

## **Analysing the Focus of Climate Change Researches for Addressing Agricultural Issues in the Niger Delta region of Nigeria**

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**Abstract:** *The study analysed the distribution of climate change researches that focused on agriculture in the Niger Delta region of Nigeria. Specifically, the study determined the distribution of climate change researches and climate change variables that are influencing crop production in the region. The study adopted systematic review and had two research questions. The study relied on data from 129 studies which were purposively selected based on 5 inclusion criteria. A structured document review guide was used to collect data for the study. The instrument was divided into 2 sections (A-B); each section collected data for a specific purpose of the study and was face validated by five experts. The internal consistency of the instrument was determined using inter-rater data agreement. The statistical tools used for data analysis were frequency counts (f) and simple percentages. Findings of the study revealed that impact studies of climate change on agriculture in Niger Delta majorly focused on farmers' awareness (24%), adaptation strategies (21.7%) and crop production (17.8%). Findings also revealed that temperature (60%) and rainfall (60%) are the major climate change variables having considerable influences on crop production. Based on the findings of the study, it was recommended among others that empirical studies for climate change impacts on agribusinesses should focus on guiding policy formulation for addressing indigenous issues.*

**Keywords;** *Climate change, Niger Delta, crop production, Variables, Empirical studies*

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### **I. Introduction**

Climate is a fundamental element of the environment on which agricultural production as well as other components of life largely depend on. Any prolonged change in climate, whether positive or negative affects agriculture in varying degrees making climatic conditions sensitive issues in agriculture. Climate change is the shift in the statistical distribution of known weather patterns when the alteration lasts for an extended period of time usually decades to millions of years (Mach, Mastrandrea, Bilir & Field, 2016; Washington State Department of Ecology, WSDE, 2016). Climate change is the statistics of the variability of temperature, rainfall, sunshine intensity, humidity, pressure, wind and other meteorological elements in a given area (Cahill et al., 2012; Pindyck, 2013; Capstick & Pidgeon, 2014). Climate change is the fluctuations in the regular pattern of weather conditions of a particular place. Climate change is the alteration in the average weather of a specific area between two different time periods (Peterson, 2009; Mendlike & Gobiet, 2016; Junk, Kouadio, Delfosse & Jarroundi, 2016). It refers to the variation in the statistical distribution of average weather conditions that influences agricultural production over a period of time. The deviations in the meteorological elements that account for the average weather fluctuation and changes are due to climate change variables. Climate change variables are the meteorological elements that influence average weather outcomes (Baede, 2015). Climate change variables are atmospheric factors such as temperature, humidity, atmospheric pressure, wind, precipitation and other meteorological factors in a given area over the stipulated periods of time (Shepherd, Shindell & O'Carroll, 2015; WSDE, 2016).

Over historical time span, there have been a number of nearly constant factors such as latitude, altitude, proportion of land to water, and proximity to oceans and mountains, industrial activities and fuel combustion, that determine the values of climate change variables resulting in different effects on various areas of the world based on the mix of the factors prevailing in such area (IPCC, 2016; Nzeadibe, Egbule & Chukwuone, 2012; Stevens & Bony, 2013; Ikehi, 2014). However, the main effect of climate change is the increasing average temperature which causes a variety of secondary effects (IPCC, 2016). The secondary effects caused by increased temperature include, changes in patterns of precipitation and rainfall, rising sea levels, altered patterns of agriculture, increased extreme weather events, expansion of the range of tropical diseases, and the opening of new trade routes among others (Thornton, van de Steeg, Notenbaert & Herrero, 2009; Ogundele, 2012). Since the last ice age, which ended about 11,000 years ago, Earth's climate has been relatively stable at about

14°C. However, in recent years, the average temperature has been increasing (Met Office, 2015). According to studies (IPCC, 2016; Kothawale, Deshpande & Kolli, 2016; Tang, Lv & Ouyang, 2016), the seven main sources of evidence for climate change include higher temperatures, changing rainfall, changes in nature (such as birds shifting their migration patterns - Chang, Dereczynski, Freitas & Chou, 2014; Franchito & Rao, 2015), rising sea levels (Uyigue & Agho, 2007; IPCC, 2016), retreating glaciers (IPCC, 2016), declining sea ice (IPCC, 2016) and shrinking ice sheets (IPCC, 2016).

These evidences have made climate change topical and further points to the fact that climate change will affect natural ecology as well as economic activities at prevailing rate. The change in climate affects crops, livestock, forestry, and fishery in various ways. Climate change threatens food security for millions though the level of impact will vary according to area. Some areas of the world could benefit from climate change, while others would be seriously harmed by it (Uyigue & Agho, 2007; Met Office, 2013). In essence, climate change remains a global issue, as developed and developing countries alike, are all experiencing the impact of climate change. The Niger Delta area found in Nigeria; a developing country is not spared as impacts of climate change on agribusiness in the area has been severally reported. As with most parts of Nigeria, in Niger Delta agriculture and farming businesses are the dominant aspect of the rural economy assuming considerable importance. The Niger Delta area like most low-lying coastal areas of the world are more vulnerable to climate change adverse. Taking its definition from the Intergovernmental Panel on Climate Change (IPCC), 'vulnerability' describes the relative degrees of climate stress on populations (exposure), responsiveness to stress (sensitivity) and the ability of populations to adjust to climatic changes (adaptive capacity). With the impeding and active stress on agriculture, high sensitivity of the economic activities of the area to climate change and poor support to increase adaptive capacity, in addition to being a coastal area, the Niger Delta, can be regarded as an area with high vulnerability.

The Niger Delta is highly susceptible to adverse environmental changes occasioned by climate variation because it is located in the coastal area of the world where the effects are more felt (Uyigue & Agho, 2007). Change in vegetation in the area is leading to the impoverishment of biodiversity and the death of various plant species found in the area. Rising temperature in the area has brought about uncertainty in the rainfall pattern, timing and amount (Aweto, 2011). Altered climate variables in the area has led to flooding, scorching temperature, coastal erosion, acid rain and increased water salination (Ikehi, 2014). Flooding in the Niger Delta area (between July and October 2012), forced rivers to overflow their banks and submerged hundreds of thousands of acres of farmland (Hassan, 2012). Besides the destruction of buildings and lives, floods ravage crops and severe transportation routes in the area. The cost of managing the land for cultivation, disease and pest control for better production has increased as a result of climate change. Food production in the region has been greatly affected and evidence of this was the high scarcity of food in the region during the lockdown and movement restrictions enforced by governments for the containment of the global outbreak of the novel corona virus (COVID-19). The government of the states in the Niger Delta enforced a lockdown order and banned inter-state movements. This meant that food supplies across states were controlled or restricted. This ban, forced states to rely on food they can produce. However, hunger and food scarcity became a critical issue for the people as quantity of food produced in each state was much lower than the demand for food. A major complain of the farmers was that the impacts of climate change are inhibiting sustainable food production in the region. With climate change impacts threatening food security in the region, this study wonders how research have contributed to understanding the problem of climate change. The study analyses the distribution of climate change researches and the most important climate change variables in the region. Understanding these, is important for suggesting suitable policies for addressing the problem of climate change as it affects agriculture in the region.

### **Research Questions**

1. How has research focused on climate change impacts on agribusinesses in the Niger Delta?
2. What are the climate change variables that influence agribusinesses in Niger Delta?

## **II. Methodology**

The study adopted systematic review of published articles on the impacts of climate change on agriculture in the Niger Delta. The study was carried out in Niger Delta area of Nigeria and had two research questions. The population for the study comprises of 1,871 empirically researched studies, made up of published researches and unpublished theses. These studies that focused on climate change and were carried out in the Niger Delta area. These studies were obtained from reliable electronic and physical databases such as Mendeley, Google Scholar and e-repository of the Nnamdi Azikiwe library of the University of Nigeria, Nsukka. The sampled studies were 129, selected using the following criteria, it must;

1. be carried out in any part of the Niger Delta
2. focus on climate change impacts on agriculture particularly on crop production

3. be an empirical research presenting statistical findings (data)
4. link any of the climate change variables to agricultural production
5. be carried out between November, 2006 – November, 2016.

The rationale for choosing 2006–2016 is based on the consideration that the period has record of studies which are reliable and comprehensive enough for the analysis. Structured Document Review Guide was used to collect data for the study. The guide developed by the researchers was used to document and harmonize information from the selected studies. The guide was divided into two (2) sections. Section A collected information on the theme, focus and area of the study of the included studies while section B collected data contained in the included studies on climate change variables, the reported change and nature of the impact on agribusiness in the Niger Delta. The instrument was face validated by five experts: one each from Departments of Agricultural Education and Agricultural Economics, University of Nigeria, Nsukka; one each from Departments of Vocational Teacher Education and Agricultural Economics and Extension, University of Benin, Benin City; one from Department of Agriculture and Rural Development, Ramakrishna Mission Vivekananda University, Belur, India (contacted on *ResearchGate*). The title of the study, the purposes, research questions, hypotheses and the studies inclusion criteria were attached and sent to the experts for restructuring and improvements where necessary. They were requested to modify the document's extracting clauses and refocus the instrument. The experts were also requested to make suggestions for the improvement of the instruments. Their corrections and suggestions were used to produce the final copy of the instruments. To establish reliability of the instrument for the coding procedures, three studies on climate change and agribusiness in Northern Nigeria were selected based on the inclusion criteria and scored by two raters. Across studies and variables, inter-rater agreement between the raters was 0.80 (translating to 80% data agreement) which is greater than 0.50 (50% data agreement benchmark) indicating that the instrument is reliable. The data collection instrument was applied on the selected studies for data extraction. The focus of the studies, the frequency and mentioned extent of climate change variables reported to be influencing agriculture in the region were extracted and quantified for data analysis. Frequency count (f) and percentage (%) were used for data analyses.

### III. Results

**Table 1; Research Focus of Climate Change Impacts on Agribusinesses in the Niger Delta**

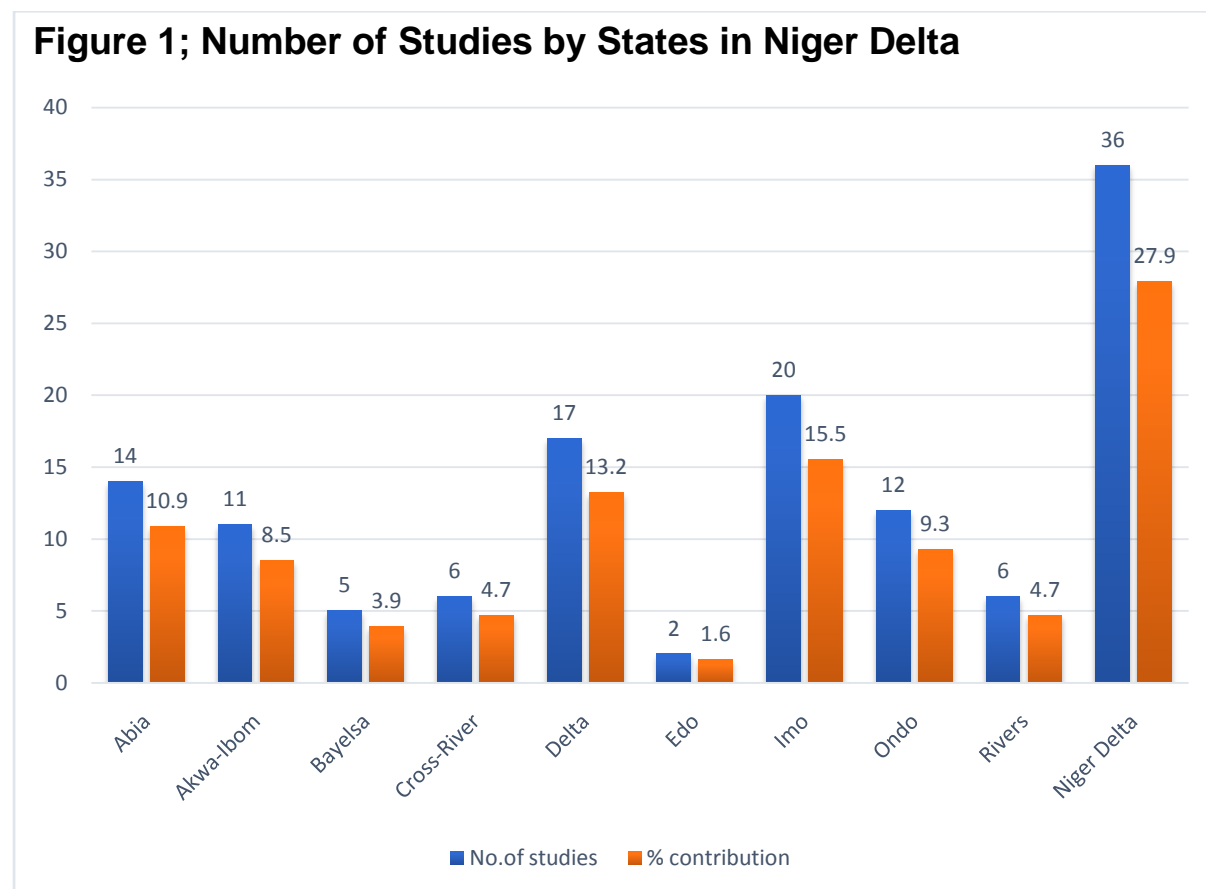
N=129

S/ N	Category	Focus	F	%	No. of studies by states/across states									
					Ab	Ak	Ba	CR	Dt	Ed	Im	On	Ri	ND*
1.	Impacts	-Crops	23	17.8	3	2	2	-	3	-	1	5	1	6
		-Fish/Animal	10	7.8	-	-	1	2	1	-	-	3	1	2
		-Farmers' welfare/ socio-economy	13	10.1	1	-	-	-	3	-	4	1	1	3
2.	Strategies	Adaptation	28	21.7	4	6	1	1	3	1	5	2	1	4
		Mitigation	3	2.3	1	-	-	-	-	-	2	-	-	-
3.	Awareness/Perception		31	24.0	4	-	1	2	5	-	7	1	2	9
4.	Vulnerability		2	1.6	-	1	-	-	-	-	-	-	-	1
5.	Influencing Factors		6	4.7	1	1	-	-	1	-	1	-	-	2
6.	Problems/Challenges		1	0.8	-	-	-	1	-	-	-	-	-	-
7.	Future projections		2	1.6	-	-	-	-	1	-	-	-	-	1
8.	Agricultural/Natural Disaster		4	3.1	-	1	-	-	-	1	-	-	-	2
9.	Policies/Legislature		2	1.6	-	-	-	-	-	-	-	-	-	2
10.	Economy/Econometrics		4	3.1	-	-	-	-	-	-	-	-	-	4
Total			<b>129**</b>	<b>100</b>	14	11	5	6	17	2	20	12	6	36

NB: Ab-Abia; Akwa-Ibom; Ba-Bayelsa; CR-Cross-River; Dt-Delta; Ed-Edo; Im-Imo; On-Ondo; Ri-Rivers; ND-Niger Delta; \*-Across states; F-Frequency; %-Percentage; \*\*- the totalling is not absolute as some studies covered more than one area of the above classifications

Table 1 presents the breakdown of research on climate change in and across Niger Delta states. Research works on impacts of climate change on crop were 23 corresponding to 17.8% research focus of the total examined studies. Studies accounting for the impacts of climate change on fish/animal were 10 corresponding to 7.8% research focus; while studies on farmers' welfare/socio-economy were 13 corresponding to 10.1% research focus. Studies classified as strategies focused more on adaptation than mitigation; there were 28 studies representing 21.7% research focus on adaptation while 3 studies were on mitigation representing 2.3% research focus. Researches on farmers awareness/perception, vulnerability of agribusiness, influencing factors to the exacerbated climate effects, problems/challenges in agriculture in climate change era, future projections of the impacts of climate change on agribusiness, agricultural/natural disasters influenced by climate

change, policy/legislative approach to climate change, and economy/econometrics of climate change in agribusiness, had 31, 2, 6, 1, 2, 4 2 and 4 number of studies representing with 24%, 1.6%, 4.7%, 0.8%, 1.6%, 3.1%, 1.6% and 3.1% research focus, respectively. The distribution and percentage contribution of studies across Niger Delta is presented on Figure 1.



Data in Figure 1 reveal that climate change studies on agribusiness using the whole of Niger Delta as the area of the study irrespective of the research focus is more than the studies carried out in single states in the Niger Delta (36), thus had the highest percentage contribution (27.9%) of studies in climate change as influenced by climate change. This is closely followed by Imo state with 20 studies (15.5%), Delta state with 17 studies (13.2%) and Abia state with 14 studies (10.9%). The state with the least contribution of empirical studies in agribusiness as impacted by climate change is Edo state, with 2 studies thus contributing only 1.6%.

Data on Table 2 indicate that the most influential (major) climate change variables posing considerable impacts on agribusinesses as revealed by 77 empirical studies in Niger Delta are temperature and rainfall. Other variables impacting on agribusiness in the Niger Delta include wind speed, relative humidity, sunshine intensity/hours as indicated by 29, 28 and 22 empirical studies on impacts of climate change on agribusinesses in Niger Delta, respectively. Atmospheric pressure and cloud cover are the least mentioned climatic variables that influence agribusiness. Climatic variables such as temperature, wind speed and cloud cover are reported to be increasing in value thus bearing negative, negative and neutral impacts on agribusinesses (agro-production) in Niger Delta, respectively.

**Table 2; Climate Change Variables that Influence agribusinesses in the Niger Delta**

N=129

S/N	Reported Climate change variable	No. Studies (F)	Reported Change	Reported Nature of Impact on Agribusiness
1.	Temperature	77	Increase in value	Negative
2.	Rainfall	77	Less Predictable	Negative
3.	Relative Humidity	28	Varying	Negative
4.	Sunshine Intensity/hours	22	Irregular	Negative
5.	Wind speed	29	Increased	Negative
6.	Atmospheric Pressure	2	Varying	Neutral
7.	Cloud Cover	1	Increased	Neutral

Note; F-Frequency

Rainfall is reported to have become less predictable resulting to negative impact on agribusiness. Relative humidity and atmospheric pressure are reported to be varying and bearing negative and neutral impacts on agribusiness. Empirical studies on the impacts of climate change on agriculture in Niger Delta indicate that sunshine intensity/hours have become irregular and its reported nature of impact on agribusiness is negative. Out the 7 reported variables, 5 are indicated to have negative impact on agribusiness while the remaining 2 are reported have neutral. The variables bearing negative impacts can be interpreted as climatic factors influencing income negatively, thus resulting in declined net income in agribusinesses.

### **Major Findings of the Study**

#### ***Research Focus of Climate Change Impacts on Agribusiness in the Niger Delta***

1. Studies on impact of climate change on crop production is more abundant, than on fish/animal production and farmers' welfare in Niger Delta.
2. Studies that focused on adaptation strategies for climate change impacts are more than those on mitigation.
3. Many studies have been carried out to ascertain awareness/perception of climate change in the region.
4. Few studies have been carried out on vulnerability, influencing factors, problems/challenges, future projections, agricultural/natural disaster, policies/legislature and economy/econometrics in relation to climate change impacts on agriculture in the Niger Delta.
5. Among the Niger Delta states, Edo state has the least contribution of empirical studies on the impacts of climate change on agriculture.
6. Higher percentage of studies on impacts of climate change on agriculture, focused on the entire Niger Delta as an area of study than a single state.

#### ***Climate Change Variables that Influence agribusinesses in the Niger Delta***

1. Temperature and rainfall and are the major climate change variables posing considerable impact on agribusinesses in Niger Delta.
2. Other climate change variables influencing agriculture in the region include wind speed, relative humidity and sunshine intensity/hour.
3. Atmospheric pressure and cloud cover are the least climate change variables posing considerable impacts.
4. Climate change variables have altered in values over the years with temperature reported to have increase, rainfall becoming less predictable, relative humidity varying, sunshine intensity/hours becoming irregular, wind speed increasing, atmospheric pressure varying and cloud cover increasing.
5. The alterations in values of climate changes variables bear negative impact on agriculture in the region.

### **IV. Discussion of Findings**

The discussion of findings of this study is presented below, according to the research questions.

#### ***Research Focus of Climate Change Impacts on Agribusiness in the Niger Delta***

Agriculture in the Niger Delta has been described as the major economic activity for the rural and indigent populace. Majority of agro-production activities are crop based, ranging from grains to tuber cultivation. This is evident in the focus of research in the region. Findings indicate that studies on impact of climate change on crop production are more abundant than those on animal/fish production and farmers' welfare. This is because Niger Delta is a tropical region with arable land and hitherto favourable weather for the cultivation of variety of crops. Therefore, impacts of climate change were recorded more on crop farmlands/plantations. According to Hassan (2012), changes in climate in Niger Delta bear direct and heavy impact on mainly crop production, and evidence of the activities leading to such impacts include rising sea levels resulting to flooding and submerging of hundreds of thousands of acres of farmland, destruction of farm buildings, ravaging crops and severing transportation routes. Other evidence of direct impacts on crop production include high temperature leading to scotched farmland and poor germination, migration and abandoning of farmland due to increased hazard in the cultivation area (Ogundele, 2012). These are likely why most impact studies on climate change and agriculture focused more on crop production in the region.

Adaptation studies presented how farmers are adjusting to existing impacts of climate change while mitigation studies report the efforts farmers and are making towards preventing or controlling future occurrences of climate change. Adaptation approaches are often short timed and are geared towards immediate ways of adjusting people, places and businesses by reducing their vulnerability to climate impacts. Therefore, it is not surprising that climate change studies in Niger Delta are more interested in how farmers are coping with

the impacts of climate change since the effectiveness of adaptation can be felt more sooner thus are easier to measure than mitigation strategies which are hoped to solve future problems by acting now.

Studies on climate change awareness/perception are abundant in the Niger Delta. According to Apata (2010), Ojutiku, Kolo and Egesie (2010) and Nzeadibe, Egbule, Chukwuone (2012) most farmers are already aware of the existence of climate change and perceives the impacts at varying degree, depending on their location and the agricultural enterprise they are engaged in or crops they are cultivating. However, very few studies focused on vulnerability, influencing factors, problems/challenges, future projections, agricultural/natural disaster, policies/legislature and economy/econometrics in relation to climate change impacts on agriculture in Niger Delta. These findings point to the fact that climate change researches in Niger Delta have not been able to quantify climate change damages in agriculture, and estimate expected outcomes for appropriate policy formulation. This create a dearth of information to guide appropriate intervention programmes and formulation of relevant policies. These findings of the study agree with that of Chang, Dereczynski, Freitas and Chou (2014) and Idrisu (2016) that the inability to assess and report extent of damage, vulnerability of farming business and project future impacts of climate change on agriculture affects short term and long-term interventions programmes as well as policy formulation. In the case of Niger Delta, the closet reports on farmers and farming businesses' welfare is the report of displaced persons by the National Emergency Management Agency (NEMA, 2012), which did not actually separate the farmers from other professions. However, the reports from NEMA is what is often used for interventions and even policy formulation.

Findings revealed that Edo state is the state with the least contribution of empirical studies to the impacts of climate change on agribusinesses in Niger Delta. This could be explained by the fact that the state is not among the coastal states in Niger Delta. Incidences, such as flooding reports occurred mostly in the cities of the state and they were mainly due to poor drainage (Uyigüe&Agho, 2007). Findings of the study revealed that most studies, focused on Niger Delta as area of study than individual states. The reasons might be that Niger Delta has a larger area of land, population and a blend of different weather which could be of interest to researchers. As described by Aweto (2011) and Fapojuwo, Ajayi and Abiona (2012), the area is divided into drier landward part where crop farming is the major agricultural activity and the seaward part (riverine and swampy area) which is characterized by extensive creeks and water bodies, where fishing and aquaculture/capture are practiced. The diversity of the area provides wide opinions, more opportunities and testable variables for researches in agricultural enterprises, especially in climate change scenario.

#### ***Climate Change Variables that Influence agribusinesses in the Niger Delta***

In agriculture particularly crop production, climatic factors are important issues to consider when cultivating. Different crops require varying amount of rainfall, temperature and sunshine hours among other factors for optimum performance. Findings of the study revealed that the most reported climate change variable influencing crop production enterprise of agribusiness are risen temperature and unpredictable rainfall patterns. This finding agrees with that of other studies. According to Bannayan, Lotfabadi, Sanjani, Mohamadian and Aghaalikhani (2011), Enete (2014) and Rahman, Kang, Nagabhatla and Macnee (2017), alterations in rainfall and temperature is the primary source of production stresses in agricultural systems. Changes in temperature, rainfall and intensity of extreme weather does have significant impacts on crop yields (Singh, 2017). For any particular crop, the effect of increased temperature will depend on the crop's optimal tolerance for growth and reproduction. In some areas, warming may benefit the types of crops grown, or allow farmers to shift to crops that are currently grown in warmer areas (Hatfield, Takle, Grotjahn, Holden, Izauralde, Mader, Marshall & Liverman, 2014). Conversely, when higher temperature exceeds a crop's optimum temperature, production is affected negatively. When climate changes, rainfall cycle, magnitude and the timing of rainfall is altered making farming more difficulty for the farmers.

Findings of the study reveals that other climate change variables influencing crop production include wind speed, relative humidity, sunshine hour, atmospheric pressure and cloud cover. These variables have been irregular and negative impacts on crop production. This finding agrees with that of Exenberger and Pondorfer (2011) and Singh (2017). According to the authors, though temperature and rainfall are the predominant variables in climate change, they are however not the only ones. Wind increases the crop water requirement due to evapotranspiration and therefore an increased need for irrigation when rainfall continues to alter. Further, several studies have revealed that the most important climatic factors that influence growth, development and yield of crops are sunshine intensity, temperature and rainfall (Ike & Emaziye, 2012; Ikehi, 2014; Ikehi, Onu, Ifeanyieze & Paradang, 2014; Ifeanyieze, Alkali, Okoye & Ikehi, 2016)

### **V. Conclusions and Recommendation**

Research on impacts of climate change in Niger Delta majorly focused on crop production, adaptation strategies, and farmers' awareness, and most of the studies used the whole of Niger Delta as the area of study. Temperature and rainfall were reported to be the major climate change variables having considerable

impacts on crop production in Niger Delta. However, indications are that empirical researches on climate change (empirical) in Niger Delta is scanty. Most research are focused on awareness and adaption. This is quite commendable. However, while the farmers are aware and are adapting, studies on other categories such as economics of climate change quantifying impacts are necessary for attracting interventions. It is thus necessary for empirical studies in agribusinesses to begin to guide policy formulation for climate change issues in the Niger Delta. Based on the findings of this study, recommendations are that research by scholars in agriculture should in addition to focusing on awareness and adaption should also focus on quantifying impacts of climate change in the various enterprises of agriculture. Such studies should account for the losses or gains attributable to climate change, extent of impact, lasting effects of the impact and suitable economic ways of adjusting in short and long term. Findings of such studies can be submitted to relevant authorities, as well be published for wide consumption. The abundance of such findings could inform/ influence policy formulation and as well guide the development of intervention programmes to address indigenous issues in crop production as it relates to climate change.

## References

- [1]. Apata, T. G. (2010). Effects of global climate change on Nigerian agriculture: an empirical analysis. *CBN Journal of Applied Statistics*, 2(1), 31-50
- [2]. Aweto, A. O. (2011). Agriculture in Urhoboland. Retrieved April 7, 2020, from <http://www.waado.org/geography/Agriculture/Agriculture-Aweto.html>
- [3]. Baede, A. P. (2015). Annex I. Glossary on climate change. Intergovernmental Panel on Climate Change Report. Netherlands Edition. p. 942.
- [4]. Bannayan, M, Lotfabadi, SS, Sanjani, S, Mohamadian, A, & Aghaalikhani, M. (2011). Effects of precipitation and temperature on crop production variability in northeast Iran. *J. Biometeorol.* 55(3):387-401. doi: 10.1007/s00484-010-0348-7.
- [5]. Cahill, A. E., Aiello-lammens, M. E., Fisher-Reid, M. C., Hua, X., Karanewsky, C. J., Ryu, H. Y., ... Wiens, J. J. (2012). How does climate change cause extinction? *Proceedings of the Royal Society B: Biological Sciences*, 280(1750), 20121890–20121890. <https://doi.org/10.1098/rspb.2012.1890>
- [6]. Capstick, S. B., & Pidgeon, N. F. (2014). What is climate change scepticism? Examination of the concept using a mixed methods study of the UK public. *Global Environmental Change*, 24(1), 389–401.
- [7]. Chang, M., Dereczynski, C., Freitas, M. and Chou, S. (2014). Climate Change Index: A Proposed Methodology for Assessing Susceptibility to Future Climatic Extremes. *American Journal of Climate Change*, 3, 326-337. doi: 10.4236/ajcc.2014.33029.
- [8]. Enete, I.C. (2014). Impacts of Climate Change on Agricultural Production in Enugu State, Nigeria. *J. Earth Sci. Clim. Change*, 5:234. doi: 10.4172/2157-7617.1000234
- [9]. Exenberger, A. & Pondorfer, A. (2011). Rain, temperature and agricultural production: The impact of climate change in Sub-Saharan Africa, 1961-2009. Retrieved 1 February 2020 from <https://www2.uibk.ac.at/downloads/c4041030/wpaper/2011-26.pdf>
- [10]. Fapojuwo, O. E., Ajayi, M. T., & Abiona, B. G. (2012). The roles of agricultural education and training in Nigerian graduates employment situation. University of Agriculture, Abeokuta, Nigeria. University Press.
- [11]. Franchito, S. & Rao, V. (2015). Studies of Climate Change with Statistical-Dynamical Models: A Review. *American Journal of Climate Change*, 4, 57-68. doi: 10.4236/ajcc.2015.41006.
- [12]. Hassan, A. (2012). Nigeria: Floods – Country shall not have food crises or famine. Retrieved July 23, 2013 from [www.allafrica.com](http://www.allafrica.com)
- [13]. Hatfield, J., Takle, G., Grotjahn, R. Holden, P., Izaurralde, R.C. Mader, T. Marshall, E. & Liverman, D. (2014). Ch. 6: Agriculture. *Climate Change Impacts in the United States: The Third National Climate Assessment*, U.S. Global Change Research Program. Pg. 150-174.
- [14]. Ifeanyieze F.O., Alkali, M., Okoye, R. N. & Ikehi, M. E. (2016). Altered climate and livelihood of farming families in Niger Delta region of Nigeria. *African Journal of Agricultural Research*, 11(10), 882-888. DOI: 10.5897/AJAR2015.10716
- [15]. Ike, P.C. & Emaziye, P.O. (2012). An Assessment of the Trend and Projected Future Values of Climatic Variables in Niger Delta Region, Nigeria. *Asian Journal of Agricultural Sciences* 4(2): 165-170.
- [16]. Ikehi, M. E. (2014). Impacts of climate change on agricultural production in the Niger Delta Area of Nigeria. Being a Masters Degree project submitted to the Department of Vocational Teacher Education, University of Nigeria, Nsukka.
- [17]. Ikehi, M. E. (2014). Impacts of climate change on animal and crop production in Niger Delta Region of Nigeria. *Research Journal of Agriculture and Environmental Management*, 3(10), pp. 528-537.
- [18]. Ikehi, M. E., Onu, F. M., Ifeanyieze, F. O. & Paradang, S. P. (2014). Farming families and climate change issues in Niger Delta Region of Nigeria: extent of impact and adaptation strategies. *Journal of Agricultural Sciences*, 5, 1140-1151. <http://dx.doi.org/10.4236/as.2014.512124>
- [19]. Intergovernmental Panel on Climate Change. (2016). AR5 Synthesis Report. 2016/PR/1. Available at [http://ipcc.ch/pdf/assessment-report/ar5/syr/SYR\\_AR5\\_FINAL\\_full\\_wcover.pdf](http://ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full_wcover.pdf)
- [20]. Junk, J., Kouadio, L., Delfosse, P. & Jarroudi, M. E. (2016). Effects of areal climate change on brown rust disease in winter wheat. *Climatic Change* 135:439–451. DOI 10.1007/s10584-015-1587-8
- [21]. Kothawale, D., Deshpande, N. and Kolli, R. (2016). Long term temperature trends at major, medium, small cities and Hill stations in India during the period 1901-2013. *American Journal of Climate Change*, 5, 383-398. doi: 10.4236/ajcc.2016.53029.
- [22]. Mach, K. J. Mastrandrea, M. D., Bilir1 T. E & Field, C. B. (2016). Understanding and responding to danger from climate change: the role of key risks in the IPCC AR5. *Climatic Change*; DOI 10.1007/s10584-016-1645-x
- [23]. Mendlik, T. & Gobiet, A. (2016). Selecting climate simulations for impact studies based on multivariate patterns of climate change. *Climatic Change* 135:381–393. DOI 10.1007/s10584-015-1582-0
- [24]. Met Office (2013b). Impacts on food security. Retrieved April 7, 2020, from <http://www.metoffice.gov.uk/climate-guide/climate-change/impacts/food>
- [25]. Met Office (2015). What is climate change? Retrieved April 7, 2020, from <http://www.metoffice.gov.uk/climate-guide/climate-change>
- [26]. National Emergency Management Agency. (2012). Emergency situation room report. Retrieved March 13, 2020, from <http://247ureports.com/flood-nema-releases-casualty-figures-of-363-deaths-2-1mn-idps>
- [27]. Nzeadibe, T. C., Egbule, C. L., Chukwuone, N. A. (2012). Indigenous innovations for climate change adaptation in the Niger Delta area of Nigeria. *Environ Dev. Sustain* 14: 901. doi:10.1007/s10668-012-9359-3

- [28]. Ogundele, B. (2012). Flood disasters will be greatest humanitarian crisis after civil war as flood sacks more rivers' communities. Nigerian Tribune. Retrieved September 23, 2012, from [www.nigeriantribune.com](http://www.nigeriantribune.com)
- [29]. Ojutiku, R. O., Kolo, R. J. & Egesie, N. N. (2010). Effect of climate change on fishery development in Nigeria: a case study of Niger State. Federal university of technology, Minna. University Press.
- [30]. Peterson T. C. (2009). State of the Climate in 2008. *Bulletin of the American Meteorological Society*, 90, 17-18.
- [31]. Pindyck, R. S. (2013). Climate Change Policy: What Do the Models Tell Us? *Journal of Economic Literature*, 51(3), 1–23. <https://doi.org/10.1257/jel.51.3.860>
- [32]. Shepherd, J. M., Shindell, D., O'Carroll, C.M. (2015). What's the difference between weather and climate?. NASA. Retrieved on March 30<sup>th</sup>, 2020, from <https://en.m.wikipedia.org/wiki/Climate>
- [33]. Singh, A. (2017). How does weather and climate affect the agricultural productivity in India. Retrieved 1 February 2020 from <http://www.myfarminfo.com/blog/how-does-weather-and-climate-affect-the-agricultural-productivity-in-india/>
- [34]. Stevens, B., & Bony, S. (2013). Climate change. What are climate models missing? *Science (New York, N.Y.)*, 340(6136), 1053–4. <https://doi.org/10.1126/science.1237554>
- [35]. Tang, X., Lv, X. and Ouyang, Y. (2016). Spatial and Temporal Variations of Extreme Climate Events in Xinjiang, China during 1961-2010. *American Journal of Climate Change*, 5, 360-372. doi: 10.4236/ajcc.2016.53027.
- [36]. Thornton, P. K., van de Steeg, J., Notenbaert, A., & Herrero, M. (2009). The impacts of climate change on livestock and livestock systems in developing countries: A review of what we know and what we need to know. *Agricultural Systems*. <https://doi.org/10.1016/j.agsy.2009.05.002>
- [37]. Uyigüe, E., & Agho, M. (2007). Coping with climate change and environmental degradation in the Niger Delta of Southern Nigeria. Community Research and Development Centre (CREDC), Benin, Nigeria. CREDC Press.
- [38]. Washington State Department of Ecology. (2016). What is climate change? Retrieved March 27<sup>th</sup>, 2020 from <http://www.ecy.wa.gov/climatechange/whatis.htm>

Ikehi M.E, et. al. “Analysing the Focus of Climate Change Researches for Addressing Agricultural Issues in the Niger Delta region of Nigeria.” *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*, 13(6), 2020, pp. 10-17.