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Indigenous Knowledge Systems and Modern Weather Forecasting: Exploring the Linkages

Enock, C.Makwara
Curriculum Studies Department, Great Zimbabwe University

Abstract. Since time immemorial indigenous knowledge systems (IKSs) were used by societies in Africa and the rest of the world for various purposes depending on the needs of the society in question. Wherever humans have settled around the world, being able to predict weather has been necessary since man has never been a passive recipient of environmental bonuses and controls. Knowledge about past disasters and climate in Africa are the accumulated experiences that have been handed down to generations through oral traditions. There is, therefore, need to investigate how traditional knowledge systems can be integrated into agricultural activities in order to minimise losses associated with extremes of climate and weather. The study was, therefore, undertaken with a twin set of objectives. The first objective was to identify, analyse and document local indicators used in IK forecasting over the study area. The second was to assess perceptions of the local communities on the application and reliability of both IK and conventional forecasting in their daily lives in order to identify the gaps and the needs for improvement .In this study, it is argued that IK can provide significant value and boosts in the improvement of forecasting accuracy and reliability if it will be systematically researched ,documented and subsequently integrated in conventional forecasting system .The results of the research could be useful in conjunction with weather forecasting information from the meteorological office to improve the timing of agricultural operations and disaster management activities.

Key words: indigenous knowledge systems, rainfall prediction indicators, seasonal forecasting, seasonal planning, climate variability, disaster management

Background

African communities and farmers have always coped with changing environments. Local communities and farmers in Africa have developed intricate systems of gathering, predicting, interpreting and decision-making in relation to weather. They have the knowledge and practices to cope with adverse environmental conditions which might occur in their localities. This implies that the enhancement of indigenous capacity is key to the empowerment of local communities and their effective participation in the development process (Boko et al, 2007 citing Leautier, 2004).People are better able to adopt new ideas when these can be seen in the context of existing practices. A study in Zimbabwe observed that farmers' willingness to use seasonal climate forecasts increased when the forecasts were presented in conjunction and compared with the local indigenous climate forecasts (Boko et al 2007, citing Patt and Gwata, 2002). Similarly, a study in Nigeria showed that farmers are able to use knowledge of weather systems such as rainfall, sunshine thunderstorms ,windstorms and harmattan (a dry ,dusty wind that blows along the north-west coast of Africa) to prepare for future weather (Ajibade and Shokemi,2003).Indigenous weather forecasting methods are known to complement farmers planning activities in Zimbabwe. Roncoli et al (2001) observe that a similar study in Burkina Faso showed that farmers' forecasting knowledge encompasses shared and selective experiences. Generally, elderly people formulate hypothesis about seasonal rainfall by observing natural phenomena while cultural and ritual specialists draw predictions from divination, dreams or visions. The most widely relied upon indicators are the timing, intensity and duration of low temperatures and wind characteristics during the early part of the dry season (May to August).Other forecasting indicators include the timing of fruiting by certain local trees, water levels in streams and ponds, insect and nesting behaviour of small quail like birds in the environment.

There has been an observed increase in climate variability in most Southern African. A comprehensive assessment of recent climatological data has revealed strong spatial and temporal variability of rainfall in most parts of Zimbabwe. This is partly due to multiple and complex features that affect spatial and temporal distribution of rainfall. This has increased uncertainty in seasonal rainfall prediction and poses a greater challenge to scientists in their effort to improve forecasting accuracy and reliability. Pertinent actions are therefore needed to address these challenges to enable the agricultural sector to significantly contribute to the attainment of Zimbabwe's development agenda and vision together with the achievement of the newly launched agricultural policy as guided by the fast track land reform and resettlement programme. The newly launched land redistribution initiative put the agricultural sector as the number one priority in all development activities, with the purpose of enhancing agricultural productivity and improving quality in agricultural produce.

However, since agricultural activities in Zimbabwe are mainly driven by rain, it means crop production to a large extent depends on right decisions being made on what to plant, when and where which in turn depends much on the accuracy and reliability of seasonal rainfall forecasting. Officially, the Meteorological Department is charged with the responsibility for monitoring and predicting weather and climate in Zimbabwe, including seasonal rainfall forecasting. Conventional weather and climate prediction is normally done using statistical and dynamical methods (Johnston et. al., 2004; Gissila et al., 2004). In spite of the slight improvement in forecasting accuracy, the present forecasting accuracy, which is 75%, is still not sufficient and the challenges are still numerous due to the strong spatial and temporal variability of the nature of rainfall (Ogallo, 1989; Nyenzi et al., 1999; Zorita and Tilya, 2002). Recent climate change projection indicates increased climate variability in the context of climate change over most parts of the world (IPCC, 2007). It is, therefore, imperative that efforts to improve accuracy and reliability of seasonal forecast be enhanced.

Systematic documentation and subsequent integration of Indigenous Knowledge (IK) in seasonal rainfall forecasting is one of the promising initiatives that needs to be explored. Historically and to date, traditional local communities in different parts of the world have continued to rely on IK to conserve the environment and deal with natural disasters. Communities, particularly those in drought and flood prone areas, have generated a vast body of Indigenous Knowledge on disaster prevention and mitigation through early warning systems and preparedness (Roncolietal., 2002; Anandaraja et al., 2008). The use of contemporary and indigenous climate forecasts information for farm level decision in Mozambique and Kenya is described in Lucio (1999) and Ngugi (1999) respectively. In Zimbabwe, local communities have been coping with drought by integrating contemporary and indigenous climate forecasting (Shumba, 1999). Using IK in weather and climate prediction, local communities in different parts of Southern Africa have been coping and adapting to increased climate variability, normally manifested in the form of increased frequency of both droughts and floods. Prediction of impending disasters has been an integral part of their adaptation strategies. Before the establishment of conventional weather and climate forecasting, older generations, especially in the rural areas in Zimbabwe, have largely relied on Indigenous Knowledge to predict weather through observing and monitoring the behaviour of animals, birds, plants and insects (Kihupietal., 2002; Mhita, 2006).

In spite of all these benefits, IK in weather and climate prediction is under threat of disappearance due to: lack of systematic documentation of the knowledge; lack of co-ordinated research to investigate the accuracy and reliability of IK forecasting and finally when old people who are the main custodians of the knowledge pass away, the knowledge which has been accumulated for many years is lost. In this study, it is argued that IKS can provide significant value and boosts in the improvement of forecasting accuracy and reliability if it will be systematically documented, researched and subsequently integrated in conventional forecasting system .The documentation of IKS will be a good resource for the establishment of IK forecasting database in Zimbabwe and will be an important resource in the establishment of effective adaptation strategies to lessen the impacts of climate change. The study was, therefore, undertaken with two main objectives. The first objective was to identify, analyse and document local indicators used in IK forecasting over the study area. The second was to assess perceptions of local communities on the application and reliability of both IK and conventional forecasting in their daily lives, agricultural activities included, in order to identify the gaps and the need for improvement .The research was thus conducted to investigate the integration of traditional knowledge systems in weather forecasting activities and its application in farming in Masvingo province's Zaka district.

Climate variability has a considerable influence on the success of agricultural production among rural communities in Zimbabwe. Of great importance in determining agricultural production are climatic elements like rainfall and temperature. Rainfall is the single most important element since most communal areas depend on rain-fed subsistence agriculture for their livelihood. Others like temperature and humidity influence the availability of moisture to crops through their influence on the rates of evaporation. Throughout history, communities have lived with and experienced climate-related disasters such as droughts, floods, locusts, birds and rodents. Weather related hazards like floods, hail, thunderstorm and strong winds have caused deaths of livestock and crop failure. This means that they should be understood in order for protective measures to be taken. It has to be borne in mind that man lives by culture rather than instinct in order to remain alive.

Recent recorded droughts in Zimbabwe were in 1981-82, 1992-93 and 2002-2003 seasons. The 1992-93 drought, recorded as the worst in living memory, caused the loss of 60 % of the national cattle herd in Zimbabwe (Ngara and Rukobo, 1992). The excess rainfall, as was experienced in 2000 during cyclone Eline, also affected the well-being of the communities and at times led to loss of life and damage to property and infrastructure (Svotwa et al 2010 citing The Manica Post, 3-9 February, 2006). Losses associated with extremes of weather and climate made communities in rural areas of Zimbabwe develop their own traditional methods to monitor and predict weather. Before the advent of modern scientific methods rural communities must have realized that some animals, birds, insects and plants had the capacity to detect and respond to changes in atmospheric conditions. The level of human cultural development also corresponds to suffering when a disaster strikes. They also mastered the positions of stars, the sun and associated shadows and the moon, the wind strength and direction and the cloud position and movement and the lightning patterns (First Science, 2004). Perceptions of local communities on conventional weather and climate forecasts are also assessed. This paper describes how farmers in south-eastern Zimbabwe, Muroyi area of Zaka district in particular predict rainfall using local environmental indicators and astronomical factors. Even without the modern way of dividing time into months, seasons and years, humans have been able to understand diurnal and seasonal changes of the environment. Such knowledge could be used in determining the timing of important agricultural activities and in predicting disasters. Wherever humans have settled around the world, being able to predict weather has been necessary for man has never been a passive recipient of environmental bonuses and controls. Thus IKSs have been in existence for a very long time having withstood the test of time.

Indigenous Knowledge Systems

Since time immemorial, indigenous knowledge systems (IKSs) have been used by societies in Africa and the rest of the world for various purposes depending on the needs of the society in question. Indigenous knowledge is a generic term that consists of the actual knowledge, skills and practices or methods of doing things based on local materials developed through various types of experimentation and practical experience overtime by the people of the place and adapted to the local situation. The term 'indigenous knowledge' is used to describe the knowledge systems developed by a community as opposed to the scientific knowledge that is generally referred to as 'modern' knowledge (Ajibade and Shokemi, 2003). The http://www.sedac.ciesin.columbia.edu website defines IKS as "local knowledge that is unique to a given culture or society". Similarly, Altieri, 1995:114 contends that IKSs are forms of knowledge that have originated locally and naturally.. According Hammersmith (2007), they are linked to the communities that produce them. He further observes that those natural communities are characterised by complex kinship systems of relationships among people, animals, the earth, the cosmos, etc. from which knowing emanates. In light of these definitions, one gets persuaded to go along with Mapara's (2009) observation that IKSs are "a body of knowledge, or bodies of knowledge, of the indigenous people of particular geographical areas that they have survived on for a very long time". These bodies are developed through the processes of acculturation and through kinship relationships that societal groups form, and are handed down to posterity through oral tradition, cultural practices like rituals, rites and oral traditions. As such, IKS are the adhesive that binds society as they constitute communicative processes through which knowledge is transmitted, preserved, and acquired by humans in society. It should not be surprising that indigenous knowledge is the basis for local-level decision-making in many rural communities in many a country. It has value, not only for the culture in which it evolves, but also for scientists and planners who are striving to improve conditions in rural localities. Thus colonisation entailed expropriating and denying indigenes access to their traditional resources, IKS and land included. Incorporating indigenous knowledge into weather forecasting and climate change policies can lead to the development of effective adaptation strategies that are cost-effective, participatory and sustainable (Robinson and Herbert, 2001).

IKSs are known by other names, and among them are indigenous ways of knowing (Nyota and Mapara, 2008), traditional knowledge, indigenous technical knowledge, rural knowledge as well as ethno-science (or people's science) (Altieri 1995:114). Indigenous knowledge systems manifest themselves through different dimensions. Among these are agriculture, medicine, security, botany, zoology, craft skills and linguistics. In Africa, like elsewhere, indigenous knowledge systems (IKSs) were used to administer peace, harmony, and order amongst people and their physical environment (Mawere, 2010). This knowledge was and still is very useful especially in summer and immediately after harvesting when crops like finger millet, rapoko and sorghum would be in need of thrashing and winnowing.

In short, IKS are those forms of knowledge that the people of the formerly colonised countries survived on before the advent of colonialism (Mapara, 2009).IK was denigrated ,despised and ridiculed by the colonialists and portraying their sciences as not only non-empirical but also as primitive, superstitious, backward and living in the dark and thus out of touch with civilisation. Communities developed traditional ways of weather forecasting that helped them to plan their activities for at least few days in advance .Indigenous ways of knowing have also brought forth useful knowledge on medicine and health. The use of proverbs is another example of ethno-knowledge that has been used in both judicial and governance matters. In matters relating to security, especially of properties like homes and livestock, indigenous people developed some mechanisms that are still used in some rural areas to monitor their properties.(e.g. rukwa, runyoka).They too have developed traditional ways of weather forecasting that helped them to plan their activities for at least few days in advance. IKSs cover various aspects of human livelihood activities with a whole range of specialized and general practitioners in a number of areas. (See summary below)

Box 1: Some human aspects covered by IKSs

Foods: the identification, production and/or harvesting of plants, animals and insects and their preparation and preservation for food.

Making of tools, instruments, utensils, containers, materials, various structures (storage / housing) and other products and the associated methods of use.

Drugs for human and animal health, food preservation and crop protection (against pests / diseases); spells, luck, love, business, etc.

Management systems and techniques for crops, livestock, ecosystems conservation and communities; this includes survival mechanisms in cases of disasters either man-made or natural.

Education, training and communication systems and means among various groups, families and individuals.

Socio-cultural aspects: (beliefs, religion, identity, music, status, moral ethics and behaviour) and this also involves conservation of the specific plants/animals and ecosystems as they are considered sacred.

It should be recognised that certain aspects of IK are very gender-sensitive and may therefore be practiced solely by either men or women. Weather forecasting, water detection, indicators of soil fertility and other events often interpreted from the behaviour of certain animals and birds or changes in the vegetation can be achieved through the use of IK. When indigenous knowledge gets adopted for widespread use, it becomes common or traditional knowledge. This way it becomes subject to change or improvement by the users without any control or reference to the original source. Therefore, the original idea, knowledge, skills and practices can be improved over time according to the influence of outside information or may even be abandoned in favour of new technology which is considered better/modern. It may therefore be hard to distinguish between indigenous and scientific/western/modern knowledge in some situations. In practice IKSs are holistic, integrated into the culture and minimize risks rather than maximize profit and therefore generalist in most aspects and is practiced from rural to urban settings as it becomes people's culture and cheaper or effective means of meeting human requirements for food, health, shelter, income, etc.

The importance of indigenous knowledge in agricultural sustainability has been repeatedly talked about, yet on the ground it is only applied sparingly (Mutasa, 2011).The President of the International Fund for Agricultural Development, Nwanze (2010), argues that local communities should be empowered to blend traditional knowledge systems with modern technology as a step to launch an evergreen revolution. The acknowledgement of the importance of IK falls in line with some development thinking which looks at local communities as beholders of valuable knowledge that can help in their development. What is surprising is that this mentality is not a recent philosophy. Rather, it has been preached on for some time, but faces challenges in convincing donor thinking whereby local knowledge is valued, especially in agricultural production and natural resources management.

Muchena and Williams (1991), argue for the importance of identifying, collecting and developing indigenous knowledge. They posit that educators can move from the familiar to the unfamiliar, from the concrete to the abstract in the process of promoting sustainable agriculture, starting with the farmers' indigenous knowledge. Indigenous knowledge can also be used to predict the amount of rainfall for that agricultural season, and inform the farmers' cropping activities. This is especially common in cases where conventional weather information is not easily accessed.

The Herald of November 4, 2010, contends that farmers should listen to the daily, weekly and monthly weather forecasts and consult Agricultural Extension Officers (Agritex) as part of their planning efforts. This of course is the ideal situation. However, not all farmers, especially those in remote areas, have access to radios and other media communicating weather forecasts, let alone having the capacity to interpret them. This is where Agritex officers should come in to fill the gap, but the situation on the ground defies this logic. The Agritex officers are crippled by the department's lack of resources as a result of the economic challenges that Zimbabwe went through in the past decade. Others have even argued that some of the officers who are expected to be interpreting this information and assisting the farmers were half-backed in a fast-track training programme to fill the capacity void in the farming community, and they need re-skilling. The above notwithstanding, I discovered that farmers rely more on indigenous knowledge and speculation in the absence of conventional weather reports when I conducted preliminary interviews in parts of Zaka/Ndanga and Bikita districts in 2010.Over-reliance on western science, however, seems to be one of the biggest challenges threatening the sustainability of indigenous knowledge.

Faced with this unfortunate possibility, it is sensible to call for the marriage of local knowledge and modern science as applying them in isolation might eliminate the complementarities that should help make the farmers succeed in the farming business. This is worsened by the absence of a documenting culture among Zimbabweans. From days of old, the locals have depended on folklore passed on from older to younger generations and most of it was through the word of mouth. Meanwhile, folktales are fast fading as grandparents and grandkids are scattered all over the world looking for greener pastures. The exposure to other knowledge and cultures in other countries might be contributing to people's treatment of local knowledge as primitive and out of touch with civilisation. Therefore only a few look at it as integral, and some have only considered using it in times of adversity. Local knowledge is not only important in farming, it is also adds value to social, economic and political development. The lack of a documentation culture is striking when one looks at the number of publications that have been written on our political leadership. The same applies to pieces written on any other subject in Zimbabwe. Most of it is foreign, and this reminds me of a question raised by Paul Robbins in his book, *Political Ecology: a critical* *introduction*. He asked how we can hear local voices if they are only mouthed through the foreign researcher (Mutasa, 2011). This question should and must constantly resonate in our minds and provoke our thinking. Surely we cannot over-rely on feeding on foreign thoughts when we have people with the capacity to write our indigenous story. Zimbabweans are capable and that capacity should be put to use.

The disadvantage with our indigenous knowledge is that it is resident only in the head of the beholder. Unfortunately when they die, they die with their knowledge. In the absence of documentation of this knowledge, the surviving generations can only misquote and misinterpret it. According to the second Africa Environment Outlook (AEO-2), published by the United Nations Environment Programme, traditional knowledge has been overlooked in the past and, in some cases, is actually being lost. And as Williams and Muchena (1991) observed, the skills to identify, collect, and develop indigenous knowledge into contemporary usable formats are needed so as to ensure the sustainability of this knowledge. Without that, our focus on the promotion of marrying local knowledge and modern science for sustainable agriculture will be futile.

Study Area

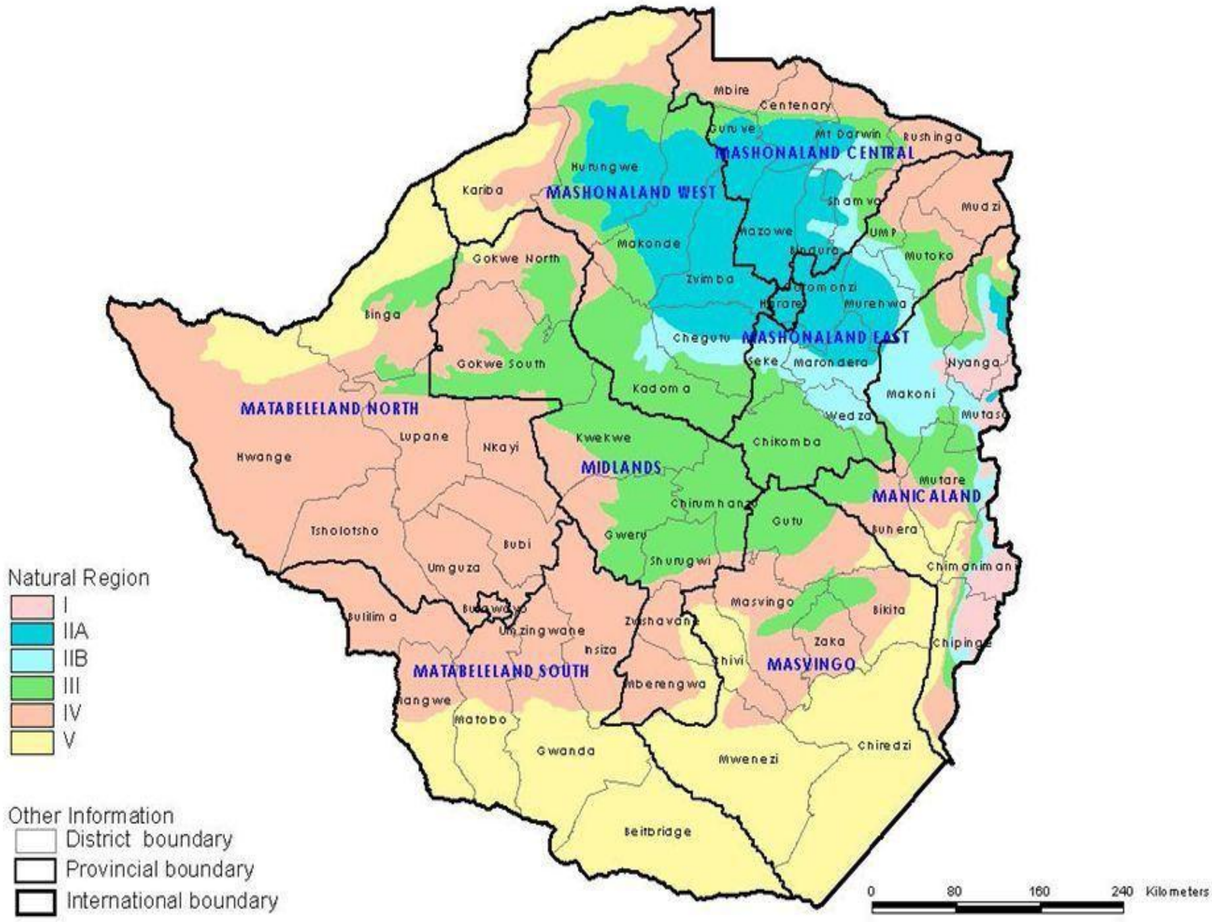
Zaka District, a semi-arid, mountainous area with erratic rainfall averaging 600-800 mm/yr lies some 350+ km to the south of Harare, Zimbabwe's capital. Muroyi Communal area [Ward 5] lies in Zaka district, about 80 km south- east of Masvingo town, the provincial capital of the province with the same name.

The study area covers the north eastern part of Zaka district, Zimbabwe.

Trees used to be closely spaced or widely spaced with a grass cover mainly of perennial species varying inversely with tree type. These trees are intermixed with several herbaceous species and shrubs. Species diversity is higher on valley bottoms and lower mountain slopes than on upper mountain slopes because of the higher moisture regimes in the latter locations. (Masocha and Gandiwa, 2001) Common tree species are Julbernadiaglobiflora(munondo/mupfuti /muzhe) and

Eupacakirkiana(mushuku) and Parinaricuratelifolia (muchakata). Most of the land has been cleared for agriculture, firewood and for brushwood fence for gardens. Drainage is dominated by Turwi river which is perennial and across which Siya dam is built.

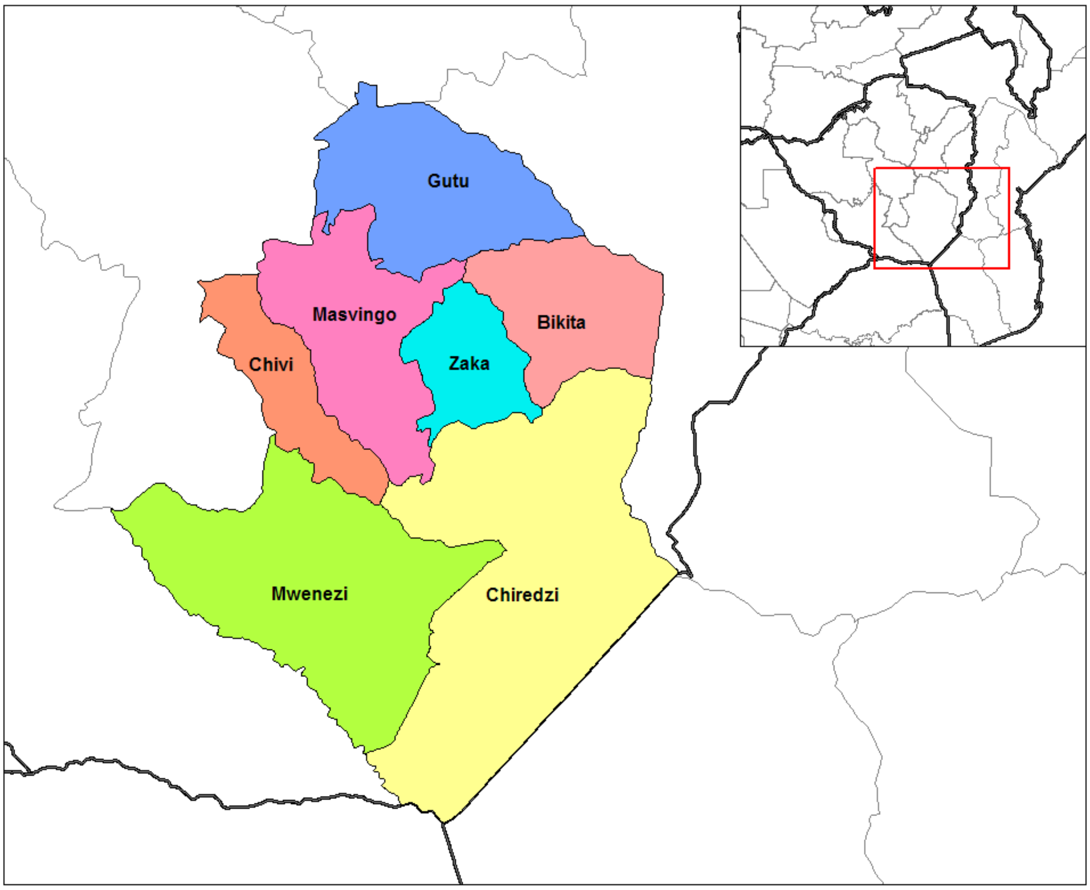
Figure 1: Zimbabwe's agro-ecological regions



Source: FAO and WFP, 2009

Non-arable land is mainly used for grazing under communal tenure. During droughts, communities in this area survive on food handouts from the Government and non-governmental organizations like CARE International. Communities in the study area can be described as poor, with limited access to economic resources hence their dependence on subsistence farming. The area experiences a tropical wet –and – dry type of climate which provides moisture for plant growth in the warmer part of the year but causes moisture deficiencies and plant stress during the cooler season. Precipitation comes mainly in the form of conventional rainfall between November and March with a minimum of 60 mm in each of the five months.

Fig 2: Masvingo Province and its districts



Source: Wikipedia, the free Encyclopedia

The peak occurs in December, which receives a mean rainfall of about 140-150mm. On average, about 700mm of rainfall is received in this part of Zaka. The region is thus characterized by prolonged unimodal rainfall regime starting from November continuing to the end of April. Communities in this area are very vulnerable to climate variability and they will be even more vulnerable under the projected climate change as most models predict a reduction of rainfall in the Southern African region and an increase in the frequency and severity of droughts and floods. Mean annual rainfall is projected to decrease by up to 6% due to the doubling of CO2 concentration in the atmosphere (Mwandosya et al., 1998; Matari et al., 2008). The reverberating projected increase in drought frequency and severity poses a serious threat to the livelihood of people around south-eastern Zimbabwe and to its economic development.

Like rainfall, temperatures fluctuate with season. The minimum temperature of 10 degrees Celsius is experienced in July while the mean maximum temperature of 26 degrees Celsius is experienced in October (Department of Meteorological Services, 2008).The area is therefore semi- arid and mountainous with erratic rainfall averaging 600-800m per year.

Soils are derived from the same parent material but differ in properties because they occupy different topographical positions. Soils range from shallow sands to mere pockets of rich clay and red soils in some localities. Sandy and sandveld soils are widespread in the southern part of the study area. Soils are susceptible to leaching and loss under heavy rains .Red clay soils are found in the mountainous northern areas of the ward. These soils are very rich in soil nutrients and support a wide range of crops like maize, ground nuts, rapoko, millet, and cotton, patches of rice, sunflower, round nuts, sorghum and assorted vegetables. Generally speaking, soils are fragile yet population density has been ever rising from 40(1982) to 65 (1992) and 72(2002) (C.S.O. 1982, 1992, 2002) persons per square kilometre, which is quite high for this fragile, mountainous and semi-arid area.

Methodology

The research was conducted from mid-July through to mid-November, 2009. The study was a descriptive survey on how traditional knowledge systems can be integrated into agricultural activities with a view to minimise the impact of extremes of weather in Muroyi Communal Lands. A total of five villages (Gumbu,Mangezi,Matowe,Mavhenyengw and Ngadzigurwe) were sampled. The selection of villages was not systematic; it was mainly based on the accessibility to the respective villages .To thoroughly explore the questions surrounding the critical role that traditional knowledge systems play in forecasting, it was imperative to solicit detailed data at extremely fine resolution. This necessitated the use of primary data as support to the existing secondary data. A series of in-depth formal and informal interviews, focus group discussions and meetings were organised with the elders. Interviews enabled the collection of data from a cross section of elders in the community as a general technique to tap into the existing wealth of experiences that have been enriched through generations. Elders were, thus, treated as key informants and helped to generate specific technical and social indigenous knowledge on weather forecasting, agricultural planning and disaster preparedness. Specific data categories collected through this method included a description of changes in behaviour by animals, flowering patterns of fruit trees, interpretation of the movements of winds and the general body feelings of the elders in relation to weather and climatic elements. It was possible to establish the appropriate types of human responses to the perceived environmental changes. Cultural practices like the rain-making ceremonies were described as a local response to the patterns of weather and these could only be conducted at specific locations, not all year round but at specific periods of the year. This was an open approach aimed at maintaining maximum flexibility so as to obtain as much information as possible. Interviews served as means to gather data through probing the perceptions, attitudes, beliefs and feelings of the elders about the critical role of integrating traditional methods into forecasting and disaster preparedness.

The majority of the people are mainly Karanga and had long period of stay in the area. They are of similar origins with similarities in knowledge and ways of interpretation of the physical environment. The crystallisation of these variables could only be possible with the use of Focus Group Discussions (FGDs) that were carefully planned along age, gender and traditional roles in the community. FGDs of up to five people were organised and the various techniques available within the community on weather forecasting and its integration into farming and disaster management were explored. The establishment of groups based on the above mentioned criteria is always prone to the effects of excluding critical information that could be enshrined within those considered as young but have been enriched on weather forecasting by their departed elders. The study had to be all-inclusive to avoid such inaccuracies and traditionally costly omissions. In this vein, prior to the detailed involvement of elders in the study, a Rapid Rural Appraisal (RRA) by way of meetings with villagers in the ward were conducted. This general methodology was critical in establishing the general traditional knowledge that exists within the community and how this could be integrated into weather forecasting and disaster management. Rapid rural appraisal was important in collecting information from a cross-section of villages within a short space of time. The information that was collected through the active participation of the villagers was then used to establish categories of knowledge that existed. These were then crafted into interviews and themes for FGDs which were established. This created the much need rapport with the community and eliminated speculation on perceived discrimination of individuals in programmes. Besides, the researcher was born and bred in the area so he was regarded as the 'son of the soil'.

The relative strengths and weaknesses of these techniques as research methods in geography and environmental studies have been long established. A triangulation approach was adopted because of the diversity of methods and overlapping data sets employed in the study. Triangulation served as a vehicle for cross checking the authenticity and validity of the various data sets generated through focus group discussions, interviews, field observations, rapid rural appraisals discussions and document reviews.

The methodology, therefore, consisted of a strong research component comprising FGDs, interviews and semi-structured questionnaires and field observations in village clusters. The first step involved organising reconnaissance meetings with the traditional leadership, the ward councillor, extension agents and other civil society organisations already working in the area to explain the project's objectives as well as ensure buy-in. Mapping was also key at this stage. This was followed by a community workshop attended by representatives of the five villages as well as traditional leaders, climate specialists, local government and specialist departments, faith representatives, school teachers and community health workers. A total 100 households participated in a workshop which was conducted during the month of December 2009. Various Participatory Rural Appraisal (PRA) techniques were used; key informant interviews were conducted with local administrative officials, elected officials, opinion leaders and technical services. Only community members, 50 years and above, were interviewed on the assumption that younger people would have less experience on climate changes and fewer relevant observations. At most 20 questionnaires were administered per village. Identification, analysis and documentation of the traditional indicators used for seasonal rainfall forecast in this were undertaken, adopting a similar approach to that by Kihupi et al, (2002. Fifty (50) respondents were randomly selected based on the age factor, where all people older than 50 years were eligible to participate in the interviews. Key informant interviews and FGDs were used in data collection. Questionnaires were administered to different groups of elders, where a check list that included issues on conventional climate forecasts knowledge, seasonal rainfall prediction and knowledge on traditional indicators and past climatic events with focus on extremes guided the interviews. The collected data was analysed and synthesized using Statistical Package for Social Science (SPSS) and Excel computer programmes. FGD discussions were important in weighing and balancing the information collected through interviews with a view to produce generalizations that represent the traditional knowledge existing in the community. Focus group discussions of up to eight people were organized and the various techniques used within the community in weather forecasting were explored.

Research Findings and Discussion

Project activities were organized into three phases. In the first phase of the project, comprehensive literature review was done in order to compare different approaches used in weather analysis. General information on weather forecasting concept and adaptation measures was analyzed. In the second phase of the project, spatial and temporal patterns of rainfall, relative humidity and temperature were analysed using various statistical methods in order to determine their distribution in space and time and depict their trend. Investigation on the indigenous knowledge approach in weather and climate prediction was also conducted. Analysis and documentation of the traditional indicators used in the ward for seasonal rainfall forecast was conducted adopting similar approach to that by Kihupiet.al (2002).The whole ward was selected for data collection.

As intimated earlier on, PRA methods, key informant interviews and focus group discussions were used in data collection. It has been found that plant phenology is widely used by local communities in the district in seasonal rainfall forecasting. Early and significant flowering of certain trees from July to November has been identified to be one of the signals of good rainfall season. The behaviour of some birds has been singled out as one of the best indicators for rainfall. Both IK specialists and meteorological experts predicted 2009/2010 rainfall season to feature normal to above normal rainfall. Systematic documentation and subsequent integration of indigenous knowledge into conventional weather forecasting system is recommended as one of the strategies that could help to improve the accuracy of seasonal rainfall forecasts under a changing climate.

The results showed that agricultural activities were related to wind systems, migratory and mating trends of wild animals and the position of the moon. The colour of the horizon at sunrise and sunset, appearances of rare animals and bird breeding patterns in river valleys were used in drought and flood prediction so were the flowering patterns of certain plant species. Traditional knowledge systems alerted people of possible disasters such as delays in the start of rains, untimely or excessive rains and spell of too high or too low temperatures. Forecasts provided farmers with guidelines for seasonal planning in terms of timing for planting, choice of crops suited to projected conditions and the likely impacts of weather on farming operations in general. The study recommends the acknowledgement and utilisation of existing traditional knowledge systems in weather forecasting in readiness for the coming agricultural season (planning animal and crop farming) and the general development of communal areas in a sustainable manner.

Farmers and weather forecasts

Among the indigenous rainfall prediction indicators that farmers in Zaka use include the density of spider webs in their locality, with a lot of spider webs indicating a very wet season (spiders don't want damp or wet conditions). .Also when spiders close their nests, an early onset of rain is expected because spiders do not like any moisture in their nests. They also look at the circular halo around the moon, known locally as *dzivaremvura*, to predict the wetness of that particular period of the season. Other indicators include animal and plant behaviour, as well as wild fruit availability and wind direction prior to the rainy season. Although these indicators can be said to be indigenous, they certainly show some level of dynamism and integration of western science which has also tapped into these and use wind direction to predict rainfall patterns. According to The Food and Agricultural Organization (FAO) (2004), in Zimbabwe, only 3% of farmers use climate information for planning purposes. Some of the reasons given are that the information is not received on time and that farmers do not trust the metrological information. Although framers listen to weather forecasts from radios, the poor and the marginalised farmers prefer to use their traditional knowledge system as a control .This said, I discovered from the research I conducted in the study area that farmers rely more on indigenous knowledge and speculation in the absence of conventional weather reports. When contemporary climate forecasting deviates from traditional forecasts, the farmers' inclination is towards indigenous information for reasons that it blends well with culture, has been tried and tested over years and is in a language that the farmers understand.

Often, there is a striking similarity between indigenous and contemporary weather indicators. Some indicators such as wind direction, clouds and temperature are the same in both systems. Farmers associate heavy production of tree leaves with a good season while high fruit production is a sign of a poor season. The reasoning behind this observation is that high fruit production implies that people will be living on fruits for lack of alternative foods. Other indigenous signs of an eminent drought include heavy infestation of most tree species by caterpillars (masondya,harati, magandari,manhemeteme-all edible worms) during spring time through to summer; late bearing and lack of figs in July-September of fig (muonde) and water berry (mukute) trees and the late maturing of acacia trees along valleys .

One of the most important animal indicators is the behaviour of insects. When a lot of crickets are observed on the ground, a poor rainy season is expected. By contrast, when jerrymanglums/sun spiders (dvatsvatsva) are visible in the area, they signal the imminent arrival of a wet spell. Elderly male farmers formulate hypotheses about seasonal rainfall by observing natural phenomena, such as the appearance of certain birds, mating of certain animals and flowering of certain plants, while cultural and ritual specialists draw predictions from divination, visions or dreams (Roncoli et al., 2001). The appearance of black and white stork (shohori/shuramvura), denderas, swallows (nyenganyenga) are associated with a good season and eminent rain. The singing of some such birds is said to be a good omen in so far as rainfall is concerned. In particular, if dendera birds are heard singing, it is believed to be a very good sign of an approaching good rainy season. Equally, if a lot of swallows and white stork are seen in the locality, they are indicative of the onset of a promising rainy season. Indeed, a stork flying at a very high altitude is associated with a good season. Others observe the signs, waiting for the cuckoo /rain bird (kohwera, in the local language) to start calling, or particular hills/mountains to catch fire in the intense heat. If a cuckoo bird is heard signing, rains are said to be just about to fall.

Others speculate on the past cold season and the relationship between cold winters and good rainfall or the patterns of good and bad seasons over the years The findings, for example, show that farmers are able to use knowledge of weather systems such as rainfall, thunderstorms, windstorms and sunshine to prepare for future weather .The most widely relied-upon indicators are the timing, intensity and duration of cold temperatures during the winter season (May to July). Other forecasting indicators include the timing of the water level in streams and ponds and insect behaviour in rubbish heap. .As the heat rises during October, conversations in Muroyi usually begin to revolve around the coming of the rains. The waiting game is loaded with expectation, speculation and concern. Everyone has a theory about the likelihood of a good or bad year, but no one knows quite what will happen. Some farmers carefully observe the changing patterns of the winds and the movement of the clouds, developing specialisations in local meteorological patterns. Wind blowing from west to east and from north to south, is assumed to bring a lot of moisture and a good rainy season. The prevalence of strong winds blowing from east to west during the day and at night between July and early November is an indicator of drought.

Indigenous climate forecast information

It is evident that local weather and climate is assessed and predicted by locally observed variables and experiences using combinations of plants, animals, insects, and meteorological and astronomical indicators. The different weather and seasonal climate indicators used to predict rainfall in the area are sampled and summarised in Tables 1 to 3 below. Most of the respondents (94%) acknowledged the existence of traditional methods of weather and climate forecasting in their communities and 92% acknowledged using traditional weather and climate forecasts in their agricultural activities. However, 64% of the respondents commented on the accuracy of IK forecasting. It has been observed that local communities in the ward rely much on forecast information from IK than from conventional methods.

Indicators from plant phenology

The survey in the ward indicated that the presence of higher than normal flowering intensity of certain trees during the months of July to November is indicative of good amounts of well distributed rainfall in the upcoming season. However, significant flowering and good fruit bearing by wild loquat (mushuku) and muchakata trees is widely considered to be an indicator of an impending poor rainfall season in the upcoming season. This should be understood against the background that windy conditions which often precede the rainy season may shake off flowers hence fewer fruits. It was found that significant flowering of bean pod, fig and water berry trees is a signal of imminent rainfall onset and abundant rainfall in the upcoming season. However, the challenge here is what is considered to be a bench mark (normal). It is, therefore, imperative that more research be conducted to quantify the norms.

Table1: Knowledge of local indicators based on plants

Feature	Observation	Implications
Wild fruits	mukute: (water berry) significant flowering muonde: (Fig tree) and Mukute: (water berry) flowering and generation of new leaves. mumveve/kagelia:when it gives a lot of sap during the dry season	starting from July through October is a signal of good rains in the coming season indicates near rainfall onset it indicates abundant rainfall in the coming season

	musekesa:Bean pod tree brachystegiaspeciformis: significant flowering starting from July through October	is a signal of good rains in the coming season
	The shooting of the sausage tree	onset of the rainy season
	muchakata and mushuku: [uapacakirkiana and Wild loquat] significant flowering and good fruit bearing	is widely considered to be the good indicator of impending drought

Indicators from animals, birds and insects

The behaviour of animals and the appearance and movement of birds and insects are frequently used by elders in the area to predict weather and climate in their communities. The migratory tendency of the white and black stock is associated with the approaching summer season. Modern scholars have also reported that many animal species undergo movements of varying distances depending on the prevailing rainfall patterns. An example of a bird whose presence is rain-associated is the Woodland Kingfisher of West Africa, the swallow and the white and black stock (Wikipedia, 2006). The local type of kingfisher is associated with heavy falls within days of its appearance as the interpretation is that the nature of the sound that it produces resembles clattering of rain drops characteristic of a heavy downpour. Land preparations and precautionary measures are adopted as a safeguard from the impending storms that could be linked to the expected rains. Heavy rains are predicted when ants emerge from their holes in large numbers to collect food from homes and the veld and this is associated with an impending long wet spell. The ants disappear less than twenty-four hours before the storm. Ant behaviour triggers farmers to collect firewood to dry places in preparation for a long wet spell. Ant behaviour has long since been regarded as a portent indicator of rain to come (Australian Broadcasting Corporation, 2006). If ants seem hyperactive or if they build high walls around the entrances to their nests then it will rain and seeing them in strange places like the ceiling or ice chest was another sign of rain (Australian Broadcasting Corporation, 2001). Equally the sight and sound of a lot of croaking frogs is indicative of an imminent wet spell.

With respect to human beings, intense thirst and a high frequency of drinking water is a sign that rains will fall. However, the period intervening this behaviour and the coming of rains was not specified. Thirst is related to heavy sweating when there is a high vapour pressure gradient between the atmosphere and the body during hot dry days (Monteith, 1996; Mount, 1976). A high vapour pressure gradient stimulates thirst and apparently on such dry days, evaporation rates are high and when the rising water is cooled sufficiently to condense, convectional rains can be received (Barry and Chorley, 1998). The rate of water loss from the body can be linked to the rate at which that water must be replaced. If these two variables do not match then it leads to dehydration and consequently death.

The breeding patterns of game animals like the impala, kudu, birds, and bushbuck to mention a few is also used in seasonal forecasts and disaster prediction. When game animals give birth in large numbers, it signifies a normal to above normal season and the reverse is true. Most tropical animals become fertile when day length is short so that they parturate in summer when food is abundant (Mount, 1976). Humans have long since discovered the mysterious reduction in animal birth rates and survival of wild animals from disasters like drought. Similarly, drought in Muroyi area is anticipated when waterfowls (masekwe and hurekure) breed on the ground and in lower patches on flood plains. Elsewhere in literature there does not seem to be any predictors of a coming drought, but there are signs of when a drought is going to break. In Australia for example, if hawks sit so close together on a tree branch, that late comers are not able to land, then the drought would have reached its lowest point.

Or if ibis's congregated in large numbers in dry waterbeds or cleared flat ground, and did their famous dance for hours on end, then the drought was about to break (Australian Broadcasting Corporation, 2001).

Another good example of animal ability to predict disasters could be what happened recently when the Tsunami struck. Despite the loss of 24000 people, wild animals seemed to have escaped the Indian Ocean tsunami, adding weight to the notion that they possess a "sixth" sense for predicting seasonal quality and impending disasters (Planet ark, 2004). Wildlife in the district, the study area included, has been reduced in numbers due to a combination of human and ecological factors. Part to the explanation of the lack of animal diversity stems from the competing need for grazing land by domestic animals and the expansion of crop agriculture into marginal areas which are habitats to the wild animals. In this regard it becomes difficult for the young generations to tap into the existing ecological wisdom when some of the animals are difficult to encounter. Given the inaccessibility they have to the modern print and electronic media there is a high probability that they entirely depend on their instincts to manage disaster risk. The appearance of large swarms of red ants in September to November, and the occurrence of large swarms of butterflies is indicative of imminent rainfall onset and it also indicates that the upcoming season will be a wet one (Chang'a et al 2010).It appears as if birds and insects instinctively detect where food might be found. In any case, weather conditions from their source regions will be hostile thus compromising food availability. As for ants, the ground might be too hot as the rainy season approaches so they seek shelter hence the need to store food underground.

Table2: Knowledge of local indicators based on animals, birds and insects

Feature	Observation	Implications
birds	(machesa) build their nests in the dry	means they are anticipating low rainfall and therefore

	season near the river bed	confident that their nests will not be swept away by heavy rains; when they build their nests high up farmers know for sure heavy rains will fall that season.
	a black crow builds a nest in an area, swallows and water fowls lay eggs on raised patches in river valley, water fowls breed on the ground under cover of grasses and reeds	it is an indication that that area would not receive rains because the birds would not risk its eggs going bad so low rainfall to drought conditions will be expected
	large numbers of white and black stock(Mashohori)in October and November .	indicates imminent rainfall onset and a good rainfall season normal to above normal season,a lot of insects(birds' food) will be anticipated
	dendera singing especially during dawn	rains are going to fall within a day to a week's time
	cuckoo bird (kohwera) singing of the bird especially in the afternoon from around 1400 hours in October and November	sign of imminent rainfall onset and a good rainfall season, its sound resembles the clattering rainfall.
	swallow(nyenganyenga) flocks seen flying all over in the area or appear in November/ appearance of large swarms	indicates heavy rain to come at that particular time. When they it indicates imminent rainfall onset. a lot of

	of swallows	insects(birds' food) will be anticipated
Insects	hasty spiders struggling to get indoors or into hiding places	an indication of the starting of manhuruka rains
	black and brown ants collecting food in the houses in large numbers	impending rains and long wet spell
	black and brown ants bring out the dead and damp food after a wet spell	short dry weather after which the rains will resume
	cicada singing in large numbers in September	marks the beginning of a normal to above normal season.
	mbalavala butterflies (black bordered charaxes)	wet conditions approaching
	charaxespollux appearance of many butterflies	indicates early rainfall onset and also give a prospect of a good season
	appearance of black butterflies in a particular area	signals a very good rainfall season over that area.
	appearance of madumbwi (red ants) treiberameisen	indicates imminent rainfall onset and signifies a prospect

		for good season
	appearance of many termites, when flying ants are seen during rainy season mujuru/termite ancistrotermessp.	this shows the sign of having more rainfall in the year.
	appearance of armyworms (mhuturu) spodopteraexempta	indicates near rainfall onset
	appearance of army worms on trees during October	signifies abundant rainfall in the upcoming season as they multiply when there is plenty of food
	appearance of madhumbudya (grass-green grasshoppers), occurrence of more grasshoppers in a particular year .	indicates less rainfall and hunger

Signs in relation to rainfall indicators from air temperature and wind

In the ward, anomalous warming during the months of August to November is an indicator of high rainfall in the upcoming season. In addition, it was indicated that an occurrence of strong winds is a signal of a poor rainfall season to come. Elders here interpret clouds in the same way as in modern day geography and meteorology. The cumulo-nimbus cloud is associated with a heavy storm with lightning and thunder (Barry and Chorley, 1998). The familiar mackerel sky (cirro-cumulus clouds) often precedes an approaching warm front, with a strong likelihood of veering winds and precipitation (British Broadcasting Corporation Weather, 2006). Even in the English culture, a morning sun illuminating clouds to the west may be an indication of an approaching depression. The other important predictor of weather is the position and the size of the moon. Simply stated, changes in the moon's movement can trigger changes in our weather

(King, 2005). This could be explained in terms of the four interfacing tides caused by lunar gravitation. If the moon has an effect on sea tides, then it should control the distribution of water. The effect spreads onto the atmosphere and weather through the distribution of clouds. From a local perspective the new and full moon phases are perceived as linked to the movements of the rain-bearing winds in the area. In most of the cases the elders are more than convinced that during the rainy season the new moon has to come with a wet spell. Once the new moon is there 'in the skies' and no rains have been received then a prolonged dry spell is expected. However, in the interim people can continue with weeding. This usually occurs between the months of December and January a period that has been established also by the meteorological office with mid- summer dry spells for the country. When this occurs, elders in the area encourage that drought resistant crops be grown as maize can easily give in to the heat and associated moisture stress before maturity.

Table3: Knowledge of local indicators based on the moon, sun or wind

Feature	Observation	Implications
Meteorological conditions	cold westerly wind damp north easterly wind winds: heavy and stormy towards the direction from which rain is coming winds in the direction of the rains clouds: low cloud perching on top of the northern and eastern mountains. clouds: high dispersed clouds ,clear sky,	dry weather wet weather in the next twenty-four hours, light showers most likely. the rains will disperse wet conditions within six to twelve hours wet spell for about a week dry weather storm within 6 to 24

	but heavy clouds appearing on the eastern horizon.	hours
	clouds: low cloud after rains.	marks the end of the wet spell
	clouds: different types	associated with weather in the same way as in morden meteorology and geography
	sky and atmosphere: strong haze in September called jechete in local language.	above average season normal
	sky and atmosphere: red sky in the west towards sunset	dry conditions persist, danger of an agricultural drought
	sky and atmosphere: clear blue sky or with clouds of great vertical extent in the eastern horizon	dry conditions ,with possibility of rains
	sky and atmosphere: hot and damp conditions after rains	rainfall expected within 12 to 24 hours more rain expected
	sky and atmosphere: cold winds after rains	dry conditions to follow ,rains expected to “clean” the new moon
	moon: full phase to new moon period	dry spell to follow for up to 21 days until full to new moon period.
	cloud conditions, no rains, up to half moon	
	sun: glaring sun no much heat output in January and September	low rainfall to drought associated with the dry spell of early to mid January, danger of an agricultural drought

	sun :glaring sun and very hot conditions in January and September north–west wind direction on November/or December. dark moon in July accompanied by cold . strong wind during the months of July through October ;heat/hot in low land areas on August high temperature in October and November. change in wind direction and temperature cold weather in July disposition of the new moon (slanted position)	preparation for rainmaking ceremonies rains expected heavy rainfall is going to fall. also it indicates due onset of rainy season. signifies good rainy season. means there will be more rainfall in the coming rainy season indicates less rainfall in the upcoming season. signifies near rainfall onset and the prospect of a good rainfall season signifies imminent rainfall indicates possibility of hail stone. Indicates more diseases and erratic rainfall upcoming rainfall season will be good.

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Fires	spontaneous fires in the sacred mountains	early rains and above average season

Forecast of 2009/2010 rainfall season in the ward using indigenous knowledge

Most of the environmental indicators that are frequently used for seasonal rainfall prediction by elders over the years were pointing towards a not so good 2009/2010 rainfall season. Observations by elders in the ward indicated that since July 2009, significant flowering of mushuku and muchakata trees had been observed across the ward was not a signal of good rains in the upcoming season. Observations based on temperature and wind direction were not that encouraging either. Thus there was a curious coincidence of meteorology and IKs in weather forecasting.

Sacred mountains likeChaziva, Chemheni,Hozvi,Hurumidza,Murove ,themselves an extension of the neighbouring Bikita Heights, in the area are used to forecast weather. The covering of these mountains' tops with mist signifies the coming of rains within a day or two. Strong condensation in such areas with a high altitude of 2500 to 3000m above sea level is not uncommon. Moist air from the Indian Ocean is forced up these mountains and condenses after cooling adiabatically. After staying in this area for a long period and by receiving information from oral tradition, the elders must have mastered this pattern of wind movement and rainfall.

Spontaneous fires (never mind who starts them) on these mountains in

September and October are regarded as a sign of a good season. When these "sacred" mountains ignite spontaneously as summer approaches, it signifies the coming of rains within a week or so, and activities like land preparation and dry planting of pearl millet, rapoko and vlei maize normally start. Calvert (1993) wrote of 'a rare to occasional fire in the late hot to early rainy season reaching aerially destructive proportions only in relatively small areas or patches of, say, 0.01 ha to a hectare or two before being extinguished by accompanying rain' that is common in Zimbabwe. Though the smoke that is released into the atmosphere is not fixed, the presence of smoke makes the sky haze and the chances that it adds to the impurities (condensation nuclei) in the air around which condensation takes place are high. Given this underlying fact, the locals will be correct to relate the spontaneous fire outbreaks to the formation of rain. The indigenous methods emphasise oral tradition, beliefs that are passed from one generation to another and not in recording the information in documents that could be read by future generations. This always brings some inaccuracies of relying on traditional forms of forecasting but then the modern approaches always work with margins of error that could also be misleading in terms of drought forecasting and mitigation. Inaccuracies in facts are not an exclusively inherent attribute of the complexity of traditional knowledge systems. In modern weather forecasting there are also errors of measurement and statistical computations.

However, the social patterns of the community in Muroyi have been changing due to a number of extrinsic and intrinsic factors. The extrinsic factors have to do with the in-coming of people from surrounding areas and far afield including the coming in of white settlers. The adoption of the alien beliefs and styles of life has made indigenous knowledge irrelevant in the face of those who have embraced modernisation as articulated by the settlers. The intrinsic factors are grouped around the spatial-temporal variations of culture as induced by societal dynamism. A major attribute of this was the conflict among leaders and elders in society, particularly the failure to adhere to the perceived ways of conducting cultural ceremonies that are linked to droughts. These disputes are often linked to the frequent occurrence of droughts in the area. The frequent droughts that are experienced the world over cannot escape the human-to-human conflicts and the human-biophysical environment conflicts. Climate change takes in a number of parameters from the socio-economic conflicts that affect our world today, to the extent that the conflict-drought linkages that are given by elders in this community may not be void of the truth of weather forecasting and disaster management.

The colour of the atmosphere and the sky are also regarded very useful in predicting weather. It was maintained that persistent coldness after the month of August is a sign of dry spells or late rains. The cold wind experienced could be the passing of the cold front after a mild to strong storms (Barry and Chorley, 1998). Persistent cold fronts coming into the country from the southeast coast of the Indian Ocean are not unusual and they might have effects on the starting of the summer season as the land is cooled, conditions that are not ideal for convective rainfall.

However, cold fronts are also responsible for frontal rainfall in the Eastern Districts of Zimbabwe. Equally important is the direction of the wind. Warm north-easterly winds bring in rainfall in the district. The rains have to follow certain belts for them to fall in Muroyi. Rainfall received in this part of the country in all the cases passes through the Bikita Heights (mountain ranges which receive some of the highest amounts of rainfall in the country). This shows a strong understanding of the micro-climate of the area by the residents. The high ground usually experiences orographic /relief rainfall that is usually persistent in the area from mid to late summer. Local people seem to have learned a lot from the behaviour pattern of rains and winds that occur in the area. Farmers expect prolonged dry spells when persistent winter coldness extends into spring. This weather pattern is often characterised by whirlwinds (chamupupuri) that raises a lot of dust. The dust causes the redness of the sky at sunrise and sunset, a phenomenon called 'horetsvuku' in local language. The redness of the sky, which depends on the amount of dust particles in the air, is regarded as a predictor of a long dry spell. Similar interpretation is given in Britain where a red sunset also suggests that dry weather is approaching (British Broadcasting Corporation Weather, 2006). Low clouds after the rains mark the beginning of dry conditions after rains. Geographically, a low cloud is a sign of temperature inversion, when warmer air is above cooler air. Low clouds form when the air near the ground cools and cannot hold as much moisture, causing water droplets to condense to form fog and mist. The presence of a low cloud shows absence of strong convections and is a clear sign of dry weather in the short term (British Broadcasting Corporation Weather, 2006).

Assessment of climate variability and weather signals in the ward

Residents of the area also look at the circular halo around the moon, known as *dzivaremvura (halo)*, to predict the wetness of that particular period of the season. Other indicators include animal and plant behaviour, as well as wild fruit availability and wind direction prior to the rainy season. Although these indicators can be said to be indigenous, they certainly show some level of dynamism and integration of western science which has also tapped into these and use wind direction to predict rainfall patterns. Over-reliance on western science, however, seems to be one of the biggest challenges threatening the sustainability of indigenous knowledge.

Outcomes

More understanding of the status and trend of climate variability in the district has been gained. Detailed spatial and temporal distribution of rainfall, temperature and relative humidity can be explained via IKSs. Similarly, spatial and temporal distribution of droughts and floods can be explained in the context of IKSs. Local environmental indicators and astronomical factors used by local communities in south-eastern Zimbabwe for the prediction of weather and climate have been identified and documented. Both indigenous and conventional forecasting methods successfully predicted 2009/2010 rainfall season. The skills, knowledge and experiences that I gained through this research have enhanced my capacity in research, awareness raising and teaching. An appreciation of the value of IKSs in weather forecasting has been enhanced too. Secondary schools in the country should be visited for climate change awareness.

During my investigation of indigenous knowledge approaches to weather and climate prediction, it was found that local communities in Muroyi area rely much on indigenous forecasting as compared to conventional forecasting information offered by Zimbabwe's Meteorological Department. This of course, is the ideal situation. However, not all farmers, especially those in remote areas, have access to radios and other media communicating weather forecasts, let alone having the capacity to interpret them. This is where Agritex officers should come in to fill the gap, but the situation on the ground defies this logic. The Agritex officers are crippled by the department's lack of resources as a result of the economic challenges that Zimbabwe went through in the past decade. Others have even argued that some of the officers who are expected to be interpreting this information and assisting the farmers were half-backed in a fast-track training programme to fill the capacity void in the farming community, and they need re-skilling. Plant phenology and animal behaviour are widely used as local indicators for weather and climate prediction.

Conclusion

It is important to continue with research on weather forecasting, climate variability and change across Africa, particularly in Eastern and Southern Africa. A comprehensive assessment of other meteorological elements including rainfall intensity , sunshine hours and evaporation need to be performed. It is also equally important to continue with the investigation on Indigenous Knowledge in weather and climate prediction in Zimbabwe with the purpose of identifying and documenting all local environmental and astronomical indicators used. It is necessary to continue with climate change awareness to students and women..Most agricultural activities in communal areas are closely linked to the weather and communities often have a store of local weather and natural disaster knowledge. Local people relate the behaviour of plants and animals to the general features of the impending rain season. The abundance of the common wild fruits is usually linked to a good season. However, the problem arising from such interpretation is that information available to the people has been learnt through oral tradition and there are no corresponding historical records of crop yields in the area. It is true that the area has suffered some of the most crippling droughts in recent years just like any other part of Zimbabwe but there is no national programme that has actively involved the locals into drought disaster preparedness. The community depends on crisis management of droughts and floods that has been adopted in recent years by donors and the central government. The best option would be to integrate local wisdom into national plans so that off and on farm coping and survival strategies are put in place for the community. Such knowledge could be used in determining the timing of important agricultural activities and in predicting disasters.

The lower parts the communal area are to the rain shadow of the rainy Bikita Heights that it is possible that the peasant farmers are able to understand the general behaviour of the rain bearing winds for the area and the premise for fusing modern technology into these existing knowledge. However, the accuracy of this knowledge is doubted. Inaccuracies in facts are not only an inherent attribute of the complexity of traditional knowledge systems but in modern weather forecasting there are also errors of measurement and statistical computations. The generality of the people in Zimbabwe have been made to think that all droughts in the country are linked to the El Nino phenomena but scientific evidence points to the fact that not all droughts are linked to this weather organism. In most cases there is a scientific interpretation to traditional folklore and mottos used but there seems to be limited scientific interest in exploring the existing gaps. Perhaps it is a clash of value systems between the modernisation philosophy and the traditionalist value system that is denigrated and perceived as 'primitive.' Exploration into such value systems has the potential to unlock sustainable resource utilisation, weather forecast and changes in crop and land use management. Governmental and non-governmental effort can integrate this traditional store of knowledge in their programmes in order to improve agricultural productivity and minimise loss of life in times of disasters. The community based approach that taps into the existing ecological wisdom gives cause for optimism provided the similarities and differences in traditional systems and modern systems of weather forecasting are further explored and understood.

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