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Indigenous-Based Practices of Adapting To Climate Change: Reflections From Chirumhanzu, Zimbabwe

[1]Albert Manyani[*], [2]Kundai Chagweda, [3]Chipo Muzenda-Mudavanhu, [4]Nelson Chanza
Bindura University of Science Education
**Corresponding Author: Albert Manyani*

Abstract: *The relevance of indigenous knowledge systems (IKS) in climate science is increasingly being given some attention. This study uses the indigenous-based knowledge, experiences and practices of villagers in Ward 23 of Chirumhanzu District in Zimbabwe to gather their ways of responding to climatic stimuli. The study area remains a climate hotspot zone where climatic vagaries have remained a major threat to the locals whose livelihoods are largely dependent on rain-fed agriculture and natural resource base. In order to understand the IKS practices in place, both qualitative and quantitative research methods were used. A total of 200 respondents participated in a questionnaire-based survey, key informant interviews and focus group discussions. Using the analytic capabilities of Statistical Package for Social Scientists (SPSS), a Multinomial Linear Regression Analysis was computed to assess the significance level of socio-demographic factors on household perception on climate change and choice of climatic response. It emerged that the study area is indigenous knowledge rich. Farmers use plant, animal, insects, birds and atmospheric indicators to predict weather conditions. Perceptions on the causes of climate change was based on cultural, religious and human induced issues which significantly vary with socio-demographic determinants. The challenges of using IKS in climate change adaptation include disappearance of key environmental indicators and poor knowledge sharing culture among the people. These challenges have therefore reduced the reliability in IKS utilization by the locals. The study suggests integration of indigenous-based knowledge with scientific knowledge as a remedy for strengthening climate adaptation strategies at community level.*

Keywords*: indigenous knowledge, climate change, adaptation, livelihoods*

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I. Introduction

Attending to the worsening impacts of climate change now requires a holistic approach that draws from the experiences of communities experiencing climatic events (Nyong *et al*., 2007; Berkes, 2009; Backstrand & Loubrand, 2012; Chanza & de Wit, 2013; Chanza, 2015). This view puts indigenous communities exposed to climatic risks at the centre of climate change enquiry. Two justifications have been advanced in this inclusivity agenda: First, as innocent victims of climate destabilization, indigenous people should not be left behind in climate change discourse (Boko *et al*., 2007; Nyong *et al*., 2007). Second, their long-time experience with environmental phenomena, most of it climatically triggered, makes their knowledge and experience useful in formulating appropriate climatic responses (Turner & Clifton, 2009; Green & Raygorodetsky, 2010; Green *et al.*, 2010; Nakashima, 2012; Chanza, 2015). Many scholars are also challenging the traditional approach to solving environmental issues like climate change. These cite the inherent limitations of scientific and technocratic purity in making interventions pragmatic and acceptable at local levels (Behringer *et al.*, 2000; Thornton *et al.*, 2006; Few *et al*., 2007; Reed, 2008; Rawlani & Sovacool, 2011; Chanza, 2014; Mya & Ford, 2014). Thornton *et al* (2006), for instance, argue that although models have been put in place to project future climate systems most of them remain largely coarse-grained and do not explain local specific changes. Behringer *et al* (2000) call for a paradigm shift in purely expert-oriented problem solving approaches given uncertainty associated with climate change phenomenon and processes to solve the problem. With specific reference to the Zimbabwean context, Mutasa (2010) noted that most farmers do not have access to mass media which disseminates weather forecast and cannot interpret climate change models. Instead, farmers rely on indigenous knowledge systems (IKS) for weather prediction and farming decisions. Although variously segmented, the evidence that indigenous people have their own mechanisms of coping with climate change has been put forward (e.g., Chanza & de Wit, 2015; Manyani & Bob, 2017). However, given the case-specificity nature in IKS use, it remains critical to gather some unique practices in other places in Zimbabwe. As a concept, IKS has been given heterogeneous terminologies and definitions. Terms in deployment include indigenous knowledge, traditional knowledge, local knowledge, traditional ecological knowledge, local ecological knowledge, indigenous climate knowledge, folk knowledge and many others. Chanza and de Wit (2015) prefer

the term 'indigenous climate knowledge' as it is more reflective of knowledge systems related to climate change. This article deploys these terms interchangeably to refer to indigenous ways used by the local people in Chirumhanzu to adapt to the stimuli brought about by change and variability in the climate system. This study advances the existing debate in IKS utility in climate science by drawing from the experiences of local people in one of the climate sensitive districts of Zimbabwe. It documents indigenous ways of adapting to climate change, the major motivation behind adopting such practices and the opportunities and challenges that the villagers face. The article begins by describing the study area and showing how it has been regarded as one of the climate hotspot zones in the country. The methods used for engaging participants, data collection and analysis procedures are later given. It is also important to discuss local perceptions on the forces behind climate change from the viewpoint of indigenous people witnessing changes in their environment. The study also records a spectrum of indigenous based indicators of climate change that range from plant, animal, insect and atmospheric predictors. This discussion is then used to contextualize the various ways used by the community to adapt to a drier climate system in the area. The article concludes by highlighting the need to integrate indigenous-based knowledge into existing conventional knowledge systems as the basis for building resilience against climatic perturbations at local level.

II. The Study Area

Zimbabwe lies in a semi-arid region with limited and unreliable rainfall patterns and temperature variations (Brown *et al*., 2012). Echoing the same sentiments Manatsa (2010) argue that, high degree of rainfall variability is the norm in Zimbabwe because it lies within the tropics to subtropics. According to Unganai (2009), rainfall exhibits considerable spatial and temporal variability characterised by shifts in the onset of rains, increases in the frequency and intensity of heavy rainfall events, increases in the proportion of low rainfall years, decreases in low intensity rainfall events, increases in the frequency and intensity of mid-season dry-spells. At the same time, some parts of Zimbabwe are becoming warmer and drier (Brown *et al*., 2012). This shows that, Zimbabwe is becoming warmer with more erratic rainfall patterns than before.Zimbabwe is experiencing an increase in frequency and severity of extreme weather events, namely tropical cyclones, floods and droughts. Crop productivity has also declined and livestock morbidity and mortality has increased (Mutekwa, 2009; Moyo *et al*., 2012). Mawere (2015) and Unganai (1996) claim that for the past two decades, Zimbabwe has been experiencing pronounced increases in temperature, recurrent droughts and unpredictable rainfall patterns which have exacerbated suffering among the people, especially in the rural areas, where majority of the population resides. Mudzonga (2012) postulates that Zimbabwe was once the breadbasket of Southern Africa, turned to be a net importer of grain due to adverse impacts of climate change on the backbone of the economy.

Furthermore, Brown *et al*. (2012) researching within Zimbabwe observes that, changes in climate have resulted in more arid environments for agricultural production, which has shifted Zimbabwe's five main agro-ecological zones. They also claimed that, rainfall patterns and crop production progressively deteriorate from Region I to V. Hence, the natural farming regions are becoming warmer with erratic rainfall. This was supported by Manyeruke *et al.* (2013) who indicate that two main food producing regions 2 and 3 has shrunk by 49% and 14% respectively. Shifting of natural farming regions affected food production resulting in food insecurity. Hence, the characteristics of the natural farming region of Zimbabwe as given by Moyo *et al*. (2012) and Mugandani *et al*. (2012) has being shifting so there is need to have a multidimensional approach when adapting to climate change.Despite the fact that, in Zimbabwe there is voluminous literature on climate variability and change, little has been done to understand the impact of climate change in Chirumhanzu District. Again, different areas have different exposure to climate change and different coping strategies. It is against this background that this study focuses on the role of IKS in climate change adaptation in Chirumhanzu District.The research was carried out in Ward 23 in Chirumhanzu District, in Midlands Province of Zimbabwe. Chirumhanzu District has twenty-five Wards but this research only focused on Ward 23 since the findings can be generalised and used in other Wards due to similar biophysical characteristics and mystical experience. According to 2012 Census results, Chirumhanzu District had a total of 80,351 people which average of household size of 4.1 (ZimStats, 2012). It covers an area of approximately 45,000 square kilometers. Chirumhanzu communal area lies in Natural Region 4 characterized by low rainfall ranging from 400-510mm per annum (Musara *et al*., 2010). Temperature ranges from 24-31˚C. The area is also subjected to severe dry spells during rainy season and frequent seasonal droughts. Rain-fed agriculture is the major source of livelihood in the study area. The area is unsuitable for dryland cropping hence people grow drought tolerant crops such as sorghum, pearl millet (mhunga) and finger millet (rapoko) and short variety crops. People also depend on livestock production, mainly small ruminants such as pigs and goats. Ward 23 has four villages which are Nyautonge, Shashe, Govere and Rupepwe (Figure 1).

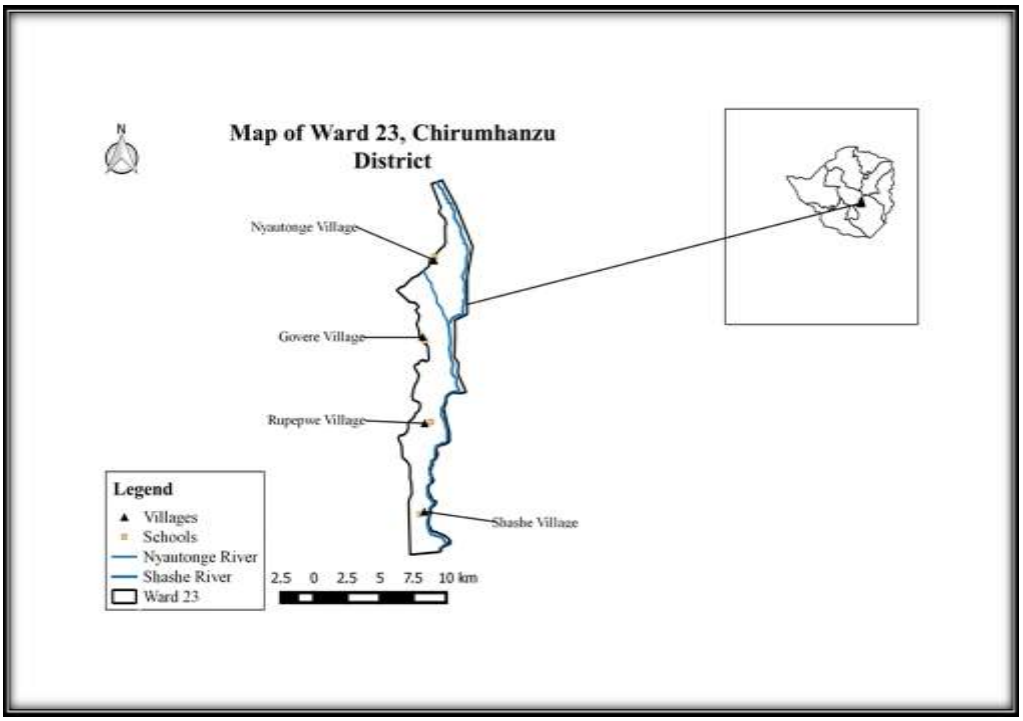

Figure 1**: A map of Ward 23 in Chirumhanzu District** (Source: Authors)

III. Methodology

This article provides insights into the experiences of local people in one of the climate sensitive districts of Zimbabwe through documenting the indigenous ways of adapting to climate change and the opportunities and challenges that the villagers face. The study followed a mixed method approach where both qualitative and quantitative research approaches were adopted. The mixed method approach allowed both forms of data collected to complement each other in order to give a more realistic interpretation of people's experiences. A questionnaire-based survey was used to collect quantitative data. Interviews and focus group discussions (FGDs) were the two principal methods employed to collect qualitative data. Multi-stage sampling techniques were employed to select the respondents for the household questionnaire, interviews and FGDs. Multi-stage sampling, whereby a sample is selected by using combinations of different sampling methods ensured adequate representation of all groups of interest, maintaining a high degree of validity and minimising subjectivity in the sample selection (Robson, 1993; Creswell & Plano, 2011). Two hundred respondents were then selected from the Ward's household list from the four villages namely: Nyautonge, Shashe, Govere and Rupepwe to respond to the questionnaire. This represented about 10% of the total households (1,986) in the Ward. The household survey questionnaire explored issues on the demographic data of the respondent, IKS, awareness of climate change issues at household level, households' perception on the causes of climate change and adaptation strategies. The interviews with household respondents were conducted in the interviewee's homes.Semi structured interviews were conducted with 15 key informants, one with the Agricultural Extension Officer, a traditional healer and the Ward officials who included the Chief, Councilor, District Administrator, four village heads and 6 elderly people who were above 75 years of age. The elderly people were selected because they had lived more than thirty years to witness the climate variability and change and had acquired IKS for generations. Interview with Agricultural Extension Officer focused on climate change and its implications on agriculture since the officer understood the climate variability and change phenomenon better than the local farmers. Interviews served as means to gather data through probing the perception, attitudes, beliefs and feelings of the elders about the critical role of IKS in climate change adaptation and planning for agricultural activities. Interview guide was used to ensure that interviewees respond to similar set of questions. The questions were open ended in order to give room for probing for information from the interviewee (Creswell, 2013 & Sarantakos, 2013).

For the FGDs, the respondents who participated in the household survey questionnaire were randomly selected considering their willingness to participate in further discussions. Four FGDs comprising of 10 members as suggested by Arino *et al.* (2016) were conducted at the homesteads of each village head in the ward. The FGDs aimed at establishing consensus and clarifications on the most commonly used indicators, the role of IKS in agricultural planning and households' perceptions on climate change.Both quantitative and qualitative data analysis techniques were used to analyse primary data. All interviews were recorded and

subsequently transcribed and translated into English for analysis. Qualitative data was analysed thematically. The data was analysed for content, whereby the researchers were looking for particular patterns, themes, concerns or responses that were posed repeatedly by respondents (Bender & Ewbank, 1994). The description and explanation of themes and concepts are presented in a narrative way. Statistical Package for Social Scientists (SPSS version 20) and Microsoft Excel were used to analyse quantitative data. Descriptive statistics such as frequencies and percentages were used to summarize the data in the questionnaires. Inferential statistics using Multinomial Linear Regression Analysis (MLRA) similar to work done by Balama *et al*. (2016), Debela *et al*. (2015) and Jiri *et al*. (2015), was computed to determine whether households' perception on causes of climate change was influenced by socio-demographic factors of the respondents. All ethical issues were considered and informed consent was sought from the participants after explaining to them the objective of the study. Confidentiality was ensured throughout the study.

IV. Results

This section presents data analysis and discusses how IKS and households' perception on climate change varies. The variables used in this study were age, sex, years stayed in the area, level of education and households' perception on the causes of climate change.

4.1 Socio-demographic characteristics of the respondents

Notably respondents from fifty years possessed rich IKS as compared to respondents below this age which indicates that, there is poor knowledge sharing culture in the area which exacerbates depletion of IKS. Manyanhaire (2015) observed that, the knowledge is a privilege of the elderly in the community who have lived the experience and are able to relate to nature in a more meaningful way.

According to the results, respondents who have stayed longer in the area have high level of IKS and a better understanding of local climate change as compared to those who stayed less time in the area. They had also developed better adaptation strategies as compared to respondents who had stayed in the study area for a short period of time (less than 10 years). In summary, number of years stayed in the area determines level of IKS.

Table 1**: Socio-demographic characteristics of the respondents (n=200)**

Socio-demographic characteristics	Respondents	n	%
Sex	Male	80	40
	Female	120	60
Age	18-30	53	27
	31-40	22	11.0
	41-50	9	5
	51-60	38	19
	61-70	26	13
	71+	52	26
Years stayed in the area	Less than 10	85	43
	10-20	33	16
	21+	82	41
Education level	Never been at school	38	19
	Primary	83	42
	Secondary	58	29
	Tertiary	21	10

Generally, there are four primary schools and no secondary school in the Ward, which is supported by large number of respondents who attained primary level. However, the proportions decrease towards tertiary level education which is described by having attained a certificate, diploma, advanced level and first degree. Similar results were obtained by Mtambanengwe *et al*. (2012) where fewer household heads obtained tertiary education. Generally more females (60%) responded to the questionnaires as they were the ones who were present at homes during the survey.Furthermore, respondents with higher level of education indicated that they understand modern climate change strategies better as compared to people with low level of education. The findings are consistent with those by Deressa *et al*. (2009) who found a positive relationship between education and adaptation to climate change in Ethiopia. The results are also in support of De Jonge (2010) who found that farmers who have attained university education are more likely to respond to climate change than farmers who have primary education. Hence, education level of households influences adaptation and climate change perception.

4.2Households' perception of climate variability and change in the area

Perception of households on climate change is a crucial pre-indicator in the adaptation process (Adger *et al*., 2009). Results from the study show that households' perceptions on climate variability and change are based on assessment of mainly rainfall and temperature events as they experience them within the area. Similar

findings were made in several studies in Africa which indicated that majority of farmers were aware of the increasing temperatures and decreasing rainfall (Nyanga *et al*., 2011; Juana *et al*., 2013; Manyani and Bob, 2017) .

4.3Perception on rainfall trends

Figure 2 shows respondents' perception on rainfall trends. Majority of the respondents (57%) highlighted that the amount of rainfall received was decreasing, 14% held the view that drought incidences were increasing, 22% suggested that the amount of rainfall was increasing and 7% thought that there was no change. Similar results were obtained by Alvera (2013) in Mbire District. Series of drought in the area is evidenced by poor harvest, death of livestock and drying water sources such as rivers, boreholes and wells. Key informants also held the view that rainfall was becoming more unpredictable than years back. What emerged from FGDs was that distinct seasons no longer existed due to changing trends in weather patterns. Such observations were also interrogated by Simelton *et al*. (2013) and Chanza and de Wit (2015).According to the AGRITEX officer in the Ward, rainfall patterns were changing. He further pointed out that the temperatures were at times unpredictable and fluctuating. Very cold and very hot conditions were experienced within the same season. The officer also argued that the decrease in production cannot be solely attributed to climate change alone but to a number of factors such as shortage of inputs and lack of farming skills

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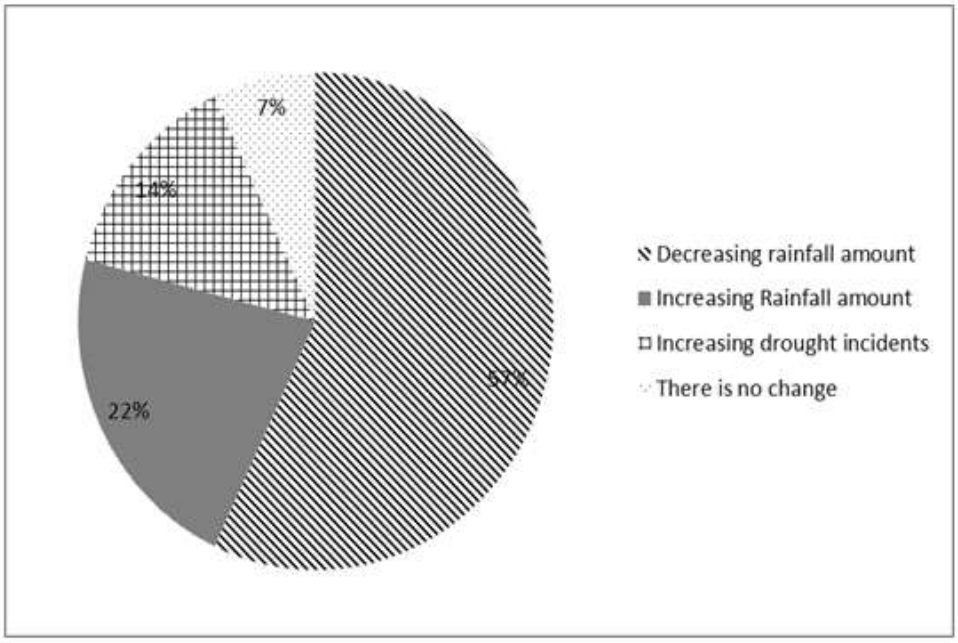
Figure 2: Perception on rainfall trends (n=200) (Source: Primary data)



4.4Perception on temperature trends

Figure 3 presents results on perception of households on temperature trends. The majority of households (54%) highlighted that increasing temperature was being experienced in the area while 25% thought that temperatures were decreasing. However, 21% were of the view that there was no change in temperature. Increasing of temperature was a commonly held view during FGDs and interviews and this authenticates what was presented by Mawere (2015) and Unganai (1996). The AGRITEX officer also held the view that in 2016 extreme temperatures were experienced in the area which affected livestock and crop production. Related studies by Kemausuor *et al*. (2011) and Deressa *et al*. (2011) indicate that most farmers perceive increasing temperature and decreasing rainfall over past decade or two. Notably, results showed good levels of climate change perception amongst households which ensures implementation of informed adaptation strategies.

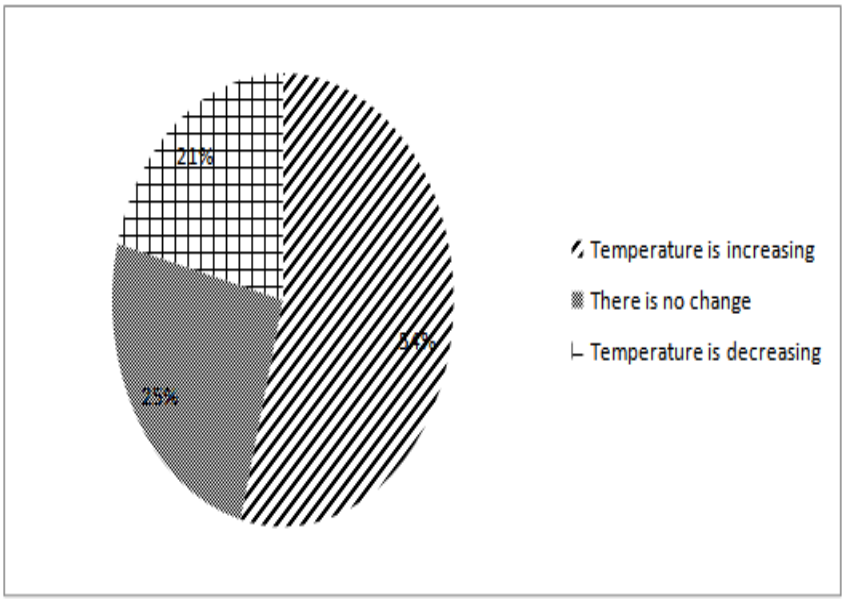


Figure 3: Perceptions on temperature trends (n=200) (Source: Primary data)

4.5 Household perception on causes of climate variability and change

This study showed that most respondents in the four villages observed that climate was changing. However, the respondents have different perceptions about the causes of climate change which were categorised into cultural issues, religious issues and human induced (scientific). Table 2 shows that the majority (55%) held the view that climate change was caused by cultural issues. Sixteen key informants confirmed that climate change was caused by disrespectful of culture and traditional believes such as lack of respect for traditional prayer shrines (*Masvingo egovere* shrine), bathing and washing with soap in mermaid pools, killing of sacred animals like python *(shato)*, incestuous behaviour *(makunakuna*), committing suicide and abortion. Similar results were obtained by Mutasa (2010), Mtambanengwe *et al*. (2012), Chanza (2014) and Soropa *et al*. (2015), who observed that a large number of people believe that climate change was a traditional issue. One traditional healer acknowledged:Vanhu vakarasha chikaranga nekuda kwezvinamato zviri kukonzeresa pfumvu. (People have forgone tradition due to Christianity which is causing untold suffering).Most respondents perceived that climate change was caused by moral decadency and the abandonment of some traditional practices such as petitioning ceremony, an observation also made by Scoones (1996) and Moyo *et al*. (2012). During FGDs respondents highlighted the inappropriate performance of petitioning ceremonies and excessive rising of churches in the area especially apostolic sects *(madzibaba)* as the root cause of series of drought in the area. Results show that most elderly people blamed Christianity for causing cultural decadency as compared to young generation which shows that age determines the perception of household on climate change phenomenon. Table 2 shows that 9% of the households highlighted that climate change was a religious issue hence nothing could be done. They believe that God was punishing people for not following his commandments. The finding concurs with the findings from a study done by Mtambanengwe *et al.* (2012) who observed that some villagers perceived climate change as a religious issue. This was supported by Muzari *et al.* (2014) who also noted that greater number of smallholder farmers in Zimbabwe perceived climate change as a purely natural phenomenon, without any human intervention being responsible for climate change. Headmen and traditional healers indicated that the view was exacerbated by rising of apostolic sects in the area whereby people are told that misery and suffering were punishment from God. This view was commonly held by a large number of participants during FGDs. It could be noted that the perception caused people to be mere victims of climate change hence affecting their adaptation capacity. This study revealed that 36.5% believed that climate change was human induced. Respondents highlighted that climate change was being caused by human activities such as technological advancement, rampant deforestation and veld fires which release GHGs into the atmosphere thereby causing ozone layer depletion. Similar findings were also made in several studies (Kintinya *et al*., 2012; Ofuoku, 2011; Manyani & Bob, 2017). One participant said:

Anthropogenic activities contributed to climate change, especially the burning of fossil fuels such as coal, petrol, diesel and other liquid fuels. Use of fire wood in most rural communities exacerbates the situation.This view was commonly held by the AGRITEX officer and respondents who attended secondary and tertiary school as compared to elderly people. These findings are supported by IPPC (2007) which highlighted that humans play a major role in causing global warming hence causing climate variability and change. This

entails that there is a relationship between level of education and climate change perception. Notably, this study revealed that 63.5% believes that climate change was caused by traditional and religious issues, a similar result to the work done by Kitinya *et al*. (2012).

Table 2: Households' perception on causes of climate change (n=200**)**

Perception of households	Frequency	Percent
Cultural issues	109	54.5
Human induced	73	36.5
Religious issue	18	9.0
Total	200	100.0

(Source: Primary data)

4.6 Relationship between socio-demographic factors and households' perception on the causes of climate change

A MLRA using SPSS was computed to determine whether households' perception on causes of climate change was influenced by socio-demographic factors of the respondents. The variables included age, sex, years stayed in the area and level of education (Table 3).The results indicated that there was a significant relationship between household perception on causes of climate change and the four factors mentioned above. For instance; age, sex, level of education and years stayed in the area were found to be statistically significant (p=0.000), (p=0.012), (p=0.000) and (p=0.000) respectively. In this case, those who were above fifty years and less educated had a perception that climate change was a result of cultural issues whilst those below fifty years and educated viewed climate change as a human induced phenomenon. This study also indicated that sex and years stayed in the area determine the perception on the causes of climate change. The results are also in agreement with researches carried out by Balama *et al*. (2016) Debela *et al*. (2015) and Jiri *et al*. (2015). Therefore, this has demonstrated beyond doubt that household perception greatly influences the understanding of climate change causes and has bearing in the choice of adaptation strategies.

Table 3: Multinomial Linear Regression Analysis results of how socio-demographic factors influence household perception on causes of climate change

Households' perception	Socio-demographic factors (Chi-square p<0.005) 95% Confidence			
Households' perception on causes of climate change	Sex	Age	Years stayed in the area	Level of education
	0.012	0.000	0.000	0.000

4.7 Indigenous knowledge Systems used in Chirumhanzu Ward 23

This study further reveals that key environmental indicators used for weather forecasting in Chirumhanzu Ward 23 are plants, animals, insects, birds and atmospheric indicators. These indicators are discussed in detail in the following sections. **Plant indicators**: This study indicated that the majority of the respondents used plant indicators for weather forecasting. According to all respondents abundance of hacha (Parinari curatellifolia), masekesa or majekenje (Piliostigma thonningi) and mazhanje (Uapaca kirkiana) fruits is a sign of impeding poor season and the reverse is true. Similar results were obtained by various researchers (Kijazi et al., 2013; Manyatsi, 2011; Makwara, 2013; Speranza et al., 2010). Respondents indicated that they relied on wild vegetables and fruits during drought. They further pointed out 1982 and 2008 as the worst drought years experienced in the area where by people survived through eating locusts and wild fruits such as hacha. This was supported by an old woman, who said: Gore ra2008 hacha ndidzo dzakararamisa vanhu vachibika mahanya, mahewu neputugadzike (In the year 2008 people survived by eating Parinari curatellifolia preparing porridge, mahewu and tea with it).However, these findings are contrary to findings from a study in Murehwa and Tsholotsho which found out that abundance of wild fruits was an indicator of a good season or wet year (Soropa *et al*., 2015). Hence, IKS is unique for a given community so it cannot be generalized (Risiro *et al*., 2012). Some respondents indicated that water berry tree *(mukute)* is also used to forecast weather conditions whereby late bearing and lack of fruits signifies low rainfall and the reverse is true, similar findings were obtained in Zaka District (Makwara, 2013). All respondents stated that the appearance of new leaves *(pfumvudza or kugokora)* on all trees signifies that rainy season is approaching. Early appearance of leaves means rainfall would be early while late appearance means rainfall would be late.

4.8Animal, insect and bird indicators

Respondents highlighted that abundance of baboons and monkeys in the area indicated high rainfall since the above animals survive on field crops. Same results were obtained by Shoko and Shoko (2013) in Mberengwa District. However, the abundance of hyenas *(mapere)* is an indication of severe drought. Household questionnaire interviewed confirmed that hyenas are an indication of suffering and are also associated with evil.

Respondents also indicated that since hyenas arrived in the area people were losing their livestock such as goats and calves which are being eaten by these carnivores at night. This was supported by the Nyautonge headman, who remarked:

Mapere akaunza zhara nepfumvu huru muzvimbo medu (Hyenas brought hunger and great suffering in our land).

This indicated that hyenas were once rare in the area hence their presence is blamed for causing series of droughts.This research revealed that people in Chirumhanzu District also observe behaviour of certain birds to predict weather conditions. All respondents stated that appearance of black and white stock birds (mangauzani or mashohwari) signifies eminent rain and their continuous presence signifies prolonged rain season. Like what was obtained by Svotwa et al. (2007) and Makwara (2013), respondents indicated that when they observe large swarms of swallow birds (nyenganyenga) it indicated the onset of promising rainfall season. The rain cuckoo (haya) is an indicator which is used by the majority in the study area. Key informants confirmed that when such birds begin singing they call for the rain which could fall within days or a week hence farmers would start assembling their farming inputs upon hearing it cries. Similar results were obtained by Manyatsi (2011) and Mtambanengwe et al. (2012) in Swaziland and Makoni and Wedza Districts respectively. The finding also concurs with the findings from a study done by Shoko and Shoko (2013) in Mberengwa District where rain bird was ranked number one bird indicator. Respondents highlighted that breeding pattern of waterfowls was another indicator of rains. When they breed on the ground and in lower patches it signified imminent drought. Similar results were also obtained by Shoko and Shoko (2013). According to the key informants, presence of *dendera* birds signified drought and suffering. However, the findings were contrary to the other study done in Zaka District which showed that when *dendera* birds were heard singing especially during dawn, it was believed to be a very good sign of an approaching good rainy season (Makwara, 2013). This proves that IKS cannot be generalized since different communities have different biophysical and mystical experiences. Again, respondents highlighted that when there were abundance of locusts and grasshoppers *(madhumbudhla)* that suggested low rainfall and drought. Manyatsi (2011) and Kijazi *et al.* (2013) obtained same results. All the key informants stated that heavy infestation of most tree species by caterpillars *(magarandi, harati)* and army worm *(mhunduru)* indicated imminent drought. This also emerged from FGDs that in 2012 severe army worms' devoured crops and grazing pastures.The household questionnaire interview highlighted that the presence of sun spiders in abundance indicated the arrival of a wet season. Respondents further indicated that presence of *ishwa* and *tsambarafuta* (insects) in abundance also signifies a good rain season. It emerged from the FGDs that movement of termites *(mateza)* and ants collecting grass and closing their holes indicated imminent rains, an observation which was also made by Makwara (2013) and Manyanhaire (2015). Incessant noise made by some insects (cricket, frogs) signified an imminent wet spell. Similar findings were also made in several studies (Manyatsi, 2011; Mtambanengwe *et al*., 2012; Risiro *et al*., 2012).

Atmospheric indicators

This study revealed that people in the study area also predicted weather conditions using atmospheric indicators. All household questionnaire interviewed indicated that the rising of temperature from August to October signified the coming of the rains (good season). According to key informants the blowing of wind in all direction from end of October signified the approaching of the rain season. Respondents also highlighted that the appearance of a hallo around the moon *(hore tsvuku)* and stars, giving a dim appearance indicated impeding rains. Similar findings were obtained by Alvera (2013) in Mbire District. It emerged from FGDs that mist or haze on hilly and mountainous terrain after the winter months signifies heavy storms. Mtambanengwe *et al.* (2012) obtained same results. Observation of cumulo-nimbus cloud signify heavy storm with lightning and thunder, an observation which was also made by Makwara (2013). Nyong *et al.* (2007); Berkes (2009); Backstrand and Loubrand (2012); Chanza and de Wit (2013) and Chanza (2015) discussed the significance of IKS in predicting and responding to climate change impacts in various scenerios.

4.9Impacts of climate variability and change in the study area

Table 3 shows that the majority of the respondents mentioned that climate variability and change was affecting their livelihoods. The study showed that 98% of the respondents noted reduced yields as an impact of climate change. This view was also highlighted by the headmen who indicated that the Chief's granary *(Zunde raMambo)* cease to exist due to successive droughts being experienced in the area. Seventy-five percent of the respondents argued that climate change and variability results in the shortening of the growing season. Shortening of growing season and prolonged dry spell is exacerbating food insecurity in the area as revealed by 61% of the respondents. Moreover, another commonly held view was depletion of water sources (89%) due drying of wells and streams. Households also indicated that they travel a long distance in search of water for both domestic use and livestock. During FGDs respondents highlighted that all streams dried up in 2015-2016 season which forced them to sell livestock before they succumb to lack of drinking water and pastures. Gwimbi and Mundoga (2010), also identified similar results where climate change had adversely, impacted the water

sector leading to water scarcity within rural communities.Further, Table 3 showed that sixty-six percent of the respondents indicated that reduction in pastures adversely affected livestock production in the area. Fifty-three percent of the respondents noted that there was an increased incidence of pests and diseases for both livestock and crops in the area. This was also noted by FAO (2008) which indicated that, among the direct effects of climate change was that there would be higher temperatures and changes in rainfall patterns, translating to an increased spread of existing diseases and micro parasites in animals as well as emergence and spread of new diseases. Similar findings were reported by Chanza (2014), who identified the pestiferous nature of problematic pests among peasant farmers in Muzarabani. Remarkably, reduction in pastures, drying of rivers and increasing incidents of pests and diseases is leading to livestock losses in the area which was revealed by 64% of the respondents. These factors also result in death of livestock hence reducing livestock herds which is regarded as sign of wealth in the Ward. Lastly, eighty-six per cent (86%) of the respondents revealed that the incomes from farming had been greatly reduced due to climate change and variability. Mutasa (2010) also revealed similar results in Buhera and Chikomba communal areas. One respondent argued: A number of children have dropped out of school because parents can no longer have surplus yields to sell for school fees.

Table 3: Climate variability and change impacts in the study area: n=200 (Multiple responses)

Impact of climate change	Number of respondents	Percentage
Reduced yield	196	98
Shortened growing season	150	75
Increasing food insecurity	122	61
Depletion of water sources	178	89
Reduced pastures	132	66
Increasing incidence of pests and diseases	106	53
Livestock loss	128	64
Reduced income from farming	172	86

(Source: Primary data)

Depletion of water sources, decreasing of yields and reduction of income from farming were commonly held views during FGDs and interviews. According to all key informants, in Chirumhanzu Ward 23 climate change vagaries increased food insecurity and impoverished households who now depend on food aid.

V. Climate Change Adaptation Strategies In The Study Area

The survey results revealed that households use multiple adaptation measures to reduce the adverse impacts of climate change in order to maintain and improve their livelihoods. Findings in Table 5 showed that most households (86%) adopted the growing of drought tolerant crops such as sorghum, millet and rapoko. Traditional crops can survive in dry and high temperature conditions which increase food security in the area. A study conducted by Gukurume (2013) reveals that there is a shifting paradigm from maize culture to traditional crops like rapoko, finger millet and sorghum which thrives under harsh conditions. Moreover, to cope with unpredictable rainfall households adopted growing of short maturing varieties. During FGDs respondents indicated that the most common short variety crops grown in the area were SC403 *(chimukadzi usaende)*, SC401, SC301, natal common groundnuts *(chimhandara, kasawaira)* and sorghum macia *(tsveta, chibuku)*. During key informant interview AGRITEX officers and village headmen highlighted that they encourage households to grow traditional crops and short variety crops. Respondents also indicated that they received short season crops from the government and donors every season.

Furthermore, 64% household respondents highlighted that they adjusted cropping calendar for planting as an adaptation strategy. For instance, they changed planting dates depending on the onset of the rain season. In most cases they practise dry planting *(kuwarika)*.When rains come they find the seeds already in the ground. Few respondents (11%) indicated that they borrowed money as an adaptation strategy. During FGDs respondents highlighted that they did not borrow money because they do not have fixed source of income. Some respondents also indicated that the interest rates are high with unbearable terms and conditions. Respondents also highlighted that they receive money from NGOs such as Action Plan who give vulnerable households five dollars per head to purchase food provisions. Table 5 shows that 43% of the household respondents adopt selling livestock as an adaptation strategy. Respondents from FGDs and interviews highlighted that people are selling livestock to purchase grain and to pay school fees. Another commonly held view during FGDs was that people exchanged livestock for grain as a last resort especially in 2008. This strategy weakened farmers' resilience to withstand climate change vagaries. Similar results were reported by Manyani and Bob (2017) in the case of Chadereka Ward 1 in Muzarabani Rural District.The survey showed that 66% of the respondents adapted crop diversification as a solution to climate change. A variety of crops is grown in a piece of land to ensure that if one crop fails another crop will have high yields. AGRITEX officers promote this strategy to ensure food security.Table 5 further indicates that 48% of the respondents adopt zero tillage *(dhiga udhle)*. Zero tillage was adopted because it conserves moisture, fertiliser and manure. AGRITEX officers in the area also

encourage households to practice zero tillage. Some respondents from interview and FGDs termed it *dhiga ufe,* meaning dig and die due to its requirement of extensive labour. Notably, despite the benefits of zero tillage few people adopted the strategy because it is laborious. The survey showed that a small portion (25%) engage into non-farming activities. Respondents indicated that non-farming activities practiced in the area include selling firewood and honey, petty trade, brick moulding, sewing mates and baskets. One of the respondents said:

We survived on selling honey and firewood to buy food stuffs and get some income for paying school fees for our children.

Hence, this study shows that households in the area adopt various measures to cope with adverse impacts of climate change depending on knowledge and financial resources.

Table 5: Climate change adaptation strategies in the study area: n=200 (Multiple responses)

Adaptation strategy	**Number of respondents**	**Percentage**
Drought tolerant crops	172	86
Short maturing varieties	158	79
Adjustment of cropping calendar	128	64
Borrowing money	22	11
Livestock sales	86	43
Crop diversification	132	66
Zero tillage	96	48
Non-farming activities	50	25

(Source: Primary data)

5.1 Challenges of using IKS in climate change adaptation

This study revealed the IKS is used in climate change adaptation in the study area to maintain and improve livelihoods. Despite, the benefits of IKS it is facing various challenges which were highlighted by households. Most respondents highlighted that some plant and animal species have disappeared as climate change impacts intensified hence their ecological functions cannot be recognised by the current generations. This study revealed that stock birds are becoming rare to encounter due to series of droughts in the area. Makwara (2013) also indicates that in Zaka District farmers observed the breeding patterns of game animals such as impala, kudu and bushbuck but now it becomes difficult for the young generations to tap into existing ecological wisdom when these animals are difficult to encounter. It can also be noted that insects tend to be unreliable due to climate change which is affecting their breeding and other features. Again, deforestation and climate changes is linked to the disappearance of insects indicators, an observation also made by Kijazi *et al*. (2013). Hence, climate change is causing disappearance of key indicators from the environment.Another commonly held view by respondents was that IKS is under threat of extinction due to human settlement *(minda mirefu)* in areas which were habitats of wildlife and excessive hunting drove wildlife away from the area. Manyani and Bob (2017) even observed that IKS was failing to impress on development initiatives in general as all its system base is under threat from climate change. Hence, it becomes difficult for instance, to predict weather condition using wildlife. Again, competition of people, domestic livestock and wild animals on biophysical resources (water sources, grazing pastures) also exacerbated the disappearance of wildlife in the area. This was supported by Manyanhaire (2015) who indicated that wildlife in Zimbabwe has been reduced in numbers due to the lack of animal diversity stemming from the competing needs for grazing land by domestic animals and the expansion of crop agriculture into marginal areas which were habitats of the wild animals.The study indicated that elderly people (fifty years and above) possessed rich IKS as compared to respondents below this age. This indicated that there was poor knowledge sharing culture in the area which exacerbated the depletion of IKS. Manyani and Bob (2017) also noted that the dissemination of the information on climate variability and change to the local communities was all that mattered. Lwoga *et al*. (2011**)** also highlighted that poor knowledge sharing culture maybe caused by lack of a system to compensate IKS holders when they shared their knowledge so people are not willing to share their knowledge. During FGDs elderly people pointed out that young generation do not have time to tap their wisdom so they no longer share it. Again, individualistic nature of IKS can result in poor knowledge sharing culture since it is passed on orally (Sithole, 2007). The challenges highlighted above shows that some IKS indicators are no longer observed hence the reliability and accuracy of IKS is eroded. This implies that there is need to document IKS regarding all facets of life.

VI. Conclusion

The study assessed the relevance of IKS in climate change adaptation in Ward 23 in Chirumhanzu District. It was intended to identify and document IKS used in the area. The study established that the area is IKS rich. Plants, birds, insects, animals and atmospheric indicators are used for weather forecasting though their significance are negatively affected by the intensity of climate change impacts. Again, the study indicated that although similar indicators are used in various communities their significance differs depending on biophysical and mystical experiences. It has emerged that IKS is used to determine timing of important agricultural

activities and planning, predicting drought and weather forecasting. In view of these findings the researcher concludes that measures must be put in place to safeguard loss of IKS. This welcomed the introduction of the new curriculum in Zimbabwean education in which Heritage Studies are made compulsory form primary level.Furthermore, the study has demonstrated beyond doubt that households' perception on climate change vary. Majority households are aware of increasing temperatures and decreasing rainfall. As a result distinct seasons are becoming difficult to identify. Again, it has been revealed that, household perception on the causes of climate change are cultural issues, religious issue and human induced which varies according to age, number of years stayed in the area and the level of education. Household's perception of climate change influences choice of adaptation strategy. This has been proved statistically significant through computing the MLRA. These and other observations have been noted by Simelton *et al.* (2013).Despite the usefulness of IKS, it faces challenge of extinction (Manyani & Bob, 2017). As a result of resettlement, adverse weather conditions and competition between human beings and wildlife, key environmental indicators have disappeared. Again, poor knowledge sharing culture in the area has exacerbated the extinction of IKS since it is not transferred across generations. This has caused people to question the effectiveness and reliability of IKS in climate change adaptation. Hence, an integrated approach is crucial for devising effective and sustainable climate change adaptation strategies.IKS is not immune from limitations; hence, there is need for harnessing IKS at local level and integrating it with western knowledge systems (WKS). This is necessary to formulate effective policies and adaptation strategies. Integrated approach is emphasised by Empowerment through Enablement Model to ensure the exchange and integration of IKS and western knowledge. This people-centered approach promotes implementation of effective climate change adaptation strategies. Again, governments need to focus on inclusion of IK in the formal education system which ensures blending of IKS and WKS.

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