Climatic Changes, Erratic Rains and the Necessity of Constructing Water Infrastructure: Post 2000 Land Reform in Zimbabwe

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Abstract: The aim of this article is to explore ways of increasing agricultural productivity in Zimbabwe in the face of the increasingly uncertain climatic conditions. Agriculture has remained crucial to economic growth in Zimbabwe while it is mainly rain-fed. The total seasonal rainfall amounts are not indicating any significant trend (increasing or decreasing) with time. Changes are only noticed in the form of prolonged intra-season dry spells, increasing rainfall variability, increased frequency of storms and hail storms and poor distribution of rainfall in a season. The Meteorological Services Department of Zimbabwe also carries out cloud seeding to enhance rainfall in all rainfall seasons. This helps more in terms of amount than temporal distribution since only clouds with potential to give rain are seeded. It is argued in this article that in order to effectively support agriculture by reducing the effects of temporal distribution of rainfall on yield, irrigation could also be used to augment water supply. Projections are that run-off will be reduced in the southern provinces more than the north by 2080 while most of the countries’ water bodies are located in Masvingo which is a low rainfall area in the south. There are also dam construction projects such as the Tokwe Mukosi that have remained incomplete for a long time. This article also argues that critical assessment of whether the operational dams are adequately maintained is need. Completion of overdue dam projects, construction of others and maintenance of operational reservoirs could create space for the collection of water during wet episodes for use during prolonged dry periods of that rainy season and avoid water stress on agriculture. The article concludes agriculture is adversely impacted by climate change in the form of prolonged intra-season dry spells and offers recommendation that use of irrigation in all areas of the country should avert adverse impacts of water stress on agriculture in Zimbabwe.

Keywords: Climate, Rainfall, Land reform, Zimbabwe, climate variability, weather, dry spells.

Introduction

Meteorological disasters in Zimbabwe are mostly related to rainfall: either too much of it or erratic rainfall amounts. Besides rainfall amounts, distribution is also a key contributor to the disasters. Rainfall episodes separated by long periods of dryness can result in crop water stress and diminished state of ground vegetation including forage for livestock. Prolonged wet spells can on the other hand lead to increased chances of flooding and flash flooding and poor aeration in the soil which can affect nitrogen uptake of the plants. Of late, the country has been affected by heat waves; more pronounced in the 2011/12 and 2012/13 summer seasons. Due to climate change the intensity and severity of these hazards are expected to increase (Brown. et al., 2012; Roudier et al., 2011; Unganai, 1996) and hence their impacts on socio-economic development (Fleischer et al., 2011). The effects of climate change are expected to severely impact on economics of developing countries whose capacity to adapt is very low (Beg et al., 2002; Berrang-Ford et al., 2011; Mirza, 2003). The capacity of Zimbabwe to adapt quickly to climate change is low because most of the adaptation projects are very localized as a result of limited funding.

The economic growth is currently low after almost a decade of hyper-inflation such that the government has inadequate resources to fund climate change projects of a national scale. There are also other priorities such as health care which also demand resources from the meager national budget. Prolonged dry spells have led to reduced agricultural productivity especially in the South of Manicaland, Masvingo, and South of the Midlands and Matebeleland provinces of Zimbabwe (Ministry of Agriculture Zimbabwe, 2008, 2009, 2011, 2012). This has led to a number of interventions by the Government, development partners, NGOs and civil organizations channeled towards response and adaptation implying need for nationwide mitigation and adaption strategies instead of ‘fire fighting’. However, the other parts of the country are not spared of the impacts of adverse weather conditions attributable to climate change. Uncertainties in starting dates of rainfall seasons are affecting most parts of the country making decision making in agriculture and other sectors difficult. As an example in the 2012/13 agricultural season most areas reached the start of the traditional second half of the season (January) before receiving reliable rainfall amounts enough for farmers to start planting while it is not clear whether seasons have shifted yet. Recently, damages were recorded in different parts of the country from strong winds with or without rainfall. Among the suspected weather phenomena is that tornadoes could now be affecting Zimbabwe due to climate change. In 2010 buildings were destroyed, trees uprooted and other livelihoods lost due to strong winds in a phenomena suspected to be a tornado which swept across areas in the Mt Darwin District of Zimbabwe. In the 2012/13 rainfall season strong winds caused destruction in Mt. Darwin, Harare, Bindura and Masvingo among other affected areas. In other events lives were lost due to flooding while some people were struck by lightning in the 2012/13 summer season.

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Provision of climate services in Zimbabwe

The Meteorological Services Department of Zimbabwe (Meteorological Services., 2013) is the custodian of weather and climate data in the country. They also do analysis to enhance the understanding of the propagation of weather and climate in space and time. They are a member of the Civil Protection Unit whose mandate is to ensure effective management of disasters in the country. In the Civil Protection Unit they advise the nation on weather and climate issues especially on the provision of early warning ahead of extremes. They are also a member of the Agricultural Coordination Working Group with the role of advising on climate issues for the benefit of agricultural productivity in the country. Among the knowledge available are the short and long term measures of avoiding or ensuring that losses due to adverse weather are at their minimum. The products range from forecasts which serve as early warning means to response and preparedness strategies based on risk profiles and lessons from past and present experiences. The procedure is now to take the information from the office computer to the beneficiaries using other means than the ones currently in use. The idea could be to develop products which can be aired to users across the country even in the absence of personnel from the Meteorological Services Department of Zimbabwe at the site of dissemination but without distortion of the information to preserve the meaning and implications or else to adequately resource MSD so that they can reach out to the users such as small holder farmers. The Meteorological Services Department of Zimbabwe collaborates with partners who include government ministries and departments, development partners and private organizations. The advantage of collaborations is that some of the partners operate in parts of the country where the Meteorological Services Department has no access due to limited resources. They then play a crucial role of disseminating the information on behalf of the department. A good example is the role played by agricultural extension workers who reach out to communities in Zimbabwe even down to village level. If many avenues could be used to disseminate advisories on managing climate extremes, the ability of the citizens to respond and prepare for them should improve.

Uptake of weather and climate information by small holder farmers in Zimbabwe

Agriculture is mainly rain-fed in Zimbabwe (Brown., et al., 2012) and the provision of accurate rainfall information by the Meteorological Services Department is crucial to agricultural productivity in the country. The seasonal rainfall forecasts are used as an early warning tool produced with a lead time of at least 3 months such that it is important for the users to know their accuracy. Analysis done using data of the period from 2000 to 2010 showed that accuracy seasonal forecasts was above 55% for all areas and higher during the October to December (OND) season than the January to March (JFM) season. The high accuracy observed was found to be contrary to claims that the forecasts are unreliable causing their uptake by farmers to be very limited (Manatsa et al., 2012). Limited uptake is, therefore, attributable to limited access and knowledge of the science (Mushore, 2013; Patt, 2001) than to the accuracy of the forecasts. There are also cases where people opt to totally abstain from science based climate information and resort to indigenous knowledge (Corinne et al., 2010). There are cases where this has worked effectively but a combination of the techniques could give better results (Corinne, et al., 2010). In East Africa, IGAD Climate Prediction and Application Centre (IPCAC) has introduced production of consensus forecast which combines evidences from the science based approach with those from the indigenous knowledge to produce forecast for the seasonal rainfall. The other challenge to the climate science which may also hamper efforts to effectively adapt to climate change is the perception that information issued by climate experts is misleading and trust placed on experts of developed countries than local scientists. However, outreach and awareness activities play a major role in clearing these discrepancies. Climate experts have realized that when evidence is presented to communities in their backgrounds or targeted activities and agrees with what they experience in their areas, trust is built between the experts and the beneficiary community. This leads to demand of climate information by the communities and improvement in their adaptive capacity which is crucial to socio-economic development of the country. Small holder farmers mostly receive climate information through partners of the Meteorological Services Department and not directly which subjects it to difficulties in interpretation and distortion. The Meteorological Services Department can mostly reach up to Province level where they mostly meet with technical experts and not the communal farmers. The other dissemination avenues such as internet, print media and electronic media are hardly accessed by most communal farmers or at least their effectiveness has not yet been assessed. The other challenge is that the climate information is mainly issued in English instead of vernacular languages which small holder farmers can understand. Some meteorological terms are too technical and difficult of lay people to interpret. There are also terms such as ‘cyclone’ which even the climate experts find difficult to express in vernacular languages. Climate experts are encouraged to reach out to the farmers to train them as well as to train all partners involved in distributing the forecasts to the users such as the Agricultural extension officers. During the 16th Southern African Regional Climate Outlook Forum (SARCOF-16) a presentation by the Ministry of Agriculture revealed that even their extension officers had limitations in disseminating the climate information due to limited understanding of the science. In response to that, trainings of extension officers on the climate science were done across the country utilizing the climate experts from the Meteorological Services Department of Zimbabwe. These efforts will go a long way in helping small holder farmers in adapting to climate change impact because in order to adapt well they need to understand the science, believe the experts and draw as much information as is available from them. In view of projected increase in frequency of high impact weather, farmers need to be able to interpret climate information in order to avoid or minimize impacts of adverse weather. The other benefit is that they will be positioned to take advantage of conducive climatic conditions and maximize agricultural production through informed decision making. Production of climate information in Zimbabwe needs to be shifted from the current supply driven to become demand driven where farmers approach

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the Meteorological Services Department with proposals of how they can collaborate to enhance best practices in agriculture.

**Recent weather and climate related socio-economic losses in Zimbabwe**

Damages due to heavy rains accompanied with strong winds and hail were recorded in February 2013 in Bindura in the Mashonaland Central Province of Zimbabwe. Big trees were uprooted with some falling on and damaging buildings (Figure 1a). Crops were broken by the strong winds and heavy rains (Figure 1b) while in some places leaves were torn by hailstones. Damages to buildings were also observed and in most of the cases walls fell (Figure 1c) and roof tops were removed. A school (Figure 1d) and a church in the area were among the damaged buildings.

![Figure 1: Damages due to storm in Bindura (Photos obtained during field visit by MSD staff)](image)

During the same season (2012/13) damages due to strong winds were also recorded in Chivi area in the Masvingo Province of Zimbabwe. There was a convective cloud and very high temperatures had been recorded in the area prior to the event implying a lot of energy in the atmosphere. Building and property were destroyed in the event (Figure 2a). Roof top was removed from the building and the metal sheets needed replacement (Figure 2d) while the winds also broke a tree (Figure 2c). The strong winds were not associated with any significant rainfall or hail. The place was actually dry for it had by then not yet received any meaningful rains. The affected communities had not yet started planted due to dryness although it was already end of December (half way through the season). They had just dug holes waiting for the first rains to enable them to start planting and guarantee germination.
The examples above (Figure 2) are of damages due to storms and in two areas in Zimbabwe only. However, extreme events were also recorded in other areas and other than storms as these included flooding (Sabi Valley), delayed onset of rains, lightning among others. This clearly indicates the importance of reaching out to the public by any useful means possible to raise their awareness on climate extremes as well as ways of avoiding or minimizing socio-economic losses associated with them. The MSD has not yet decentralized some of its activities implying need for stakeholder thematic networks (Ziervogel & Downing, 2004) by which the information can reach the wide spectrum of climate data users especially the rural and remote communities. The MSD also need to be financed enough to carry out outreach and awareness activities.

Figure 3: Crop water satisfaction for the 2011-12 summer season in Zimbabwe.

Figure 3 shows the Geo-Spatial Water Requirement Satisfaction Index (Geo-WRSI) map for the 2011-12 rainfall season in Zimbabwe (Ministry of Agriculture Zimbabwe, 2012). This was computed at the end of season therefore showing the extent to which the water requirements of the crops were satisfied and including the effect of distribution. Prolonged dry spells caused crop water stress in the
southern provinces of the country. Prolonged intra-season dry spells have lately become a major cause of agricultural losses in Zimbabwe (Ministry of Agriculture Zimbabwe, 2008, 2009, 2011, 2012). The extent of the damages and losses as well as projections indicate the importance of coming up with strategies to increase the adaptive capacity of the nation (Brown., et al., 2012; Mirza, 2003; Najam et al., 2003).

**Time series analysis of rainfall in Zimbabwe: Is the annual rainfall decreasing with time?**

Although current trends are not yet clearly showing that (Mazvimavi, 2010), rainfall is projected to decline with time in Zimbabwe (Brown., et al., 2012; Unganai, 1996). Naturally no climate events are, unless by mere coincidence, equally the same and this variability is indicated by fluctuations of the dotted line in figure 4. In order to separate variability from climate change, there should be a statistically significant trend observed within the variability to define a change. The time series analysis (Figure 4) depicts climate variability without showing significant properties of change in seasonal rainfall amounts received in Zimbabwe. Mazvimavi (2010) also showed that rainfall totals in Zimbabwe are not changing significantly except for a few places and extreme events such as rainfall intensity and prolonged dry spells and rainfall projections have remained uncertain (Roudier, et al., 2011). The amount of water available annually is adequate to support traditional agricultural activities in all the areas of Zimbabwe. Agriculture in Israel is successfully sustained by average annual rainfall amount of less than 400mm while Zimbabwe receives an average of 600mm annually. There are inadequate irrigation infrastructures to collect water or channel it towards use in agriculture at a national scale. Where dams are available only a few, mostly commercial farmers, can use them to support agriculture.

![Figure 4: Time series analysis of rainfall in Zimbabwe](image)

The fact that seasonal rainfall is not changing while cases of yield reduction due to water stress are increasing appears like a myth. Water supply in the form of seasonal rainfall seems to have remained ‘unchanged’ but yield reduction being due to stress caused by poor distribution of the seasonal rainfall coupled with high evapotranspiration rates due to rises in temperature (Brown., et al., 2012). Participation of the government, the private sector and foreign partners in establishing in availing resources for dam construction projects and development of irrigation infrastructure will help in speeding up the adaptation process and increase agricultural productivity.

**Curbing agricultural loss due to poor rainfall distribution**

Crop growth is in stages whose water requirements differ and the failure to supply the needed water may lead to stress and crop failure or reduce tonnage at the end of the season. The impacts are worse if the crops are strained during the flowering and reproduction stages. Given that the total amounts falling in a season have not changed significantly (Figure 4) (Mazvimavi, 2010), efforts should target at relieving the adverse impacts of mainly temporal distribution of the rainfall coupled with high evaporation in any season. Farmers exhaust less costly techniques before they implement new technologies (Fleischer, et al., 2011). Continued loss due to rainfall distribution implies their techniques need to be enhanced by a mix of options most of which require funds and government or private sector support. This can be done by ensuring that most of the run-off is channeled to reservoirs, and that the number of reservoirs is increased and fairly distributed across the country. The intercepted water should then be channeled to agriculture to irrigate the fields whenever the dry spells prolong and there is a forecast for further prolonging. This implies close cooperation between the climates experts, the...
experts in water management and the beneficiary communities. Dam construction projects such as the Tokwe Mukosi need to be speeded up to add to the number of potential sources of water for agriculture. The operational dams need to be maintained through efforts which include protection against siltation and pollution and ensuring that the walls and banks are in good state. Removal of silt in heavily silted dams will also increase the volume of water that they can carry and increase volumes of water potentially available for agriculture and other uses as water demand of these is projected to increase (Wei et al., 2009). Projections are that run-off will decrease due to high evaporation in the southern parts of the country and there will be a reduction in areas suitable for maize production (Brown., et al., 2012). This implies need to construct more dams across the country. Redistribution of the water resources should be done to minimize migration of people and reduction in agricultural yield. If only a minority have access to water infrastructure then only a small proportion of arable land will be productive thereby reducing the contribution of agriculture to national growth.

**Recommendations**

This article recommends completion of overdue dams, construction of other water infrastructure fairly across Zimbabwe and establishment of irrigation infrastructure to support agriculture. It also recommend other water harvesting techniques and soil moisture conservation during the farming season should be promoted.

**Conclusion**

The total seasonal rainfall amount in Zimbabwe has not yet shown significant decreasing trend with time. The major meteorological factor affecting rain-fed agriculture is temporal distribution of rainfall with prolonged intra-season dry spells resulting in crop water stress mostly in the southern provinces of the country. The operational water reservoirs in the country need to be adequately maintained while dam construction projects need to be speeded up and enhanced as a strategy to curb impacts of poor temporal distribution of rainfall in the country. This increases the capacity to store water during wet spells and use it when dry periods intend to prolong during a rainy season to avoid water stress on agricultural productivity.

**References**


