Assessing the Sustainability of Climate Change Response Measures to Farming Practices in an agricultural enclave in the Eastern Region of Ghana

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Abstract

Given the fundamental role of agriculture in human welfare, concern has been expressed regarding the potential net effects of climate change on agricultural productivity. Response strategies to climate change impact in the Agricultural sector is therefore an imperative. However, not all response activities to climate change impact can be considered good enough to be sustainable. Thus the study investigated the response strategies of farmers in Oboadaka, a farming community in eastern region of Ghana as to whether they qualified as sustainable impact response measures or otherwise. The framework for classifying the impact response measures was summarized as follows: reacting to experienced and/ or current impacts alone qualified as coping whereas such measures that in addition to reacting to current impacts anticipated future impacts and allowed a plan to adaptively manage the response measures qualified as sustainable adaptation. The method employed to achieve the results was largely qualitative case study method. The findings established the fact that farmers perceived the climate to have changed; farmers viewed climate variability and climate change to mean the same thing- a change in weather patterns whether long or short term. It emerged that the responses to the impact of climate change were part of reactionary responses or strategies which were short term. Analyzing the strategies, it was concluded that, the climate change impact response practices of farmers in the study area qualified as coping and not sustainable adaptation measures needed to build resilience to future climate change.

Keywords: Climate Change, Adaptation, Resilience, Coping, Sustainability, Oboadaka

Introduction

The phenomenon of climate change has implications for human existence and livelihood activities including farming. Globally, it has been reported that, climate change is impacting agricultural productivity (Faures et al, 2013). Given the fundamental role of agriculture in human welfare, concern has been expressed regarding the potential net effects of climate change on agricultural productivity, (Apata et al, 2009). Kang et al (2009) opined that, results from crop models indicated significant reduction (25%) in wheat production in some characteristically high temperature locations. Similarly, MacCarthy et al (2021), reported a reduction of −19 and −20% of maize by 2069 under unsustainable development pathway in Ghana and Mali respectively. Hence the rising temperature posed a serious risk to food security in some regions in the world especially the lower latitudes where high temperature characteristically prevails.

Having noted the lower latitudes and the corresponding potential impacts of the changing climate, Dube et al (2016), posited that, the impact of climate change is felt everywhere but the developing regions (mostly located in the lower latitudes) were the hardest hit due to their higher levels of vulnerability compared to the developed regions (mostly located around mid or higher latitudes). Parks and Roberts (2006) made this assertion much earlier by noting with reference to developing countries (Mozambique, Honduras, Pacific Islands) that, they were experiencing the “first and worst” impacts of climate change although they did not cause it. The high level of vulnerability of the developing world is due to lack of resources needed to adapt or simply put, low adaptive capacity (Dube et al, 2016;

Mora et al, 2013).

Thus it is most worrying that projections have intimated that by 2050 Africa and the rest of the developing regions, would play host to most of the population increase that would occur in the world (Faures et al, 2013). This concern is right because the region's high vulnerability to the impact of least mitigated climate change, would predispose the increased population to the climate impacts including food and water insecurity. The implication is that until there is a shift from the business as usual traditionally inefficient agricultural production to one that is climate resilient and smart, more people would be prone to climate related impacts and vulnerabilities.

West Africa including Ghana is located within the lower latitudes. Inadvertently, this is part of a larger region experiencing rising temperatures with all its agro - ecological implications. Traore et al (2013) reported predictions by the IPCC about temperature increases in Sub Saharan Africa which was in the order of 3.3ºC by the end of the 21st century. Analyzing average monthly temperature data from the World Bank Group, (World Bank Group Climate Change Knowledge Portal, 2019), the mean annual temperature for Ghana for each year since 1950 till 2016 showed a trend indicative of rising temperatures. To buttress this point, between 1950 and 1959, data analyzed indicated that the mean decadal temperature was 27.08ºC. Comparing this mean decadal temperature to the period between 2007 and 2016 (which was 27.81ºC), it showed a marked trend of increasing temperatures. Furthermore, the data from World Bank Group (World Bank Group Climate Change Knowledge Portal, 2019) which was again analyzed, indicated a 1.32ºC increase in mean annual temperature in Ghana between 1950 and 2016. This is significant and, such temperature increases has dire consequences for cereal crop yields (Myers et al, 2017).

Apart from the indicated temperature trend, most of Ghana's crop farming is dependent on rainfall (Asante and Amuakwa – Mensah, 2014) and as such, as the country's rainfall pattern skew towards significant decreases in amount and period (Owusu et al, 2008), this makes the sector vulnerable to climate change and climate variability. Thus apart from other factors, the steady rise in temperature and decreases in precipitation may have contributed to the conclusion made by the World Bank (2010) report suggesting declining agricultural productivity in Ghana.

Under the foregoing, it is obvious that to ensure food, fibre and livelihood security, Ghana requires sustainable climate change impact response measures undertaken by local farmers and policy makers to combat these climate change challenges.

Adaptation to climate change is thus an imperative. However, it is important to mention that not all climate impact response strategies would lead to sustainable development. What makes the difference between adaptation that would ensure sustainable development success and one which will not, is the type of impact response measures undertaken. The impact response measures undertaken should be the type that is sustainable according to Daze et al, (2009) classification of adaptation and does not foreclose future impact response strategies. The typologies in table 1 characterizes coping/ unsustainable strategies and sustainable adaptation strategies.

Again, it is important to stress that the IPCC (2007) distinguished between coping as short term impact response and adaptation as long term impact response. The IPCC (2012) report stressed that, climate change adaptation included planning for the uncertain future. Coping involved reacting to adverse climate impact in the short term. The type of climate impact response measure undertaken is therefore very critical. It is important to note that private and public adaptation can be identified based on their sources. According to IPCC (2001) any climate impact response action emanating and undertaken solely by individuals, household or a business is classified as private adaptation. The public adaptation is any climate impact response action or policy emanating and undertaken by local, state, national governments or

TABLE 1
Characterization of Climate Impact Response Strategies

Characteristics of Coping and Adaptation Strategies	
Coping (Unsustainable) Strategies	**Adaptation (sustainable) Strategies**
Short-term and immediate: *It is season based.*	Oriented towards longer term livelihood security: *It assist livelihoods to be robust and able to withstand hazards*
Oriented towards survival: *It is hazard specific and surviving that hazard only.*	Results are sustained
Not continuous: *Piece meal strategies that do not build on each other.*	A continuous process: *It is a process that builds up on previous strategies to make it more robust and able to withstand future hazards.*
Motivated by crisis, reactive: *Reactionary strategies to current or previous crisis situations. Ex - Post strategies.*	Involves planning: *ex – ante strategies*
Often degrades resource base	Uses resources efficiently and sustainably
Prompted by a lack of alternatives	Focused on finding alternatives that builds on previous strategies.
	Combines old and new strategies and knowledge

international agencies. This study focused on the sustainability or otherwise of private adaptation (impact response measures) of farmers in the Semi Deciduous Rainforest zone of Ghana using a case study approach.

Materials and methods

Framework of the Study

The study followed the thematic structure of Anatomy of Adaptation by Smit et al (2000). MOEJ (2010) Approaches to Climate Change Adaptation and Daze et al (2009) characterization of what constituted coping and adaptation measures provided the framework for the discussion of sustainability of the private adaptation practices in the study area. According to MOEJ (2010), response to climate impact risk must be premised on one or a combination of the following concepts and they include risk avoidance, reduction of negative impacts, risk sharing, risk acceptance and exploitation of opportunities. The climate impact response measures that ensue from using these concepts must lead to neutralizing or reducing current and future climate change impacts, hence ensuring sustainable development.

The IPCC (2001) stated that systems have a coping range. This coping range has evolved to allow systems to accommodate some level of deviations from 'normal' conditions, but rarely the extremes (IPCC, 2001). Thus it was not surprising when the IPCC (2012) further indicated that coping results in basic functioning in the short term. It is thus worth noting that, projections and reports of the increased frequency and intensity of extreme climate related events which falls outside the coping range of systems (MOEJ, 2010; IPCC, 2012) is a cause for concern. With the frequency and intensity of extreme climate events expected to increase (IPCC, 2001), coping with climate change and variability which is basic and short term (IPCC, 2012) is not enough to assure sustainable development. A reactionary short term coping strategy needs to give way to medium to long term adaptation that is planned and anticipatory (Smit et al, 2000; MOEJ, 2010). This implies that, reactionary measures to previous and current impacts need to expand to include measures that can deal with anticipated future impacts.

Daze et al (2009) stated that, the process of adaptation required attention to current shocks, and model – based future impacts. The frameworks for adaptation by Smit et al (2000) and MOEJ (2010) also provided guidance to climate change impact response along the same focus: that, one must react to experienced and current impacts as well as the anticipated future impacts.

The framework by Smit et al (2000) was christened gross anatomy of adaptation to climate change and climate variability (Figure 1).

The framework was divided into two parts. The first part which addressed what adaptation meant included examining climatic and non-climatic stimuli impacting a system and how the system also responded to the impact. The second part examined the effectiveness and sustainability of the undertaken responses. MOEJ (2010) Framework of adaptation and Daze et al (2009) coping and adaptation characterization were used to evaluate the undertaken impact responses for effectiveness and sustainability.

In this paper "What is Adaptation", refers to adjustments in socio-economic systems through processes, practices, and structures to moderate damages or to benefit from opportunities in response to actual and/ or expected climatic stimuli and their effects or impacts (IPCC, 2001). On "Adapting to what?" that had to do with changing or changed climatic and non - climatic elements creating the impacts and vulnerabilities. The paper sought to identify the perception of farmers on what climatic/ weather elements had actually changed or were changing and what effects those changes have had or were having on their livelihoods. Again, based on past and present changes, the paper sought to investigate farmers' projections of changes in the climatic elements and how their expected impacts would be on their livelihoods (Smit et al, 2000). Some attention was also given to non – climatic factors that were also impacting farmers' livelihoods and accentuating lowering of production levels.

It is obvious that "what adapts" was the system that was receiving the impact from those changing/ changed climatic elements. In this paper, this meant the farming system in the community and how it had been affected and/ or being affected?

In the next stage of the framework, "How is adaptation taking place?" the paper outlined how farmers were responding to these impacts with new practices and innovations. In addition the outcomes were also recorded.

The second part of the framework was directed at the evaluation of the climate impact responses in order to ascertain how good

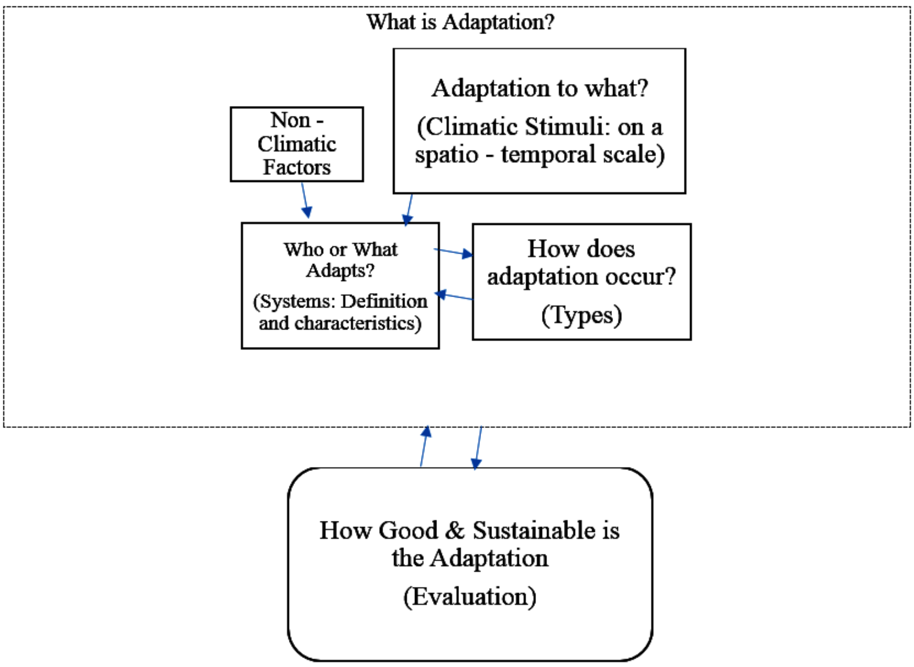

Fig. 1 Adapted from Smit et al (2000). Gross Anatomy of Adaptation to Climate Change and Variability

and sustainable they were. An assessment of how fitting the responses were towards current impacts and how prepared they were to respond to future impacts formed part of the evaluation. How good and sustainable or otherwise their responses were was thought to have implications on sustainable development. The adaptation framework provided by the MOEJ (2010) was used as a complementary framework to evaluate the response measures to determine their effectiveness. The evaluation for sustainability of the farmers' impact response measures was based on the characteristics of adaptation and coping by Daze et al (2009) and MOEJ (2010) framework for adaptation that also stressed on climate change adaptation being proactive in nature to address anticipated future impacts.

Study Area

The study was carried out in Oboadaka in the Akuapem South District in the Eastern Region of Ghana. The study location forms part of an important agricultural enclave of Ghana where pineapples were cultivated for export. The people of Oboadaka were mainly farmers who cultivated staples like maize, cassava, plantain, cocoyam for subsistence and non-staples like pineapple for commercial purpose (GSS, 2014). In a study on idiosyncratic shocks and welfare dynamics, Adjei-Holmes et al (2010) concluded that Oboadaka is part of a region considered to be poor. The study showed that 98.6% of the population obtained their drinking

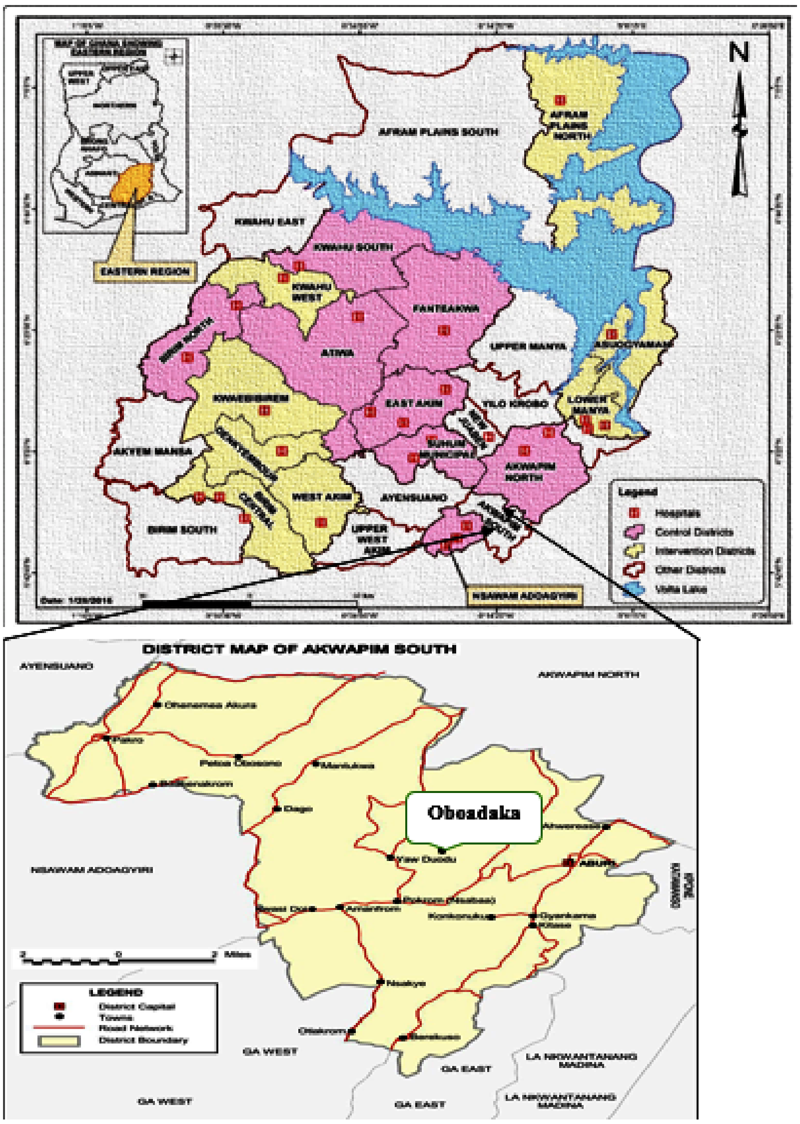

Fig. 2 Eastern regional and District Map of Akwapem South showing Oboadaka

Source: Adapted from researchgate.net and GSS (2014).

water from untreated sources and the highest education of up to 88% of the population was Junior High School (JHS) largely because they could not afford to continue. The study area was part of the semi deciduous forest belt of Ghana (Issaka et al, 2012). The location experienced a double maxima rainfall regime (GSS, 2014). According to data from the Ghana Meteorological Agency, the annual rainfall amount for the district of the study area ranges from 1250mm to 2300mm (GSS, 2014).

Oboadaka was selected for this case study because it has close proximity with two urban centres, yet it is impoverished despite the expectation that development should have defused to the community from the two growth poles: Aburi and Nsawam. Christaller's central place theory asserted that a development deficient area most likely got developed by the presence and interaction with a nearby growth pole (developed centre) (King, 2020). The study wanted to establish if the main economic activity (farming) which generated interaction between the community and the growth poles had been affected by climate change impacts. The study further sought to assess the sustainability of the responses to climate change among others in the study area.

Study Design and Research Method

The study used a qualitative research approach. This was because a qualitative study design was most appropriate for eliciting the emerging views, meanings and perceptions (Creswell, 2014) of rural folks on climate change and its impacts on their livelihoods. In addition, the qualitative study design afforded the ability to explore for the emerging coping or adaptation strategies being practiced by the rural farmers to reduce their vulnerability to these climate impacts.

The qualitative research method employed in this study was the case study method. The case study method "involves the study of an issue explored through one or more cases within a bounded system" (Creswell, 2007). It is also a research method for in – depth study of real life issue in a contemporary context (Yin, 2009). Thus this method was chosen because it was one of the most effective methods in qualitative studies used to conduct in – depth research into this highly varied contemporary phenomenon in-situ (Creswell, 2014). Climate change adaptation is a contemporary issue that requires in-depth investigation to know and understand the practices of participants in order to provide some analysis on development implications. Thus case study offered one of the most appropriate methods.

Data Collection Methods, Sampling Techniques and Sample Size

The data collection relied heavily on key informant interviews (KII), focus group discussions (FGD), observations and field notes. The sampling technique was of a complex design. The techniques employed in the study included criterion purposive sampling, snowball and stratified random sampling. Criterion purposive sampling was used to identify the sampling frame for the study in order to select only farmers who had stayed and practiced farming in the community for at least ten years and who were experienced enough to be able to give account of their experiences and perception about climate and its impact on the study location. This sampling technique of selecting participants is in tandem with qualitative studies approaches (Palys, 2008). Ten years as minimum residency period in the community was required to be able to fit the time scale chosen for analysis.

After the sampling frame had been achieved through the criterion purposive sampling technique (25 farmers), a stratified random sampling was used to draw the participants for the focus group discussion. Random numbers within a range from 1 to 25 were called out by the farmers who formed part of the sampling frame. For selecting participants from each sex stratum, numbers 1 to 13 represented names of male participants and 14 to 25 represented names of female participants. Farmers in the male stratum called out eight (8) different numbers. The farmers in the female stratum also called out seven (7) different numbers. The numbers that were mentioned corresponded to particular names of farmers on the lists. These farmers became selected participants for the Focus Group Discussion. The participants for the Focus Group Discussion (FGD) were thus males and females. More importantly, it was intended to bring out the various perspectives held by the males and the females on the various matters of discussion.

The Oboadaka elected electoral area representative at the District Assembly (assembly man) who was also a leading farmer and had lived in the community for over 20 years was criteria purposively selected to participate in a key informant interview (KII). Using the snow ball approach, he and subsequent selected farmers assisted to select 5 other chief farmers with over 15 years' experience in farming in the community to participate in the other KIIs.

In all 21 participants were selected to participate in various forms of interviews. Fifteen participated in three sessions of focus group discussions while the remaining 6 participated as key informants who were interviewed individually. After the second focus group discussion, it was realized that not much of new information was emerging. A third focus group discussion was organized and conducted to test for information saturation and it also provided the same information provided by the first two discussions. Further discussions were then halted. After the fourth key informant interview, new information provision by the subsequent informants were limited. After the 6th key informant interview, information saturation had been achieved.

Data Collection Sources and Analysis

The primary data came from summaries and quotes of key informant interviews (KII), focus group discussions (FGD), observations and field notes to augment the secondary data that was used for the study. Other primary data used also included rainfall as well as temperature data for the Aburi catchment area which included Oboadaka. It was obtained from Ghana Meteorological Agency (Gmet), Aburi. The temperature and rainfall data were obtained in their raw state. Using Microsoft Excel, the data was analyzed for trends and presented in the results section with bar, line and trend analysis graphs. Interview guides were used to direct the interviews and an audio recorder, pen and a notebook were used to record the interviews. Rapid Assessment Summaries (RAS) were used as a source and basis for results presentation. This involved avoiding long laborious and verbatim transcription. The audio data was translated into vital summaries written out directly from listening to the audio without losing memorable quotes and expressions. The summaries and quotes were then coded and re-grouped under pre-determined themes. Some coded summaries which were re-grouped, emerged as new themes and were presented as part of the results. The results served as the basis for the discussion stage of the paper which indicated the classification of the various climate impact response measures and their implications thereof for sustainable development.

Secondary data was mainly sourced from published literature including books, journal articles, conference and seminar materials, and World Bank Climate Change database.

Results

According to Smit et al (2000) climate change adaptation is explained by analyzing data and seeking answers to questions like "Adaptation to What (Climatic and non-climatic stimuli)", "Who or What Adapts", "How does Adaptation Occur" and "How good is the Adaptation" as shown in the framework (Figure 1). Thus in this study, the gross anatomy of adaptation framework by Smit et al (2000) provided the structure for the analysis of "what is the adaptation practiced in the study area". The results presentation followed the same structure. The results also emphasizes 'How good the adaptation was" to be able to qualify as sustainable adaptation or unsustainable coping strategy.

Adaptation to What?

The perceptions about climate change expressed in this study by participants included:

Change of date for the commencement of crop supporting rainfall during the rainy season. This paralleled similar findings in the transition zone of Ghana (MFCS, 2014). Other publications including Fadina & Barjolle (2018) also reported rainfall delay. Thus the start of the rainfall season during the major rainy season has shifted from March to April and sometimes beyond, shortening the major season. Respondents remarked as follows: *"Rainfall timing has shifted. Previously, the rainfall season started early and by 15th March it has rained enough and maize could be sown. Planting that early was good for our crops and not much pests could attack and destroy the crops. Yield levels were higher if by May the maize plants had started flowering or tussling. However, there has been persistent late onset of the rainy season for some years now." (KII 1, 2018).*

As reported in Central America by Harvey et al (2018) was this parallel perception of increased frequency of intense rainfall for a short period of the season especially around June and July in Oboadaka. This event is characterized by little sunshine interspersed between days of heavy rainfall. This causes the maize and other vegetable crops to fail on the field due to too much rainfall. The remark is indicative of this view: *"During some parts of the rainy season, the frequency of the rainfall events is increased and this affects our crops negatively. The rains fall almost daily. We would have preferred if it rained once or twice a week with sunshine interspersing the rains" (KII 2, 2018).*

Conversely, it is interesting to note that while excess and frequent rainfall during part of the rainy season doused their crop productivity, intermittent short periods without rainfall during part of the rainy season and much longer and intense harmattan seasons also occurred in the study area. This exacerbated the dipping of crop productivity. The variability in the drought and the rainfall patterns was hence debilitating. The responses from participants exhibited indicate such. *"Currently the drought pattern is not stable. Each year has its peculiar drought pattern. There are times when the drought period is short (January to February). At other times, the drought duration is long spanning Mid-September to March or beyond. The year 2018 experienced the long spell of the dry season and indeed life was difficult for us" (KII 1, 2018).*

"Crops like maize, cassava and plantain require consistent and regular alternating patterns of rainfall and sunshine to aid crop growth. However, the sun could scotch on daily basis for two to three weeks without any rainfall. When the rains become inconsistent or irregular and the crops are scotched by the intense insolation from the sun, the growth and maturity of the crops take a much longer time if they survive at all and this dips yield levels" (KII 3, 2018).

Looking at the figure 3, inter annual rainfall pattern for more than a decade was rightly described as "unpredictable" or variable. This perception was validated by annual rainfall data from the Ghana Meteorological Agency (GMet) which revealed inter annual variability between 2000 and 2016 in Aburi GMet enclave which includes the study area.

Furthermore, a critical examination of total rainfall figures during the active crop growing period (April to July) of the major seasons for more than a decade (between the years 2000 and 2016) confirmed the slightly declining rainfall amount asserted by study participants. Figure 4 indicates the trend with the dotted trend line.

Change in humidity was expressed in terms of the disappearance of morning dense fog in the hilly countryside of Oboadaka as one of the manifestations of climate change. The dense fog could impair vision and drench anyone who walked through the bushes. It could support crop growth. It was remarked in an interview as follows: *"There is also the*

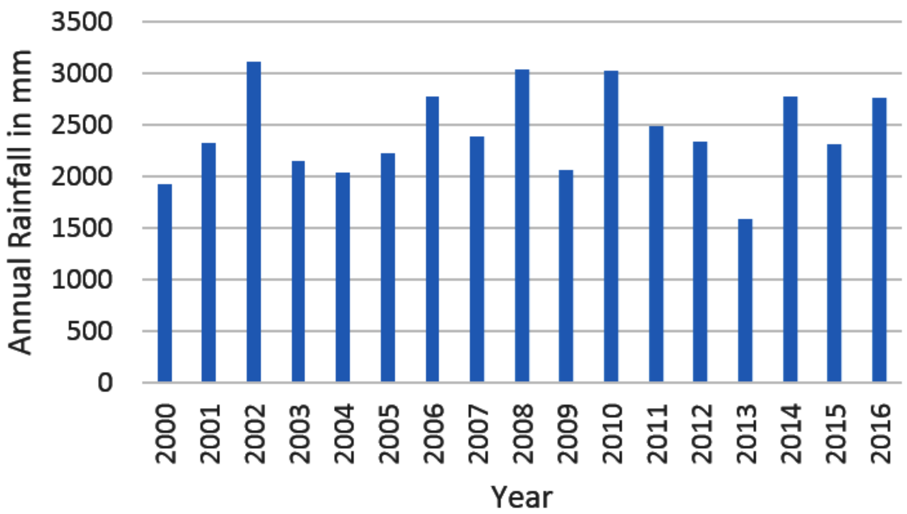

Fig. 3 Inter Annual Rainfall Trends in mm from 2000 to 2016 in Aburi and its Environs

Source: Raw Data from Ghana Meteorological Agency. Graph developed by researcher

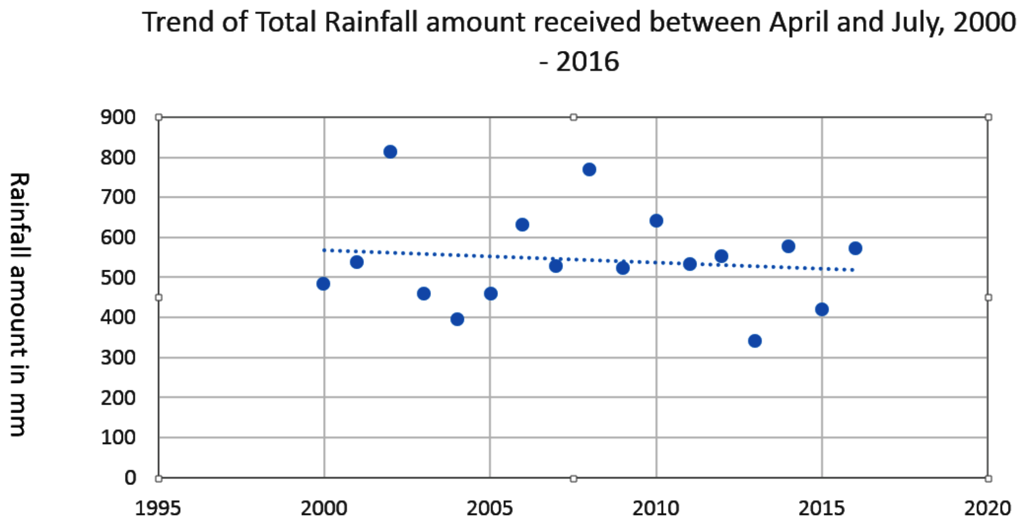

Fig. 4 Trend of Total Rainfall amount received between April and July from 2000 to 2016

Legend: The X (horizontal) axis shows the years from 1995 to 2020. The Y (vertical) axis shows the total rainfall amount received between April and July in mm. Each dot represents total rainfall amount received during the active growing period in a particular year. The trend line across the dots is showing the declining trend

disappearance of heavy fog which encouraged crop growth even in the absence of consistent rainfall" (KII 2, 2018).

Another identified perception of climate change which was in tandem with Niang et al (2014) observation for Africa was the increased air and soil temperatures which made crop cultivation during March a futile endeavor. Crops grown in March experienced crop withering due to lack of regular rainfall and prevalence of high temperatures during the day. A participant commented as follows: *"Increased insolation resulting in increases in temperature is another change I have observed about changes that have occurred with the weather. The increase in temperature destroys our crops like plantain and cassava. The heated soils destroy the cassava while the warm air dries the plantain trees. Hitherto, these crops didn't have a problem with the weather". (KII 3, 2018).* Temperature data from the Ghana Meteorological Agency

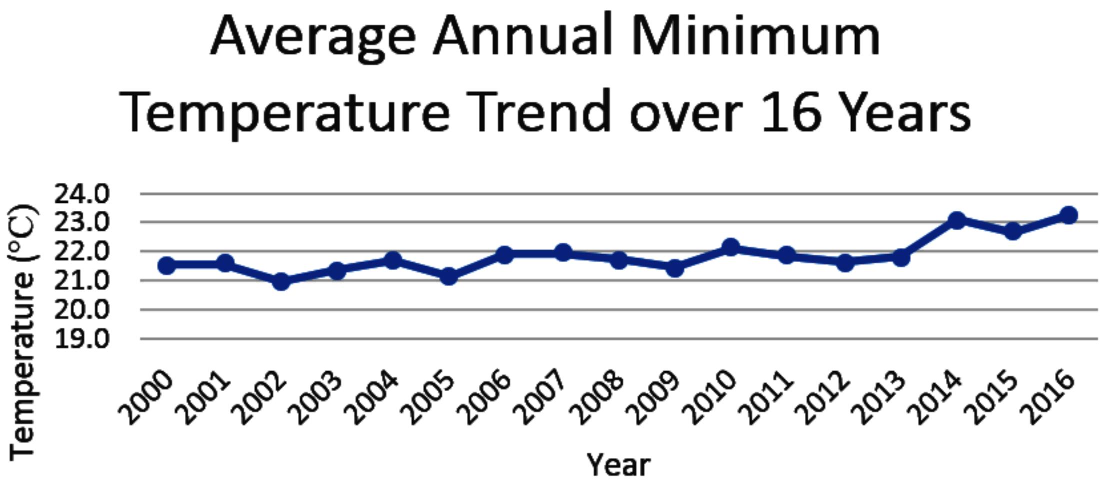

Fig. 5 Average Annual Minimum Temperature Trend over 16 year

(GMet) for the study area also supported the view that atmospheric temperature was rising. Average annual minimum temperatures over the past 16 years showed an increasing trend. This is congruent with the projection of Niang et al (2014) which observed that minimum rather than maximum temperatures would rise. Figure 5 shows the increasing trend.

It is important to mention that there were other non-climatic factors such as lack of farm capital and equipment, non-availability of labor, and introduction of non-evaluated crop varieties affecting the farming system in Oboadaka.

Who or What Adapts

This section of the results, provided a description of the impacted farming system by the perceived climatic changes identified.

Crop farming activities were planned and conducted to coincide with the two rainfall seasons. Thus Oboadaka had a major (whose current period is April to August) and a minor planting seasons (which is also September to November).

Land tenure complications has left farmers with no option but to cultivate on fragmented farmlands. Thus farmers in Oboadaka cultivate crops on two or three parcels of land at different locations. Preparing and cultivating each parcel of land by the same farmer requires considerable amount of time. However, a shortened rainfall period in the major rainy season like what was observed in Central America (Harvey et al, 2018) together with limited access to hired labor and modern technology made cultivating all different parcels of land on time challenging. Farmers were mostly late to cultivate the last parcel of land after cultivating the first few parcels of land on time. The farmers either abandoned the cultivation of the last parcel of land or tried their luck with it. Either way the risk of loss of income was heightened. Remarks from a participant in FGD 1 (2018) vividly captures this view: *"Rather than the rains beginning in March, it starts in April shortening the rainy period of the major season and this limits our activities. In addition, there are intermittent breaks in rainfall during the major rainy season"*.

Related to the forward shift of the major rainy and planting season to April was the phenomenon of the major season almost coinciding with the minor growing season. Farmers who cultivated some of their parcels of land late during the major season mostly missed out in the minor growing season because their major season crops were not harvested early enough to allow for minor season cultivation on the same piece of land. A participant succinctly recounted his experience in 2017 as follows: *"Last year, I planted maize on my last parcel of land in late June when it was still raining and I was forced to harvest it when it was not completely dried* *in October because I wanted to do something on the land for the minor season. However, I could not do any serious cultivation on the whole land because minor season planting time had long elapsed and I was afraid that the rains would stop mid-way when my late crops were still growing and then wither. That would mean losing money so I did something small" (KII 5, 2018).*

From the above quote, this meant that some significant volume of produce that would have been realized in the minor season was never produced. The same participant decried his loss in potential income and food security in a comment that follows: *"The resultant effect was reduced annual yields and income which affected household food security".*

Land preparation for crop farming has also been impacted by the changing pattern of the vegetation due to climate and human activities. It is important to note that, climatic patterns affects vegetation distribution (Straher, 2011). The proliferation of elephant grass immediately after broad leaved vegetation including trees is cleared was a widespread phenomenon necessitating the implementation of a new land preparation strategy by farmers. The management of elephant grass as weed was not common place in the study area until recent times. Controlling the grass was an imperative during land preparation. The quote below was a sentiment expressed about this recent phenomenon by a study participant: *"Weeding is undertaken early to give ample time for the grass to emerge and be controlled before planting is done. Emergence of grass after clearing broad leafy weeds was not common in Oboadaka some years ago. However, it is now common place and its management must be part of land preparation otherwise one cannot do any meaningful farming" (KII 3, 2018).*

Apart from the control of grass as weeds during land preparation, there had been a surge in pests attack on crops in recent times. According to the farmers, this could be due to the changing climate among other factors. Increasing temperature enables pests to breed in their numbers, attack and feed on crops (Jaglan et al (2016; Sharma, 2014). The comment by a participant in KII 6 is succinct: *"…the changed climate has resulted in the emergence of worm and insect pests that destroy maize crops on my farm. They attack the maize plants by feeding on the unfolding leaves and destroy the plant".*

It was also stressed by Sharma (2014) that changes in cropping patterns occasioned by climate change would influence insect pest distribution. It was therefore not surprising when it was suggested that the changing climate which had forced a change in the planting time has thus resulted in increased pest attacks. The growth period of the late planted maize coincided with the proliferation of pests which fed fat on the crops. Thus the comment below is instructive:

"Previously, the rainfall season started early and by 15th March it has rained enough and maize could be sown… Planting that early was good for our crops and not much pests could attack and destroy the crops." (KII 1, 2018).

How is adaptation occurring (Climate change impact response strategies)

One of the most widespread climate change impact response strategies of the current farming system at Oboadaka was shifting the planting time of crops especially maize from March to April and May. Delayed planting time strategy was also observed in parts of Ethiopia by Sani et al (2016). In Oboadaka delayed planting enabled planting of maize and cassava to coincide with the onset of relatively regular rainfall. Again, this prevented the high temperatures and irregular rainfall around March from destroying the crops. The remarks of a participant in a focus group discussion was indicative of this point: *"The main response feature is to delay planting of especially maize to between April – May 10th. Previously, farmers planted in March. Today, if a farmer planted in March, it was certain that the crop will wither due to irregular rainfall and intense heat from the sun". (FGD 3, 2018).*

Related to the above strategy was the practice of diversification of planting time. Farmers cultivated some parcels of their land late around June whereas the same farmers cultivated other parcels of land in April. This reduced the risk of losing all their crops in a single April cultivation regime should the rainfall temporarily cease for a while during the major rainy season's cultivation period and resumed after a while of drought spell. The late cultivation normally coincided with the resumption of the rains which tended to be very heavy after that drought spell. The maize crops grew very fast during that period and if the rains did not cease early, the late cultivated maize crops were successful. A key informant remarked as follows: *"As insurance against rainfall variability, part of the land is delayed in cultivation while the other part is cropped in April. This helped to guard against losing all crops from a single cultivation regime. It was assumed that, if the relatively early planted crops failed as a result of wet season intermittent rainfall cessation, the delayed crops would coincide with the return of the rains before the season ended. If the April planted field did not fail and the late planted fields also did not experience an early cessation of the rains then the farmer could have a good harvest" (KII 4, 2018).*

Another climate impact amelioration strategy practiced in Oboadaka was crop diversification. Currently, each farmer cultivated more than one crop in each season. This was also a trend identified by Sani et al (2016) in part of Ethiopia. Comments by participants revealed that, some crops like pineapple, cowpea and cassava could withstand the declining rainfall between April and July (during the active growing period) and some level of drought hence they were gaining cultivation attention of farmers in the study area. In addition, the high market value of these crops especially pineapple played an important factor for their inclusion into the diversity of crops cultivated. This strategy was practiced in order to offset potential losses in the event of maize production failures due to rainfall variability. It is however important to note that, offsetting loss by another climate resilient or high market value crop does not take away the fact that income and food has been lost that would have contributed immensely to household and community development. The following comments by participants expressed farmers' practice of crop diversification: *"We don't cultivate one crop. Losses from the maize and tomato farms were offset by income from pineapple and cassava proceeds. ... My long term response strategies to climate change impact include diversification of crop farming activities to include crops with high market value such as pineapple" (FGD 2, 2018).*

It is noteworthy to mention that, farmers used intuition and experience to decide what to cultivate and when to do the cultivation. Dependence on experience and unscientific intuition amidst climate uncertainties or climate variability was problematic. Decisions on what crops to grow and when to cultivate them was purely ad hoc in nature or at best reactionary to the prevailing weather condition. A participant remarked as follows: *"If my assumption about the weather doesn't hold, I would also change my plans for the farming season. If it rains more when I expected it not to, I would plant more water loving crops like plantain. However, if the rainfall volumes reduce for a long period of time, I would change my style of farming. I would quickly grow crops that can do well with limited rainfall like pineapple which can withstand drought for up to 2 years. My locally gathered experience about managing the weather and what I can plant during such low rainfall years would guide me to decide what I grow" (KII 1, 2018).*

The Goodness and Sustainability of the Adaptation

This section focuses on how good and sustainable the applied impact response strategies were. MOEJ (2010) framework for adaptation and Daze et al (2009) distinction between coping (unsustainable) and adaptation (Sustainable) characteristics were used for the analysis.

According to MOEJ (2010) framework of adaptation, adaptation is planned and undertaken to manifest the following characteristics: risk avoidance, risk sharing, reduction of negative impacts, acceptance of impacts and exploitation of opportunities. Climate Change impact response measures should focus on at least one or a combination of these characteristics in the short term [less than a decade] as well as in the medium to long term [a decade and upwards] (MOEJ, 2010). This is because climate change and its impact is already taking place and it is projected to increase in severity as well as in geographical coverage (IPCC, 2007).

The response strategy involving a shift in planting time from March to April and beyond in response to climate change and climate variability had the characteristics of risk avoidance and reduction of negative impact as prescribed by MOEJ (2010). This strategy is consistent with findings by Fosu Mensah (2012) and Tachie-Obeng et al. (2013) for the forest - savanna transition zone of Ghana. However, it was found to be short term, reactionary to the current weather pattern, imprecise, inefficient with time use and neglected the projected future climate change (intensified drought) and its impact that is likely to increase (IPCC, 2007).

The change in planting time for crops is basically to avoid or reduce the risk of crop failure due to high temperature (33.9ºC in 2014, 33.4ºC in 2015, 35.2ºC in 2016) as well as delayed and irregular rainfall in March. If drought conditions prevailed through April and May after planting has been done, this strategy would not be an robust impact response measure. It is important to mention that, it is basically a crude reaction to the current impact of climate change and climate variability without anticipating projected future impact [from reducing rainfall, increases in rainfall variability, drought and temperature (Niang et al, 2014)] and associated response strategies. Again, farmers' planting time is experimental and not based on any scientific meteorological guide. It is also season specific and depends on farmers' perception of prevailing weather conditions. Clearly this strategy is good for the interim but it is short term, does not guarantee good results, time use inefficient and reactionary. Hence it is a coping strategy (Daze et al, 2009; Smit et al, 2001) and an unsustainable one.

A comment from farmers also indicated the following: *"if prolonged drought occurs, the pineapples may also not yield very well. After forcing pineapple to fruit, it requires 2 to 3 months of regular rain to develop its fruits well. The absence of water will reduce the size and weight of the fruits by about 20 to 30 percent" (KII 3).* According to the IPCC (2007) fourth assessment report, it was estimated that, for sub Saharan Africa, rainfall variability, temperature increases and drought condition would intensify by the decades through to the end of the century. It was thus important to note that, the crop diversification strategy adopted by farmers at Oboadaka without other incremental impact response measures could not withstand intense weather events like prolong drought, intense rainfall variability and soaring temperatures especially if these changes happened faster than the crops could adjust. This strategy, although it was vital and potentially a sustainable impact response measure, it was being applied as an unsustainable coping strategy. This is because farmers had no plan as to how to adaptively manage it incrementally like introducing irrigation. In the event of intense weather pattern which threatened to collapse this strategy, a farmer remarked as follows: *"... farmers cannot do anything more than they are already doing. Government would have to come to our aid otherwise, there would be hardship" (KII 3).* Farmers were applying this strategy on short term basis and that has made it a coping strategy when it should not be. Barimah et al (2014) and Fosu – Mensah (2012) suggest more drought resistant crops like sorghum and millet to be adopted by farmers in the transition zone.

It was also admitted that, farming decisions were ad hoc in nature. This was so in order to take advantage of the prevailing conditions. If some particular crops were cultivated based on farmer knowledge and predicted weather condition for a period but it turned out not to be the case, farmers would quickly convert the failing farm into another crop that would likely be suitable for the prevailing weather. Clearly, this was a good salvaging strategy but it indicated inefficient resource utilization hence an unsustainable adaptation measure (Daze et al, 2009). Time and other inputs would have gone wasted. The comment below is indicative of this strategy: *"...However, if my assumption about the weather doesn't hold, I would also change my plans for the farming season. If it rains more when I expected it not to, I would plant more water loving crops... However, if the rains reduce in volumes for a long period of time, I would change my style of farming. I would quickly grow crops that can do well with the limited rainfall... My locally gathered experience about managing the weather and what I can plant during such low rainfall years would guide me in what I grow" (KII 1, 2018).*

Discussion

The characteristics of reduction of negative impact and risk sharing from MOEJ (2010) framework of adaptation are identified in the farmers' strategy of deliberately cultivating different parcels of land at different delayed dates. This is done to spread and reduce the risk of crop failure in a single cultivation regime due to rainfall variability. It was assumed that if crops planted in April failed or yielded poorly due to temporary rainfall cessation mid-way through crop growth, the late planted crops' growth and grain filling would coincide with the return of the rainfall before the rainy season broke completely again. Farmers did not want to lose all their crops to a variation in the rainfall, a phenomenon whose occurrence affected their food and income security. Hence farmers sought to reduce the impact by ensuring that if crops on one field failed there was the potential for another field's crops to survive to supply the food and the income. Although, there would be some impact when some crops failed or were not able to yield as expected due to rainfall variability, the impact on households would be reduced. It is essential to note that, Bhardwaj et al (2002) in a study on tepary beans indicated that, delayed planting in mid – June resulted in reduced yields. Although the crops are different, it would be instructive to also investigate the yield levels in late (June) planted maize to determine its productivity around the semi deciduous forest belt of Ghana. It must be stressed that the planting date diversification strategy was reactionary to rainfall variability, oriented towards surviving it (coping characteristics according to Daze et al, 2009), speculative and subject to endless land availability. These made it unsustainable impact response measures especially in the face of increasing competition for land and projected intensification of climate variability (IPCC, 2007). It was basically meant to cope on the short term (IPCC, 2007) with the changing climate while extra land was available and affordable. Farmers conceded that there was also no certainty of success for April nor June planted crops. This strategy appeared to be good but it was purely based on luck. A farmer could have both April and June cultivations succeed or fail depending on weather conditions. Hence this strategy was also not sustainable.

In tandem with the framework from MOEJ (2010), the strategy of crop diversification to include cowpea and the resuscitation of the pineapple industry in the study area involved an attempt to accept some level of risk and take advantage of the opportunities presented by the prevailing climatic conditions of increase in temperature and the declining rainfall. The farmers believed that the current level of temperature increase, rainfall variability and drought conditions could be tolerated by these two crops (cowpea and pineapple) which have been added to their cultivated crops. According to Williams et al (2017) and De Azevedo et al (2007) pineapple can tolerate some amount of drought and temperature increases. In addition, cowpea is best suited for locations with relatively dry conditions (Gomez, 2004). Hence the relatively dryer conditions occurring in Oboadaka during the crop growing period of the major season made the cultivation of cowpea a good option which fitted the circumstances. It must be mentioned that, prolong drought or intense rainfall variability would be detrimental to these crops (de Azevado et al 2007), even though they currently best fit the occasion.

It has been established that the response strategy involving a shift in planting time from March to April and beyond was short term and reactionary to the current weather pattern and thus qualify as a coping strategy. It would be recalled that in 1982 through to 1983, prolonged drought and unusually strong spell of harmattan occurred in Ghana and devastated crop farms among others (Dei, 1988). If the 1982 through to 1983 type of drought and harmattan (Dei, 1988) were to recur as an intensified climate change, this strategy would not be able to ameliorate the expected climate impact on crops. It would not assure long term livelihood security and robustness, a trait needed to qualify it as a sustainable adaptation measure (Daze et al, 2009).

As has been demonstrated, coping strategies which inure to basic functioning in the short term (IPCC, 2012) are shattered in the face of climate change intensification or extreme events (UKCIP, 2007). ProVention Consortium (2009) thus intimated that a more robust impact response initiative than is currently being applied will be necessary to reduce vulnerability to a future climate change. This is likely due to climate change intensification as projected by IPCC (2014). Proposed by Neeliah et al (2006), irrigation of cultivated crops provides one of the best sustainable adaptation to mitigate the current and potential future impacts necessitating delayed crop cultivation.

The strategy of crop diversification to include cowpea and the resuscitation of the pineapple industry in the study area to reduce over dependence on maize, tomato, and plantain which were so vulnerable to the climatic variability was an important strategy. Crop farmers in the transition zone of Ghana used similar strategy by diversifying their crops to include cashew in order to minimize their losses to climate change (Barimah et al, 2014). Tree crops have been used as part of crop diversification strategy in other jurisdictions notably in Benin (Fadina and Barjolle, 2018), and Central America (Harvey et al (2018).

The crop diversification strategy adopted by farmers at Oboadaka in this study was not associated with any other incremental impact response measure to withstand intense weather events like prolong drought, intense rainfall variability and soaring temperatures. In addition, farmers had no plan to adaptively manage the response measure incrementally like introducing irrigation and thus the strategy was being applied as an unsustainable coping strategy. Obviously, the responses by the farmers were reactionary, short term, survivalist, inefficient in resource use and thus qualified as a short term coping strategy according to Daze et al (2009) typologies for coping and adaptation strategies. It can be inferred that the farmers were not focused on sustainable adaptation which is anticipatory, long term and adopts incremental approaches (Daze et al, 2009).

Conclusion

The climate impact response strategies used included shift in planting time from March to April and beyond; diversification of planting time, diversification of crops and farm conversion from one crop to another when necessary. The study concluded that the farmers' response strategies to climate impact qualified as coping strategies which were not sustainable due to the manner in which they were being applied and the fact that they were not anticipatory. This was because, characteristics of coping according to Daze et al (2009) was found in the current farmer impact response in the study area. The coping strategies were reactionary, inefficient, ad hoc, short term and based on trial and error as well as speculation. This signified that, their adaptation capacity was weak. A strong sustainable adaptation capacity must entail impact response strategies that reduce current impacts and vulnerabilities in addition to anticipating future climate risks and adequately taking steps to ameliorate the anticipated future climate impacts (Smit et al, 2001). However, the futuristic anticipation and amelioration of expected climate impacts was lacking in the farmers' impact responses. A more sustainable adaptation measure that could replace shift in planting date, diversification of planting date and farm conversion to another crop is water smart irrigation that would ensure current and future plant water needs are met. Maintaining or growing trees to provide shade and maintain soil water for crops, moderate temperature and sink carbon could also be another sustainable adaptation strategy. The crop diversification strategy could have been made more sustainable if farmers had the incremental plans of being seed and water smart as suggested in Aggarwal et al (2018). Thus plans to eventually introduce efficient irrigation and more drought resistant cultivars (Barimah et al, 2014) of the pineapple and cowpea that can withstand intense dry and hot weather rather than rely on varieties used to rainfall and optimal temperatures.

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