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# Assessment of Environmental Degradation Caused By Drought Copping Strategies in Yobe State

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**ABSTRACT:** Many studies have highlighted the threats of drought in the context of climate change. Droughts have caused more damage in the second half of the 20<sup>th</sup> Century than any other weather events. This paper reviews the threats of drought and its impacts in Yobe State, Nigeria. Drought has had both direct and indirect impacts on physical, social and economic phenomena. Habitat destruction, livestock mortality, water scarcity and species extinction will probably increase in the future due to climate change. Questionnaires were administered to farmers in Yobe State to evaluate the impacts of drought. Some 1,040 questionnaires were distributed and 721 were filled and returned (return rate of 69.3%). It is believed that the effects will be more pronounced and severe in semi-arid regions, including the Sahel of West Africa. Yobe State is in semi-arid north-east Nigeria, where results from the survey show that drought affects people's livelihoods and environment. The survey should contribute to improved understanding of drought in Yobe State and to aid recommendations for mitigation. This study has proposed a new definition of drought i.e. *"Drought is the shortage of rainfall or water that affects people's livelihoods and the environment, both directly and indirectly."* Further work will utilise this definition to evaluate the impacts of drought.

**KEY WORDS:** Drought, climate change, weather events, Sahel, semi-arid, environment.

## I. INTRODUCTION

Drought is one of the most damaging natural disasters in terms of lives lost and economic effects (Van Loon and Laaha, 2014). It is regarded as a natural phenomenon and impacts accumulate slowly over a long period. Drought is insufficient precipitation that leads to water scarcity, which is triggered by meteorological parameters, including temperature, precipitation and humidity (AMS, 1997). There are several definitions of drought, all depending on the research focus and impacts of drought. It is a shortage of precipitation in a particular place over an extended time, which may be weeks, months, years or decades (Solh and Maarten, 2014). There are debates over definitions of drought. Some studies agree that rainfall deficiency is the main cause of drought (Agnew and Chappell, 1999; Palmer, 1965). Tannehill (1947) stressed insufficient soil moisture content, whereas others (Solh and Maarten, 2014; Wilhite, 2005; Van Loon and Laaha, 2014) used deficiency of precipitation.

There are four identified types of drought; these are meteorological, agricultural, hydrological and socio-economic drought. This study highlights the probable effects of future climate change on drought and recommends possible mitigation measures to address these impacts. The effects of drought in Yobe will be discussed. Research aims to develop a mitigation strategy to minimise future impacts of drought in the State. For this study, a literature review was conducted to synthesise collected information on global impacts. This is to advocate the importance of drought mitigation and management to reduce future intensity, severity and distribution on vulnerable communities. This study has therefore proposed a new definition of drought. Drought has no universal definition, and the proposed definition is: *"Drought is the shortage of rainfall or water that affects people's livelihoods and the environment, both directly and indirectly"*.

Climate change is one of the multiple factors considered to increase drought vulnerability in Sub-Saharan Africa (SSA). It is probable there will be frequent and severe drought events in the region due to changing climate (Williams and Funk, 2011). Numerous studies (Olesen and Bindi 2002; Mirza, 2003; IPCC, 2007) have emphasised the issue of climate change and its impact on many sectors and aspects of the environment and



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economy. For example, Europe has witnessed increased mean surface temperatures of  $\sim 0.8^{\circ}\text{C}$  over the 20<sup>th</sup> Century. Global Climate Modelling (GCM) simulations of annual temperatures in Europe showed that the continent has warmed by  $0.1\text{--}0.4^{\circ}\text{C}$  in the past two decades (Olesen and Bindi, 2002; Smith and Olesen, 2010; IPCC, 2014). However, despite the projected rise in temperature in Europe, it is expected that southern and north-eastern Europe will experience most temperature increase (Parry, 2000).

## II. EFFECTS OF DROUGHT AND ENVIRONMENTAL DEGRADATION

Africa is well-known for desertification and drought (Agnew and Chappell, 1999). The Continent has one of the harshest climate conditions in the world (Sivakumar and Wallace 1991). Africa's drylands are characterised by high temperatures, low humidity, low soil moisture and variable rainfall. There are three African regions where drought is a dominant feature, the Kalahari-Namib region, the Sudano-Sahelian region and Mediterranean Africa (UNEP, 1992). Drought often occurs in SSA and affected over 40 million people in the 1980s. Due to the unpredictable climate variables in the Sahel, climatologists have failed to understand the extent of droughts. Many natural disasters affect Africa, but drought has the most negative impact in terms of the number of people affected (Vicente-Serrano *et al.*, 2012). Drought has also caused epidemics and land degradation across Africa and is among the natural disasters that have caused highest mortality in Africa. From 1974-2007  $\sim 450,000$  people died due to drought (Vicente-Serrano *et al.*, 2012).

In 2011, severe drought struck Somalia, causing an immense humanitarian crisis, which affected over 10 million people; 2 million among them were malnourished children. Some 380,000 refugees migrated to Kenya (Vicente-Serrano *et al.*, 2012). In Africa, one-third of the Continent is described as desertified and  $\sim 73\%$  of agricultural lands are degraded (UNEP, 1992). If there are two-three seasons of drought across those regions, it causes severe environmental stress. In Africa, drought and floods account for  $\sim 80\%$  of life and economic loss (Bhavnani *et al.*, 2008). In 1990/1991 the GDP of Zimbabwe decreased by 11% due to drought related-issues. In Kenya, the 1999 and 2001 droughts cost an estimated \$2.5 billion (Bhavnani *et al.*, 2008).

Wossen *et al.* (2017) showed that lack of formal insurance and a safety net in most African countries further increase vulnerability. Having such measures would reduce drought shock on farmers and increase their ability to cope. Farmers in Australia have the safety-net of insurance from the government and other financial support. Improving the drought tolerance of crops can also serve as means of reducing drought risk to enhance future food security and simultaneously serve as insurance against crop failure (Wossen *et al.*, 2017). Crop production during drought depends on its length and timing (Bodner *et al.*, 2015). Drought decreases agricultural land productivity and thus food supply. Many people migrate from rural to urban areas due to drought, which increases stress on water and other natural resources. In the past three decades, there have been efforts by governmental and non-governmental organisations, for example the 'Organisation of African Unity', to address the issues of drought and desertification in Africa (Msangi, 2004). The effort was introduced due to the 1968-1973 droughts, where the affected areas included the Eastern Sahel and Southern Africa. This was the first time in the Continent where ecological degradation received full attention from governments. Some countries have faced rainfall shortages, including Zambia, Tanzania, Namibia, Kenya, Somalia, Zimbabwe and South Africa, which decreased their agricultural production (Edossa *et al.*, 2010). Rainfall received in these countries was mostly well below average, which led to starvation and human deaths. Droughts have damaged fragile ecosystems, increasing desertification in some parts of those countries (Msangi, 2004). This led to habitat fragmentation, destruction and loss, which endangered the survival of many species of flora and fauna (Wood *et al.*, 2000). In Africa, drought issues are usually regional rather than general disasters. Ethiopia has faced severe droughts, which occur once every 10-15 years (Abate, 1994).

## III. DROUGHT IN YOBE STATE

Yobe State (lat.  $10.578\text{--}13.377^{\circ}\text{N}$ ; long.  $9.654\text{--}12.689^{\circ}\text{E}$ ) is among the 36 states of Nigeria and covers  $47,153\text{ km}^2$  (Figure 7). According to the National Population Commission (NPC) Yobe State had a population of 2,321,339 million people at the last (2006) census (NPC, 2006). In the study area, desertification and drought are the main environmental issues and the region has long dry seasons, recurrent drought, skeletal soils and sparse vegetation cover (Dabi and Anderson, 1999; Obi, 2012). It shares western boundaries with Jigawa and

Bauchi States; Gombe and Borno States to the south-east and an international boundary of 323 km with the Niger Republic to the north (Abdullahi *et al.*, 2006). Yobe State is located in the Sudano-Sahelian vegetation zone of Nigeria, which is characterised by hot and dry weather for most of the year (Abdullahi *et al.*, 2016). The State has 17 Local Government Areas (LGAs) (i.e. Bade, Bursari, Damaturu, Fika, Fune, Geidam, Gulani, Jakusko, Karasuwa, Nangere, Nguru, Potiskum, Tarmuwa, Yunusari, Gujba, Machina and Yusufari (Abdullahi *et al.*, 2016).

#### IV. METHODOLOGY

A questionnaire survey was used to obtain field information on drought from farmers in Yobe State. The results provided insights on how drought affects human activities and the environment in Yobe. In this study, quantitative methods were employed, which was considered the most suitable method for the empirical study.

#### V. QUANTITATIVE METHODS

Quantitative research is an investigation used for testing hypothesis based on variables. It is measured numerically and analysed statistically to determine whether to reject or accept a hypothesis (Amaratunga *et al.*, 2002) and can be used to explain social phenomena (Bryman, 2008). Researchers choose, based on how accurate the method addresses their problems (Huberman and Miles, 1994). In social science research, survey is the most used technique and was thus used in this research. It is also used to collect opinions from the sample population (Creswell, 2014). Questionnaire survey is highly suitable technique to collect large data-sets, thus this research employed the sampling technique. Quantitative methods ideally involve probability sampling to enable statistical inferences (Creswell and Clark, 2007).



Figure 7: Map of Nigeria showing the location of Yobe State and the State Capital (Damaturu) (Source: Google, 2016).

#### VI. QUESTIONNAIRE SURVEY

Questionnaire surveys are widely used to gather information on peoples' opinions and views. Questionnaires usually contain close-ended questions, (e.g. 'Yes'/'No,' 'Agree'/'Disagree,' and a ranking scale for participants to choose from. There are questionnaires that contain few open questions, which give respondents free options to choose or write their opinion (Denscombe, 2007; Abubakar, 2013). Some studies use standardised questionnaires; thus, adopting a standardised format of questions (Denscombe, 2007). Other studies used customised questionnaires that are adapted to the purpose of their research. There are no strict rules on how to design a questionnaire, but it is important that the questionnaire addresses the research objective(s) (Smith,



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2010). This study administered 1,040 questionnaires to Yobe State farmers and 721 were completed and returned, a return rate of 69.3%. The results tables are presented in Appendix A.

## VII. SURVEY RESULTS

Some 97.9% of respondents considered themselves to be 'victims of drought,' whereas 2.1% of respondents did not (Table 1). Most respondents practise rain-fed farming (Table 2). Drought severely affected social activities and the environment in Yobe State. Some 96.2% of farmers believed that drought highly to severely affects social activities (Table 3). Respondents were asked to estimate their harvests loss due to drought in the past 10 years (2009-2019) and most farmers lost an estimated 70-80% of their harvests due to drought (Table 4). An assessment on how drought affects livestock showed that 97.8% of respondents lost  $\geq 5$  livestock (Table 5). Some 93.5% of respondents believed that drought occurred  $\geq 3$  times over the past decade (2009-2019) (Table 6). During droughts people use different coping strategies (Table 7). Responses strongly suggest that drought has caused severe harvest losses and increased food prices in the markets. There was need to investigate if poverty causes environmental damage in Yobe State. Some 88.5% of farmers believed that drought causes severe to very severe environmental damage (Table 8) and 98.5% of respondents believed that drought causes desertification (Table 9).

## VIII. DISCUSSION

Attempting to comprehensively define drought is complex. Several studies (e.g. Palmer 1965; Agnew and Chappell 1999; Udmaleet *al.*, 2014; Solh and Maarten 2014) provided different definitions of drought. The definition considered most apt for socio-economic drought is that of Wilhite (2005), who defined drought as "*the deficiency in precipitation that, when extended to a particular period, is insufficient to meet the needs of human activities and environmental demand.*" Numerous studies have identified four types of drought, which are meteorological, agricultural, hydrological and socio-economic droughts (Wilhite, 2005; Wanders and Wada, 2014). Based on the information gathered in this study, a new definition of drought is proposed as "*the shortage of precipitation or water that affects people's livelihoods and the environment, both directly and indirectly.*" Many definitions of drought have not stated both the direct and indirect impacts of drought, as shortages of water or precipitation affects both people and the environment directly and indirectly and *vice-versa*.

All types of drought have different impacts on society and the environment. However, socio-economic drought is linked, either directly or indirectly, to all types of drought. Figure 10 explains how the different types of drought form socio-economic drought. The manifestation of the different types of drought over time develops into socio-economic drought. Decreased precipitation affects recovery levels of water bodies and agricultural production. Ground-water levels fall, decreasing water supply via boreholes, hand-pumps and wells for human activities. Other types of drought can develop into socio-economic drought, which is defined on the basis of how it manifests.

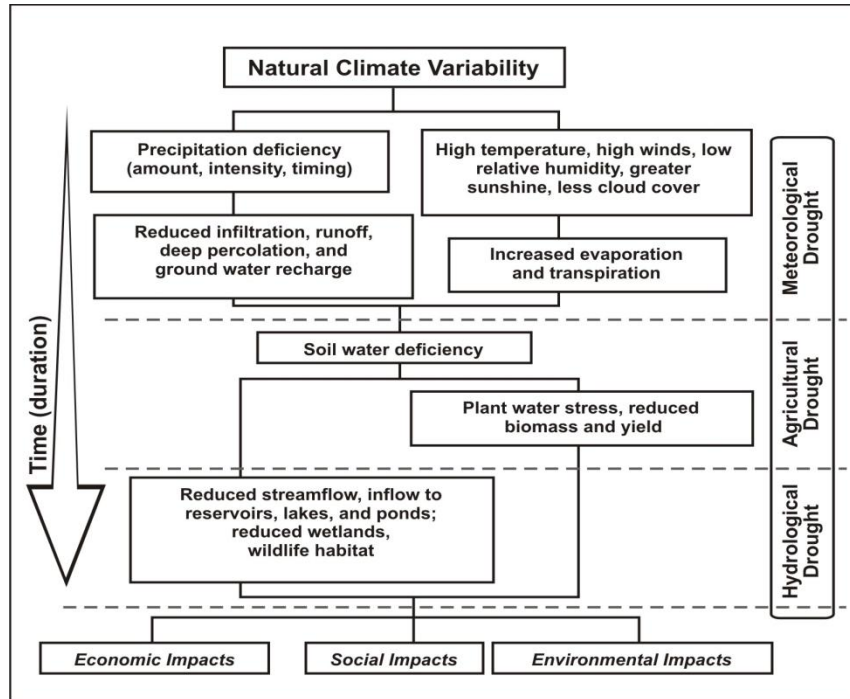


Figure 10: Different types of drought and their connection with socio-economic drought (Source: Okorie, 2003).

Drought effects are intensifying due to current patterns of climate change and there is an urgent need to prepare and plan for drought mitigation and management in order to decrease impacts on people’s livelihoods, environment and water resources. Improper drought mitigation and management will further affect the world’s drylands, which are especially prone to damage by drought (Wilhite, 2005). Hence individuals, communities and governments have roles to play in drought mitigation and management processes. Results from the questionnaire survey showed that drought has affected many farmers in Yobe State in multiple ways. Drought has caused environmental degradation, further damaging dryland ecosystems. Sahelian farmers depend on rain-fed farming (Shiferaw *et al.*, 2014) and the same applies to Yobe farmers. Results from the survey showed drought has occurred within every two years in the last decade (2009-2019) in Yobe State. Drought occurrence has increased in Nigeria during the 2<sup>nd</sup> half of the 20<sup>th</sup> Century (Shiruet *et al.*, 2018). Most respondents have lost their harvests over the last decade due to persistent drought, with losses of 70-80% of their harvests and livestock. This threatens livelihoods, as most farmers’ are unemployed with no alternative source of income.

In Yobe State, most farmers reduced the size of their farms for fear of losing more harvests. However, other farmers migrated to greener pastures for their harvests and some farmers resort to deforestation, especially after high harvest losses. It is also difficult for farmers to store for the eventuality, as they hardly harvest enough for a year, let alone store for anticipated drought. Many drought victims tend to end up in abject poverty if there is recurrent severe drought. Farmers generally believed that poverty causes further environmental damage after drought (Table 8). The act of cutting down trees without replacement causes habitat fragmentation, habitat destruction and decreased floral and faunal populations (Musa and Shaib, 2010). Farmers recognised that desertification has increased due to their activities.

Farmers believe they can be assisted by the government to reduce drought impacts and desertification. According to the survey results farmers lost 16-20 of their livestock during drought over the last decade (2009-2019). Farmers showed that livestock sales cannot compensate for their harvest loss. Due to lack of feed and risk of livestock hunger, the market value of livestock drops. It is important to have measures in place to address the problems of environmental destruction in Yobe State. Land degradation in the Sahel is caused by climatic drought and anthropogenic factors (population growth, over-grazing and agricultural activities) (UNISDR,





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2011). Most Africans are dependent on agriculture as their main source of income, ~80-90% of the people in the Continent, especially in the Sahel region are actively involved in agriculture. This research established that there is severe environmental degradation and improper land management in Yobe State, including bush burning, deforestation, overharvesting and overgrazing on marginal land. Farmers overwhelmingly believed that their activities affect the environment. Proper agricultural practises and support for farmers will reduce the rate of environmental degradation caused by farmers in Yobe State. This can be achieved through training, education and proper land use management.

## IX. CONCLUSIONS

Drought and its impacts are invidious issues. Climate change is a global problem and it is difficult to predict future trends of weather events, including drought and floods. Future weather events will probably be more severe and costly in terms of damage. Rainfall patterns in Yobe State are generally low but variable; increasing the vulnerability of Yobe to drought. Farmers stated that their major problem is rainfall, which they said has been inconsistent in recent years. The increasing demand for water across the globe due to population and economic growth and social demand makes drought impacts a global problem that needs to be mitigated. Survey results from Yobe showed that drought has affected people's income, which in turn has negative environmental impacts. It is evident that drought has caused major environmental degradation such as over-hasting, bush burning, deforestation and overexploitation of natural resources including water and fish resources. As a contribution to progress, a workable framework for drought amelioration is being developed for Yobe State.

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## Appendix A

### Tables of results

Table 1 Drought victims

Are you a drought victim?					
		Frequency	%	Valid %	Cumulative %
Valid	Yes	706	97.9	97.9	97.9
	No	15	2.1	2.1	100.0
	Total	721	100.0	100.0	

Table 2: Types of farming practised

Type of farming				
		Frequency	Valid %	Cumulative %
Valid	Irrigated farming	51	7.1	7.1
	Rain-fed farming	452	62.7	69.8
	Livestock farming	46	6.4	76.1
	Mixed-farming	172	23.9	100.0
	Total	721	100.0	

Table 3: Effects of drought on social activities

How drought affects social activities				
		Frequency	%	Cumulative %
Valid	Moderate	27	3.7	3.7
	High	445	61.7	65.5
	Severely	249	34.5	100.0
	Total	721	99.0	



Table 4: Loss of harvest in the last 10 years (2009-2019)

Loss of harvest in 10 years					
	%	Frequency	%	Valid %	Cumulative %
Valid	30-40	30	4.2	4.2	4.2
	50-60	112	15.5	15.6	19.7
	70-80	381	52.8	52.9	72.6
	90-100	197	27.3	27.4	100.0
	Total	720	99.9	100.0	
Missing	System	1	0.1		
Total		721	100.0		

Table 5: Numbers of livestock deaths due to hunger

Number dead livestock				
		Frequency	%	Cumulative %
Valid	0-5	16	2.2	2.2
	6-10	181	25.1	27.3
	11-15	176	24.4	51.7
	16-20	220	30.5	82.2
	≥20	128	17.8	100.0
	Total	721	100.0	

Table 6: Past drought events in last 10 years(2009-2019)

Past drought events in 10 years					
		Frequency	%	Valid %	Cumulative %
Valid	0-2	47	6.5	6.5	6.5
	3-5	328	45.5	45.6	52.1
	6-9	109	15.1	15.1	67.2
	≥10	236	32.7	32.8	100.0
	Total	720	99.9	100.0	
Missing	System	1	0.1		
Total		721	100.0		

Table 7: Drought coping strategies through sales, migration and reducing farm area

		Frequency	Valid %	Cumulative %
Valid	Reduce area of harvest	159	22.1	22.1
	Sell stored stock	303	42.2	64.3
	Sell livestock	38	5.3	69.6
	Migration	206	28.7	98.3
	Do not harvest	12	1.7	100.0
	Total	718	100.0	
Missing	System	3		
Total		721		



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Table 8: Poverty causes environmental damage

		Frequency of respondents	%	Valid %	Cumulative %
Valid	Moderate	83	11.5	11.5	11.5
	Severe	307	42.6	42.7	54.2
	Very severe	329	45.6	45.8	100.0
	Total	719	99.7	100.0	-
Missing	System	2	.3	-	-
Total		721	100.0	-	-

Table 9: Drought and desertification

Drought causes desertification?				
		Frequency of respondents	%	Cumulative %
Valid	Yes	710	98.5	98.5
	No	11	1.5	100.0
	Total	721	100.0	-