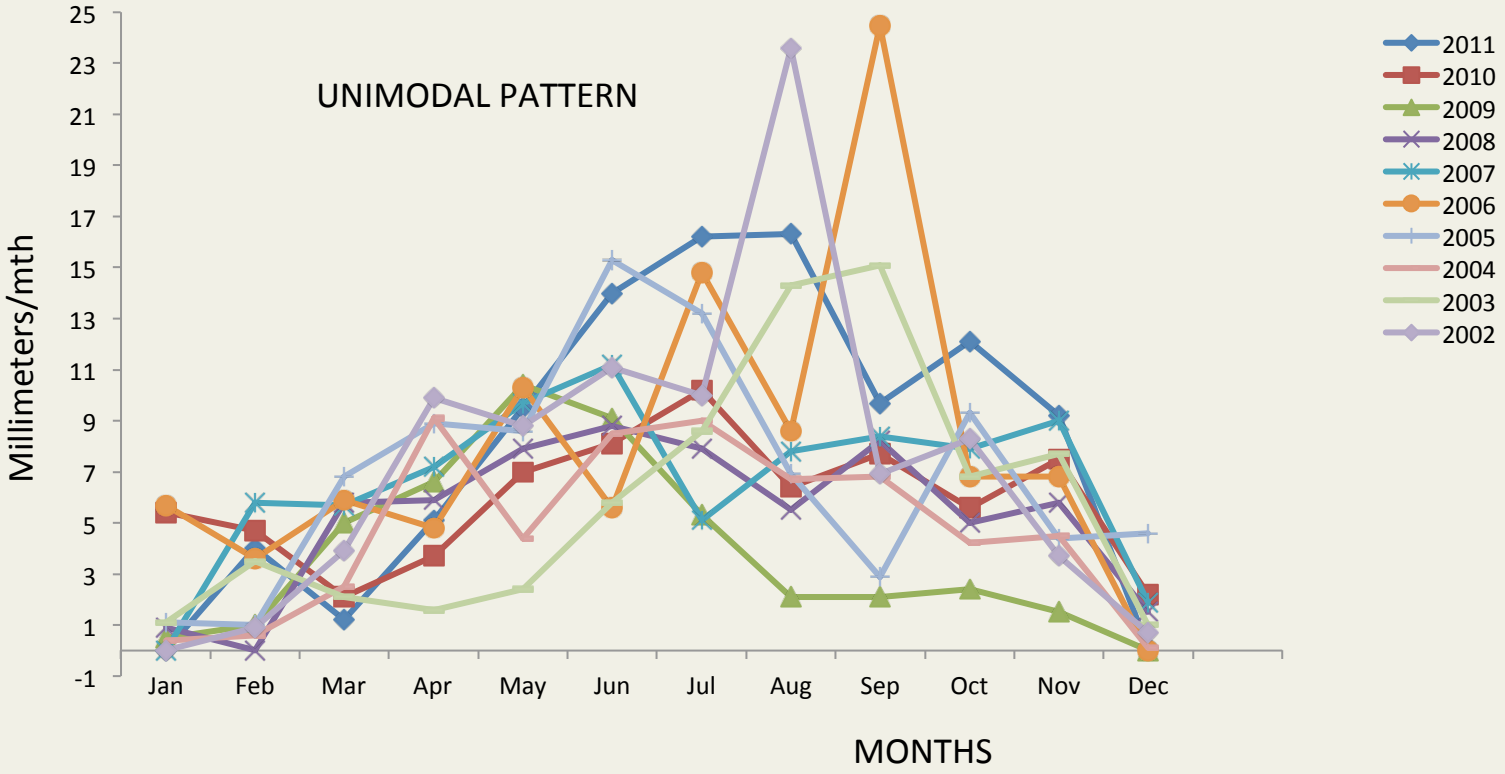

Fig. 2 : SEASONAL RAINFALL DISTRIBUTION IN CALABAR ,2002-2010

RELATIVE HUMIDITY DISTRIBUTION 2002-2010

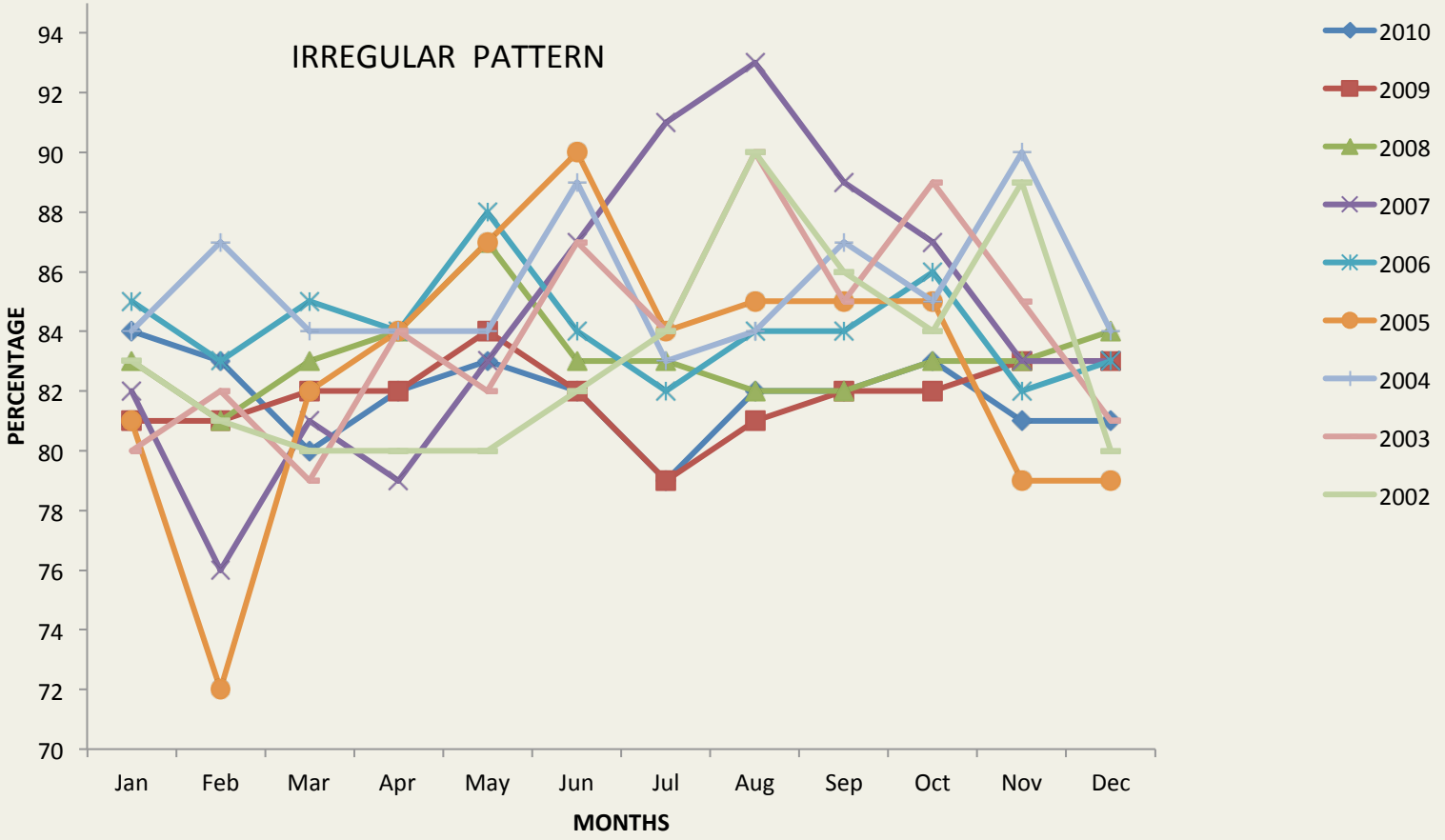

Fig. 3 : SEASONAL RELATIVE HUMIDITY DISTRIBUTION IN CALBAR ,2002-2010

AIR TEMPERATURE DISTRIBUTION 2002-2010

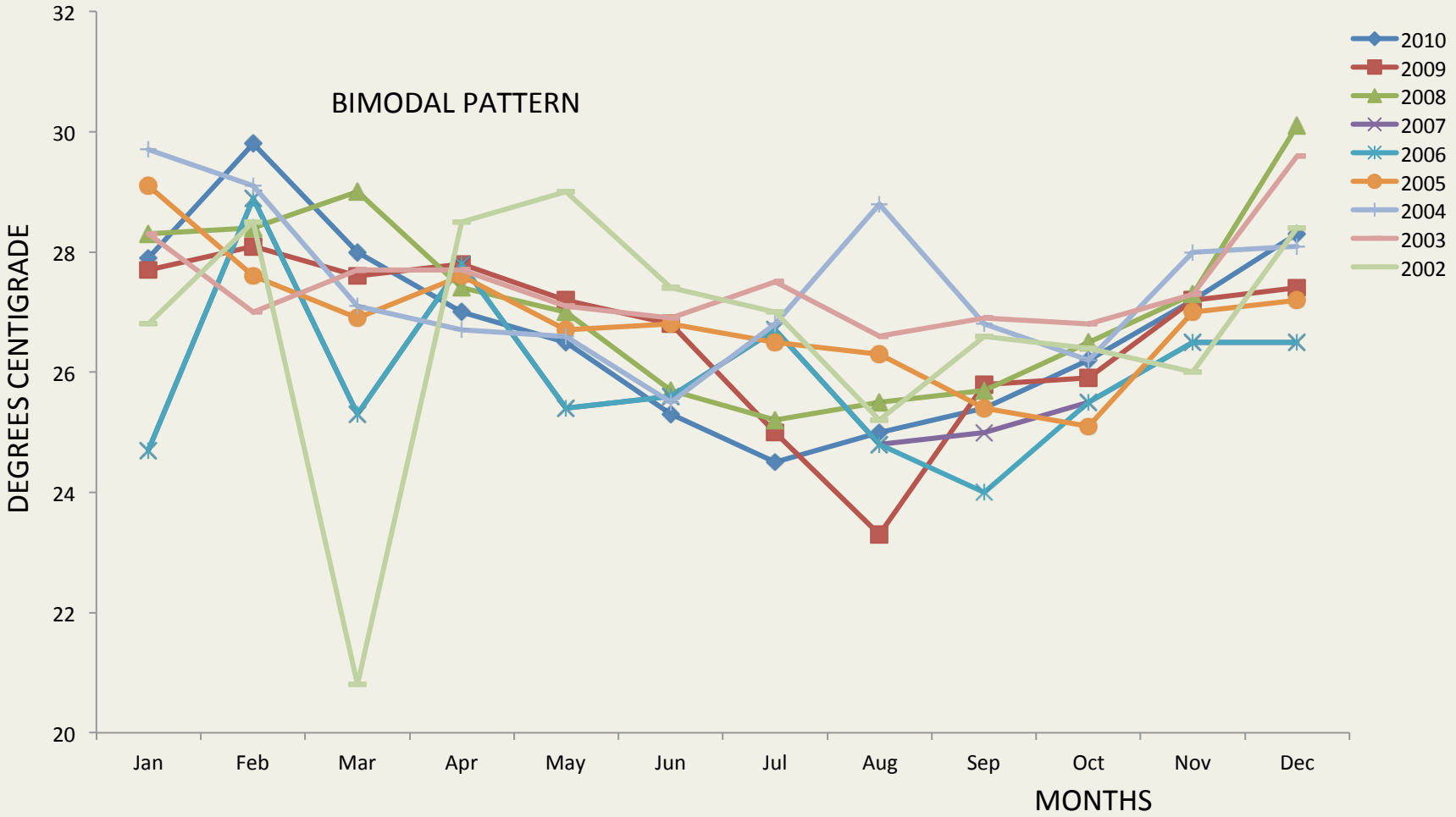

Fig. 4: SEASONAL TEMPERATURE DISTRIBUTION IN CALBAR ,2002-2010

TIME SERIES MODELS FOR CLIMATIC FACTORS

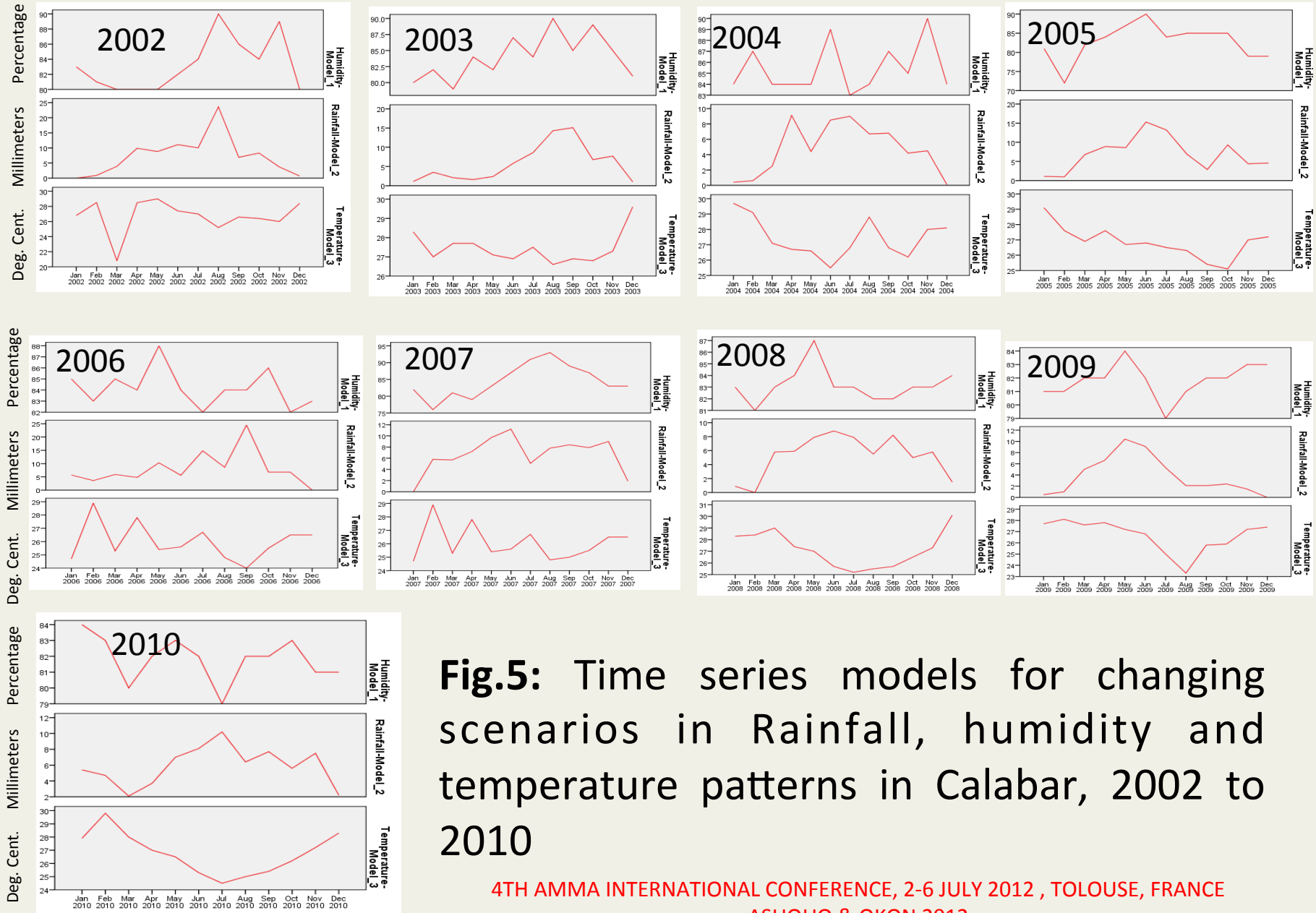

Fig.5: Time series models for changing scenarios in Rainfall, humidity and temperature patterns in Calabar, 2002 to 2010

ACCUMULATED TIME SERIES MODEL: 2002-2010

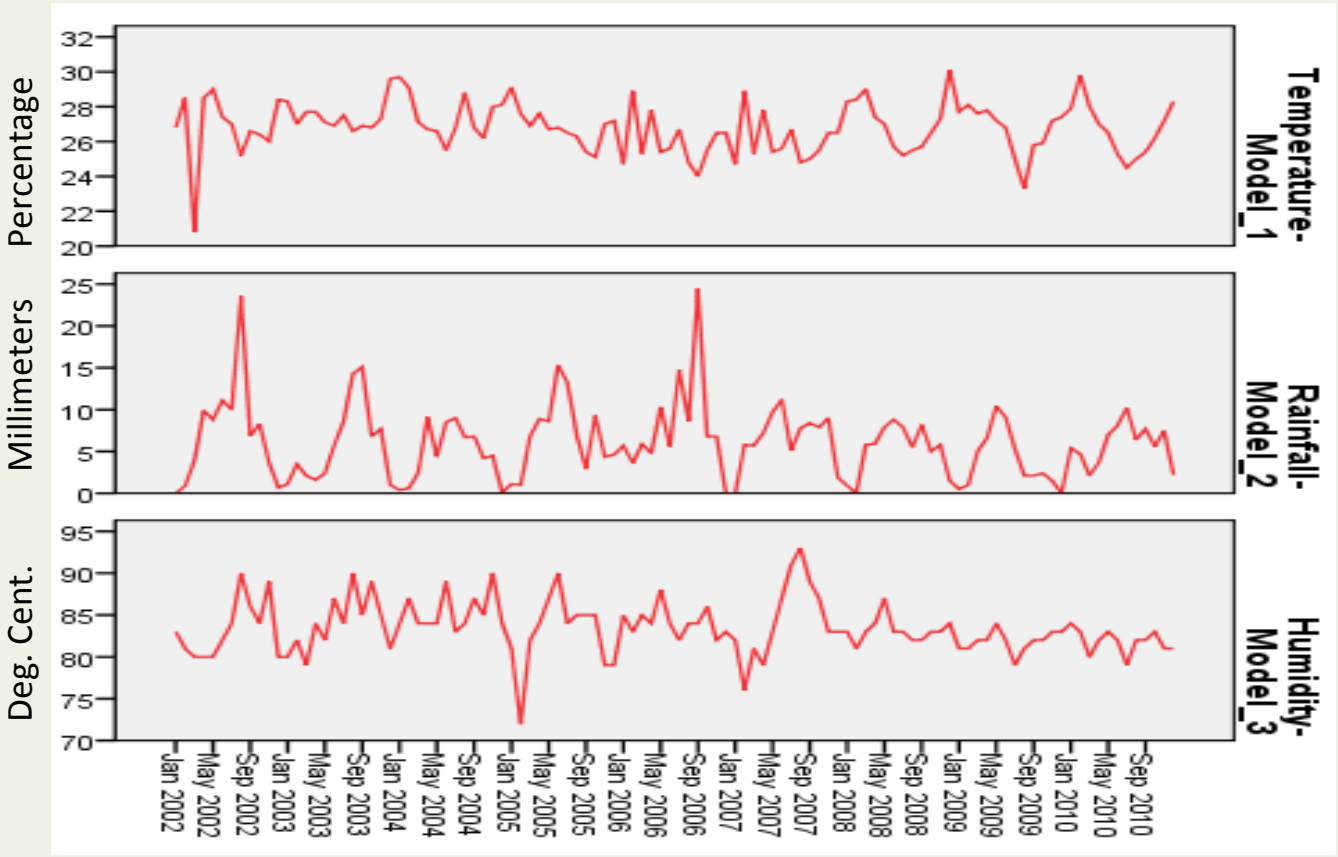

Fig. Time Series analysis of Temperature, rainfall and Humidity between 2002 to 2010 in Calabar , Nigeria

ACCUMULATED TIME SERIES MODEL STATISTICAL DATA: 2002-2010

- Rainfall was dominantly unimodal-2002,2003, 2005, 2006, 2009 years but bimodal- 2004, 2007 and 2008;
- Temperature dominantly bimodal -2002, 2003, 2004, 2006,and 2007 years except 2005, 2008, 2009 and 2010 were unimodal.
- Humidity had no regular pattern

Table 2: Pearson Correlations between Rainfall, Humidity and Temperature for the period 2002 - 2010

PARAMETER		TEMPERATURE	RAINFALL	HUMIDITY
Temperature	Pearson Correlation	1	-.348**	-.192*
	Sig. (2-tailed)		.000	.046
	N	108	108	108
Rainfall	Pearson Correlation	-.348**	1	.353**
	Sig. (2-tailed)	.000		.000
	N	108	108	108
Humidity	Pearson Correlation	-.192*	.353**	1
	Sig. (2-tailed)	.046	.000	
	N	108	108	108

**** Correlations significant at 0.01 level, * Correlation significant at 0.05 level**

WIND DIRECTION & DISTRIBUTION BETWEEN 2002 2010

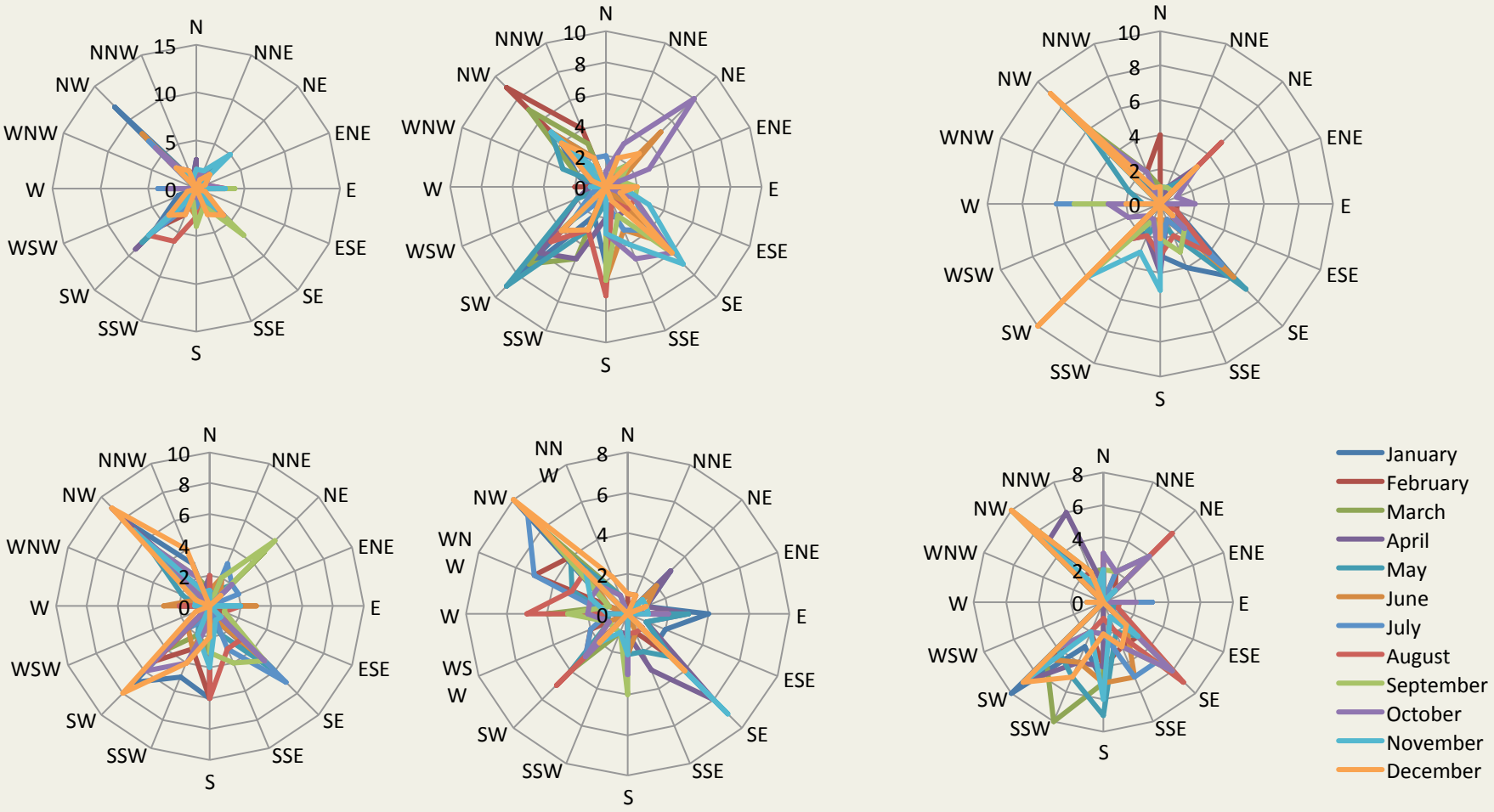

Fig. 6:WIND ROSE SHOWING % FREQUENCY DISTRIBUTION OF WIND DIRCTION IN CALBAR 02-2010

DISCUSSION

- **Calabars' climate is affected immensely by the great seasonal reversing winds of tropical maritime airmass blowing from the Atlantic ocean and interacting with the tropical continental airmass (harmattan winds) from the Sahara.**
- **The variability in climate is observed to influence the inter-seasonal occurrences of weather elements thereby contributing markedly to disruption of marine ecosystems dynamics, with significant impacts on fish-dependent human coastal communities and increased levels of flooding, accelerated erosion, loss of wetlands and mangroves, and seawater intrusion into freshwater sources (Simire, 2011).**
- **This has brought a shift in ITCZ resulting in increased frequency of rainfall, accompanied by devastating effects (storms and flooding) during the period.**
- **The changing pattern in rainfall, high relative humidity (> 80%) , annual temperature and wind percentage frequency distribution are remarkable and are attributed to climate change effects in the region.**

IMPLICATIONS TO AGRICULTURE AND WATER MANAGEMENT SCHEMES IN SOUTHERN NIGERIA

- An increase in rainfall in the southern region such as Calabar, accompanied by high inter-annual variability, could be detrimental to the hydrological balance of the region and disrupts various human dependent socioeconomic activities such as fishing activities due to increase in water level, migration of brackish fish species towards the coastal marine areas, deterioration in water quality, flooding of coastal farmlands and settlements among others.
- Climate variability could render the management of water resources more difficult within the coastal states since an increase in water table (aquifer over-recharge) could result in the collapse of coastal structures and may adversely affect the water quality by increasing the concentrations of pollutants brought in through inundation/ seepage of sewage and industrial effluents and the overflow of waste and burrow pits which are often used as dumpsites for both domestic and industrial waste in the absence of engineered landfill sites (Asuquo, 2011).
- Could lead to increased in the recurrence of water borne diseases such as typhoid fever, hepatitis, cholera and dysentery especially in rural areas.
- Adaptation options may include water harvesting and efficient water management and water usage schemes(IPCC (1997).

CONCLUSION/RECOMMENDATION

- Climate variability presently reported has affected the inter-annual and inter-seasonal distribution of rainfall, humidity, temperature and wind distribution in Nigeria. There is the need for proper planning and design of water resources development schemes in Nigeria and particularly along the coastal cities of West African sub-region.
- Since the drivers of seasonal and annual changes are mostly natural, establishment of well equipped weather monitoring stations will complement the efforts of existing Meteorological Stations eg NIMET, especially in the tropical humid zones.
- Continuous monitoring of climatic factors is inevitable for ground-truthing information and data generated by satellite imagery systems.
- Special Funding of result–oriented researches is paramount for research Institutes in the region particularly targeted for the monitoring of the West African Monsoon (WAM) system which will facilitate acquisition of data urgently needed for policy formulation in West and Central Africa.

ACKNOWLEDGEMENTS

I greatly acknowledge the role and assistance by the following individuals:

- Arona DIEDHIOU – France
- Jennifer Chika MBAMA – Nigeria
- Régine DARROS – Meteo France
- Jean-Philippe LAFORE – Meteo France
- Prof. James EPOKE – Vice Chancellor, University of Calabar, NIGERIA
- AMMA Organizing Committee/ Conference Secretariat

THANK YOU

FOR LISTENING