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Perception and adaptation practices of smallholder farmers to climate variability in the Lower River Region, The Gambia

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Abstract

Climate change and variability present challenges to food security in the Gambia. Yet, it is not clear how smallholder farmers in the Gambia are adapting to climate change and variability. This study explored the extent of climate variability and the adaptation practices of smallholder farmers in the Lower River Region of The Gambia. The study used questionnaire surveys (with 180 households) to assess the perception of smallholder farmers on rainfall and temperature patterns. The study used climate data from 1981 to 2016 and employed the modified Mann-Kendall test to understand the extent of climate variability in the study area. The results showed a significant variability in mean annual rainfall during the last 35 years in the Lower River Region of The Gambia. The perception of study respondents revealed that, erratic rainfall pattern and increased temperature were consistent with the available empirical rainfall and temperature data. In response to these perceived changes, smallholder farmers have initiated a number of on-farm and off-adaptation practices to address the threats of climate variability. The key on-farm adaptation practices include the use of drought tolerant crops varieties, changing planting date, planting of early maturing varieties, irrigation and land fallowing. In terms of off-farm adaptation practices, smallholder farmers were engaging in livelihood diversification, temporary migration, charcoal production and firewood selling. Others were also relying on remittances from friends and families to address the risk associated with climate variability. The study concludes that, smallholder farmers in the study communities were knowledgeable about climate fluctuations, and have adopted appropriate practices to address these changes. The study recommends strengthening the capacity of smallholder farmers through skill acquisition to manage future consequences of climate change and variability.

Keywords: food security, West Africa; participatory methods; community, agriculture, The Gambia

Introduction

Climate change and variability will continue to adversely affect economic development in many economies across the African continent. The recent Special Report by the Intergovernmental Panel on Climate Change (IPCC) suggested that climate change would adversely affect sustainable development and the poverty reduction efforts (Roy *et al*., 2019). This could increase inequality and leads to enhanced vulnerability of marginalized socioeconomic groups including women, children and the elderly. Africa contributes about 4 % of the world's total green house gas emissions globally (Raupach *et al.,* 2015). This notwithstanding, the continent is the most vulnerable region to extreme

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climate events (IPCC, 2014). This vulnerability is partly attributted to its livelihood dependence on seasonal rainfall and weak adaptive capacity (Cooper *et al*., 2008). Global circulation model (GCM) analyses have projected a decrease in productivity of all major crops in sub-Saharan Africa due to increased temperature, rainfall variability, increased potential evapotranspiration (PET), runoff and drainage by the year 2075 (Msowoya and Madani, 2016). Climate projections suggest a reduction of seasonal rainfall amount, which is possible in the Sahel to Sudano-Sahalien zone of The Gambia, particularly during the only unimodal growing season June to October (Sylla *et al.*, 2010). This will skew the inter-annual rainfall distribution from normal leading to a reduction of rainy days (Nicholson, 2000).

Agriculture, the backbone of Gambian economy is negatively impacted by climate change and variability and this is manifested in low productivity of major crops in recent years and increasing household food insecurity (Kutir, 2015). Challenges associated with climate change and variability in the Gambia are more severe in the Sahel and the Sudano-Sahelian zones of the country (Sanneh and Hsu, 2013). Annual temperature of The Gambia has risen by historic records, approximately 1.0^0 C since 1960 and is expected to increase by between 1.1 and 3.1^0 C by 2060 (Amuzu *et al*., 2018). Erratic weather patterns that describe the climate in the Gambia coupled with other challenges such as low soil fertility, salinization, poverty, food insecurity and inadequate policies in agriculture exacerbate development in agriculture. Based on this biophysical and climate variations, adaptation practices need to be integrated into the farming communities to manage the adverse effects of climate change and variability.

Adaptation has been defined as adjustment in ecological, social or economic systems in response to actual or expected stimuli and their effects or impacts" (Smit and Wandel, 2006). Based on their timing, adaptations can be anticipatory or reactive, and depending on their degree of spontaneity, they can be autonomous or planned (Smit and Wandel, 2006). Previous studies (including Elum *et al*., 2017; Antwi-Agyei *et al*., 2014, Codjoe *et al*., 2014) have shown that, in many parts of sub-Saharan Africa, changing planting date and crop mixed are farm adaptation strategies used along with the application of intensive inorganic fertilizer application practiced by local farmers.

Adaptation strategies are anticipated long-term plans for future climate consequences whilst coping strategies are those immediate actions taken to offset the challenges related to climate variability (Makuvaro *et al*., 2017). Berman *et al*. (2012) reported that, institutions play a key role by regulating the services of markets, community resource management and land resources, which are important for adaptation and coping strategies of rural communities.

Studies on climate change adaptation dwell on how individuals develop and maintain strategies as self-asset, and how such individual asset improved household livelihood (Malik *et al.,* 2010; Alemayehu and Bewket, 2017). Calzadilla *et al.* (2013) observed that adaptation is viewed as individual obligations to offset any risk associated with external sock. From the individual perspective, Reid *et al*. (2003) proposed that individual resources can influence climate change adaptation but may not be enough to build resilience at the community level.

Several studies have highlighted the value of adaptation practices to address the adverse impacts of climate change. For instance, Antwi-Agyei *et al.,* (2014) explored the livelihood adaptation options available to farming households in Ghana. Others studies including Neset *et al*. (2018) and Antwi-Agyei *et al.* (2018) have examined the sustainability of adaptation practices of smallholder farming households. Yet, despite agriculture being reported as the sector most affected by climate change and variability, empirical evidence on autonomous adaptation practices of smallholder farmers in the Gambia is largely lacking, making it difficult to identify appropriate strategies to address climate risks. The aim of this study was to understand the extent of climate variability and the key adaptation practices employed by smallholder farmers in the Sudano-Sahelien agro-ecological zone in the Lower River Region of The Gambia. To achieve this aim, the study seeks to answer the following research questions:

1. What is the extent of climate variability in the Lower River Region of the Gambia?
2. What is the awareness level of smallholder farmers to climate variability in the study communities?
3. What are the adaptation practices employed by smallholder farmers to address climate variability in the study communities?

Study area and Research Methods

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Description of the study area

The study was carried out in the Lower River Region (LRR) of The Gambia, which is located between latitudes 13^0 34' 0" N and longitudes 14^0 47' 0" W. The region has an agrarian economy and more than half of its inhabitants are directly or indirectly involved in crop production (Yaffa, 2013). LRR was selected as the study area because of its geographical location in the Sudano-Sahelien zone of The Gambia, which is characterized by inadequate potential irrigation opportunities during dry season (Sillah, 2013). Loum and Fogarassy (2015) identified that cereal production will be affected by climate change in Sudano-Sahelien zone. LRR is also characterized by high rate of bush fires and poor soil fertility (Peters, 2000).

Two administrative areas were selected from the LRR divided into two kingdoms called Kiang and Jarra based on the geographical scope of south bank designed by the British (Touray, 2016). The kingdom of Kiang is classified into Kiang West, Central and East districts whilst Jarra West, Central and East districts were classified as Jarra kingdom (Figure 1; Table 1). The two kingdoms fall within the same agro-ecological zone but have different socio-economic activities (Table 1). The selection of the kingdoms was based on their geographic proximity to river Gambia, which is influenced by seawater inundation that adversely affect rice production to meet the growing population demand for food security. During World Food Program (WFP) vulnerability assessment, the LRR was identified as the most vulnerable region to food insecurity in The Gambia due to climate change (UN-WFP, 2016).

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Characteristics	Kiang	Jarra
Mean annual rainfall (mm)	550-800	600-900
Rainfall patterns	Uni-modal	Uni-modal
Farming system	Predominantly family farming	Predominantly family farming
Major crops grown	Maize, groundnut, millet, rice, sorghum	Rice, groundnut, maize
Main livelihood activities	Agro-pastoralist	Agro-pastoralist
Average temperature	Min 20 °C, Max 36 °C	Min 20 °C, Max 36 °C
Population	30,168	52,193
Agricultural population (%)	53	52
Food poverty (%)	71	50
Ethnic composition	Majority "Mandinka"	Majority "Mandinka"

Table 1: Key demographic and socioeconomic characteristic of the study districts

Data compiled from Department of Water Resources of The Gambia, Regional Agricultural Directorate (LRR) and Population data from Gambia Bureau of Statistics (GBOS, 2013)
Farm family farming: is a farming system where farmers commute to the farm outside their homes and return after work. This is a common practice in the rural Gambia.
Food poverty*: when farming household cannot meet the daily required minimum calories of 2400 per day per person (O'Connor et al., 2016).*

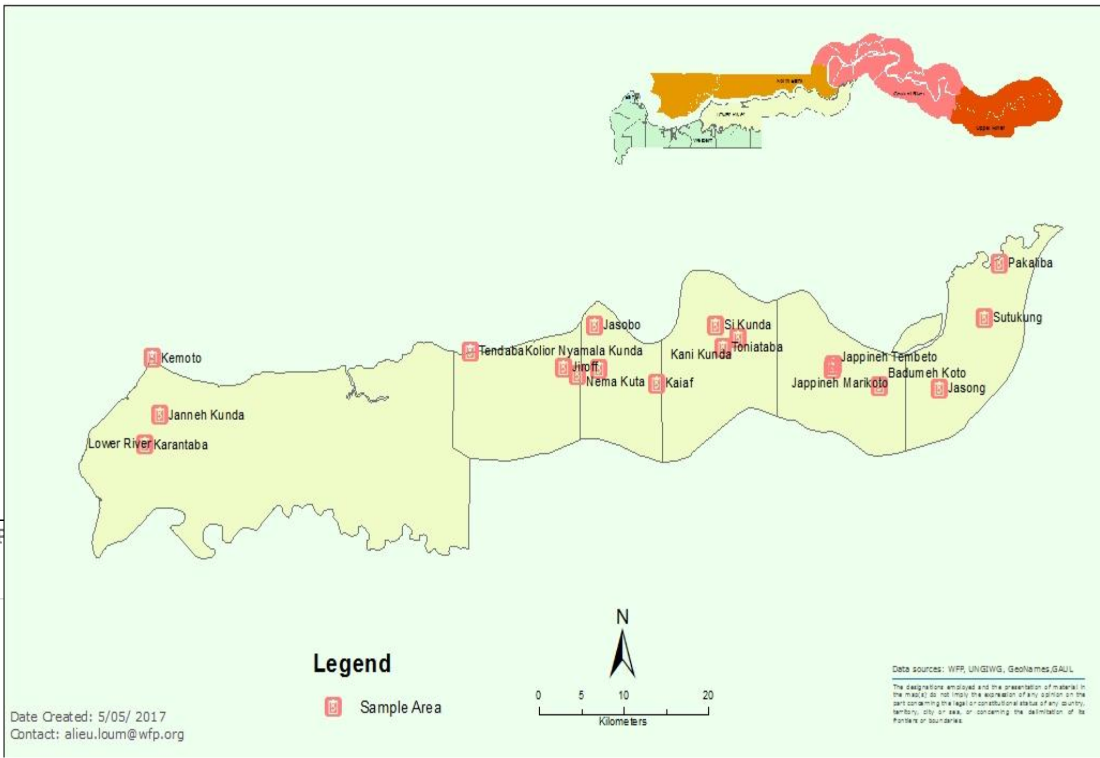

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Figure 1: Location of study villages in Lower River Region of The Gambia

Research methods

The data presented in this paper were collected in August 2017 using a mixture of different approaches – household survey, focus group discussions and key informant interviews. Data collection started with consultation at the Regional Agricultural Directorate to prepare a checklist of communities close to the riverbank. The two kingdoms were visited through trekking in consultation with the community heads and the agriculture extension agents. A questionnaire survey was used to collect information on socio demographic, climate change perception and key adaptation practices by smallholder farmers. In each kingdom, nine communities were selected (Figure

1). Ninety questionnaires were administered in each of the kingdoms, giving 180 household questionnaire surveys. Sampling of respondents involved stratification of households into different gender groups. Interviews lasted between 30 minutes to one hour and was recorded with the consent of the interviewers. The interviews were conducted in the local language (Mandinka) and later translated into English with the help of an expert linguistic. Five focus group discussion (FGD) (for separate males and females) were conducted in the surveyed kingdoms. Four key informants were selected from different institution dealing with agricultural activities.

Annual time series data on rainfall and temperature were obtained from the Department of Water Resources of The Gambia for three weather stations in Lower River Region (Jenoi, Kwenella and Kiang Karantaba). The time series rainfall data used for the study was for the period of 1981-2016 for Jenoi, 1991-2016 for Kwenella and Kiang Karantaba weather stations and was measured in millimetres (mm).

Data analysis

A non-parametric test Mann Kendall test was performed to analyze the time series climate data which assumed that the data is normally distributed (Basarir *et al.*, 2017). The test is set out with two hypothesis; that is the null hypothesis H0: which assumed that there is a trend in the data whereas the alternative hypothesis H1: on the contrary assumed that there is no trend in the data. The computation of the analysis was performed using XLSTAT 2016 plug-in for Microsoft Excel, exploring the climate variables monthly rainfall and temperature from June-October 1981 to June-October 2016 duration using Mann Kendall test (Karmeshu, 2012).

$$Zs = \begin{cases} \frac{S-1}{\sigma}\ for\ S > 0 \\ 0\ for\ S = 0 \\ \frac{S+1}{\sigma}\ for\ S < 0 \end{cases} \text{………………………Equation. 1}$$

The test statistic Z is used as a measure of significance of trend. This test statistic is used to test the null hypothesis, H0. If (Zs) is greater than Zα/2, where α represents the chosen significance level (e.g.: 5 % with Z 0.025 = 1.96), then the null hypothesis is invalid implying that the trend is significant.

The data from the questionnaire were input into Microsoft Excel (Version 2016), coded for quantitative data to be analysed using the Statistical Package for Social Sciences (SPSS) to ensure ease of appropriate statistical analysis. Descriptive statistics for quantitative data were analysed from interview questionnaires coded numerically and

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reported the output as frequencies and percentages. Qualitative data were coded and analysed using content analysis to identify the emerging themes.

Results

When Mann Kendall statistical test was performed on the time series temperature data, the results was not significant (Table 2). However, Figure 2 showed the variability of mean temperature in an increased linear direction, indicating that the variation is not uniform. The results showed a sharp decrease in mean temperature in 2006.

Table 2: Results of the Mann-Kendall test for temperature data from (1981 to 2016) for Jenoi Lower River Region

Region	Mann Kendall Test					
	Mann Kendell Test Statistics (Zs)	Kendall's Tau	Var (S)	p-value (two tailed test)	Alpha	Test Interpretation
JWS	1.9	0.2222	0.0000	0.059	0.05	rejected H0

Jenoi Weather Station (JWS)

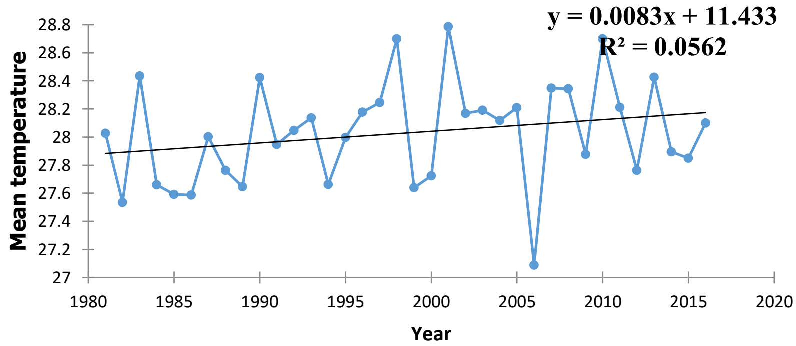

Figure 2: Linear trend line corresponding to temperature data for Jenoi LRR

Table 3 shows the results of Mann Kendall test on time series annual rainfall data for Jenoi, Kwenella and Kiang Karantaba weather stations in Lower River Region. Jenoi and Kwenella weather stations were statistically significant indicating the null hypothesis is rejected; while Kiang Karantaba weather station was not statistically significant hence, the null hypothesis failed to be rejected indicating absence of trend in the precipitation. The linear trend line of the annual rainfall data depicted an increasing trend for Jenoi (Figure 3) and Kwenella (Figure

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4) weather stations whereas Kiang Karantaba (Figure 5) weather station shows a decreasing trend. This indicates that Jenoi and Kwenella weather stations show a positive slope with a change point of trends in 2003 for Jenoi and 1997 for Kwenella respectively whilst Kiang Karantaba shows a negative slope with a change point of trends in 2000s.

Table 3: Mann-Kendall test for Rainfall data for Genoi, Kwenella and Kiang Karantaba weather stations Lower River Region

Region Weather Stations	Mann Kendall Test					
	Mann Kendell Test Statistics (Zs)	Kendall's Tau	Var (S)	p-value (two tailed test)	Alpha	Test Interpretation
JWS	3	0.3524	0.0000	0.0022	0.05	Accepted H0
KWS	2	0.2835	2057.3333	0.0448	0.05	Accepted H0
KKWS	-1.5	-0.2123	2057.3333	0.1355	0.05	Reject H0

JWS= Jenoi Weather Station KWS=Kwenella Weather Station KKWS= Kiang Karantaba Weather Station

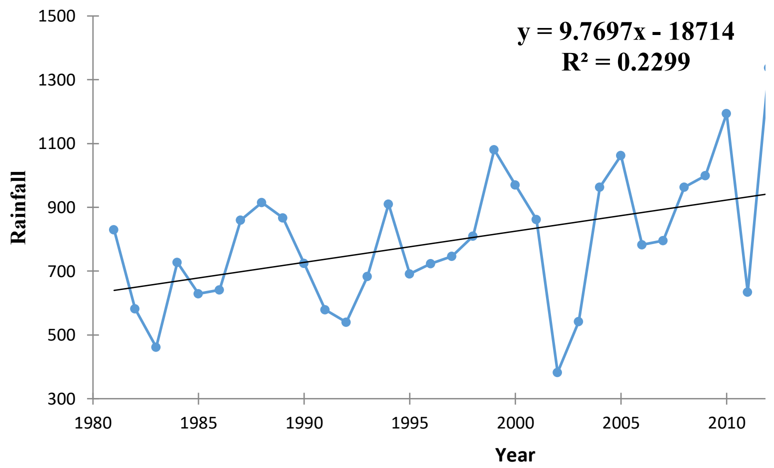

Figure 3: Linear trend line corresponding to rainfall data for Jenoi

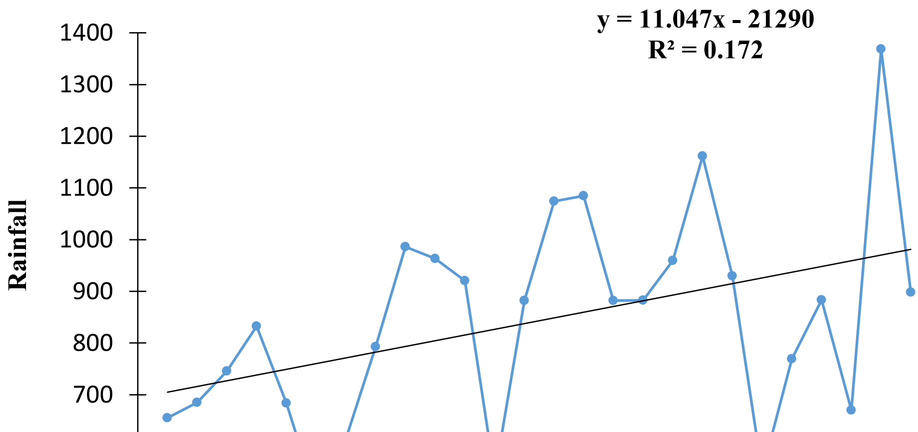

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Figure 4: Linear trend line corresponding to Rainfall data for Kwenella

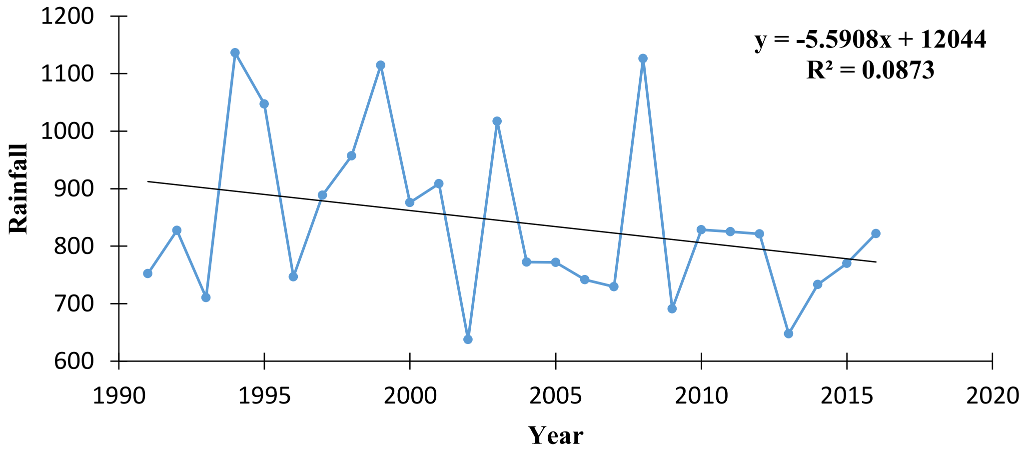

Figure 5: Linear trend line corresponding to rainfall data for Kiang Karantaba LRR

Farmers' perception on temperature and rainfall patterns in Lower River Region

Table 4 presents how different households perceived changes in some of the climate variables within the two kingdoms of Lower River Region. Majority (86.7%) of male farmers in Kiang perceived climate change as increased in temperatures presently as compared to when they started farming. An overwhelming majority (93.3 %) of their female counterparts also realized that temperatures have increased now than before. In the Jarra kingdom, 84.4 % and 97.8 % of male and female females respectively agreed that temperature is increasing. However, in Jarra the perception differs between male and female farmers in terms of the length of growing season rainfall.

About 33.3% of female farmers reported that the only reliable growing season rainfall has been reducing compared to during childhood whilst only 17.8 % of male farmers observed the shortening of the growing season in Jarra (Table 4). Rainfall events and duration were instances that farmers could easily remember. In terms of rainfall durations, majority (82.8 %) of the farmers in the two kingdoms reported that rainfall duration during the farming season has reduced. In Kiang, majority (68.9 %) of male farmers have observed considerable shift in onset of the rains whilst majority (80.0 %) of female farmers agreed a shift in the onset.

Table 4: Percentage of households that perceived changes in the temperature and rainfall patterns in the Kiang and Jarra, Lower River Region of The Gambia

Variables	Kiang		Jarra		
	Male (n=45)	**Female (n=45)**	**Male (n=45)**	**Female (n=45)**	**Total (n=180)**
(a) Temperature					
Increased in temperature	86.67. (39)	93.33 (42)	84.44 (38)	97.78 (44)	90.56 (163)
(b) Rainfall					
Decreased in length of rainfall	35.56 (16)	33.33 (15)	17.78 (8)	33.33 (15)	30 (54)
Decreased in rainfall events	24.44 (11)	8.89 (4)	15.56 (7)	37.78 (17)	21.67 (39)
Decreased in rainfall duration	86.67 (39)	84.44 (38)	86.67 (39)	73.33 (33)	82.78 (149)
Shift in rain onset	68.89 (31)	80 (36)	73.33 (33)	60.00 (27)	70.56 (127)

Numbers in bracket are counts and those not in brackets indicate percentages of households

Adaptation practices adopted by smallholder farmers to manage climate variability

Table 5 provides an overview of the smallholder farmers adaptation practices, which are categorized on-farm and off-farm adaptation practices. The use of early maturing crop varieties is used more by both male and female farmers in Jarra than their counterparts in Kiang. About 62.2 % and 48.5 % of male and female farmers, respectively, in Jarra reported using crop diversification whilst 37.8 % and 40.0 % of male and female farmers in Kiang practised crop diversification. The results showed that, 24.4 % of male farmers practised supplementary irrigation occasionally whilst only 35.56 % of female farmers in Kiang practised supplementary irrigation. Integrated pest management (IPM) is a conventional pest control measures used to manage pest and disease outbreaks. The results showed that Jarra farmers adopted the use of IPM than farmers in Kiang. A female focus group participant in Kiang remarked.

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Since the colonial era (1960) in The Gambia, we used to plant our rice nursery in the late May and by the time it's early June we receive the first rain for transplanting. I continued planting on that sequence until the late 80s when the onset started changing to late June. Then we started to extend the information to agricultural research and extension to help us with early maturing and drought tolerant crops to offset the consequences of late onset [Focus group member, Kiang, August 2017].

In the male focus group, a participant mentioned that rainfall situation in the area is erratic and that they have to think of ideas to cope with the changing rainfall patterns.

Before independence when I used to work with my grandfather, we used to experience heavy rains for a week without stopping. Now, all the fertility of the soil is gone and we have started changing to early maturing cowpea varieties and maize disseminated by agricultural extension services. This has helped to prevent the danger of total crop failure by erratic rainfall when these crops mature before the season ends [Focus group member, Jarra, August 2017].

Off-farm adaptation practices reported by study respondents included petty trading and temporary migration. Temporal migration is a common practice in rural Gambia where farmers move elsewhere for short period to look for livelihood support. The findings revealed that in Kiang, about half (51.1 %) of the male farmers migrated in search of better livelihood option compared to their female counterparts (35.6 %). A key informant from regional agricultural directorate narrated:

Households in these two kingdoms have shifted attention to non-farm income jobs than during the early 1980s. Previously in the 1980s, most of the farmers in these two kingdoms produced bumper harvest as food basket of the country alongside with raising livestock. With the advent of climate change and migration of youths as the labour force to other places in search of greener pasture, most vulnerable households began selling firewood and charcoal that are non-rain dependent to supplement their household needs [Key informant, August, 2017].

Table 5: Percentage of households who reported using a particular adaptation practice

	Kiang		Jarra		
Adaptation practices	**Male (n=45)**	**Female (n=45)**	**Male (n=45)**	**Female (n=45)**	**Total (n=180)**
(a) On-farm adaptation practices					
Drought tolerant crops	71.11 (32)	64.44 (29)	75.56 (34)	77.78 (35)	72.22 (130)
Early maturing crops	75.56 (34)	62.22 (28)	82.22 (37)	82.22 (37)	76.00 (136)
Alley farming	37.78 (17)	33.33 (15)	31.11 (14)	37.78(17)	35.00 (63)

Diversification of crops	37.78 (17)	40.00(18)	62.22 (28)	48.49 (22)	47.22 (85)
Fallowing	73.33 (33)	62.22 (28)	68.89 (31)	53.33 (24)	64.44 (116)
Changing planting date	68.69 (31)	62.22 (28)	75.56 (34)	60 (27)	66.67 (120)
Supplementary irrigation	24.44 (11)	35.56 (16)	24.44 (11)	46.67 (21)	32.78 (59)
Crop rotation	66.67 (30)	37.78 (17)	53.33 (24)	60 (27)	54.44 (98)
IPM	17.78 (8)	35.56 (16)	31.11 (14)	40 (18)	31.00 (56)
Contour farming	26.67 (12)	33.33 (15)	26.67 (12)	28.89 (13)	28.89 (52)
Agroforestry	42.22 (19)	46.67 (21)	40.00 (18)	37.78 (17)	41.67 (75)
Zero tillage	24.44 (11)	26.67 (12)	26.67 (12)	8.89 (4)	21.67 (39)
(b) Off-farm coping practices					
Petty trading	28.89 (13)	31.11 (14)	40 (18)	62.22 (28)	40.56 (73)
Remittance	33.33 (15)	37.78 (17)	26.67 (12)	28.89 (13)	31.67 (57)
Temporal migration	51.11 (23)	35.56 (16)	42.22 (19)	57.78 (26)	46.67 (84)
Charcoal production	26.67 (13)	31.11 (14)	11.11 (5)	17.78 (8)	21.67 (40)
Firewood selling	26.67 (12)	28.89 (13)	13.33 (6)	15.56 (7)	21.11 (38)

Numbers in bracket are counts and those not in brackets indicate percentages of households
IPM: Integrated Pest Management

Discussion

Extent of climate variability in the Lower River Region

Increased in temperature was observed from Lower River Region in 35 years' time interval and showed a positive trend, which raises concern for agricultural production and the attainment of the Sustainable Development Goal 2, achieving food security. Changes in temperature pattern in a positive direction may lead to high rate of evapo-transpiration and increase in water demand for many crops (Juana *et al*., 2013). Elsewhere in sub-Saharan African, Msowoya and Madani (2016), concluded that increased in temperature may induce evapo-transpiration especially in the Sahel region leading to ecosystem desiccation. Increased in temperature can also cause extreme heat waves, which can trigger delay in cropping cycle and species reproduction (Salvo *et al.*, 2013).

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Regarding the output of the analysis of Mann Kendall test of total annual rainfall in LRR, it's worthy of concern to explore the ecosystem impacts that could be triggered if torrential rains persist in some parts and there is deficiency in other parts of the LRR in the future. For swamp agro-ecologies, vulnerability to flooding may cause detrimental submergence of rice if increased rainfall continues in the future whereas on the contrary, if below annual rainfall level continues, it may trigger high salinity effect in the swamp ecologies, leading to crop failure (Tanaka *et al*., 2017). Such results corroborate previous studies by Atherton and Slobodan (2013) who reported that a reduction in rainfall in the coastal area may lead to high salinity effect in rice growing ecologies. Increased rainfall can adversely affect crops that are sensitive to waterlogging conditions and can cause destruction of structures, outbreak of mosquitoes and water-borne diseases (Rieckmann *et al*., 2018). Increased heavy downpour of rainfall may lead to water erosion, runoff and leaching of nutrients beyond the rooting zones of crops (Bostick *et al.,* 2007). The experience of high rate of decreasing trend observed in Kiang Karantaba during the 36 years period of the rainfall time series data calls for attention; if the situation should persist in future, food security and poverty rate will be high in this part of the region.

Farmers' perception of climate variability in the study communities

The findings from the perception of farmers on temperature and rainfall variability are consistent with the meteorological data in terms of temperature variability (e.g. Smit *et al.* 2001; Shah and Dulal, 2015). Climate change perception informed farmers about current behaviours of weather patterns within their system of operation and how they will respond to base on their level of exposure (Mertz *et al*., 2009; Simelton *et al*., 2011). Based on timing, rural farmers have vast knowledge and do share socio-ecological knowledge about early warning signs for weather forecasting; this is the most relevant part of the coping mechanism and adaptation practices to climate variability (Kristjanson *et al.,* 2012). Similar studies have shown that sub-Saharan African farmers have used their local knowledge to predict the weather which can be relevant for climate change adaptation (Mertz *et al*. 2009; Antwi-Agyei, 2012; Waha *et al., 2013;* Simelton *et al*., 2011).

On-farm adaptation and off-farm coping practices

The findings further suggest that farmers employ a host of on-farm adaptation practices, including alley farming, supplementary irrigation, crop rotation, agroforestry, zero tillage and changing planting date. The identified practices are similar to those practised in other parts of sub-Saharan African used by smallholder farmers to tackle recent climate variability (Antwi-Agyei *et al.*, 2014; Guan *et al*., 2017; Kumasi *et al*., 2017). However, our findings revealed that generally the number of adaptation options identified regarding on-farm practices were limited and may not be able to support production in future. This could be due to the fact that, farmers choice of using a particular strategy depend on how easy and less labour it required (Smit and Wandel, 2006). Access to basic resources and assets as well as government programmes may be limiting factors, which could further compound household vulnerability to climate variability (Yesigat *et al.*, 2015; Antwi-Agyei *et al*., 2015).

In most parts of sub-Saharan Africa, contour farming is a technique used to minimize soil nutrient loss hence controlling erosion (Gis *et al.*, 2013; Bera *et al*., 2016). Contour farming is said to mitigate nutrient movement by erosion, increase soil conservation, boost productivity and reduce cost of inputs for production and is predominantly practised by male farmers in the study area (Sonko *et al.,* 2016). Male farmers are predominantly upland dwellers where they grow cash crops and coarse grains, which is said to demand more labour than rice production. Inadequate access to inputs and poor soil fertility in some of the communities have driven some male farmers, particularly experienced farmers, to shift into border areas to secure fertile farmlands and till savannah woodlands into croplands in Kiang kingdom (Rurinda, 2014) . Due to the high incidence of poverty in these regions (Nkechi *et al.,* 2018), there are often severe limitations on smallholder farmers' capacities to effectively adapt to the worsening soil and climatic conditions. Consequently, these farmers were forced to shift to alternative options to adapt such as involving in business during dry season (Loum and Fogarassy, 2015). The challenges that both men and women experienced when struggling to fulfil their roles were among the causes of variation in perceiving the change in climate (Zampaligr *et al.*, 2014).

The empirical evidence from the survey results revealed that households in the study kingdoms engaged in a range of off-farm coping practices to have a better livelihood option from climate risk associated with crop failure. Most of the farmers in Kiang Kingdom reported relying on social support in the form of remittance from family members in the cities and other philanthropies. Receiving remittance as livelihood options have been skyrocketing for the past decades where households sell assets to send their youths in search of better livelihood elsewhere in the Europe and America (Kuye *et al.*, 2006). These findings supported the study by Kebbeh (2014), who reported

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that, remittance support from emigrants outside Gambia accounts for 4 % of the youth population most of whom are from rural Gambia. A similar study in Malawi, identified climate change as the driving forces of youth migration from rural-urban or cross border migration in search of better livelihood options to support families in the form of remittance (Murray *et al*. 2016).

Conclusion and recommendations

The extent of rainfall trend in Lower River Region indicated that, the distribution is erratic and not uniform within the region. Increased in temperature was observed over the 35-year period within the study region as indicated by the meteorological data. These could trigger the seasonal climate effect, thereby affecting seasonal crop yields. Both men and women perceived that climate is changing, and these perceptions were consistent with available climate data. Based on the erratic nature of rainfall and temperature variability in the Lower River Region of The Gambia, farmers employed various on-farm adaptation and off-farm coping practices to address the consequences of climate variability on livelihoods. The key on-farm adaptation practices include the use of drought tolerant crops varieties, changing planting date, planting of early maturing varieties, irrigation and land fallowing. In terms of off-farm adaptation practices, smallholder farmers were engaging in livelihood diversification, temporary migration, charcoal production and firewood selling. The adoption of drought tolerant crops and early maturing crop varieties by rice and maize growing farmers is considered as national adaptation plan of action. The study recommends that policy makers should incorporate climate change adaptation practices into rural policies that will improve rural food security. For example, community driven development project that will decentralize local training on food processing and trading into the rural areas so that households can be directly involved. Therefore, farmer associations should be strengthened to foster the spread of climate adaptation information to areas vulnerable to climate change and variability.

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