International Journal of Arts Humanities and Social Sciences Studies
Volume 4 Issue 9 ǁ Nov. 2019
ISSN: 2582-1601
www.ijahss.com

Effect of Climate Change on Infrastructural Facilities: A Case Study of Ado Ekiti, Ekiti State, Nigeria

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Abstract: *The paper examined the effect on infrastructural facilities in Ado Ekiti. Data for the study were obtained from five (5) selected areas in Ado Ekiti using purposive sampling technique, which are: Odo-Ado Area; Ajilosun Area; Adebayo Area; Housing Area and Olorunda Area. The instrument used to collect the data was a structured questionnaire. The analyses of the data using a descriptive and inferential method of data analysis revealed that climate change has significant effects on infrastructural facilities. The study concluded that several infrastructural facilities in the study area were in deletrous and salterous condition as a result of change in climatic pattern. Therefore the study recommended that efforts towards sustainable infrastructural facilities should be adopted by Engineers and planners, there should be adequate provision for long-term infrastructure that will adapt to climate change as well as use of competent engineers and planners is required for sustainable development of infrastructural facilities among others.*

Keywords: *Climate, Climate Change, Climatic System, Regional, Infrastructure and Facilitie.*

I. Introduction

Climate can be defined as the regular pattern of weather conditions of a particular place. Adebayo (2007) also sees climate not only the average weather condition but also the deviation or variability from such average weather condition.

Intergovernmental Panel on Climate Change (IPCC 2007) refers to climate change as any change in climate overtime whether due to natural variability or as a result of human activities. According to United Nations Framework Convention on Climate change (UNFCC) sees climate change as attributed directly or indirectly to human activities that alter the composition of the global atmosphere observed over comparable time.

The climatic system is a complex, interactive system consisting of the atmosphere, land surface, snow, ice and ocean and other bodies of water and living things (Oyewumi, 2015). The atmosphere component of the climate system is characterized and usually described in terms of mean and variability of temperature, precipitation and wind over a period of time, ranging from months of millions of years. The system evolves in time under time under the influence of its own material dynamic and due to change in external factors, examples include volcanic eruptions, solar variations, and human induced changes in atmospheric composition. Climate, in turn responds directly to such changes as well as indirectly, through a variety of feed mechanism.

Adeola (2018) defines an Infrastructure as the fundamental facilities and systems serving a country, city, or other area, including the services and facilities necessary for its economy to function.

The effect of climate change on infrastructure facilities has been a major borne of contention amidst both the climatologists and urban planners. Climate affects infrastructures such as electric poles, water supply, roads, buildings and many other infrastructures.

This research work broadens the effect of climate change on these infrastructures and how the infrastructural facilities can be model to adapt to various climatic changes in the environment.

Karl (2009), evaluated the changes in the global transportation as a result of climate change in. Climate change has adversely been affecting the vulnerability of infrastructural facilities. Various studies on exposure to vulnerability and reduction of impacts of climate change have been closely analyzed. He evaluated the likelihood and consequence of climate-related impacts on infrastructures providing policymakers with some guidance on the level of risk associated with it. He is of the view that climate has great impact on growth and development of infrastructural facilities in the whole world.

Snover(2007), opined that the climate effects and pavement performance, road use demand, and road design and maintenance are additional modeling tools to make the connection between climate projections and road system component in America. These studies showed that climate has a major consequence on transportation activities as well as power facilities.

Adebayo (2011), indicated that floods as a result of heavy rain are ranked as a high risk event for the constant damaging of social infrastructures in South Western Nigeria especially the areas liable to be flooded.

Thus, due to increase rate of urbanization in Ado Ekiti, the city has continuously being experiencing changes in size, morphology and population, the activities and effects of climate change and global warming on electricity lines and electric poles, telecommunication, buildings and other structures are cogent areas which were looked into in this study. The infrastructure solidity of a city is a major determined by the intensity of its climatic nature. Considering the nature of roofs and roofing materials, electric poles, and roads in the study area, there is a quest to look into the cause of the condition in line with the climatic nature and condition in the area.

II. The Study Area

Location and Boundary

Ado Ekiti is located between latitudes $7^{0}31^{1}$ N and $7^{0}47^{1}$ N of the equator and between longitude $5^{0}05^{1}$ E and $5^{0}23^{1}$ E of the Greenwich meridian . (fig 1.1). Ado Ekiti has length and breadth of 32 and 28 km respectively and share boundaries with six (6) of the administrative division of Ondo State. It is about 199km to the northern Ekiti and Erio to the North(43.5km), Ijero to the north east (7.5km), southern and south eastern to the south (59km) and western Ekiti of the west (9km). Politically, Ado Ekiti is the capital city of Ekiti state and has since 1996 enjoyed this status. Ado Ekiti has evolved and continued to enjoy urban status and adequately qualify to be called a city as it reflects a political, economic, social and cultural identity than many modern urban areas lack.

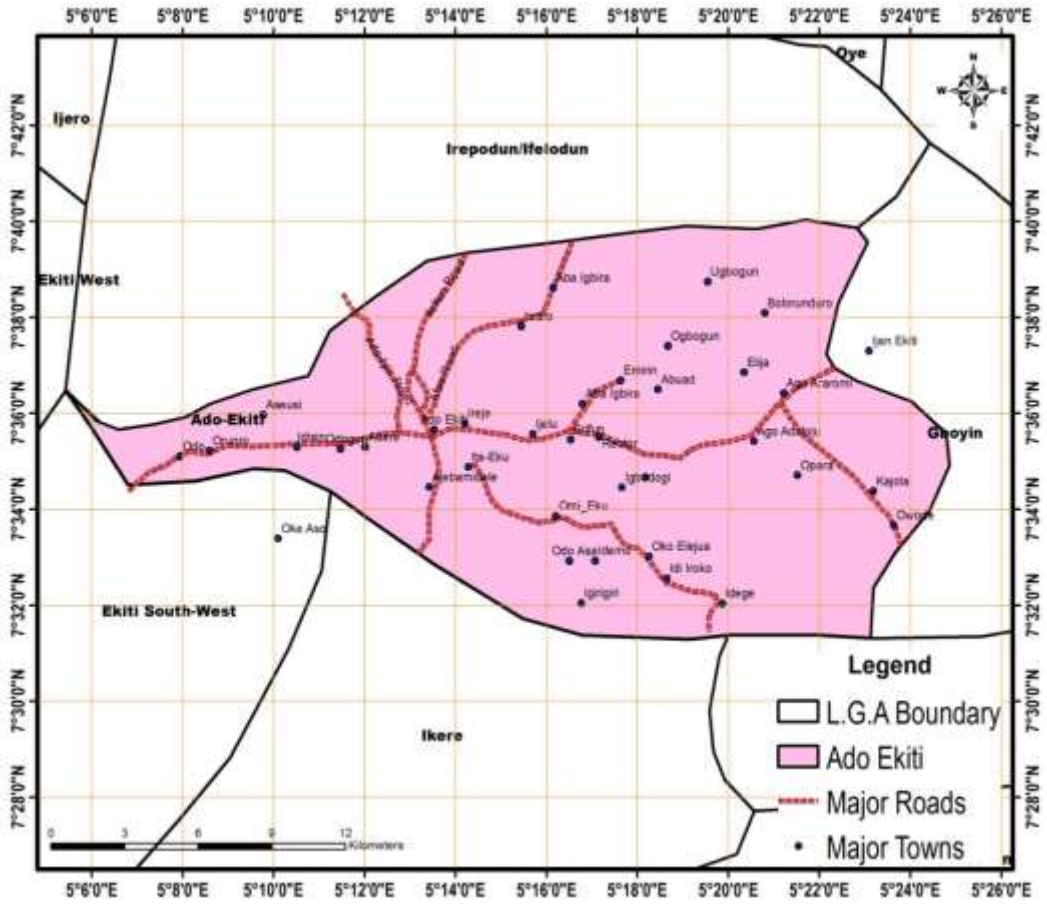

Figure 1: Map of Ado Ekiti

The population of Ado Ekiti was put at 149, 472 (NPC1991) before the State was created after which was put at 308,621 as at 2006 census by the National Population Commission. In 2016, the estimated population of Ado Ekiti can be put at 420,234 using 2.5% growth rate. Root crops and grains are cultivated at near farms while tree crops such as rubber are cultivated in distant farms. Ado Ekiti region show spatial specification of agricultural production while the north east part such as Iworoko, Are, Afao, and Igbemo are noted for rice , the east to southern part specializes in yam and cassava while the western part produces cocoa and plantain.

Climate and Vegetation

Ado Ekiti has tropical wet and dry climate which supports all grasses and other vegetation which is interspersed with short scattered trees (derived savanna). The climate is divided into two parts Northern derived savanna and Southern climatic belt. The city has a mean annual rainfall of about 1.318mm, there are double maximal rainfalls with the peak in June and September the rainfall is mainly concentrated between April and October, it rains for an average of 9-11 days per month during this period except in September when it rains at least once in two days.

The mean monthly temperature is very high ranging between 25^0C and 28^0C and in March reaching about 29^0C the days are very hot during the dry season from November to January with temperature typically between 33^0C TO 34^0C while from February to April values are frequently between 34.6^0C and 37^0C.

Under the latter condition, air is generated by mechanical devices like fans, cannot have cooling effect on human body which maintained at a constant temperature of 367^o C. the diurnal range of temperature of characteristically high for the city, the most suitable period is from June to October. Daytimes are very sunny with bright sunshine of about 6.5 to 7.7 hours daily from November to May while from June, August and September, the heavy cloud cover of the period reduces the time to between 3.3 to 4.4 hours.

III. Objectives Of The Study

The objective of the study is to examine the effects of climate change on infrastructural facilities.

IV. Literature Review

Incorporation of climate change impacts into transportation decisions is still a relatively new concept. As decision makers in various sectors grapple with information on climate change effects and how they may or may not impact their core mission(s), they are turning to existing tools and approaches for guidance. To date, three closely-related approaches are being used to help transportation decision makers consider and prepare for future climate impacts: vulnerability assessment, risk assessment, and adaptation assessment.

Vulnerability assessment begins with the identification of existing stressors facing transportation systems and projects how climate change will impact and/or introduce new stressors in the future. The findings of the assessment can then be ranked to assess, prioritize, and address vulnerabilities.

Risk assessment evaluates the likelihood and consequence of climate-related impacts on transportation and can be rooted in engineering applications. Many times this assessment will quantify the product of the probabilities of exposure and vulnerability. This assessment provides transportation policymakers with guidance based on quantitative analysis of the level of risk associated with changing climate conditions.

Adaptation assessment identifies plans, prioritizes, implements, and measures transportation management options available for effectively adapting to climate change impacts. This assessment may discuss ways to reduce transportation vulnerability, increase resilience and or highlight regions of retreat. These approaches have been applied at varying levels of sophistication in assessing climate change impacts on human and natural systems. This document details how these approaches have been or could be used to integrate climate change impacts into transportation decisions and ultimately increase the adaptive capacity of the highway system.

The water cycle sets the stage for all life to exist, and is a driver of climate-related change through changes in precipitation, runoff, and evaporation. Water supplies and water management are also strongly affected by changes in temperature and extreme events, such as droughts and floods. Some observed impacts of climate change on the water cycle include intensified floods in some regions, summer droughts in much of the United States, and changes in seasonality of runoff (Karl, 2012). Water supplies are being reduced by climate change and are affecting ecosystems and livelihoods in many regions across the nation (e.g., the Southwest, the Great Plains, the Southeast, and the islands of the Caribbean and the Pacific, including the state of Hawaii).

The U.S. energy supply system is diverse and robust in its ability to provide a secure supply of energy with only occasional interruptions. However, current and projected impacts of climate change will shift seasonal patterns of energy use toward a reduction in heating and an in-crease in cooling requirements. Along with a variety of economic factors and an increase in extreme events in vulnerable areas, shifts in energy use and

climate extremes pose risks to energy security. Extreme weather events and water shortages are already interrupting energy supply, and impacts are expected to increase in the future. Most vulnerabilities to and risks of interruptions in energy supply and use are created by local events, but the impacts often are national and international in scope (Wilbanks, 2012).

Moreover, the impacts of sea level rise in combination with storm surge and subsidence are increasing the risks to coastal energy facilities (U.S. DOE and NREL 2013).

V. Sampling Techniques And Procedures

The study employed the use of purposive sampling method to select five areas in the study area, these include: five selected areas in Ado Ekiti, and the selected areas include: Odo-Ado Area; Ajilosun Area; Adebayo Area; Housing Area and Olorunda Area. Simple random sampling technique was use to administered a total of One hundred and twenty five (125) copies of questionnaire in which each area got 25 copies of questionnaire.

VI. Data Analysis

The research employed both descriptive and inferential statistical analysis techniques in order to proof the researcher's validity and reliability. The techniques employed include, Chi-Square and Simple percentage table. Chi-square was used to determine either to reject or accept the hypothesis that stated that "Climate change does not have effect on Infrastructural Facilities in the study area".

VII. Results And Discussion

The research findings are discussed below with the tables containing information from the survey carried out by the author in 2019.

Table 1: Awareness about climate change

ITEMS	**RESPONSES**	**FREQ**	**%**
HAVE YOU HEARD ABOUT CLIMATE CHANGE BEFORE?	YES	116	92.8
	NO	9	7.2
	TOTAL	**125**	**100%**

Source: Author's Field survey, 2019

The table 1 showed the response of the people to know if they have heard about climate change before in the study area. The result shows that majority of the respondents agreed to have heard about climate change before; this is shown in the result where 92.8% of the respondents responded that the climate change is not a strange language to them.

Table 2: Comparison of rainfall of the present with the past

HOW CAN YOU COMPARE THE RAINFALL OF THE PRESENT TO THAT OF 10-20 YEARS AGO?	TOO HEAVY	16	12.8
	HEAVY	92	73.6
	LOW	17	13.6
	TOTAL	**125**	**100%**

Source: Author's Field survey, 2019

However, in table 2, comparing the rain of this present time to that of 10-20 years ago, the larger respondents of about 73.6% agreed that there is heavy rainfall in the present as compared to the past while 12.8% agreed that the rainfall is now too heavy compare to the past years, also 13.6% agreed that it is low. Therefore it can be seen from the responses that rainfall has increased drastically from what it used to be in the past.

Table 3: Comparison of sun intensity of the present with the past

DO YOU NOTICE THAT SUNSHINE IS HARSHER NOW THAN THE LAST 10 YEARS?	YES	100	80
	NO	25	20
	TOTAL	**125**	**100%**

Source: Author's Field survey, 2019

In table 3, the respondents said that they have noticed that sun intensity is higher in the present than what is experienced in the present, 80% agreed to this while 20% declined.

Table 4: Effect of the changes on infrastructure

DO YOU THINK THAT CHANGES IN CLIMATIC CONDITION HAVE NEGATIVE EFFECT ON INFRASTRUCTURAL FACILITIES?	YES	102	81.6
	NO	23	18.4
	TOTAL	**125**	**100%**

Source: Author's Field survey, 2019

It is evident in table 4 in which 81.6% of the respondents agreed that the climate changes has negative effect on the infrastructural facilities in the study area while the remaining 18.4% declined this. However, these changes in climatic condition were agreed upon by the respondents to have negative effects on the infrastructural facilities in the study area.

Table 5: Awareness of erosion on infrastructure

HAVE YOU EXPERIENCED EROSION OR FLOODING ON INFRASTRUCTURAL FACILITIES IN YOUR AREA?	YES	96	76.8
	NO	29	23.2
	TOTAL	**125**	**100%**

Source: Author's Field survey, 2019

In the same vein, in table 5, the effect of erosion and flooding on infrastructure as responded by the respondents cannot be over-emphasized. 76.8% of the population has experienced the effect of erosion and flooding on infrastructure in the area while the remaining 23.2% have not. This simply means that infrastructure facilities is being affected by erosion in the study area.

Table 6: Effect of erosion on road facilities

IS EROSION ONE OF THE MAJOR PROBLEMS AFFECTING THE ROAD CONDITION?	YES	117	93.6
	NO	8	6.4
	TOTAL	**125**	**100%**

Source: Author's Field survey, 2019

In table 6, 93.6% respondents agreed that the major problem affecting the condition of road is erosion while 6.4% decline. Owing to this, we can see that climate change have great negative influence on road infrastructures.

Table 7: Effects of rainfall on electricity supply

IS HIGH RAINFALL ONE OF THE MAJOR PROBLEMS HINDERING ELECTRICITY SUPPLY?	YES	105	84
	NO	20	16
	TOTAL	**125**	**100%**

Source: Author's Field survey, 2019

In the same vein, in table 7, 84% of the respondents agreed that high rainfall is one of the major factors affecting electricity supply in the study area, while 16% declined to this. With this, it can be seen that rainfall is really affecting electricity supply in the study area. As a result of high rainfall, electric poles are affected in the study area. This implies that high rainfall causes the falling down of electric poles whereby there is breakage in the transmission of electricity in the study area.

Table 8: Effects of flooding on building and building foundation

IS FLOODING ONE OF THE FACTORS AFFECTING BUILDING AND BUILDING FOUNDATION IN YOUR AREA?	YES	98	78.4
	NO	27	21.6
	TOTAL	**125**	**100%**

Source: Author's Field survey, 2019

In table 8, considering flooding as one of the major factor affecting building and building foundation in the study area, 78.4% agreed to that fact that flooding affects building and building foundation, while 21.6% declined to this fact. High level of flooding results to the weakening of building and building foundations.

Table 9: Effects of solar intensity on roofs

IS HIGH SUN INTENSITY A MAJOR TREAT TO ROOFING MATERIALS IN YOUR AREA?	YES	93	74.4
	NO	32	25.6
	TOTAL	**125**	**100%**

Source: Author's Field survey, 2019

In table 9, 74.4% of the respondents affirmed that high sun intensity is a treat to roofing materials, while 25.6% declined to this. Consequently, building roofs especially aluminum roofing sheets constantly get rust due to the high sunshine thereby causing the tearing and wearing of the roofing materials. From the above research work, it can be affirmed and agreed upon that climatic change have diverse effect on infrastructural facilities in the study area.

Table 10: Chi Square Test Analysis

Items	x^2	$x^2_{0.05}$	**Degree of freedom (df)**
EFFECT OF CHANGES IN CL CONDITION ON INFRASTRUCTUR FACILITIES	13.052	9.488	4

Source: Author's Field survey, 2019

This analysis was carried out in line with the questionnaire on climate data collected in the administered study areas of this research. The analysis of the hypothesis of the study was done using the inferential statistics of Chi-Square (x^2). The Chi-Square (x^2) test is carried out at 5% level of significance.

VIII. Hypothesis

H_O :There is no relationship between Climate change and infrastructural facilities

From table 10, 5 cells (50.0%) have expected count less than 5. The minimum expected count is 4.60. From the Chi-Square result above, the chi-square calculated (x^2) is greater than the chi-square tabulated ($x^2_{0.05}$), hence, we reject the null hypothesis (H_O) and accept the alternative hypothesis (H_I). We therefore conclude that, changes in climate condition have significant impact on infrastructural facilities in the study area.

IX. CONCLUSION

The research revealed that many infrastructural facilities were in deplorable state, some were totally destroyed as a result of the effect of climate change. Also, the view or focus of the government, non-government and individuals are not towards the effect of climate change on the infrastructural facilities, thereby causing damages to the infrastructures. However, the research review that maintenance of infrastructure will not solve the problem of infrastructural facilities unless climate change is put into consideration for adequate planning. The research review a glance that infrastructural facilities are to pass through stages like vulnerability, risk, mitigation and adaptation process, furthermore, that the more the changes in climate, the more damages to infrastructural facilities, if adequate measure are not taken. Finally, the result shows that climate change is responsible for poor management of infrastructural facilities.

X. Recommendations

Strategies to evolve sustainable infrastructural facilities should be adopted by Engineers and planners in which they are central to the process of adaptation, ensuring that current assets are protected. It is recommended that there should be adequate provision for long-term infrastructure that will adapt to climate change. It is very important that Meteorological agency must be carried along before, during and after planning of infrastructural facilities as this will provide more sustainability strategies for the infrastructures through the use of the information supplied by the agency.

The need for provision of adequate engineers and planners is required for sustainable development of infrastructural facilities as these people are responsible for the structural development of infrastructures. There is need for Innovation of new technology in all aspect of infrastructural facilities. It is also recommended that adequate data about different inventories of infrastructure facilities should be taken for proper use and sustainable development. Furthermore, there must be adequate monitoring through GIS, Remote Sensing, Mapping etc, for effectiveness and functionality of infrastructural facilities. Finally there should adequate public enlightenment on various ways of using infrastructural facilities to avoid further damages.

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