Research Article

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Climate change impacts on cattle production: analysis of cattle herders' climate variability/ change adaptation strategies in Nigeria

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Abstract: The study examines the seasonality in climate and extreme weather events, and its effect on cattle production in the Guinea Savannah ecological zone of Nigeria. The study uses both quantitative and qualitative approaches. Climate data of 34 years were used to examine the trends in rainfall pattern and climate variability while household survey was used to appraise the herders' awareness of climate variability/change impacts and adaptation strategies. Cumulative Departure Index (CDI) method was used to assess the extreme weather events while descriptive statistics and multinomial logistic (MNL) regression model were used to identify the factors that determined herders' adaptation strategies to climate change. The results revealed a significant spatiotemporal variation in both rainfall and temperature with CDI ranging from -1.39 to 3.3 and -2.3 to 1.81 respectively. The results revealed a reduction in the amount of water available for cattle production. From survey results, 97.5% of the herders identified drought as the major extreme weather event affecting livestock productivities in the study region. In the herder's perception, the droughts are more severe in recent years than 34 years ago. The results from MNL revealed that extreme weather events, such as drought, has a positive likelihood on migration, at a 10% level of significance, the events has led to migration of cattle herders from the northern part of the study area toward the southern part in recent years.

Keywords: Climate change, extreme weather events, livestock production, Nigeri

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1 Introduction

The demand for livestock products in the world is fast increasing due to a rapid increase in world population leading to growing demand for meat, especially in developing countries. This trend is expected to rise the number of livestock reared worldwide, a setting which is threatened by climate change (Banik et al., 2015). Despite the high demand for livestock products, the impacts of climate change on livestock have been reported in many research publications (Tubi and Feitelson, 2016, Zhang et al., 2013, Neibergs et al., 2017). The foremost impact of climate change on herders is the loss of livestock, which results in reduction in the food supply to the ever-increasing population, especially in Africa (Clarke et al., 2012). Other studies have shown that the reductions in the number of cattle are due to death caused by lack of green pasture during extreme drought events, disease and starvation, as herders do not have enough fund to buy processed food for the cattle(Kabonesa and Kindi, 2013, Ojima et al., 2017, Roever et al., 2015). Nonetheless, the response of herders to climate change varies greatly due to differences in their adaptive capacities (Grothmann and Patt, 2005, Martin et al., 2008). Herders' responses to climate change are determined by many factors. It has been reported that farmers' experiences, level of education, lack of confidence on protective measures or perceived ability to carry out these measures, lack of adequate and timely information, available resources and innovation or costs of response actions are seen as the main important factors (Davies, 2016, Mortimore and Adams, 2001, Leach et al., 1997, Ayanlade et al., 2017). Thus, herders in sub-Saharan Africa are going to be much more vulnerable to climate change compared to those in the developed country. This is due to the fact that herders in sub-Saharan Africa are high dependence on natural pasture which is under the threat of climate change (Leal Filho, 2010, Change, 2001, Neibergs et al., 2017).

The impacts of drought have recently been the focus of a number of publications in very different regions, but the effects of drought on herders have only been discussed in recently years discussed (Tubi and Feitelson, 2016, Zhang et al., 2013, Neibergs et al., 2017). In recent years, studies have examined the effects of drought on livestock populations as one of the evidences of climate change impacts on livestock management systems in African rangelands (Martin et al., 2014, Thornton et al., 2015, Descheemaeker et al., 2016, Carfagna et al., 2018). Earlier studies have reported that with the projected impacts of climate change, African farmers, might not be able to tame the future/present adverse effects (Azuwike and Enwerem, 2010, O'Brien et al., 2009). What is obvious from literature is that the majority of recent studies reported that farmers in Africa regions have the low adaptive capacity to the anticipated climate change, consequential of the high level of poverty, lack of economic and technological resources, and insufficient safety nets, inadequate accessibility to social amenities and high level of illiteracy (Olawuyi, 2018, Ayanlade et al., 2018a, Ayanlade et al., 2017, Bryan et al., 2018, Crick et al., 2018, Zougmoré, 2018).

In Nigeria, cattle are very sensitive to extreme climate events; as temperature and rainfall determine the water availability, level of comfort, and consumption pattern of the cattle. During drought and intervening dry spell, cattle drink more water and less digestible feed need more water; this is because water is needed to maintain coarse feed in the cattle gut system (Hassan et al., 2019, Ayanlade et al., 2018b, Ibrahim et al., 2019). This widens the disparity of water supply to water demand of cattle; as there is less water available with the occurrence of drought to meet increased demand for water caused by drought. This divergence necessitates the constant migration of Fulani herders from an area with low water availability and dry pasture to where there are perennial water supply and green pasture. The Fulani herders are the major herders in West Africa, who engage in cattle tending. However, if Fulani herders are unable to peacefully coexist with their host communities, particularly farmers, they can only survive either by settling, by flexible movement patterns that involve encountering new arable communities every year or by intimidation of the farmers. Different Fulani herdsmen group sometimes practices all of these simultaneously. Increased competition of pastoralists for a declining 'stock' of grazing land and the inability of most Fulani herdsmen to build a peaceful relationship with the host community has pitched the Fulani herders against farmers (Dewan, 2019). The conflict between the host community and Fulani herdsmen has become so common especially in the Guinea Savannah of Nigeria. Conflicts between the herdsmen and the crop farmers, made local authorities in Borno and Plateau states to expel 700 pastoralists from Borno state in the northeast in May 2009, and some 2,000 from Plateau in April 2010, respectively (Chigozie, 2012, Ducrotoy et al., 2018, Bukari and Kuusaana, 2018, Maiangwa, 2017).

Hitherto, most of the studies in this region focused on Sudan and Sahel Savannah areas (Kutama et al., 2010, Adejuwon, 2006), several others address the issue globally with little or no consideration given to the climate change in the Guinea Savannah- especially its impacts on cattle rearing. Also, detailed accounts of the effects of climate change on individual herder under traditional pastoral conditions are missing. Majority of earlier studies in Guinea Savannah looked into climate variability on another aspect of agriculture such as tuber crops, maize and farm crops (Ayanlade et al., 2010, Odekunle et al., 2007, Ayanlade, 2009), with no attention given to cattle rearing in the region. Thus, the present study is intended to help fill this gap. This present study aims, therefore, at assessing the major extreme weather events; it impacts on water availability for cattle production and the cattle herders' responses to climate change in Guinea Savannah ecological zone of Nigeria. This study is based on the hypothesis that the primary impacts of climate change in Guinea Savannah of Nigeria is the incidence of prolonged drought and intervening dry spell, which affects water availability and vegetation distribution thereby affecting the availability of pasture for feeding cattle.

2 Materials and methods

2.1 Study area

The study area is the Guinea Savannah of Nigeria, located in the "middle belt" of the country (Figure 1). It is approximately between latitude 6^{O} -10^{O}N of the equator and longitude 3^{O}-13^{O}N and is the most extensive ecological zone, covering almost half of country. The region is characterized as typical of the West African Savannah climate with annual rainfall of 700–1600 mm with the wettest months are August and September. The mean monthly temperature ranges from 26.7°C in the south to 27.8°C in the northeastern part (Kowal et al., 1972). Maximum temperature can reach 40°C, particularly in April while minimum temperature can be as low as 18°C between December and January. The climatic patterns are as a result of the movement of the inter-tropical convergence zone. The climate and soil types of all

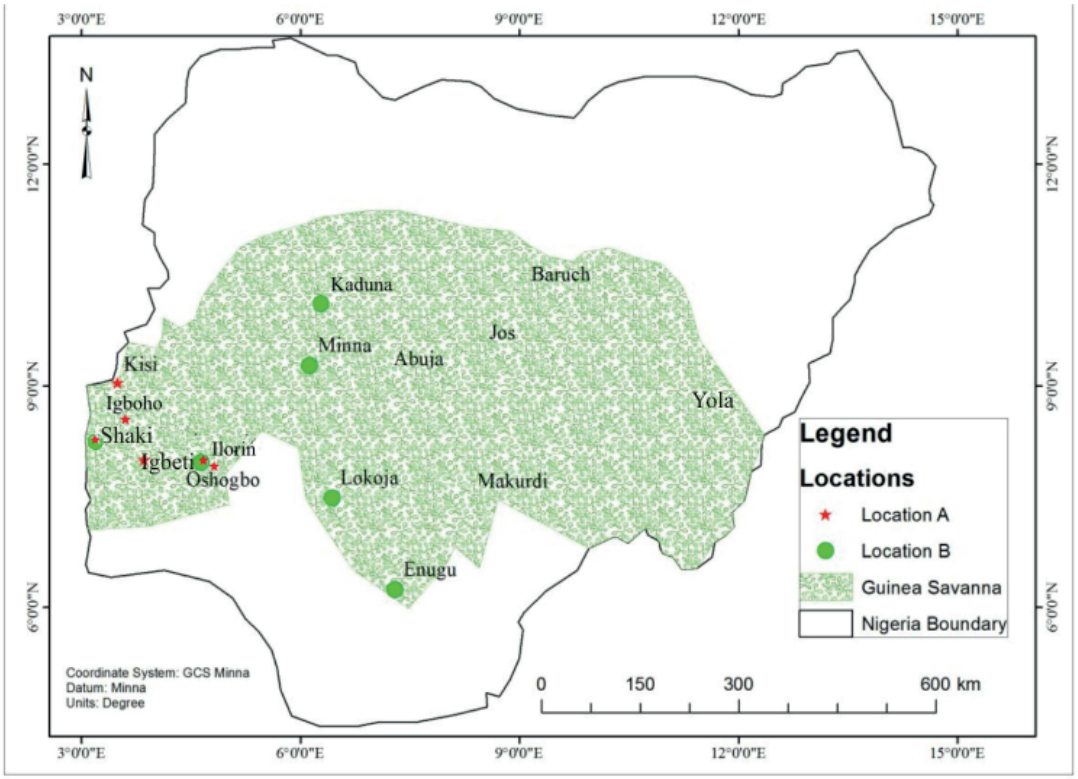

Figure 1: Map of Nigeria showing the study area and the sites where climate data (locations filled with circles) and survey data (asterisked locations) were collected.

Guinea Savannah of Nigeria give opportunities for mass agricultural production. The area is endowed with a good climatic condition which favours the mass production of the livestock on which this study focuses.

2.2 Data collection and analysis

Both climate and survey data were used in this study. Daily rainfall data was used to examine the pattern of rainfall in the study area. The data covered six weather stations: Enugu, Shaki, Ilorin, Kaduna, Lokoja and Minna, spanning 34years (more than three decades) from 1984 to 2017. Survey data were collected through structured questionnaires and in-depth interviews. The major aim of using survey is to understand the herders' response to climate variability in the study region. To achieve this, formal questionnaire surveys were carried out targeting two different groups: the herdsmen and the herders' wife on the field and in their huts. The data collected through survey include age, marital status, educational status, average monthly income, religion and ethnic, years of farming experiences. The study examined the perception of herders on extreme climate events such as; water availability and coping strategies of cattle rearing**;** the element of weather that has a critical effect on the cattle, extreme climate event which is the major threat to the herders' cattle, a major source of water supply, the average amount of water a cattle consume daily, the distance covered in seeking for water during rainy season and the distance covered in seeking for water during drought and prolonged the dry season.

This study used questionnaire because of the inherent ability of a questionnaire to collect a large amount of information from a large number of people in a short period of time and in a relatively cost-effective way. To validate data collected through questionnaire, the study adopted group interviews with some herders in each village. This study used both questionnaire and face-to-face interview because of the importance of both methods of collecting quantitative data and to eliminate disadvantages posed by using only one of them. The interview of old herdsmen helped in gathering data based on their experience on drought and cattle rearing; it generated data on the occurrence of drought and effect on cattle rearing, and adaptation and coping strategies adopted to ameliorate the effect on cattle production. A total number of 100 questionnaires were administered

Table 1: Distribution of sampled rangelands.

Location	Total number of sampled herdsmen	Total number of sampled herdsmen wives	Total
Eyenkorin	10	2	12
Igbeti	16	3	19
Igboho	16	3	19
Ilorin	12	4	16
Kisi	12	4	16
Shaki	14	4	18
Total	80	20	100

Source: Field Survey 2017, 2018/2019

using random sampling while a minimum of 6 herders were interviewed in each location (Table 1). Because of their low level of education, each questionnaire was administered at the point of contact with the respondent. Therefore all questionnaires (100) administered were retrieved. This study was based, therefore, on climate and survey data because of the inherent ability of these sources of data to give valid and precise data. The social survey was conducted in this study to acquire data from the cattle herders in order to know the effects of climate change on cattle rearing in the Guinea Savannah of Nigeria, and the local adaptation and coping strategies adopted during this period. Climate data complemented the survey data, thus, the combination of survey data and climate data made the result of this study a tenable one. Combination of both methods of data collection helped to examine how survey information actually mirrors the historical meteorological data.

To understand the spatiotemporal rainfall variability in the Guinea Savannah; a study year is divided into three periods: early growing season, late growing season and dry season. The early growing season ranges from April to mid-July as early wet season, mid-July to October is classified as the late growing season, and the dry season which is always characterized with Harmattan and dry weather is between November and March. Both descriptive and inferential statistics were used for this study. Cumulative Departure Index (CDI) method was used to assess the extreme weather events while descriptive statistics and the multinomial logistic regression model were used to identify the factors that determined herders' adaptation strategies to climate change. CDI was used to assess the annual and seasonal rainfall variability and intensity of dry spell during growing seasons; patterns of onset and length of both dry and rainy season; and assessment of the overall intensity and within-season rainfall. Cumulative Departure Index (Hein et al., 2019, Ayanlade et al., 2017, Ashipala, 2013) was calculated using:

$$\mathrm{CDI} = \frac{(Ra - Rm)}{SD} \quad (1)$$

Where CDI is the cumulative departure index; R_a is the actual rainfall for the dry season, early rainfall season and late rainfall season (developed from monthly rainfall data); R_m is the mean rainfall while SD is the standard deviation of the total length of the period of study.

Multinomial logit (MNL) was used to analyze the factors of herders' adaptation decisions to climate change; the choices of adaption options, the herders' responses and what factors determine those choices (Abid et al., 2015, Deressa et al., 2009). The MNL was used in this study because it permits the analysis of decisions across more than two categories of variables (Equations. 2 and 3), allowing the determination of choice probabilities for different categories (Wooldridge, 2002). This approach allowed a high level of specification of the relations between adaptation strategies and underlying socioeconomic variables which determine the choice of climate change adaptation methods. The model is specified as follows:

$$P_{(y = j/x)} = 1 - (P_1 + P_2 + P_3 + \cdots P_j) \quad (2)$$

Let *Y* denote a random variable with values (1.2.....j) for a positive integer *j* and *x* set of variables (Wooldridge, 2002). In this study, *y* is a dependent variable that represents the adaptation strategies from the set of adaptation measures, whereas *x* represents the factors that influence the choice of adaptation strategies and P_1, P_2...*Pj* as associated probabilities, such that $P_1 + P_2 + \ldots + Pj = 1$. This explains how a certain change in *x* affects the response probabilities

$P(y = j/x)$, $j = 1, 2...J$. Since the probabilities must sum to unity, $P(y = j/x)$ is determined once the probabilities for $j = 2...J$ are known.

In the MNL model, it is usual to designate one as the reference category. The probability of membership in other categories is then compared to the probability of membership in the reference category. Consequently, for a dependent variable with j categories, this requires the calculation of $j - 1$ equations, one for each category relative to the reference category, to describe the relationship between the dependent variable and the independent variables. The estimation of the MNL model for this study was conducted by normalizing one category which was named as "base category". The responses (adaptation measures) of herders were grouped into three and the base category was "others strategy." The theoretical explanation of the MNL model is that in all cases, the estimated coefficient should be compared with the base group or reference category (Gujarati, 2004). Therefore;

$$\Pr_{(yi = j/x)} = \mathrm{pr}_{ij} = x = \frac{\exp(x\prime\beta j)}{\sum_{J=2}^{J} exp(x\prime\beta j)} \qquad j = 1, 2 \ldots J \qquad (3)$$

For j > 1 the choice of the reference category was based on empirical literature and theoretically motivated. The generalized form of probabilities for an outcome variable with j categories is the parameter estimates of the MNL model only provide the direction of the effect of the independent variables on the dependent (response) variable; estimates represent neither the actual magnitude of change nor the probabilities (Belay et al., 2017).

3 Results and discussions

3.1 Rainfall variabilities during early and late growing seasons

Figures 2 and 3 illustrate the CDI of the rainfall during growing seasons for the selected study sites over the periods between 1984 and 2017. The results revealed both intra and inter annual variability in both early and late growing season rainfall in all the selected stations. The rainfall varied greatly, with a reduction trend in rainfall and high intensity of the dry spell during both growing seasons. The results revealed a reduction in the amount of annual rainfall, with virtually no two consecutive years having the same amount. The variation is not only within the year but also between the early and the late growing seasons, which indicates that the region is characterised by of extreme climate events within the growing seasons (Figures 2 and 3). There appeared to be a high rainfall fluctuation in recent years, with the much recurrent incidence of drought and intervening dry spell in the region. It is obvious that out of 34 years, only 7 years have relatively normal and below normal of dry spell intensity during the early growing season (Figure 4A), however nearly 10 years out of 34 years during late growing seasons (Figure 4). This result implies that rainfall was much more varied in the early growing season than the late growing season, with nearly 23 years' experience much dry spell which is above normal. Two major findings are evident from these results: (1) the prolonged intensity dry spell makes it very hard to predict the rainfall, the during early growing season in these stations; and (2) it can also be inferred from both Figures 4A and 4B that year 2007 was a drought year with much of dry spell intensity and low amount of rainfall in both growing seasons.

The results from survey illustrated comparable findings with that of much prolong dry spell and drought during the growing seasons. During the interview, many herders reported that "prolong dry spell and drought have been the major extreme climate event affecting cattle production in the Guinea Savannah ecological zone of Nigeria". Table 2 presents the perception of herders on the impacts of a major element of climate on cattle production. It is apparent that 93.7% of the herders perceived increase in temperature as the major element of climate that had critical effects on cattle but only 6.3% observed rainfall as the major element of climate with serious effect on cattle production in the study area (Table 2). The majority of the herders, nearly 97.5%, identified drought as the major climate event that poses a serious threat to cattle production in the Guinea Savannah Ecological zone of Nigeria. Only 2.5% of the respondents chose flood as the major extreme climate event that poses threat to cattle production in their area. We observed that most of the cattle herders who perceived flood effects were herders who live close to big river or dam. They live close to a water body, supposed, to have free access to water, but most of these water bodies overflow their bank in wet years. In general, the major finding from this study is that the prolonged dry spell is not only determines the condition of the rangeland, but also determines the cattle comfort; eating and drinking habit; and livestock's health. Studies in other part of the world have reported that the rise in temperature is a usual event during prolonged dry spell, which increases the rate of evapotranspiration (Munkhtsetseg et al., 2007), thus, led to a reduction in the amount of water available to the cattle, reduces the comfort of the cattle despite the increases the amount of water needed by the cattle (Golher et al., 2015).

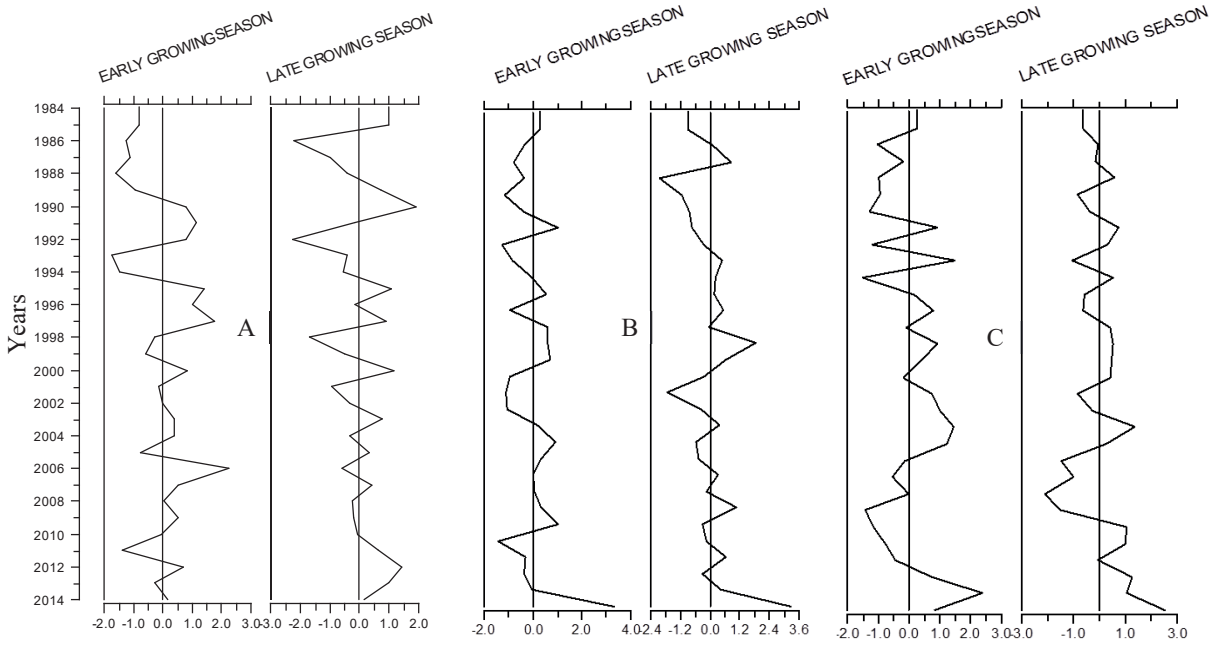

Figure 2: Rainfall variability during early and late growing seasons in Enugu (A), Ilorin (B), and Kaduna (C), based on Cumulative departure Index (CDI) between 1984 and 2014.

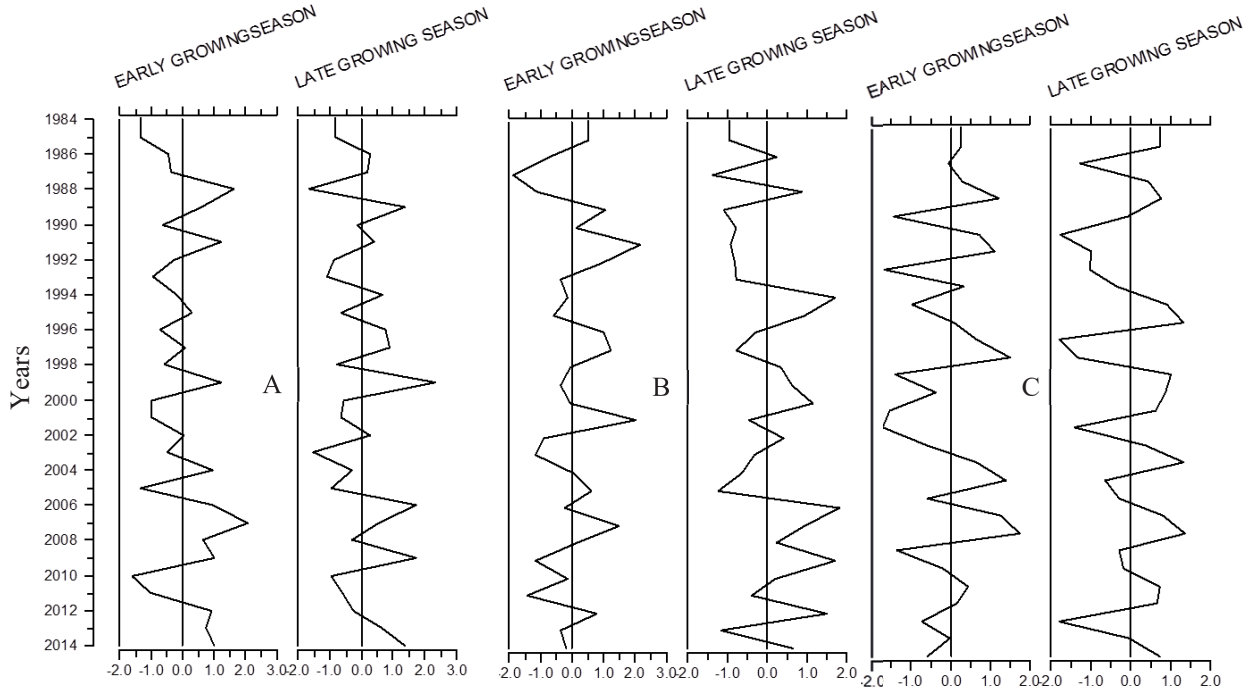

Figure 3: Rainfall variabilities during early and late growing seasons in Lokoja (A), Minna (B), and Shaki (C), based on Cumulative departure Index (CDI) between 1984 and 2014.

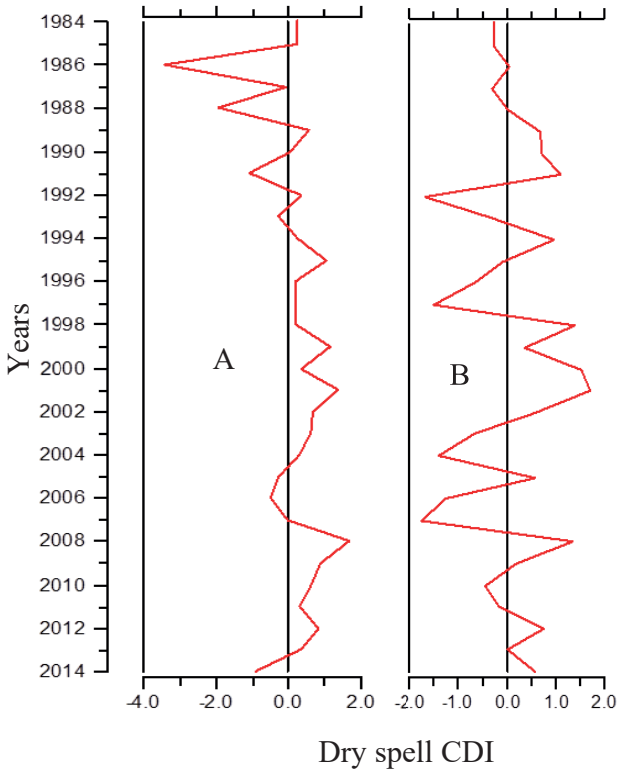

Figure 4: The intensity of Dry spell during the early (A) and late (B) growing seasons in Guinea Savannah of Nigeria, between 1984 and 2014

Table 2: Major elements of weather and major extreme climate events which had deleterious effects on cattle.

Variables	Mean or percentage
Element of weather that has critical effect on cattle	
Temperature	93.3%
Rainfall	6.1%
Wind	0.1%
Humidity	0.2%
Major extreme climate event	
Drought	97.5
Flood	2.5
Cyclone	0.2%
Others	0.1%

Source: Field Survey 2017, 2018/2019

3.2 Herders' adaptive capacities and adaptation strategies during extreme weather events due to climate change

Nearly 52% of them engaged in migration, as adaptation strategies, in the time of drought, though, about 15% of herders stated that they reduced the amount of water consumed per day while 33% turned to other sources of water supply. Majority of the respondents who turned to other sources of water supply or reduction of the amount of water used per day were herders' wives. What is obvious from these results is that the majority of the cattle herders travelled many Kilometers in searching for water during drought (Table 3). The results from the meteorological analysis above show tremendous climate variability with much more prolonged dry spell during the growing seasons with lots of impacts on cattle rearing in the region. Throughout prolong drought, farmers are often the first to feel the stresses from climate variability and change, with herders bearing the hardest brunt, because crop farmers can streamline their cultivation of crops to the rainfall pattern to ameliorate the impact of climate problems. Unfortunately, herders have no growing season or harvesting time, their cattle will drink and eat throughout the year which increases their vulnerability to climate extreme events. This necessitated good adaptation strategies, but the herders in this region have low adaptive capacity due to their location, the pattern of movement, level of education, low resources, and their belief of climate variability and change as the wrath of God, as result of their underprivileged knowledge of climate change (Brooks et al., 2005, Grothmann and Patt, 2005).

For example, the result in Table 3 shows that the majority of cattle herders travelled many Kilometers in searching for water during drought. Table 3 shows that 42.5% migrate to 1km in seeking water when the climate is normal, with only 3.8% covering more than 10km. This is understandable in time of normal rainfall; water was always available for the cattle within 1km of the herders' residents. Cattle also need less for evaporative cooling because of cool weather. But in time of drought, intermittent rivers easily dried up through evaporation, thus during the drought about 47.5% travel between 5.1km to 10km and the majority (45%) travel more than 10km during the prolonged dry spell and drought (Table 3). These results imply that the majority of the cattle herders migrated very long distance in search of water. This "travel is usually frustrating", many herders stated during the interviews. The frustration resulting from longtime migration in searching for water during drought, may be the major reason why most Fulani herders are unable to peacefully coexist with their host communities, particular farmers along wetland. According to Chigozie (2012),

the increased competition of pastoralists for a declining 'stock' of grazing land and the inability of most Fulani herdsmen to build a peaceful relationship with the host community had pitched those (Fulani herders) against farmers. The conflict between the host community and Fulani herdsmen had become so common especially in the Guinea Savannah of Nigeria. For instance, on 18 December 2009, there was a clash between the farmers and the Fulani herdsmen as pastoralists attacked the crop farming village - two weeks after a clash with farmers on 6 December 2000 when herdsman led their cattle into rice fields resulting in the death of a farmer. Conflicts between these herdsmen and the farmers, made local authorities in Borno and Plateau state to expel 700 pastoralists from Borno state in the northeast in May 2010, and some 2,000 from Plateau in April 2009, respectively (Chigozie, 2012).

The adaptive capacities of the cattle herders were examined against the major factors which determine their adaption strategies. Table 4 illustrates the results from the multinomial logit model (MNL) which was used to estimate the determinants of farmers' choices adaptation methods to the impacts of climate change. In this analysis, "other" was used as a base category and the estimated coefficients compared with the base category. The results revealed that the adaptive capacities of herders to climate change vary with some variables such as age, education, position, ethnicity, and the number of cattle in the herd, extreme climate event, a major shortfall of water, and the reason for the water shortfall. The results indicate that age, education and years of experiences have a positive likelihood effect on migration, as the responses of the herders to climate change (Table 4). This may be as a result of the fact that majority of the herders are illiterate, nearly 91% of the respondents were without formal education. Number of cattle in the herd has a negative likelihood, -1.767 likelihood @ 0.01level of significant, on how cattle herders' responds to climate variability and change in the Guinea Savannah ecological zone of Nigeria. However, income has the highest likelihood effect on the cattle herders' choice of adaptive strategies, especially migration, with 4.22 likelihood @ 0.05 level of significant (Table 4). This implies that the number of cattle in a herd tend to make the herder decide to migrate or not to in time of climate variability and change. This result is also supported by the outcome of interview of the Fulani "Seriki" (Fulani head). They said that "in time of water deficit the herders with a large number of cattle tend to divide their cattle into parts and set will migrate to a different direction in search of good pasture and water". The result in Table 4 also indicates that there is a positive likelihood of extreme climate event on the turning to another source of water supply with 6.64 likelihood. It means that the type of extreme climate event will affect one source of water supply than the other. Reason for the shortfall of water also has a positive likelihood on migration, with 2.07 likelihood @ 0.01 level of significance. If the water deficit is as a result of an increase in population or climate change, the herders tend to migrate to another rangeland, but if it is as a result of intervening dry spell or little dry

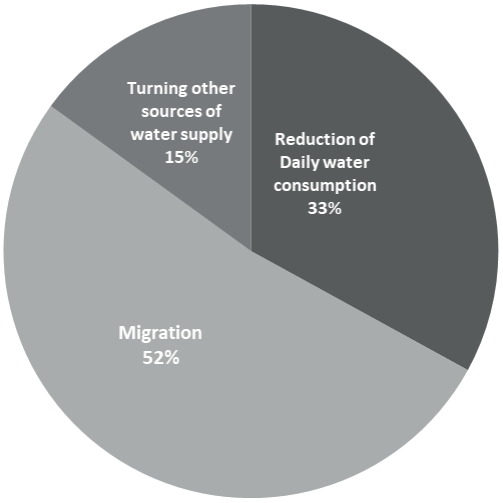

Figure 5: Adaptation methods of herders to climate change.

Table 3: Distance covered in seeking for water.

Variables	Mean or percentage
During the rainy season	
<1km	42.5%
1.1km to5km	35.0%
5.1km to 10km	18.8%
>10Km	3.8%
During the dry season	
<1km	2.5%
1.1km to 5km	11.3%
5.1km to 10km	41.3%
> 10km	45.0%
During the drought	
< 1km	3.8%
1.1k to 5km	12.5%
5.1km to 10km	47.5%
> 10km	36.3%

Source: Field Survey 2017, 2018/2019

Table 4: Parameter estimates of multinomial logit model for climate variability and change adaptation decision.

Variable	Reduction in the amount of daily water	Migration	Turning to other source of water
Age	-7.557*** (1.426)	1.883** (0.111)	-.389* (0.005)
Marital	7.846*** (0.802)	1.474*** (0.036)	3.689*** (0.200)
Educational	-2.994** (1.150)	-17.318** (2.375)	-3.389** (1.445)
Position	.042* (0.000)	0.659** (0.058)	-0.381** (0.019)
Income	4.354** (0.410)	4.222** (0.390)	0.945** (0.019)
Ethnic	2.939* (0.001)	-14.704*** (1.731)	-5.047
Number of cattle	-1.866*** (0.554)	-1.767*** (0.534)	-2.165*** (0.744)
Climate	-6.598* (0.004)	1.771* (0.000)	6.641* (0.005)
Shortfall of water	3.422** (0.226)	0.088* (0.000)	-1.312** (0.031)
Reason for water shortfall	1.612*** (0.779)	2.065*** (1.227)	-1.082* (0.380)

***, **, * Significant at 0.01, 0.0 5, and 0.1probability level, respectively. Log likelihood: 45.987

season they will turn to other adaptation strategies. These results are in accordance with the work of (Ainsworth et al., 2008, Smit and Wandel, 2006, Cooper et al., 2008) that there is a strong relationship between climate and human migration patterns; it also suggested that migration is the main change strategy which cattle farmers engage during drought.

The use of the MNL model specification was found to be suitable for this study. This model has been used previously by different studies to estimate the determinants of climate change adaptation options by smallholder farmers(Belay et al., 2017, Deressa et al., 2009). The problem of multicollinearity among the explanatory variables was tested using variance inflexion factor and contingency coefficient for continuous and dummy explanatory variables. In both cases, no problem of multicollinearity was detected. Hence, the parameter estimates of the MNL model were used to provide the direction of the effect of the independent variables on the dependent (responses) variable, whereas estimates represent neither the actual magnitude of change nor the probabilities

The combination of both climate and survey data in the assessment of herders' responses to climate variability and change makes this study a thorough assessment. Climate data ascertained the variability and change. Climate varies greatly across time and space. It also indicated that climate is hard to predict especially by the local farmers because of its inconsistent trend. Survey data, on the other hand, show the perception of climate variability and change. As also noted by (Ayanlade et al., 2017), that farmers in southwestern Nigeria have good perceptions of climate change and its impacts on livestock agriculture. Also, survey data indicated the degree to which climate perturbation had injurious effects on cattle production in the Guinea Savannah ecological Zone of Nigeria. It was also inferred from the survey data that the responses of the cattle herders were only fair. The effectiveness of the responses of cattle herders was not adequate enough to raise the standard of cattle production in the Guinea Savannah ecological zone of Nigeria.

4 Conclusions

This study assessed the responses of cattle herders to climate change in the Guinea Savannah Ecological zone of Nigeria. In this study, drought was seen as an extreme event resulting from climate change with its impacts on cattle production in the region. The results revealed variability in rainfall, with virtually no two consecutive years, with the same amount of rainfall. The study further demonstrates that rainfall variation occurs in both inter- and intra-annual but much more obvious during the early and the late growing seasons. One of the findings of this study revealed that drought is the major climate event that poses a serious threat to cattle production in the Guinea Savannah Ecological zone of Nigeria. Nearly 97.5% of cattle herders' perceived drought as the major climate event affects major values chain in cattle productivities. The major findings of this study are that: (1) approximately 47.5% of cattle herders travelled between 5.1 km to 10 km during prolong drought, in searching for water while the majority of them usually migrate to the location of available water and green pastures; (2) cattle herders' travelling and migration are "usually frustrating" to the herders and sometime upshots communal conflicts between the Fulani herders and wetland farmers. Both crop farmers and herders are really frustrated, because many farmers claimed that "herders knowingly leave their cattle graze farmers crops which usually create conflicts".

Based on the results from the social survey, the herders perceived that the droughts are more severe in the recent years than 30 years ago. This makes them to travel longer distances with their herds in recent years. Although, different cattle herders respond in different ways to climate stress; their level of adaptive measures ranges from almost none to extensive. The results from present study revealed that age, education and years of experiences have a significant effect on migration while other factors seem to have low effect on the responses of the herders to climate change. The herders' adaptation strategies to cope with climate change include water management, migration, turning to other source of water with migration being their major adaptation method. Despite all this adaptation strategies, the results from this study further revealed that, the herders' adaptive capacities depend on: their level of income, experiences and age, marital status, education level, number of cattle. It is obvious that, short fail of water and reason for water shortage was one of the major factors that influence the choice of adaptation strategies. Still coping with climate change is strongly determined by the ways that farmers continuously respond to a multitude of pressures, trends and abnormal seasonal changes (Davies et al., 2009, Mortimore and Adams, 2001, Scoones, 2009). Generally, the results from this study imply that adaptation is important because of the frequencies of extreme climate events across the the study region, with negative impact on the livelihood of several herders' communities. The study concludes, thus, that the cattle production in the Guinea Savannah is under the threat of climate variability/change and the adaptive capacities of the herders are very low. In the Guinea Savannah of Nigeria, however, with fluctuating rainfall patterns, increasing temperature and reduction in water availability; climate change adaptation should be a major priority because of the region's vulnerability. Though cattle rearing are one of the major enterprises in this study sites, the present study revealed that livestock production in Nigeria is very vulnerable to the influence of extreme weather events such as drought. Therefore there is a need for government to support the local herder for effective production since the herders' responses were greatly influenced by demography characteristics as well as available resources types of extreme climate event, the reason for water and fodder shortage. Above all, there is a need for supporting for indigenous adaptation strategies of the herder, with intervention policies that will help herders with wide range of institutional and technological supports.

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contributed in data collection, data analysis, and other various levels of expertise. All authors contributed considerable revisions. Both authors read and approved the final manuscript.

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