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Impacts of Climate Change on Agricultural Production in Enugu State, Nigeria

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Abstract

Climate Change is increasingly one of the most serious national security threats which will have significant impacts on natural resources, ecosystem and biodiversity. At the same time, it is likely to trigger food insecurity, human migration, economic, and social depression, environmental and political crisis, thereby affecting national development. To analyze the climate change impact on agricultural productivity in Enugu state, the study used primary data that have been collected from Enugu State Agricultural Development Programme (ENADP) on productivity for four decades. Also, rainfall data for thirty years (1981–2010) were collected from Nigeria Meteorological Agency to generate seasonality index and reliability index. The data have been analyzed using descriptive statistics and correlation analysis. Also, literatures were identified for review through a comprehensive search by using electronic and non-electronic databases. Related published literature and documents were searched in a systematic way using a range of key words relating to climate change impacts and agriculture. The study showed a general change in the seasonal rainfall regime. Rainfall regime in the state falls under a markedly seasonal regime with a long drier season; and a reliability of rainfall regime characterized by a more marked variability in the months of maximum rainfall. These changes are notable indicators of climate change. Again, the study showed that all the traditional crops with the exception of cassava and pepper had a significant field decrease as rainfall continued to be more erratic. The literature review indicates that climate change and agriculture both have double-barrel effect on each other. Reducing climate change – induced threats to agriculture that contributes to national development, there will be a need for farmers in Enugu to respond by planting different climate–adapted species, using pesticides and altering the dates of planting, harvesting and irrigation.

Keywords: Climate change; Rainfall; Seasonality index; Reliability index; Agriculture; Productivity

Introduction

The triple whammy problems of rapid increase in population, climate change and pressure on resources are major constraints to adequate agricultural production. Among the three, climate change is the most pressing challenges that the world faces today. Climate change is a defining phenomenon of the century. Given current atmospheric concentrations of Greenhouse Gases (GHGs), the world is already committed to significant warming. This is a serious challenge, given the wide range of expected climate impacts on natural systems, as well as on human societies, as assessed in the most recent report of the Intergovernmental Panel on Climate Change [1]. Climate change threatens to undermine the progress that has been achieved to date, especially in the agricultural sector [2].

It remains unclear; however, what the character of the new climates will be when they become fully established. While certain areas could become drier, others could be wetter. Also major shifts of climatic belts could occur. How, when and where these could happen remain largely unresolved [1]. The Stern Review, for example concluded that (i) the costs of climate change – induced extreme weather events could reach 0.5 – 1% of GDP by the middle of the century; (ii) a 2 to 3 degree Celsius rise in temperature could reduce global output by 3%; and (iii) if that rise should become 5 degrees, up to 10% of global output could be lost. The Review also concluded that it would need 1% of GDP to stabilize emissions at manageable levels.

In Nigeria, the climate change phenomenon manifests in many respects apart from the rising sea level and inundation of coastal lands by sea water. These include increased frequencies of extreme climatic events like strong storms, floods and above average daily minimum and maximum temperature [3]. There have also been marked intra- and inter annual rainfall variability [4]. As shown by Ojo et al. [5], the durations and intensities of rainfall have increased in the last three decades, producing large runoffs, floods and water logging in many places. Also temperature has continued to be above normal with relatively higher figures in 1973, 1987 and 1998. Most stations have had temperature increases of 0.2 to 0.3°C per decade in Nigeria.

The actual and potential impacts of climate change in Nigeria are considerable and have far reaching effects. All sectors of our socio-economic development, including agriculture are vulnerable to climate change. It presents significant threats to the achievement of the Millennium Development Goals especially those related to eliminating poverty and hunger and promoting environmental sustainability.

Productive agriculture is essential to feed a growing population and sustain modern civilization. Climate affects agriculture, a fact well known to every farmer. Year-to-year variations in harvest are largely due to variations in temperature and precipitation that can make the difference between bountiful "bumper" crops and economic ruin. The persistent sahelian drought of 1969 – 73 [6] and later the spell of 1979 – 83 [7] are outstanding examples.

The realization of these impacts, therefore, calls for a more detailed analysis of the threats posed by climate change to agriculture in Enugu State. The main thrust of this paper is to analyze and discuss the effects

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of climate change on agriculture in the state for application in crop production planning.

The Study Area

Enugu State is located on the Northwestern fringe of southeastern Nigeria between latitudes 6°30N and 7°10N and longitudes 6°35E and 7°30°E. It is located in the plains exceeding 200 metres above mean sea level and high lands, which is part of Nsukka – Udi – Okigwe Cuesta.

Enugu State has an estimated population of about 4,1671 million people [8]. The land area is approximately 16,727 square km. The soil type is mostly hydromorphic, which is heavy and composed of silt and clay.

Methodology

Rainfall data for thirty years (1981 – 2010) were collected and analyzed to obtain seasonality index and reliability index. Crop yield data for four years from the four decades were also obtained. Again literatures were identified for review through a comprehensive search by using electronic and non-electronic databases. Related published literature and documents were searched in a systematic way using a range of keywords relating to climate change impacts and agricultural production.

Results and Discussion

Production pattern over the years

Rainfall departures from normal have been reported to be up to 30 percent in the Northern and Southeast parts of Nigeria [9]. Agu [10] reported a 10 percent departure in Enugu areas from 1991 to 1995; while Enete [11] and Enete and Okolie [12] observed a seasonality index of 0.814 (81.4%) for the period 1973-2003 for Nsukka and the Environs.

According to Walsh and lawler [13] classification (Table 1), rainfall regime in the State falls under a markedly seasonal regime with a long drier season; and a reliability of rainfall regime characterized by a more marked variability in the months of maximum rainfall. These changes according to summer [14] are notable indicators of climate change. It should be noted therefore, that the general change in the seasonal rainfall regime observed in the study appeared as a sufficient indicator of climate change in Enugu State. This by implication changed the farming rhythm in the State as well as productivity yield.

S1 Class Limits	Type of Rainfall Seasonality
0.19 and above	Very equable
0.20 – 0.39	Equable with a definite wetter season
0.40 – 0.59	Rather seasonal with a short drier season
0.60 – 0.79	Seasonal
0.80 – 0.99	Markedly seasonal with a long drier season
1.00 – 1.19	Most rains in 3 months or less
1.20 and above	Extreme, almost all rain in 1-2 months

Source: Walsh and Lawler (1981)

Table 1: Classification of Rainfall Regimes.

Table 2 shows the descriptive estimates of production pattern over the years in Enugu State. The highest yield for each decade was selected. These yields were correlated with annual rainfall pattern. It was observed from Table 2 that all the traditional crops with the exception of cassava and pepper had a significant field decrease as rainfall continued to be more erratic. The immediate response to this ugly trend has been increasing use of irrigation throughout the state and a shift from stable crops to economic crops such as pepper, vegetables as well as planting around flood plains of major rivers and streams.

Implications of climate change on agriculture

Changes in atmospheric CO_2, temperature, precipitation, and soil moisture, individually or together, could alter crop production [15]. Higher Atmospheric CO_2 levels could stimulate photosynthesis and crop production - a process called the CO_2 fertilization effect.

In many crops, a significant increase in daytime temperature maxima during the growing season reduces photosynthesis and increase evapotranspiration, leading to a reduction in yield. However, if warming does occur primarily at night, rather than during the day, this could greatly reduce the negative impacts of climate change on crop productivity [16]. A decrease in water availability would results in decreased food production in regions where water becomes critical. Also, as crops are stressed by climate change they become more vulnerable to damaging pests and diseases [17].

Climate also affects animal husbandry. Indirect effects include climate-induced changes in the availability and price of feed grain and in pasture and forage crop yields. Extreme heat can affect the health of animals. For example, heat will kill poultry and decrease milk production in Cows. Also, climate controls the distribution of livestock pests and diseases [18].

Effects of agriculture on climate change

The global flux of several greenhouse gases is influenced by agriculture. Land clearing, much of it from agriculture is the second largest source of CO_2 emissions after fossil fuel combustion, accounting for 10 to 30% of net global CO_2 emissions [15]. Forests, grasslands, and soils store large quantities of carbon per unit area than most crops and when they are cleared for cultivation, much of this carbon is released to the atmosphere. Mean estimates of carbon loss from the conversion of terrestrial ecosystems to agriculture range from 21 to 46% [19].

S/No.	YEAR	1981			1991			2001			2010
	Annual Rainfall	3167.9mm			1824 mm			1393.9 mm			1247 mm
	Crop	Area HA	Prod. MT	Yield HA	Area HA	Prod.MT	Yield HA	Area HA	Prod.MT	Yield HA	Area HA
		"000"	"000"	"000"	"000"	"000"	"000"	"000"	"000"	"000"	"000"
1	Cassava	157.51	1454.5	9.6	234. 9	2215.5	2215.5	9.4	293	3001.5	1o24
2	Yam	78.03	811.6	10.4	83.55	1044.4	14.2	71.1	1114.2	9.4	59.03
3	Rice	27.09	59.6	2.2	28.38	95.34	25	25.06	48.7	2	29.5
4	Coco Yam	106.66	725.3	6.8	106.04	901.4	8.5	95.02	797.7	6.6	52.82
5	Pepper	0.07	0.03	0.42	0.05	0.02	0.31	2.89	4.34	1.5	40.2

Source: ENADP (2010)

Table 2: Crop yield Estimates.

Some agriculture produces Methane (CH_4) – the second-most important greenhouse gas. Paddy rice cultivation is responsible for about 40% of global CH_4 emissions. In flooded rice paddies, microbial decomposition of high organic aquatic sediments, under low oxygen conditions, release CH_4 gas to the atmosphere. This source will continue to grow as rice cultivation expands in the future [15]. Livestock production is responsible for about 15% of global CH_4 emissions. Ruminant animals (cattle, sheep, goats, etc) digest grasses and other cellulose forage in their stomachs and release CH_4 to the air. Cattle represent about 75% of the total livestock CH_4 emission.

Nitrous oxide (N_2O) is another greenhouse gas closely linked to agricultural activities. Like carbon, Nitrogen in vegetation and soils is lost to the atmosphere during land clearing. Also, nitrogen fertilizers are applied to crops, and generally enhance growth. However, excess nitrogen from fertilizers is leached into the soil and, through microbial denitrification, converted to volatile N_2O and released into the atmosphere. Estimates of N_2O release from agricultural fertilizers range from 0.1 to 1.5% of applied nitrogen [15]. Again, different agricultural practices have different consequences for greenhouse gas emissions. Intensive agriculture uses large quantities of fossil fuel for tilling and harvesting and soil carbon can be depleted.

Adaptation Strategies

There are a number of influences that could mitigate the negative effects of climate change on crop production. First, and perhaps most important, is the potential for farming practices to adapt to climate change by planting different climate-adapted species, using pesticides, or altering the dates of planting, harvesting and mitigation. Such adoptions could minimize the impacts of climate change on crop yields.

Conclusion

Climate change will have direct impacts on agriculture in Enugu State. While some crops, like cassava or pepper may increase in their yield or range, climate change will increase existing risks of extinction of many threatened crops or lead to reduction in productivity. Climate change is expected to increase the frequency and intensity of severe weather events. Unfortunately, Enugu State like many other states in Nigeria largely lacks the infrastructure necessary to respond adequately to such events. Diseases such as malaria are likely to have wider ranges, impacting more poor farmers that are already most affected by such diseases. In the same manner, pest and crop diseases will expand affecting quantity and quality of crops.

Changing rainfall pattern in Enugu State could devastate the rain-fed agriculture on which Enugu farmers depend on for survival. Increased occurrence of drought may lead to reduced agricultural yields and diminished food security. Water supplies may also be altered, primarily through changes in temperature and rainfall. In general, climate changes have the potential to lead to large disruptions in agricultural sector in the state and have adverse impacts on food security.

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