PERCEPTION OF CLIMATE CHANGE AND IMPLICATIONS ON THE LIVELIHOOD OF THE PEOPLE OF LAVUN- SOUTH (DOKO AREA) IN LAVUN LOCAL GOVERNMENT AREA OF NIGER STATE, NIGERIA

Salawu **Ezekiel**[1], Mohammed Ahmed **Emigilati**[2], Solomon Ndace **Jiya**[3], Ishaku **Ibrahim**[4]

[1]Department of Geography, Federal University of Technology, Minna, Niger State, Nigeria Email: salawuezekiel74@yahoo.com
[2]Department of Geography, Federal University of Technology, Minna, Niger State, Nigeria
[3]Department of Geography, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria
[4]Center for Preliminary and Extra-moral Studies, Federal University of Technology, Minna, Niger State, Nigeria

Abstract
This study is basically aimed at assessing the public perception of climate change among the people of Lavun-South of Lavun Local Government Area. Temperature and rainfall data covering 30 years were used and (1010) one thousand and ten questionnaires (QS) distributed in various villages within the study area. Results show that there is an increasing trend in temperature and rainfall with a shift in onset and cessation patterns which has reduced its intensity. The changes in various climatic variables and their impacts on agricultural production have made the people of Lavun-South to be aware of the phenomenon (climate change). Mean annual maximum temperatures of Lavun-South were computed for thirty years. It is revealed that temperature in (1992-2002) has the higher shift from the mean than in between (1982-1991 and 2002-2011), the mean value shows progressive increase from 33.60C to 34.10C (increase of 0.50C). The mean annual rainfall computed for fourteen years reveals that rainfall is above the mean value. In response to climatic changes, the inhabitants are less aware of the reality and its deep consequences. They are still superstitious about climate and the environmental changes. The study recommends there should be a comprehensive enlightenment strategy to raise awareness of climate change impacts and commence aggressively implementation of key adaptation strategies; forecasts and early warnings on weather variables by the Nigerian Meteorological Agency (NIMET) or other related agencies should be well communicated and made available to the rural areas of Nigeria.

1.0 Introduction

Climate is the average temperature, precipitation and wind over a long period of time. Climate change is widely agreed to be a reality (Kurukulasuriya and Rosenthal, 2003) and the world community faces many risks from it (Twomlow *et al*, 2008); as the inevitable changes in climate patterns the world is facing will undermine the services ecosystems provide; thereby threatening peoples' livelihoods (IUCN, 2008). It has emerged as one of the most crucial environmental challenges of the 21st century (Bizikova, and Burton 2008). Climate change poses a real threat to the developing world. If unchecked, it will become a major obstacle to continued poverty reduction (USAID, 2007). Climate change refers to shifts in the mean state of the climate or in its variability, persisting for an extended period i.e. decades or longer (USAID, 1991). Climate variability refers to variations in the mean state of climate on all temporal and spatial scales beyond that of individual weather events (USAID, 1991).

According to IPCC (2007), "climate change is an issue for sustainable development mainly as one of many sources of possible stress. Its significance lies primarily in its interactions with other stresses and stress-related thresholds, such as population growth and redistribution, social and political instability, poverty and inequity. Most human activities and societies can adapt to given information, time and resources about climate change, this suggests that, actions which moderate the rate of climate change are likely to reduce the negative effects of climate change on sustainable development (Wilbanks, 2003). Rebetez (1996) was of the opinion that climate change cannot be perceived directly by individuals because of the temporal scales associated with it. In addition, human perception of climate is strongly influenced by expectations, which may have little relationship to the true nature of climate as provided by the instrumental record (Rebetez, 1996). Some recent studies give evidence that public perception of climate change may also be affected by different cultures. For instance, according to The American Experience (2008), US-Americans, a moderate perception of climate change is a risk while British people are rather concerned about the same issue. In contrast, Semenza *et al.* (1996) found out that almost all respondents (USA) have heard about climate change or global warming, are rather concerned (women more than men) and some 50% reported behaviour changes like decreased energy usage at home, reduced gasoline consumption, increased recycling and some other behaviors.

Assessing the impacts of and vulnerability to climate change and subsequently working out adaptation needs requires good quality information. This information includes climate data, such as temperature, rainfall and the frequency of extreme events, and non-climatic data, such as the current situation on the ground for different sectors including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity, and coastal zones (UNFCCC, 2007). Several web-based movements that link energy-conscious individuals with others in their community are highly needed which have sprung up in recent years to bring concrete awareness to the rural dwellers for a rightful perception on climate change in USA which is expected to be adapted to by other countries (Wikipedia, 2010). According to the report, there has been a surge in published social science papers looking into the U.S. public's perception of climate change. The report also said that, climate researchers are eager for social scientists to tell them what they know about human perception, their behavior and why a majority of Africans and Americans are not taking action that could significantly reduce their own carbon footprint.

The objectives of the study were:

1. To assess people's perceptions on the phenomena of climate change.
2. To assess the level of climate change awareness of people of Lavun south (Doko area).
3. To analyze some climatic data trend in order to ascertain the reality of the phenomenon (climate change) on the study area.
4. To proffer possible means for awareness and possible solutions to the impacts of climate change on the people of Lavun local government.

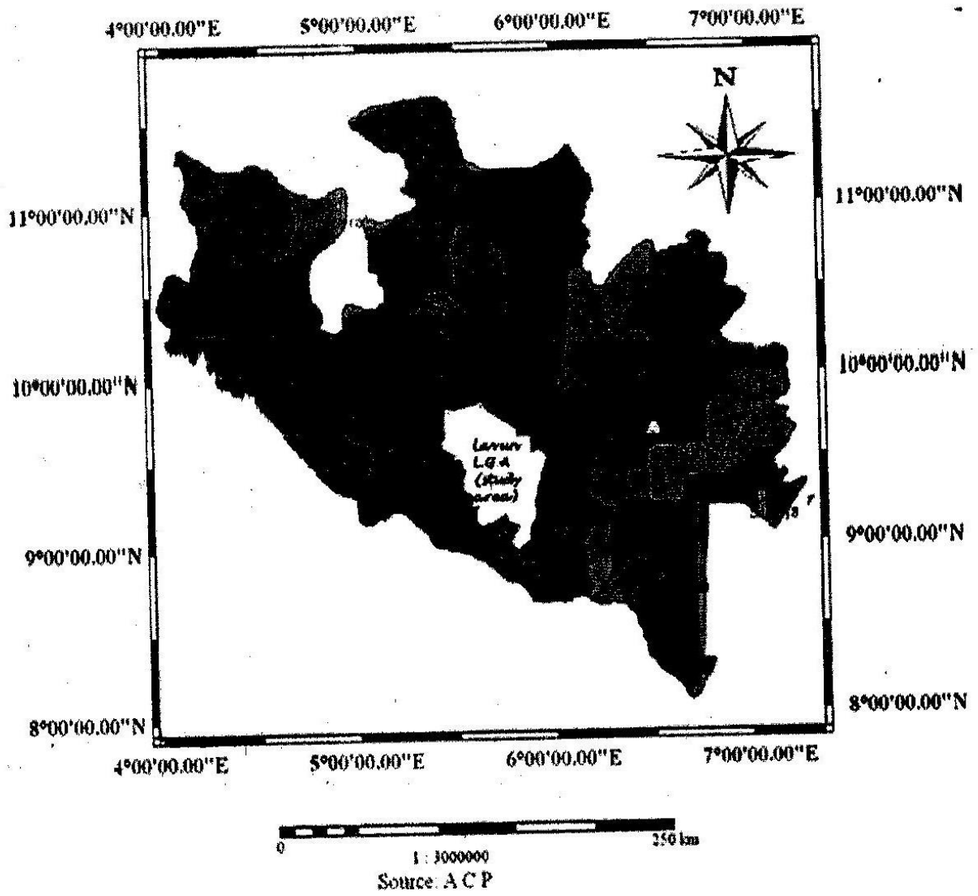

Fig. 1. Map of Niger state showing the study area. Source: Niger State Ministry of Land Survey (2012)

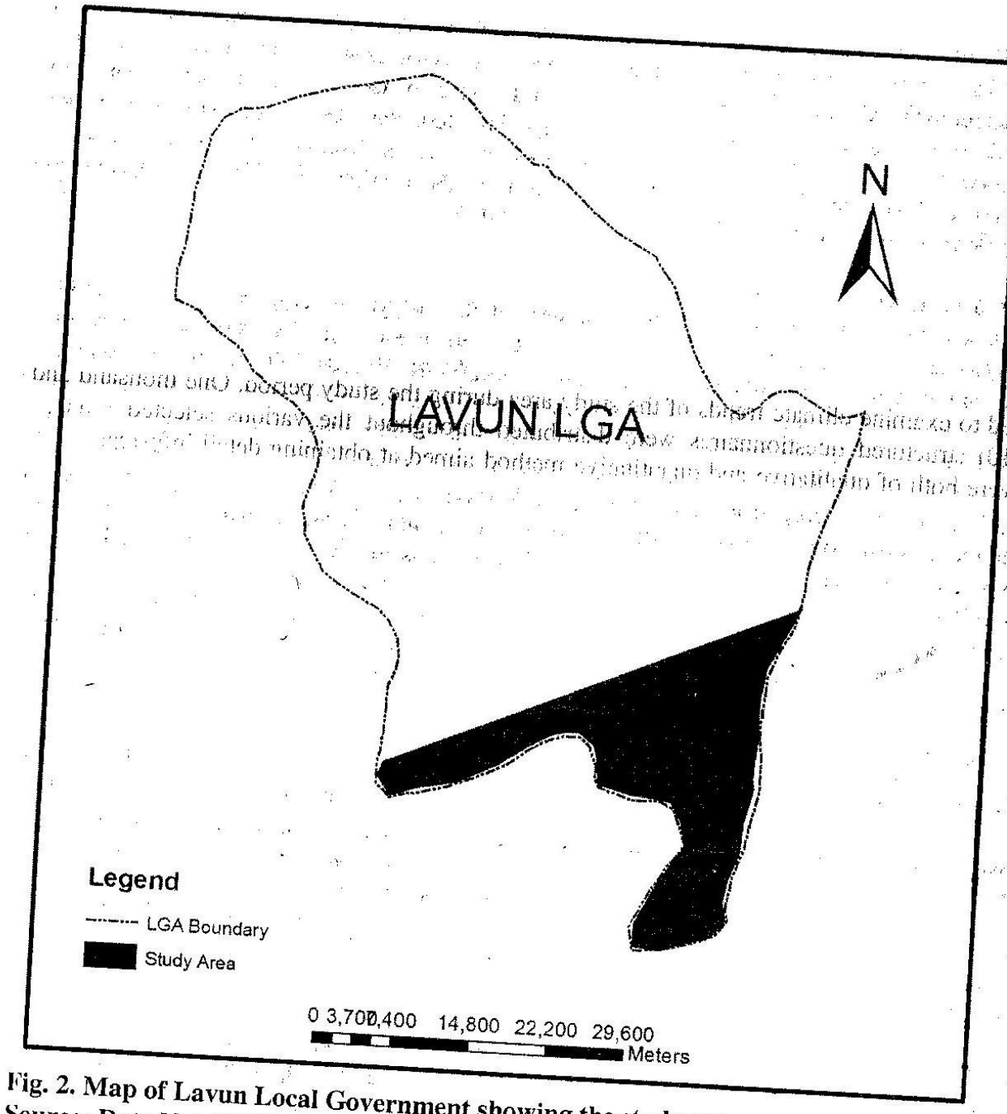

Fig. 2. Map of Lavun Local Government showing the study area. Source: Data Net (2012).

2.0 Description of the study area

Lavun-south (Doko area) is situated in the middle belt of Nigeria. It is the main zone of Nupe Benins (the main origins of Nupe speaking language with Doko as the headquarters). The study area is located between latitude 9°.04'-9°.11'N and longitude 5°.93'-6°.02'E. The annual rainfall amount has been estimate to be between 1,120mm-1,300mm. Raining season begins mostly in March and ends early October but peaks by August-September. There exist long hours of sun shine with high radiative power across the study area. The mean monthly temperature is highest in March above 30.1°c and lowest in August at 25.5°c. The relative humidity ranges from70 to110 depending on the amount of rainfall per year (National Cereal Institute, Baddegi, 2012). Lavun-

south falls within the guinea savannah which is the transitional zone between the rain forest in south and savannah in the north, but much of the characteristic of guinea savannah than of the rain forest. The study area is much cover by wood land and grasses of various species ranging from the height of 8cm to 1m. The soil is undulating rolling dissected plain, developed on undifferential basement complex consisting of mainly granite rock, gneisses and schist. The surface soil are loamy-sand, alluvial deposit and sand store. The sub-top soils consist of laterite at the upper part of the study area (Niger State Ministry of Agriculture, 1982).

3.0 Materials and Methods

Climate data (specifically rainfall and temperature) of the study area acquired over a period of thirty (30) years was utilized. The acquired data sets were mean annual maximum temperatures and total annual rainfall for all the years acquired from NCRI, Baddegi. These climate data sets were used to examine climate trends of the study area during the study period. One thousand and ten (1010) structured questionnaires were distributed throughout the various selected villages which were both of qualitative and quantitative method aimed at obtaining detail information on personality, concepts, perceptions, ideas and suggestions of an individual for better qualitative and quantitative information. It was used to examine the actual climatic changes and variations perceived and experienced (witnessed) in the locality, various impacts these changes had on their livelihood, and the adaptation measures put in place. The respondents were given enough time to freely go through the questionnaire and treat it rightly. It was distributed regardless of sex, age background and social status so as to have much detail information. Politically Lavun-south is divided into three subzones and each was well represented.

4.0 Results and Discussion

Rainfall and temperature were the two climatic elements chosen for this study due to the fact that they are the most variable and fastest changing climatic elements which do influence other elements. They also do have greater impacts on human settlements and human activities both directly and indirectly than other elements in terms of development, health and agriculture. From the questionnaire distributed and received and the discussion had with some professionals coupled with the field studies, all the respondents and resource persons clearly testified that these two elements are variable and unpredictably changing with the effect of their changes so high on the agricultural production, especially in recent years.

Tables 1 and 2 show the mean annual rainfall amount and deviations from the mean in Doko area computed for a period of thirty years. The deviations were computed by subtracting the thirty year mean of 1181.3mm from the mean rainfall amount recorded in each year. These figures show that within the thirty year period, fourteen (14) of those years had rainfall amounts above the mean value, with the highest rainfall amount of 1488mm (306.7mm above mean) occurring in 2010. A decrease in mean annual rainfall amount was recorded for the rest sixteen (16) years. Out of these sixteen years, six years (6 years) had values less than 1000mm with the greatest decline recorded in 1983 (834.8mm or -346.5mm below the mean). Figure2 shows that positive deviations greater than 100mm were recorded for nine out of the thirty years under study. These were 1985, 1991, 1993, 1997, 2007, 2008, 2009, 2010 and 2011. These substantiated the findings by Nicholson *et al.* (2000), Chappell and Agnew (2004), and Dai *et al.* (2004) that in West Africa, a decline in annual rainfall had been observed since the end of the 1960s, with a decrease of 20 to 40%

observed between the periods 1931- 1960 and 1968-1990 and are contributors to the drought periods of the 1970s and 1980s.

Buba (2009) study also attested to this downward trend in rainfall amount recorded in most of the meteorological stations across northern Nigeria. These studies affirmed the IPCC 2007 report which observed that annual precipitation had changed with the tropical and sub-tropical regions recording decreased precipitation in recent decades. Furthermore, the rainfall variability highlighted by Rosenzweig et al. (2007) and Trenberth *et al.* (2007) conclude that precipitation has much larger spatial and temporal variability than temperature. This variability has far-reaching impacts on water availability and quality (Sissoko *et al.* 2010) and is very critical for rainfed agriculture, since it is the major means of livelihood in the study area.

Table 1: Mean Annual Rainfall of Doko Area and it Deviation (1982-2011)

S/No	Years	Annual Rainfall (mm)	Deviation from mean (mm)
1	1982	990.7	-190.6
2	1983	834.8	-346.5
3	1984	995.5	-185.8
4	1985	1365.5	184.2
5	1986	955.2	-226.1
6	1987	1186.2	4.9
7	1988	1140.1	-41.2
8	1989	1125.1	-56.2
9	1990	1209	27.7
10	1991	1363.9	182.6
11	1992	936.7	-224.6
12	1993	1373.4	192.1
13	1994	1159.8	-21.5
14	1995	1102.1	-79.2
15	1996	1155.9	-25.4
16	1997	1325	143.7
17	1998	997.7	-183.6
18	1999	1154.7	-26.6
19	2000	1208	26.7
20	2001	1256.6	75.3
21	2002	1020.8	-160.5
22	2003	1088.2	-93.1
23	2004	1181.4	0.1

24	2005	1207.1	25.8
25	2006	1121.6	-59.7
26	2007	1296.7	115.4
27	2008	1373.4	192.1
28	2009	1523	341.7
29	2010	1488	306.7
30	2011	1302	120.7
		Total=35438.1	x□ =1181.3

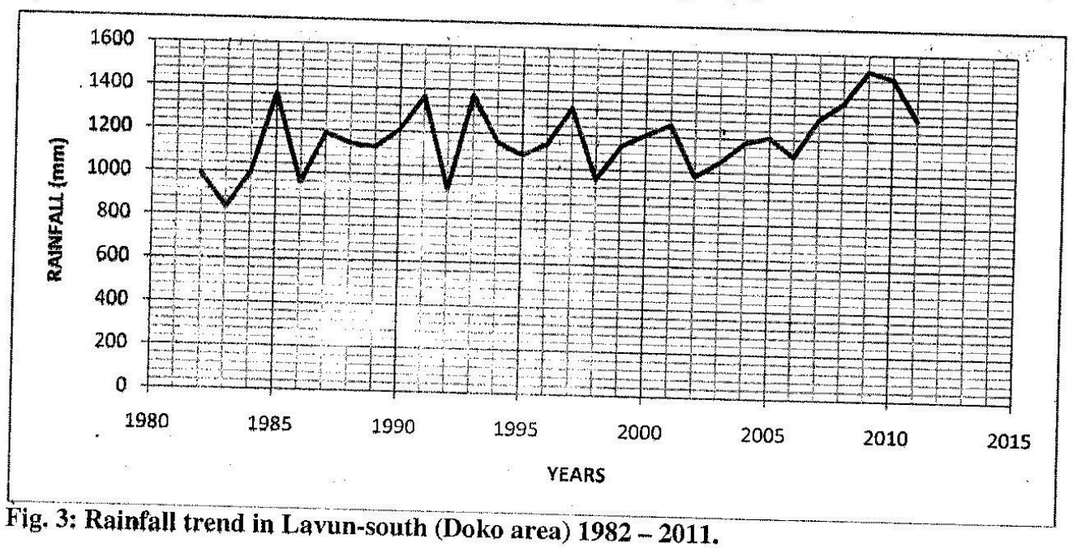

Fig. 3: Rainfall trend in Lavun-south (Doko area) 1982 – 2011.

Figures 3 and 4 highlighted the highly variable temperature of Lavun-south area during the study period showing the positive deviations (increase) from the mean annual maximum temperature of 34°C that occurred from1983, 1993 to 2000 and 2002 to 2006. The lowest annual maximum temperature was recorded in 1982, which had mean annual temperature of 32.9°C (or -1.1°C negative deviation from the mean) while 1998 had the highest mean annual temperature of 34.8°C or 0.8°C positive deviation. The graph shows that out of the thirty year (30 years) period, temperature was higher than the mean in fourteen (14) of those years (1983,1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2002, 2003, 2004, 2005 and 2006,); while in fourteen (14) years, temperatures were lower than the mean (1982, 1984 to 1992 and2007- 2010). Decadal mean annual maximum temperatures of Lavun-South (Doko area) were analysed for the thirty year period. For the following decades 1982-1991, 1992-2001 and 2002-2011, the corresponding decadal mean annual temperature were 33.6°C, 34.2°C and 34.1°C respectively. Although, the third decade appeared to have a slightly lower mean annual temperature (34.1°C) than the second decade (34.2°C), the mean values show a progressive increase from 33.6°C to 34.1°C within a period of thirty years i.e. a positive deviation of 0.5°C from the thirty year mean.

Table 2: Mean Annual Maximum Temperature of Doko Area and it Deviation (1982-2011)

S/No	Years	Average (Max) Temp (°C)	Deviation from Mean (°C)
1	1982	32.9	-1.1
2	1983	34.2	0.2
3	1984	33.8	-0.2
4	1985	33.6	-0.4
5	1986	33.2	-0.8
6	1987	33.3	-0.7
7	1988	33.8	-0.2
8	1989	33.8	-0.2
9	1990	33.9	-0.1
10	1991	33.4	-0.6
11	1992	33.8	-0.2
12	1993	34.4	0.4
13	1994	34.1	0.1
14	1995	34.4	0.4
15	1996	34.3	0.3
16	1997	34.3	0.3
17	1998	34.8	0.8
18	1999	34.2	0.2
19	2000	34.1	0.1
20	2001	34	0
21	2002	34.1	0.1
22	2003	34.3	0.3
23	2004	34.2	0.2
24	2005	34.4	0.4
25	2006	34.4	0.4
26	2007	33.9	-0.1
27	2008	33.6	-0.4
28	2009	33.9	-0.1
29	2010	33.9	-0.1
30	2011	34	0
		TOTAL=1019	x□ =34

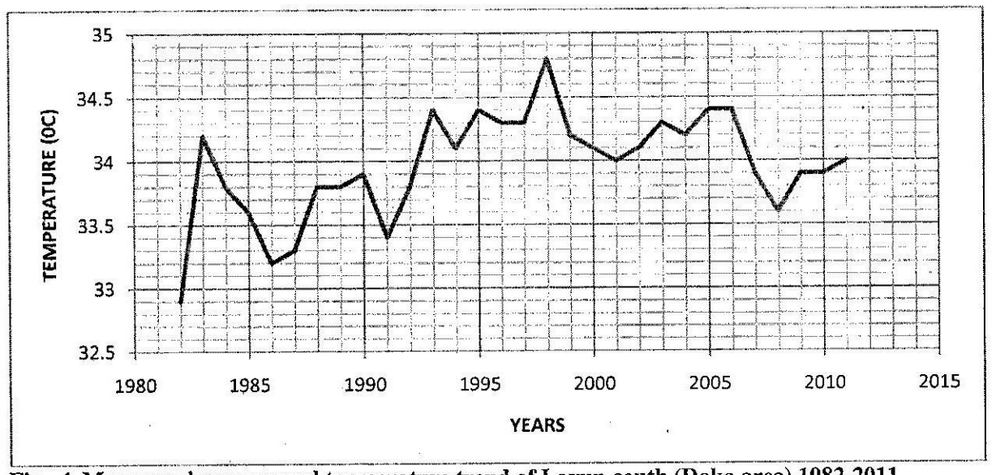

Fig. 4. Mean maximum annual temperature trend of Lavun-south (Doko area) 1982-2011

According to the Intergovernmental Panel on Climate Change (IPCC 2007), increases in greenhouse gas emissions have been associated with an increase in the mean global temperature of 0.3°C - 0.6°C since the late 19th century. These widespread changes in extreme temperatures were recorded over the last 50 years with all decades, since the 1970s, having higher than the average temperatures of the previous 100 years by about 0.2°C per decade. This is also supported by Buba (2009) who found out that beginning from the 1970s, there has been a general temperature shift in Northern Nigeria, with increasing temperatures (significant at the 95% confidence level) across northern Nigeria. In the case of Lavun south, the increase in temperature is as high as 0.5°C as shown by decadal analysis of the mean annual maximum temperature values. The impact of a similar rise of temperature higher than 0.4^0C in average (mean) temperatures, in a study by Chinese Academy of Social Science (CASS), showed an annual 7% reduction in glacier extent and widespread melting of permafrost in the Tibetan Plateau in Western China due to 0.9^0C (Khoday 2008). To further emphasize this result, Hansen and Sato (2011) stated that further global warming of 1°C defines a critical threshold and beyond that we will likely see changes that make Earth a different planet than the one we know. In fact, the melting of glacier in the Tibetan Plateau is regarded as a "tipping point" below 1°C. Recent studies (Hansen *et al.*, 2000; IPCC, 2007; Lenton *et al.*, 2008; Lenton, 2011) have discussed these critical thresholds as "tipping points" that trigger sudden and irrevocable changes in climate. For example, a small increase in temperature or other change in the climate could trigger a disproportionately larger change in the future.

New *et al.* (2006) had also reported that between 1961 and 2000, there was an increase in the number of warm spells over southern and western Africa, and a decrease in the number of extremely cold days. The observation by respondents, and Health Officer and some elders interviewed confirmed that, in recent times (since the 1990s), temperatures in Lavun south area has consistently been higher than normal. On changes in rainfall amount, 54.6% of respondents had observed that this had increased most especially between 1980 till date, while 41.9% had observed a decrease. This disparity was markedly different in perceived changes in temperature, wind speed and sunshine intensity. All respondents indicated that these had increased in intensity mostly between 1980s and the present. These responses attest to the fact that the most critical

determinant of climate change is temperature, whose changes are felt directly by mammals. It is worth noting that even the 6.5% that stated they had not observed any change in climate of Lavun south area, still indicated that they had observed some changes in climatic elements such as temperature.

The study showed that, for respondents (92.8%) who were aware of changing climate conditions, the main sources of information were daily weather reports on television (51.5%) and knowledge of geography (27.6%). Only 2% indicated that information was through extension workers of Agricultural Development Project and from local government agriculture department. From this study, it is evident that although radios sets are the cheapest electronic means of obtaining information by the rural dwellers, this has not been fully exploited in creating awareness on climate change in Lavun-south area. From the study, it is clear that human activities are affecting the environment and the climate of the area for the fact that 52.5 % of the respondents strongly agreed and 28.6% agreed, while, none strongly disagreed. There are still few among the aged people who go by superstitious believes on changes occurring in the environment, although, the bulk of the respondents strongly disagreed (55.5%) and 14.5% disagreed. 28.9% of the respondents strongly agreed and 65.5% did agreed that yearly rains is not supporting crop production as it use to in many past decades. However, none disagreed to this point. It is very clear from the study that, climate change has led to crop infestation and diseases in the study area since about 80% of the total respondents strongly agreed, 12.7% agreed, while, none disagreed. Through the discussions with some respondents during the field work, they were convinced that the cost of crop production is high with low yield at the harvest due to climate change. This is highly confirmed through the responses where 9.6% of the respondents strongly agreed, and 74.8% agreed. On the question that the environment is suffering from excessive de-vegetation and decline of forest resources due to climate change, 59.7% of the respondents strongly agreed that it is true, and 30.3% of the respondents agreed.

About 30.9% of the respondents agreed that there is an increase incidence of floods during the raining season. This response comes from those of the flood plain of river Niger and of river Kaduna or at the very river bank. However, 40.7% of the respondents disagreed. 85.3% of the respondents strongly agreed that there is an increase incidence of droughts during raining season with 14.7% agreed and none disagreed. 21.1% of the respondents indicated that the threat of climate change is more on food supply, followed by instigating disasters such as disasters caused by wild wind and thunderstorm. 20.6% indicated threat of climate change on fuel wood availability with 18% indicating threat on biodiversity quality and sustainability, and12.9% indicating threat on their health.

5.0 Conclusions

From the climatic data results presented and analysed of the study area, it is very clear that the climatic elements especially, rainfall and temperature that are easy to be sensed by rural dwellers is undoubtedly changing irrationally and spontaneous over time. The people of Lavun south (Doko area) are of high perception that the changes in rainfall and temperature patterns, their variability have great impacts on their livelihood especially on agriculture which is their primary occupation and means of livelihood over decades. But, with all these, the reality about the deep consequences of this climate change are not clearly understood by them because most of the people are still under the confusion of superstitious believes about climate and the environment in general. Based

on the findings of this study, the following recommendations have been made; the various tiers of government and stakeholder should develop and implement a comprehensive communications strategy to raise awareness of climate change impacts and commence aggressively implementation of key adaptation strategies. Radio awareness should be enhanced as well as forecasts and early warnings on weather variables are broadcast not just on NTA Network News but on radios as well by the Nigerian Meteorological Agency (NIMET) or other related agencies. Forestry and vegetal cover policies should be reinforced in the rural areas. Advance understanding of rural environment vulnerabilities, impacts, and adaptive responses in a variety of their local contexts through case studies should be enhanced. In addition to identifying vulnerable communities, studies should also identify vulnerable populations (native populations on rural and/or tribal lands) that have limited capacities to response to climate change. Better understanding of climate change at the community scale would provide a basis for adaptation research that addresses social justice and environmental equity concerns.

References

Buba, F.L. (2009). Evidence of Climate Change in Northern Nigeria: Temperature and Rainfall variations. An unpublished Ph'D Thesis submitted to the Department of Geography, Bayero University, Kano, Nigeria. October, 2009.

Chappell, A. and Agnew, C.T. (2004). Modelling Climate Change in West African Sahel rainfall (1931-90) as an artifact of changing station locations. *International. Journal of Climatology*, 24, 547-554.

Dai, A., Lamb, P.J., Trenberth, K.E., Hulme, M., Jones, P.D. and Xie, P. (2004). The recent Sahel Drought is real. *International. Journal of Climatology*, 24, 1323-1331.

Hansen, J.E., and Sato, R. (2011). Paleoclimate implications for human-made climate change. In *Climate Change at the Eve of the Second Decade of the Century: Inferences from Paleoclimate and Regional Aspects: Proceedings of the Milutin Milankovitch 130th Anniversary Symposium*. A. Berger, F. Mesinger, and D. Šijači, Eds. Springer, in press.

IPCC (2007a). Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor M. and Miller H.L. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC (2007b). Summary for Policymakers. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. and Hanson, C.E. Eds., Cambridge University Press, Cambridge, UK, 7-22.

IPCC (2007d). Core Writing Team, *et al.* ed. *Climate Change 2007: Synthesis Report. A Contribution of Working Groups I, II, and III to the Fourth Assessment Report of the Integovernmental Panel on Climate Change*. Geneva, Switzerland: IPCC.

IUCN (2008). *Adaptation to Climate Change*. A Position Paper by International Union for Conservation of Nature (IUCN) presented during the fourteenth session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP14), Poznan, Poland, 1-12 December 2008.

Rebetez 1996. in Intergovernmental Panel on Climate Change (IPCC); *third assessment report 2006*, (Climatic Change 32: 495-509).

Kurukulasuriya P. and Rosenthal S (2003). Climate Change and Agriculture. A Review of Impacts and Adaptations. Climate Change Series Paper No. 91 Climate Change and Agriculture. The World Bank Environment Department, Washington, D.C U.S.A.

Lenton, T. M., Held, H., Kriegler, E., Wall, W. H., Lucht, W., Rahmstorf, S. And Schellnhuber, H. J. (2008). Tipping elements in the Earth's climate system. *Proceedings of the National Academy of Sciences. USA* **105,** 1786–1793.

Lenton, T. M. (2011). Early Warning of Climate Tipping Points. Nature Climate Change, Macmillan Publishers, 1, 201-209.

National Cereal Research Institute, Baddegi (2012).

New, M., Hewitson, B., Stephenson, D.B., Tsiga, A., Kruger, A., Manhique, A., Gomez, B. Coelho C.A.S. (2006). Evidence of trends in daily climate extremes over Southern and West Africa. *Journal of Geophys. Res.–Atmos.*,111,D14102, doi:10.1029/2005JD006289.

Nicholson, S.E., Some B. and Kone, B. (2000). An Analysis of Recent Rainfall Conditions in West Africa, including the rainy season of the 1997 El Nino and the 1998 La Nina years. *Journal of Climate*, 13, 2628-2640.

Niger State Ministry of Agriculture (1982).

Rebetez, M. (1996): Cited in Intergovernmental Panel on Climate Change (IPCC); *third assessment report 2006*, (Climatic Change 32: 495-509).

Rosenzweig, C., Casassa, G., Karoly, D. J., Imeson, A., Liu, C., Menzel, A., Rawlins, S., Root, T.L., Seguin, B., Tryjanowski, P. (2007). Assessment of observed changes and responses in natural and managed systems. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden P.J. and Hanson, C.E. Eds., Cambridge University Press, Cambridge, UK, 79-131.

Semenza, J.C., Rubin, C.H., Falter, K.H., Selanikio, J.D., Flanders, W.D., Howe, H.L., Wilhelm, J.L. (1996). Heat-related deaths during the July 1995 heat wave in Chicago. *New Eng. J. Medicine* 335, 84-90.

Sissoko, K., Herman Vankeulen, H., Verhagen, J., Tekken, V., and Battaglini, A. (2010). Agriculture, Livelihoods and Climate Change in the West African Sahel. *Regional Environmental Change* DOI 10.1007/s10113-010-0164-y

The American Experience: Surviving The Dust Bowl: People & Events: The Drought, PBS

http://www.pbs.org/wgbh/amex/dustbowl/peopleevents/pandeAMEX06.html. Retrieved 2008-12-29.

Trenberth, K.E, Jones, P.D, Ambenje, P., Bojariu, R., Easterling, D., Klein T. A., Zhai, P. (2007) Observations: Surface and Atmospheric Climate Change. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., Qin, D., Manning, M. Chen, Z., Marquis, M., Averyt, K.B., Tignor M. and Miller H.L. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 235-336

Twomlow, S. J., Mugabe, F.T., Mwale, M., Delve, R., Nanja, D., Carberry, P., Howden, M. (2008). *Building adaptive capacity to cope with increasing vulnerability due to climatic change in Africa – A new approach*. Physics and Chemistry of the Earth 33 (2008), 780–787.

UNFCCC (2007a). Climate Change: *Impacts, Vulnerabilities and Adaptation in Developing Countries*. United Nations Framework Convention on Climate Change (UNFCCC), Bonn, Germany, p43-81

USAID (1991). Climate change report, 1991. *Climate change and adaptations*.

USAID (2007). Climate change report, 2007. *Climate change and adaptations*

Wikipedia, the free encyclopedia. Retrieved 2010.

Ilbanks, T.J. 2003: Integrating climate change and sustainable development in a place-based context. *Climate Policy*. Supplement on Climate.