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The Knowledge of Climate Change among the Paddy Farmers of Kahama District, Shinyanga Region Versus Meteorological Data

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The study investigated the knowledge of the paddy farmers of Kahama District on climate versus three decades meteorological data in the District. Cross sectional research design was employed on which a randomly selected sample of 312 farm households were interviewed. The study employed a triangulation approach on which primary data were collected through household surveys, field observation and key informants' interviews. Secondary data on the other hand were obtained from the Tanzania Meteorological Station (TMA) and were subjected to excel sheet on which linear series of rainfall and temperature were reported. The findings from primary and secondary data revealed changes in both rainfall and temperature in around three decades. The knowledge among the farmers on climate change was reported to be acquired in diverse ways

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including from the meteorological stations, information sharing among the farmers, NGOs and own experience. Farmers perceived a decreased in the onset and cessation of rainfall, increased pests and diseases and increased drought incidences. Secondary data obtained from the meteorological station confirmed the decreased rainfall and rising temperature in 30 years. These challenges negatively impact paddy productivity in the study area. The study recommends on upscaling of information dissemination among the farmers and across the other parties involved in paddy productivity. Further investigation on contextual-level adaptation responses is recommended as well.

Keywords: Knowledge; climate change; paddy farmers; Kahama district.

1. INTRODUCTION

Climate change is a pressing global challenge that possesses significant threats to entire agricultural systems, including paddy farming. Besides posing significant challenges to the agricultural systems worldwide it affects crop production and the entire livelihood systems. Rice constitutes one of the major cereal crop produced in most SSA countries and has the potential to contribute to food security [1]. In many SSA countries rice is one among the most important food crop and it is being produced in diverse agroecological zones ranging from upland to the lowlands and in flooded environments as well [2]. The impacts of climate change on paddy farming are wide-ranging and multifaceted, affecting various aspects of production, livelihoods, and food security. According to a study by Wassmann et al. [3], changes in precipitation patterns can disrupt the traditional planting and harvesting schedules, affecting crop yields and overall productivity. Climate change is causing a gradual increase in global temperatures, which has implications for paddy farming. Higher temperatures can accelerate crop development, resulting in shorter growth cycles and reduced yields. Additionally, extreme heat events can lead to heat stress in rice plants, affecting their growth and productivity. The study by Pandey et al. [4] earmarked the increasing global temperature concerning to the reduced paddy grain quality and quantity. Similarly, Maclean et al. [5] mentioned paddy as one of the vulnerable grains to pests such as the brown planthopper and diseases like blast and sheath blight. These pests and diseases significantly impact crop yields.

Paddy farmers in Kahama District are particularly vulnerable to the impacts of climate change due to their reliance on rainfall patterns and temperature regimes for successful rice cultivation. Among the notable impacts of climate change in farming practices in Kahama District include the decreased crop yields and increased pests and diseases due to the changes in rainfall and temperature patterns [6].

Nonetheless, the extent to which paddy of Kahama District farmers have appropriate knowledge on climate change hence device appropriate intervention has not received enough attention. Hence, it is not well understood. This problem statement aims to evaluate the level of knowledge of climate change among paddy farmers in Kahama District concerning meteorological data, as well as identify potential gaps in knowledge and understanding. By addressing these gaps, stakeholders can develop targeted interventions and strategies to enhance climate change awareness among paddy farmers, promoting adaptive practices and resilience in the agricultural sector. The study has addressed the following questions: i) what is the level of knowledge paddy farmers of Kahama District have on climate change, ii) which indicators do paddy farmers use to define climate change in Kahama District, iii) which sources of information are utilized to disseminate climate change information among the paddy farmers in Kahama District?, iv) which activities have been perceived by the paddy farmers to trigger the decrease in rainfall and rising temperature in three decades? v) which changes in rainfall and temperature have been scientifically observed in the period of three decades in relation to meteorological data?

The study is significant in different ways including the following: First, the study will inform development practitioners on the required areas regarding climate change strategies which require adaptation intervention on paddy farming. In terms of the global development policies the study contributes to addressing Thirteens Sustainable Development Goal which stresses on taking appropriate actions to combat climate change. The study further forms the milestone among the agricultural practitioners towards assisting the smallholder farming communities to devise appropriate intervention measures.

2. THE STUDY AREA AND METHODOLOGY

2.1 The Description of Study Area and Justification for of Its Selection

The study was conducted in Kahama District, which is located in Shinyanga region. The district is among three administrative districts in Shinyanga region namely Kahama, Kishapu and Shinyanga. Kahama has three councils among six councils of Shinganga region, namely Kahama Town Council, Ushetu District Council and Msalala District Council. The district has total surface area of 9463 square kilometres which is distributed in five divisions consisting of 58 wards, and 246 villages and 35 streets (Shinyanga Regional Commissioner's Office, 2019). Kahama District lies between Latitudes 30 15// and 4030// South of the Equator and between Longitudes 310 30// and 440 15// East of the Greenwich Meridian and South of Lake Victoria. The total population for the Municipality according to 2022 National Population and Housing Census was 453,654 [7].

The district has been designated as a hub by Africa Rice centre for the promotion of paddy production in the Western part of the country. It's among the three districts chosen and operates as a hub in the country, others were Kilombero and Kyela, with the sole aim of promoting the best and efficient practices in paddy production and marketing. Kahama District is known for production of paddy varieties like Kalamata, Mpyakambili, Mabeyenge, Bisholi and Kahogo but in the market all of these rice varieties have been grouped as Shinyanga rice. The area was chosen mainly because it lies in one of the key ecologies for paddy production and semiarid which the impacts of climate change in terms of droughts are well evidenced.

2.2 Sample and Sampling Procedures

Selection of the study area was guided by the available information which indicates Kahama Municipality as a hub in paddy farming in the Lake Zone. Besides the aforementioned importance, the incidence of climate change has been observed in Kahama District. The next sampling stage involved the selection of the five wards. These were purposely selected from three councils (Kahama, Msalala, and Ushetu) forming Kahama District. The selected wards were Mondo, Kagongwa, Ntobo, Chela, and Nyamilingano. Two villages were purposely selected from each ward for a detailed study, namely, Mondo, Bumbiti, Kagongwa, Gembe, Ntobo A, Kalagwa, Chela, Chambaga, Nyamilingano, and Ididi respectively. The sampling frame of the study was the list of households in the study villages of which the sampling unit was the farming household. Household is defined as a group of people living together and choose the authority of one person as a household head. The sampling frame was useful in determination of sample size and selection of a representative sample. It was found that the selected villages had a total of 8,832 households. Judgmental sampling technique used to select 20 key informants procedure. Table 1 present distribution of sampling frame in study villages.

Sample size was determined using the equation for determination of sample size for known population and proportion by [8] which is postulated as:

Table 1. Distribution of households in study villages

Council	Wards	Villages	Number of households
Kahama	Mondo	Mondo	770
		Bumbiti	608
	Kagongwa	Kagongwa	3,585
		Gembe	698
Msalala	Ntobo	Ntobo A	802
		Kalagwa	665
	Chela	Chela	638
		Chambaga	597
Ushetu	Nyamilingano	Nyamilingano	216
		Ididi	253
Total			**8,832**

$$n = \frac{z^2 \cdot p \cdot q \cdot N}{e^2 (N-1) + z^2 \cdot p \cdot q}$$

Where;
n = Sample size
z = Standard variate at a given confidence level (which is 1.96 at 95% confidence level: basing on table of area under normal curve)
p = Sample Proportion
q = 1 – *p*
N = Size of population (Number of farmer households)
e = Precision (acceptable error)

Data for the calculation were:

z = 1.96
p = 0.7 (Population varies in terms of practicing paddy farming or otherwise)
q = 0.3
N = 8,832
e = 5% (0.05)

Inserting data into the equation:

$$n = \frac{(1.96)^2 (0.7)(0.3)(8832)}{(0.05)^2 (8832) + (1.96)^2 (0.7)(0.3)} = 311.32 \approx 312$$

Thus, 312 respondents were interviewed during structured interviews. Number of respondents from each village was determined through proportionate stratified sampling which allowed for sampling of the proportional number of respondents from each village according to its population size. The following equation for proportionate sampling by Skinner [9] was used:

$$P_i = \frac{N_i}{N} n$$

Where;
P_i = Proportional sample of each village
N_i = Number of household in each village
N = Total household forming the sampling frame
n = Sample size.

The computations and sample size for each study village are depicted in Table 2.

These sampled units in each villages were randomly selected using rottery system from the updated village households list.

2.3 Methods of Data Collection

The study utilised both primary and secondary quantitative and qualitative data. Primary data were collected using survey and participatory rural appraisal (PRA) methods on which household questionnaire survey, in-depth interviews, focus group discussion and direct field observation techniques were employed. Semi-structured questionnaire, checklist of questions, checklist of themes and checklist of things to observe were used as tools for data collection. Secondary data involved meteorological data on the trends of rainfall and temperature changes in the period of three decades from 1991 to 2022. These time series data for weather conditions were acquired from the Tanzania Metrological Agency (TMA).

Table 2. Proportional sample in study villages

Villages	Number of households	Sample size
Mondo	770	770/8832 x 312 = 27
Bumbiti	608	608/8832 x 312 = 21
Kagongwa	3,585	3585/8832 x 312 = 127
Gembe	698	698/8832 x 312 = 25
Ntobo A	802	802/8832 x 312 = 28
Kalagwa	665	665/8832 x 312 = 23
Chela	638	638/8832 x 312 = 23
Chambaga	597	597/8832 x 312 = 21
Nyamilingano	216	216/8832 x 312 = 8
Ididi	253	253/8832 x 312 = 9
Total	**8,832**	**312**

2.4 Data Analysis

Qualitative data were analysed contently and quantitative data were analysed statistically using Statistical Package for Social Sciences (SPSS) software. Selected socio-economic and demographic characteristics were analysed through descriptive statistics on which frequencies and scores were produced. Views and opinion aired out during the key informants' interviews and Focus Group Discussions were analysed based on contents. Time series data were subjected to the Excel sheet where linear trends of both rainfall decrease and rising temperature over thirty years were produced.

3. RESULTS AND DISCUSSION

3.1 Socio-economic and Demographic Characteristics of Respondents

The study analysed socio-economic and demographic characteristics of the respondents in order to establish the baseline characteristics of the paddy farmers of Kahama District. These characteristics form important parameters in relation to the present study. They include age, sex, level of education, marital status, farm ownership and the length of time stayed in the study area. The socio-economic characteristics of the respondents in this study are presented in Table 3. Of the household heads interviewed, 73.7% had age range of 25-54 years old. This implies that active working forces dominates agriculture activities in the study area and have historical patterns of climate change and variability. Age of respondents, for instance determines their experience and overall knowledge on climate change together with ways to adapt to its impacts.

The other demographic variable was sex of the respondents. The study analysed sex of the respondents so as to draw a picture on the degree of involvement of both male and female headed households in paddy farming in the study area. Regarding sex of the respondents, 81.1% of interviewed respondents were men and all married. Besides, sex and household size may affect access to various resources and adaptive capacity which may impact adaptation to climate change negatively or positively. This is important to culture of the study area where the producer (men) to be recognized as grown up person have to engage in marriage. This is justified as 96.5% of respondents are households' heads. This is important to the climate change adaptation and mitigation because this group are aware of the historical trend of the study area as well as existing indigenous technical knowledge (ITK).

Furthermore, the findings showed that the study villages were found to have large household sizes. Results show that 54.5% have 4-6 persons per household and 44% have at least 6 persons. This is due to the culture of marrying many wives (polygamy) which results in a good number of the household members in each household most of them being dependents who are required to feed and take care of. Also, regarding education background of the surveyed population, the findings revealed that majority had primary education (77.3%). The findings underscore that farming is dominated by the household heads with low education attainment. The possible explanation dwells on the shortage of schools especially primary schools which acted as a hindrance in the acquisition to formal education among the majority in the study area. Low education level limits the accessibility to formal employment opportunities to the other sectors different from agriculture. In addition, the finding indicates that farming is the livelihood option among the communities whose household heads are illiterate or semi-illiterate. Thus, it indicates that majority have no other employment option than engagement in farming practices. Besides, households of the study villages found to have average income per month resulted mostly from small-scale farming. Results show that 83.6% have income of at least TZS 100,000 which means at least TZS 3,500 per day (Table 3). This shows that households in the study villages are living nearby poverty line and small-scale farming is somehow rewarding; however, there is a need of commercializing and improve agriculture production and productivity to sustain human wellbeing and welfare.

3.2 Living Experience in the Study Villages

Living experience is an important aspect in the bid to establish the general knowledge local communities have on the changes in climatic parameters namely rainfall and temperature occurred in the area in the period. This is based on the fact that climate change can be determined and documented for any period range compared to climate change which shall be at least past 30 years. The findings indicates that 84.3% of respondents lived in the study villages for at most 30 years. Thus, majority have a good local memory of different environmental aspects and the resultant changes so far occurred in the study area. The study indicates that most of the respondents (80.1%) are immigrants who born outside the village but within the district. Thus, there are pooling factors that attracted them to settle in the study villages includes favorable weather condition for agriculture activities compared to their origin villages as supported by 73.7% of immigrants (Table 4).

3.3 Awareness of Climate Change among the Paddy Farmers

3.3.1 Knowledge of climate change among paddy farmers

The study examined the level of knowledge of climate change among the paddy farmers in the study area in order to establish the missing gaps. The knowledge forms a paramount determinant on the level of intervention required on climate change challenges among the paddy farmers of Kahama District. It is a key aspect in adoption of risk reducing practices as well as withstanding and recovery from climate-related disasters [10,11]. The findings indicated that nearly all households (99.7%) in study area seem to be generally aware of the climate change as indicated in Table 5. The findings further indicated that the respondents reported that the knowledge on the same has been acquired in diverse ways mostly from own observation (99.7%), told by neighbors (94.6%), others reported to be informed by the NGO working in the study area (100%) and listening to the radio (87.2%). These findings indicate that in the study area information dissemination between the farmers and other stakeholders involved in paddy productivity is adequate. As of the period in which most of the farmers have become aware of climate change, the findings showed that most of them (69.7%) acquired climate change knowledge long time ago as indicated in Table 5. This finding is directly linked to the nature of activities which exclusively depend on climatic parameters. The finding is also linked to the farmers experience in the study area where majority of them reported to have stayed in the area for about 30 years. The results imply that, climate is changing and communities are aware of the changes but still its impacts affect their livelihoods. The need for transforming communities to climate change resilience emerged as an adaptation agenda.

3.4 Perception of the Paddy Farmers in the Study Area Regarding the Changes in the Aspects of Climate Change

The study sought to ascertain the general perception of the paddy farmers of Kahama District of the key indicators of climate change so far observed in the study area. The findings showed that paddy farmers of Kahama District link climate change with the changes of some climatic aspects observed in the study area. There are aspects of climate change that have been changed as indicated in Table 6. The changed aspects include seasonal drought, intra-seasonal dry spells, erratic rainfall (irregular onset/ stop), high temperature, crops insects/pests, livestock insect pest, livestock disease, and human diseases. Furthermore, erratic rainfall, crops insect/pests and human diseases are aspects that have been noticed to occur frequently. These changes have direct implications on paddy production and other farming practices pursued in Kahama District. These negative climatic change pose potential negative implication in the entire farming practices particularly among the smallholder farmers who are characterized by the limited capital. Subsequently, this reinforces the need for immediate action to normalize the situation based on the adaptability capability of the community.

3.5 Meteorological Data on Three Decades Temperature Trends in Shinyanga Region

Meteorological data collected from the Meteorological Station confirmed the findings from the household survey by indicating increasing trends in temperature in the entire Shinyanga Region. The overall trend shows the rise in temperature from 1991 to 2022 with 2022 exhibiting the highest level of temperature compared to the rest of the years under investigation. The increasing trend of temperature is statistically significantly at P=0.02 (Fig. 1). This trend has the direct negative implication in paddy productivity in the study area which exclusively depends on the rainy cycles. This confirms to the perceptions of the respondents during surveys and interviews which revealed increasing temperature for some years. The impact of the increased temperature trends in three decades is particularly more serious in the study area which constitutes majority of smallholder farmers. This group is likely to have low adaptive capacity on climate change. This concurs to the household surveys among the paddy farmers who confirmed increasing temperature trends in Kahama Municipality. To offset the increasing trends of temperature appropriate intervention is prerequisite.

Meteorological data on rainfall trend in Shinyanga Region confirmed responses of the paddy farmers by showing decreasing trend of the mean annual rainfall between 1991 to 2022 (Fig. 2). The highest decrease has been observed between March and May. Coupled with increasing temperature trends this negatively affects paddy productivity. In addition to farming practices, the decreasing rainfall trends negatively affect the entire livelihood of the paddy farmers whose livelihood exclusively depend on the rain fed farming.

3.6 Perception of the Paddy Farmers on the Causes the Changes in Climate

The study was interested to establish perception of the paddy farmers on possible causes of climate change. The general understanding of the farmers is key as a baseline step towards intervention options. Regarding the aforementioned aspect, the findings revealed that the farmers have their perceptions regarding the changes in climatic parameters so far occurred in three decades. They showed different factors that are likely to trigger the changes in climatic parameters. These include the natural factors as well as the man-made factors. The man-made causes mentioned include population increase, deforestation, overgrazing and monoculture (Table 7). Generally, despite the natural phenomena the whole Shinyanga Region is one among the areas in Tanzania which are severely deforested partly due to overgrazing and population pressure. Thus, the perception of the respondents on the possible drivers of climate change concurs with scientific analysis which categorically earmarks deforestation among the significant driver of the overall emission of carbon dioxide which subsequently triggers climate change. Perceptions of these farmers seem to be different from the perception from the other studies which linked climate change with spirituality issues such as devine intervention against societal malpractice [12,13,14]. In the similar vein, in Rombo District, Tanzania some local community members viewed climate change as a punishment from God due to the increased sinners [15]. This indicates that paddy farmers of Kahama District appears to be well informed of climate change situation and they connected it with daily socio-economic activities.

3.7 Access to Weather Forecast Information

The study investigated whether the farming households in the study area apart from their own experience have access to weather forecast information. The study revealed that 97.8% of households in the study area have access to weather forecast information (Table 8). This was observed nearly across all the sampled villages. Multiple response answers in Table 8 indicates that, information on the onset of rainfall, cessation of rains, amount of rain and drought periods are mostly accessed information through the District Metrological Station, TMA announcements through media, extension officers, village meeting, and NGOs working in the study area. District Meteorological Station claimed by most of the respondents (75%) as the most reliable weather information source. This indicates that, communities are well connected to weather information sources and that they are able to information from reliable sources. Meteorological information is very key in agricultural practices. This is important as it triggers appropriate planning for the different agronomic practices including planting, growth and development. Indeed, it is an entry point towards appropriate climate change intervention in the local context. Obvious, meteorological information helps these farmers in creating resilience against weather risks which threaten agricultural productivity. Therefore, the possible explanation for this is that farmers rely on rainfall which necessitates the quest for reliable information regarding climate change. Given that, paddy production is more sensitive to water then accessibility to weather information curtailing to rainfed paddy production.

Table 3: Socio-economic and demographic characteristics of respondents (Contd.)

Information	Kahama				Msalala				Ushetu		Total N=312
	Mondo		Kagongwa		Ntobo		Chela		Nyamilingano		
	Mondo n=27	**Bumbiti n=21**	**Kagongwa n=127**	**Gembe n=25**	**Ntobo A n=28**	**Kalagwa n=23**	**Chela n=23**	**Chambanga n=21**	**Nyamilingano n=8**	**Ididi n=9**	
Age class: 15-24 Years	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2 (0.6)	2(0.6)
25-34 Years	9 (2.9)	0(0)	0(0)	10 (3.2)	7 (2.2)	4 (1.3)	0(0)	6 (1.9)	2 (0.6)	2 (0.6)	40(12.8)
35-44 Years	0(0)	5 (1.6)	25 (8)	10 (3.2)	14 (4.5)	3(1)	4 (1.3)	5 (1.6)	2 (0.6)	3(1)	71(22.8)
45-54 Years	8 (2.6)	7 (2.2)	76 (24.4)	0(0)	0(0)	4 (1.3)	10 (3.2)	10 (3.2)	4 (1.3)	0(0)	119(38.1)
55-64 Years	1 (0.3)	5 (1.6)	0(0)	5 (1.6)	7 (2.2)	8 (2.6)	9 (2.9)	0(0)	0(0)	1 (0.3)	36(11.5)
≥ 65 Years	9 ((2.9)	4 (1.3)	26 (8.3)	0(0)	0(0)	4 (1.3)	0(0)	0(0)	0(0)	1 (0.3)	44(14.1)
Sex of respondent: Male	18 (5.8)	16 (5.1)	102 (32.7)	25 (8)	21 (6.7)	23 (7.4)	23 (7.4)	21 (8.7)	2 (0.6)	2 (0.6)	253(81.1)
Female	9 (9.7)	5 (1.6)	25 (8.0)	0(0)	7 (2.2)	0(0)	0(0)	0(0)	6 (1.9)	7 (2.2)	59(18.9)
Marital status: Married	27 (8.7)	21 (6.7)	127 (40.7)	25 (8)	28 (9)	23 (7.4)	23 (7.4)	21(6.7)	8 (2.6)	9 (2.9)	312(100)
Status of the respondent: Head	27 (8.7)	16 (5.1)	127 (40.7)	25 (8)	28 (9)	23 (7.4)	23 (7.4)	21 (6.7)	8 (2.6)	3 (1)	301(96.5)
Spouse	0(0)	5 (1.6)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	5 (1.6)	10(3.2)
Brother/sister	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1 (0.3)	1(0.3)
Household size: 1-3 Persons	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	4 (1.3)	0(0)	0(0)	1 (0.3)	5(1.6)
4-6 Persons	19 (6.1)	13 (4.2)	75 (24)	20 (6.4)	7 (2.2)	19 (6.1)	0(0)	10 (3.2)	2 (0.6)	5 (1.6)	170(54.5)
7-9 Persons	0(0)	8 (2.6)	0(0)	5 (1.6)	14 (4.5)	4 (1.3)	10 (3.2)	11 (3.5)	6 (1.9)	3(1)	61(19.6)
≥ 10 Persons	8 (2.6)	0(0)	52 (16.7)	0(0)	7 (2.2)	0(0)	9(2.9)	0(0)	0(0)	0(0)	76(24.4)
Education background: Incomplete primary	1 (0.3)	16 (5.1)	51 (16.3)	18 (5.8)	0(0)	16 (5.1)	0(0)	0(0)	0(0)	4(1.3)	106(34)
Complete primary	17 (5.4)	5 (1.6)	26 (8.3)	7 (2.2)	21 (6.7)	3(1)	23 (7.4)	21 (6.7)	8 (2.6)	4 (1.3)	135(43.3)
Incomplete secondary	9 (2.9)	0(0)	50 (16)	0(0)	7 (2.2)	4 (1.3)	0(0)	0(0)	0(0)	0(0)	70(22.4)
Complete secondary	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	(0.3)	1(0.3)
Average household's income per month: ≤ TZS 100,000	0(0)	0(0)	0(0)	0(0)	7 (2.2)	0(0)	4 (1.3)	0(0)	0(0)	9 (2.9)	20(6.4)
TZS 100,001-199,999	26 (8.6)	12 (3.8)	102 (32.7)	25 (8)	7 (2.2)	12 (3.8)	5 (1.6)	6 (1.9)	8 (2.6)	0(0)	203(65)
TZS 200,000-299,999	1 (0.3)	9 (2.9)	25 (8)	0(0)	7 (2.2)	8 (2.8)	9 (2.9)	15 (4.8)	0(0)	0(0)	67(21.5)
≥TZS300,000	0(0)	0(0)	0(0)	0(0)	7 (2.2)	3(1)	5 (1.6)	0(0)	0(0)	0(0)	22(7.1)

Figures outside and inside the parentheses are frequencies and percentages respectively

Table 4. Distribution of the Respondents in terms of the Living Experience in the Study Villages

Village's living period: 1-10 Years	0(0)	0(0)	0(0)	0(0)	7 (2.2)	0(0)	0(0)	0(0)	0(0)	2 (0.6)	9(2.9)
11-20 Years	18 (5.8)	21 (6.7)	76 (24.4)	20 (6.4)	14 (4.5)	20(6.4)	4 (1.3)	0(0)	8 (2.6)	0(0)	181 (58)
21-30 Years	9 (2.9)	0(0)	26 (8.3)	5 (1.6)	0(0)	0(0)	9 (2.9)	21 (6.7)	0(0)	3(1)	73 (23.4)
31-40 Years	0(0)	0(0)	0(0)	0(0)	7 (2.2)	3(1)	10 (3.2)	0(0)	0(0)	2 (0.6)	22 (7.1)
41-50 Years	0(0)	0(0)	25 (8)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1 (0.3)	26 (8.3)
> 50 Years	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1 (0.3)	1 (0.3)
Place of origin:Born in the village	0(0)	0(0)	25 (8)	0(0)	7 (2.2)	3(1)	0(0)	0(0)	0(0)	3(1)	38 (12.2)
Born outside the village but within the district	27 (8.7)	21 (6.7)	102 (32.7)	25 (8)	21 (6.7)	20 (6.4)	0(0)	21 (6.7)	8(2.6)	5 (1.6)	250 (80.1)
Born outside the region	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	23 (7.4)	0(0)	0(0)	1(0.3)	24(7.7)

Table 5. Knowledge of climate change among paddy farmers

Information	Kahama				Msalala				Ushetu		
	Mondo		Kagongwa		Ntobo		Chela		Nyamilingano		
	Mondo n=27	Bumbiti n=21	Kagongwa n=127	Gembe n=25	Ntobo A n=28	Kalagwa n=23	Chela n=23	Chambanga n=21	Nyamilingano n=8	Ididi n=9	Total N=312
Awareness on CC: Yes	27 (8.7)	21 (6.7)	127(40.7)	25 (8)	28 (9)	23 (7.4)	23 (7.4)	21 (6.7)	8 (2.6)	8 (2.6)	311(99.7)
No	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1 (0.3)	1(0.3)
Source of awareness*: Own observation	27 (8.7)	21 (6.7)	127 (40.7)	25 (8)	28 (9)	23 (7.4)	23 (7.4)	21 (6.7)	8 (2.6)	8 (2.6)	311(99.7)
Extension officers	8 (2.6)	6 (1.9)	127 (40.7)	5 (1.6)	21 (6.7)	11 (3.5)	18 (5.8)	10 (3.2)	6 (1.9)	5 (1.6)	217(69.6)
Village meetings	27(8.7)	21 (6.7)	102 (32.7)	25 (8)	21 (6.7)	11 (3.5)	18 (5.8)	21 (6.7)	6 (1.9)	6 (1.9)	258(82.7)
Told by neighbors	18 (5.8)	21 (7.7)	127 (40.7)	25 (8)	21 (6.7)	23 (7.4)	23 (7.4)	21 (6.7)	8 (2.6)	8 (2.6)	2952(94.6)
Input suppliers	0(0)	0(0)	25 (8)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	25(8)
Told by NGO working in our area	27 (8.7)	21 (6.7)	127 (40.7)	25 (8)	28 (9)	23 (7.4)	23 (7.4)	21 (6.7)	8 (2.6)	9 (29)	312(100)
Researchers	1 (0.3)	11 (3.5)	25 (8)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	37(11.9)
Listening to radio	27 (8.7)	21 (6.7)	102 (32.7)	25 (8)	21 (6.7)	23 (7.4)	23 (7.4)	21 (6.7)	8 (2.6)	1 (0.3)	272(87.2)
Department of meteorology	0(0)	0(0)	25 (8)	0(0)	7 (2.2)	3(1)	14 (4.5)	0(0)	0(0)	0(0)	49(15.7)
Period of acquired CC awareness: Recently	9 (2.9)	8 (2.6)	51 (16.3)	20 (6.4)	0(0)	0(0)	0(0)	0(0)	2 (0.6)	5 (1.6)	95(30.4)
Long time ago	18 (5.8)	13 (4.2)	76 (24.4)	5 (1.6)	28 (9)	23 (7.4)	23 (7.4)	21 (6.7)	6 (1.9)	3(1)	216(69.2)
None of the above	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1 (0.3)	1(0.3)

**Multiple response answers*

Table 6. Aspects of climate change that have been changed

Aspects	Changes		Frequency					Severity				
	Yes	**No**	**MF**	**F**	**LF**	**NF**	**DK**	**MS**	**S**	**LS**	**NS**	**SN**
A	312 (100)	0(0)	46 (14.7)	142 (45.5)	122 (39.1)	2 (0.6)	0(0)	95 (30.4)	107 (34.3)	105 (33.7)	5 (1.6)	0(0)
B	312 (100)	0(0)	111 (35.6)	104 (33.3)	87 (27.9)	10 (3.2)	0(0)	59 (18.9)	130 (41.7)	107 (34.3)	5 (1.6)	11 (3.5)
C	307 (99.4)	5 (1.6)	289 (92.6)	23 (7.4)	0(0)	0(0)	0(0)	299 (95.8)	13 (4.2)	0(0)	0(0)	0(0)
D	4 (1.3)	308 (98.7)	0(0)	4 (1.3)	9 (2.9)	33 (10.6)	266 (85.3)	0(0)	3(1)	0(0)	42 (13.5)	267 (85.6)
E	0(0)	312 (100)	0(0)	0(0)	9(2.9)	33 (10.6)	270 (86.5)	0(0)	0(0)	0(0)	42 (13.5)	270 (86.5)
F	0(0)	312 (100)	0(0)	0(0)	0(0)	42 (13.5)	270 (86.5)	0(0)	0(0)	0(0)	42 (13.5)	270 (86.5)
G	250 (80.1)	62 (19.9)	0(0)	5 (1.6)	122 (39.1)	156 (50)	29 (9.3)	0(0)	12 (3.8)	173 (55.4)	98 (31.4)	29 (9.3)
H	0(0)	312 (100)	0(0)	0(0)	0(0)	42 (13.5)	270 (86.5)	0(0)	0(0)	0(0)	43 (13.8)	269 (86.2)
I	299 (95.8)	13 (4.2)	1 (0.3)	274 (87.8)	36 (11.5)	0(0)	1 (0.3)	0(0)	254 (81.4)	57 (18.3)	0(0)	1 (0.3)
J	280 (89.7)	32 (10.3)	0(0)	30 (9.6)	250 (80.1)	32 (10.3)	0(0)	0(0)	15 (4.8)	265 (84.9)	7 (2.2)	25 (8)
K	16 (5.1)	296 (94.9)	0(0)	7 (2.2)	15 (4.8)	43 (13.8)	247 (79.2)	2 (0.6)	7 (2.2)	14 (4.5)	43 (13.8)	246 (78.8)
L	263 (84.3)	49 (15.7)	0(0)	8 (2.6)	253 (81.1)	44 (14.1)	7 (2.2)	0(0)	17 (5.4)	243 (77.9)	44 (14.1)	8 (2.6)
M	277 (88.8)	35 (11.2)	0(0)	244 (78.2)	4 (1.3)	33 (10.6)	31 (9.9)	1 (0.3)	238 (76.3)	24 (7.7)	2 (0.6)	47 (15.1)

A=Seasonal drought, B=Intra-seasonal dry spells, C= Erratic rainfall (irregular onset/ stop), D= Floods, E= Stormy rainfall, F=Strong wind (hurricane), G= High temperature, H= Extreme cold, I= Crops insect pests, J= Livestock insect pest, K= Plant disease epidemics, L= Livestock disease, and M=Human diseases MF = More frequent, F= Frequent, LF= Less frequent, NS= Not frequent, DK= Do not know MS= More severe, S= Severe, LS= Less severe, NS= Not severe, SN= Not sure

Table 7. Reasons for changes of aspects of climate change

Reasons for changes of aspects of CC	Kahama				Msalala				Ushetu		
	Mondo		Kagongwa		Ntobo		Chela		Nyamilingano		
	Mondo n=27	Bumbiti n=21	Kagongwa n=127	Gembe n=25	Ntobo A n=28	Kalagwa n=23	Chela n=23	Chambanga n=21	Nyamilingano n=8	Ididi n=9	Total N=312
Disappearance of forests	0(0)	0(0)	0(0)	0(0)	7 (2.2)	0(0)	0(0)	0(0)	0(0)	3(1)	10(3.2)
Increased number of people	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2 (0.6)	2(0.6)
Overgrazing of animals (cattle)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2 (0.6)	2(0.6)
Monoculture for long period	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1 (0.3)	1(0.3)
Natural phenomena	0(0)	0(0)	25 (8)	0(0)	21 6.7)	0(0)	9 (2.9)	0(0)	0(0)	1 (0.3)	35(11.2)
Climate change	27 (8.7)	21 (6.7)	102 (32.7)	25 (8)	28 (9)	23 (7.4)	14 (4.5)	21 (6.7)	8 (2.6)	0(0)	262(84)

**Multiple response answers*

Table 8. Access to weather forecast information

Information	Kahama				Msalala				Ushetu		
	Mondo		Kagongwa		Ntobo		Chela		Nyamilingano		
	Mondo n=27	Bumbiti n=21	Kagongwa n=127	Gembe n=25	Ntobo A n=28	Kalagwa n=23	Chela n=23	Chambanga n=21	Nyamilingano n=8	Ididi n=9	Total N=312
Accessibility to weather information: Yes	27 (8.7)	20 (6.4)	127 (40.7)	25 (8)	28 (9)	23 (7.4)	23 (7.4)	21 (6.7)	8 (2.6)	3(1)	305(97.8)
No	0(0)	1 (0.3)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	6 (1.9)	7(2.2)
Type of accessed weather information *: Start of rain	27 (8.7)	21 (6.7)	127 (40.7)	20 (6.4)	28 (9)	23 (7.4)	23 (7.4)	21 (6.7)	8 (2.6)	3(1)	301(96.5)
End of rain	27 (8.7)	21 (6.7)	127 (40.7)	25 (8)	28 (9)	23 (7.4)	23 (7.4)	21 (6.7)	8 (2.6)	3(1)	306(98.1)
Amount of rain	27 (8.7)	21 (6.7)	127 (40.7)	25 (8)	28 (9)	23 (7.4)	23 (7.4)	21 (6.7)	8 (2.6)	3(1)	306(98.1)
Drought periods	27 (8.7)	21 (6.7)	127 (40.7)	25 (8)	28 (9)	23 (7.4)	23 (7.4)	21 (6.7)	8 (2.6)	2 (0.6)	305(97.8)
Floods	0(0)	0(0)	26 (8.3)	5 (1.6)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	31(9.9)
Temperature	8 (2.6)	0(0)	51 (16.3)	20 (6.4)	21 (6.7)	0(0)	5 (1.6)	10 (3.2)	8 (2.6)	2 (0.6)	125(40.1)
Source of weather information*: District metrological station	27 (8.7)	21 (6.7)	127 (40.7)	20 (6.4)	14 (4.5)	23 (7.4)	4 (1.3)	21 (6.7)	8 (2.6)	1 (0.3)	266(85.3)
TMA announcement through media	27 (8.7)	21 (6.7)	127 (40.7)	25 (8)	28 (9)	23 (7.4)	23 (7.4)	21 (6.7)	8 (2.6)	3(1)	306(98.1)
Local (0ndigenous) weather forecasting	10 (3.2)	15 (4.8)	25 (8)	15 (4.8)	7 (2.2)	19 (6.1)	0(0)	0(0)	4 (1.3)	3(1)	98(31.4)
Extension officers	9 92.9)	15 (4.8)	127 (40.7)	20 (6.4)	21 (6.7)	23 (7.4)	18 (5.8)	11 (3.5)	6 (1.9)	2 (0.6)	252(80.8)
Village meeting	27 (8.7)	21 (6.7)	127 (40.7)	25 (8)	21 (6.7)	15 (4.8)	23 (7.4)	11(3.5)	6 (1.9)	2 (0.6)	278(89.1)
Local news papers	0(0)	0(0)	0(0)	0(0)	7 (2.2)	8 (2.6)	0(0)	0(0)	0(0)	1 (0.3)	16(5.1)
Researchers	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1 (0.3)	1(0.3)
NGOs working in our area	27 (8.7)	21 (6.7)	127 (40.7)	25 (8)	28 (9)	23 (7.4)	23 (7.4)	21 (6.7)	8 (2.6)	9 (2.9)	312(100)
Most reliable weather information source: District meteorological station	27 (8.7)	21 (6.7)	102 (32.7)	20 (6.4)	14 ((4.5)	20 (6.4)	0(0)	21 (6.7)	8 (2.6)	1 (0.3)	234(75)
Announcement through media	0(0)	0(0)	0(0)	5 (1.6)	14 (4.5)	0(0)	19 (6.1)	0(0)	0(0)	2 (0.6)	40(12.8)
Extension officer	0(0)	0(0)	25 (8)	0(0)	0(0)	3(1)	4 (1.3)	0(0)	0(0)	0(0)	32(10.3)
I don't know	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	6 (1.9)	6(1.9)

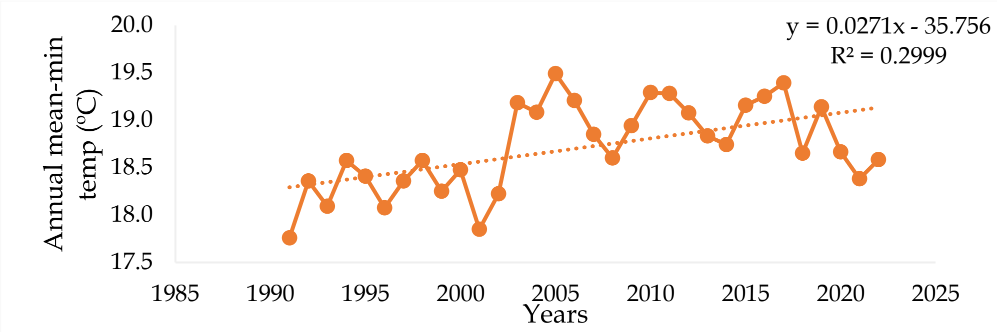

Fig. 1. Temperature trends in Kahama District from 1991 to 2022
Source: Tanzania Meteorological Station, 2023

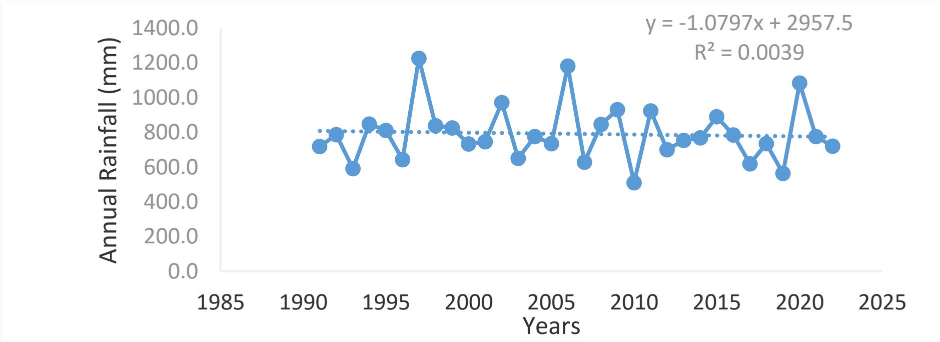

Fig. 2. Trends of annual rainfall in Kahama District from 1991 to 2022
Source: Tanzania Meteorological Station, 2023

4. CONCLUSIONS AND RECOMMENDATIONS

The study has revealed the perceived direct observable changes in climatic parameters in three decades which is evidenced by sustained rising in the local temperature as well as the decreased rainy cycles. Farmers' observations were confirmed by metolorogical data which revealed three decades changes in rainfall and temperature in the District. This indicates that climate change in Kahama District is the reality and it is seriously affecting agronomic activities and the entire livelihood of the farmers. The study further established that there is smoothness in information sharing concering climate change among the actors in paddy farming in Kahama District. This leads to the conclusion of upscaling information sharing as a milestone in devising appropriate intervention responses.

It is recommended to the government through the ministry responsible for agriculture to assist the paddy farmers to devise intervention measures to help the smallholder paddy farmers to sustain their agricultural practices.

Since the majority of the paddy farmers appears to be pegged into a cluster of smallholder farmers it is therefore recommended to the government to assist these farmers through increased subsidies. This will be valuable among the farmers in their efforts to sustain their farming practices and subsequently enhance resilience to the shocks of climate change. The present study is limited on the investigation of the knowledge of paddy farmers on climate change. Further investigation on adaptation measures among paddy farmers on climate change is recommended to explore their best adaptation practices.

CONSENT

As per international standards, respondents' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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