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Anthropogenic flash floods and climate change in rural Zimbabwe: impacts and options for adaptation

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Abstract. Zimbabwe has been affected by numerous floods-related disasters in the recent past. These disasters often left rural communities in difficult socioeconomic situations. Floods are among the major water-related hazards and natural disasters worldwide. They are associated with excess rainfall, resulting in river overflow due to climate change . Developing countries constitute a large number of losses caused by water hazards. Thereby, in these countries, the vulnerabilities of households that depend on rain fed agriculture and livestock production for their livelihoods increases. This review paper seeks to establish the association between anthropogenic flash floods and climate change and unearth the impacts; vulnerabilities and adaptation options associated with anthropogenic flash floods in rural Zimbabwe. The study found that numerous anthropogenic activities perpetuate an increase in flood risk. These include littering, river or dam regulation measures, intensified land use and emissions of greenhouse gases, which subsequently result in global climate change. The impacts of flash floods established in the study include drought, food insecurity, displacements, malnutrition and severe effects on subsistence economy. The study concluded that even though most rural communities in Zimbabwe are vulnerable to the effects of floods, they have devised numerous diverse adaptation strategies to cope with the changes in the environment.

Keywords. Adaptation, Climate change, Flash Floods, Rural Zimbabwe, Subsistence economy

1. Introduction

Natural hazards occur in all parts of the world,however, there is a huge variation on distribution in terms of time and space. The occurrence of natural disasters is associated with severe disasters. Cerulli et al. (2020) argue that the uneven distribution of population exposes citizens in some countries to natural hazards more than citizens in others. As such, variety awareness levels differ in accordance with location. Moreover, there is also need for an increase on hazard awareness in order to reduce negative impacts of natural disasters (Ribeiro et al., 2020). This is because when people are aware of risks that they are confronted with, they will be in a position to seek measure to reduce potential losses. Natural hazards come in two broad categories that are namely; tectonic and weather hazards. The types of hazards that fall under these broad categories include drought, flood, tropical cyclone, sea level rise, dust storm, thunderstorm, tornado, forest or wildland fire, heavy rain, strong wind, volcanic eruption, earthquake and tsunami (Cerulli et al., 2020).

This study seeks, generally, to reveal the association between anthropogenic flash floods and climate change[1]. Specifically, the study also seeks to unearth the socio-economic impacts,

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vulnerabilities and adaptation options associated with anthropogenic flash floods.[2] Gholami et al. (2009) refers to anthropogenic activities as all causes of climate change that have human related. The authors provided a correlation between an increase in human population and the rise in illegal and incorrect use of natural resources. Moreover, apart from incorrect use, overpopulation also informs the need for human expansion which results in deforestation for the purpose of agriculture and human settlement. Zimbabwe has experienced numerous flood related hazards in the recent past. This study therefore seeks to ascertain whether the causes of the floods were anthropogenic or natural[3].

2. Background information

Climate change impacts are remarkable around the world and they are widely noticed in the developing world (IPCC, 2013). More than a decade ago, UNFCCC (2007) reported that Africa has been found to be the most affected continent in the world and the level of vulnerability to climate hazards is intriguing. The reason for this is that the continent accommodates areas that have climates that are among the most variable in the world in terms of seasonal time scales. This consequently results in a situation where floods and droughts can correspondingly occur in the same area during the same period (IPCC, 2007). Due to the constant shifts in weather conditions which result in low harvests by farmers in rural communities there is anticipated severe challenges and threats to livelihoods. Consequently, it has been reported that due to floods resulting from climate change, food and water shortages are common phenomenon throughout most of Africa, whereas desertification is expected to remain a major threat in arid and semi-arid regions (Christensen et al. 2007). These consequences of climate change are a sign that there is need for sustainable methods to be employed in order to adapt to the effects of the phenomenon of climate change.

Returning to the focus of this article, in the recent past, Zimbabwe has experienced numerous flood disasters, particularly during 2016-2017 Zimbabwe floods and during 2019 where Tropical Cyclone Idai hit the eastern part of Zimbabwe along the border with Mozambique. The impact of the floods has always been severe in rural communities where there is no infrastructure and the economy is largely subsistence. Floods are a result of excess rainfall, river overflow, climate change and human activities (UN-WATER 2005). As a result of unpredictable climate change variabilities, water hazards tend to pose more threat to communities in future. This is because it is widely believed that the magnitude and frequency of floods is on the verge of increase in the 21st century due to changes in mean or variability of climate change (IPCC (2001a). A large number of all losses caused by flood related hazards occur in the developing countries (World Bank, 2000).

Further, it is also widely known that floods are the most recurrent and prevalent disaster in the world. They result in devastating effects on the lives of millions of people, their properties as well as infrastructure and the natural environment (Salami, Von Meding & Giggins 2017). Therefore, households that depend on rain fed agriculture and livestock production are at increasing risk and vulnerability. Just to paint a picture on the continent about the devastating effects of climate change in Africa. The El Niño-related flood in East Africa destroyed infrastructure and property worth about US$1.8 billion between 1997 and 1998 in Kenya (Dey & Singh 2006). Fabiyi and Oloukoi (2013) assert that there is a frequent occurrence of floods in the Nigerian rural coastlines due to ocean surges. The floods are also witnessed in instances where there is an overflow in the network of river systems and creeks towards the Atlantic Ocean. The floods have been reported to have serious effects on the livelihoods of coastal settlements and the affected communities employ indigenous approaches to adapt to the impacts of the floods.

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In Zimbabwe, the damages that resulted from floods have enabled communities to come up with various coping indigenous strategies as a means to sustain livelihoods. Rahmato (1991) pointed out that in the developing world, rural communities employ local knowledge to reduce damage caused by floods. The most common weather hazards experienced in Zimbabwe include tropical cyclones, which cause intense rainfall of approximately more than 100 mm in 24 hours and thunderstorms sometimes leading to hailstorms, floods and flash flooding (Brazier et al., 2015). To that end, the socio-economic impacts of floods namely declining harvests, displacements, damage to infrastructure and spread of disease among others have resulted in the crafting of diverse coping strategies by the community. Balgah et al. (2015) examined the social impacts of the disaster by assessing the value of loss in terms of socially important variables such as human lives and books. As a result, since floods frequently leave communities vulnerable, it is the core aim of this study to assess the socio-economic impacts of floods in rural Zimbabwe.

2.1 Floods in Rural Zimbabwe

The incidence of floods has become a common phenomenon in rural Zimbabwe. Most rural communities in Zimbabwe have at one point been severely affected by floods and its aftermath. In the year 2000, Tropical Cyclone Eline caused flooding in the Zambezi Basin and killed 700 people, left more than 500,000 homeless and destroyed infrastructure worth $1 billion (Gwimbi 2009). Again, in March 2003, Tropical Cyclone Japhet caused flooding in Guruve and Muzarabani districts in the Zambezi basin (Madamombe 2004). It is important to note that vulnerability to floods is due to numerous factors that include the location of homes in floodplains among other factors (Gwimbi 2009). The lower Zambezi is more vulnerable to floods and the word Muzarabani means “flood plain” in the Shona language (Madamombe 2004). In the recent past Zimbabwe has witnessed severe floods that are worth noting.

The most common flood related disasters in recent memory were witnessed in Tokwe Mukosi, Masvingo, Tsholotsho and Kanyemba Mbire District. Of interest is the 2017 tropical storm Dineo and 2019 Cyclone Idai, which left many homeless and helpless in some parts of the country. The Tokwe Mukosi floods occurred in February 2014 after the torrential rainfall pounded in the Masvingo Province. The flooding left over 1 500 families homeless. As a result of that, more than 3,000 families in Zimbabwe's south-eastern Masvingo Province were forcibly resettled to small plots of undeveloped land. Due to forced climate change induced relocation, people faced numerous hardships which included a lack of adequate food, shelter, health and education facilities. The families stayed in Chingwizi transit camp since torrential rains in early 2014 caused water levels in the catchment area of the partially constructed Tokwe-Mukosi dam to reach dangerously high levels and the affected villages were relocated.

Over 800 people in the Siphepha, Tsholotsho district were serious affected by the tropical storm Dineo in 2017. Due to the floods, community members were displaced and subsequently evacuated. Thobega (2017) revealed that Tsholotsho District was one of the most affected places due to the fact that many families lost their homes to flooding or excessive moisture. Masvingo province also significantly suffered from the floods. The province received 223mm of rainfall in February 2017 and it caused unfathomable damage of greater magnitude to the human livelihood. Thobega (2017) revealed that the incidence broke a 100-year record in Zimbabwe and left most districts in the southern parts of the country battling with floods. It was confirmed by the Ministry of Environment, Water and Climate that Rupike in Masvingo received 223mm of rainfall within 24 hours and Bikita received 169mm and Zaka 149mm. As a result, the floods were severe and many households were left homeless (Pindula News 2017). The aftermath of these excessive rainfall, left people, particularly those who are living below

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$10 a day to experience feelings of helplessness and frustrations, hoping that those who have will assist them.

The major effect that the floods posed on communities in the affected areas is social vulnerability. Tellman et al. (2020) emphasise the importance of social vulnerability research in disaster prone areas. The argument by the authors was that social vulnerability research originates from risk hazard that exposes people or places to environmental threats. This threat consequently has effects on the livelihoods of communities. Moreover, Tellman et al. (2020) also advocate for place-based assessments of vulnerability. This is largely because vulnerability assessments determines coping capacity of a given community. For instance in this paper, the cases used i.e. Tokwe Mukosi, Masvingo, Tsholotsho and Kanyemba Mbire District are unique in their own ways such that the coping capacities are also unique.

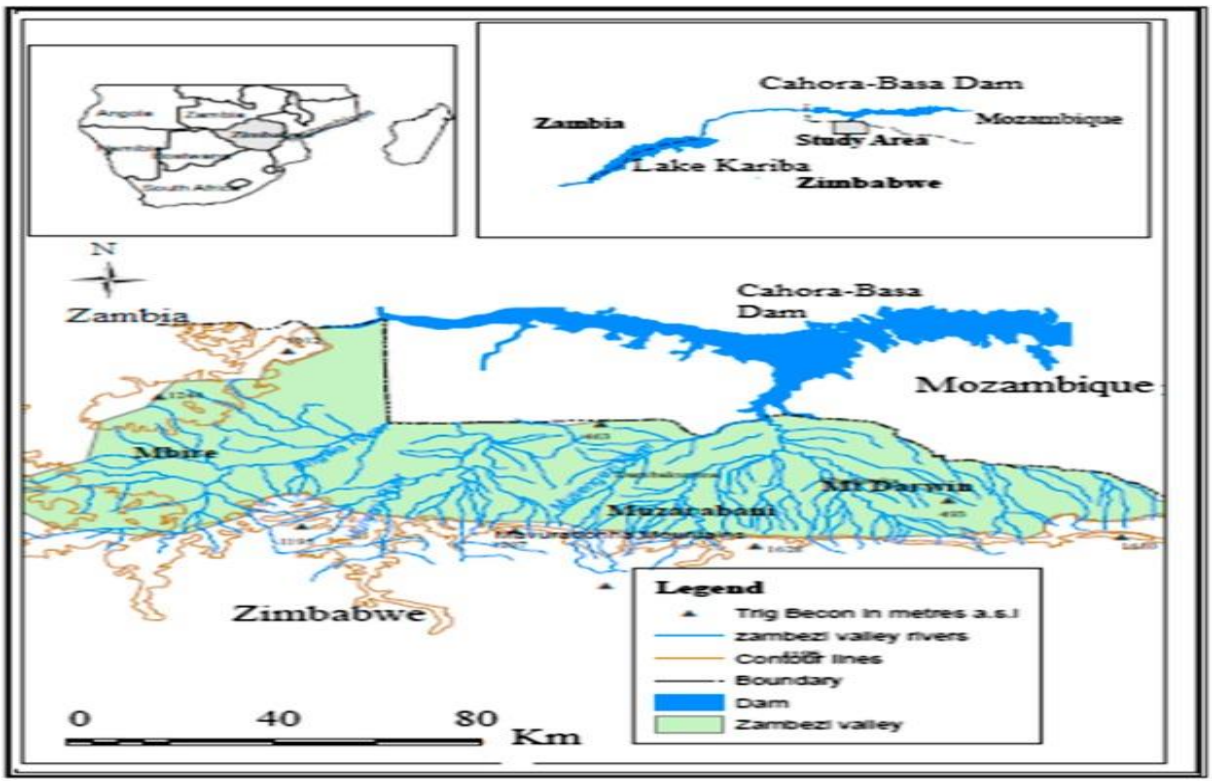

Figure 1: Location of Cahora Basa Lake
Source: Adapted from Mavhura, Manyena and Collins (2017)

Bosongo (2011) found that floods have frequently occurred in Kanyemba Mbire District of Zimbabwe in the recent two decades. Apart from the floods of 2010, the community has also been affected by other incidents of flooding in 1982, 1988, 1993, 1996 and 2007. The major factors that were identified as the cause of floods in Kanyemba are as follows; Firstly, the 1996 and 2010 floods occurred around March at a time when Cahora Bassa Lake reached its highest level (*See. Figure 1*) and this was combined with local rainfall. Secondly, when the Kariba dam rises, water is released from the dam and the backflow from Cahora Bassa increase substantially. Lastly, it can be noted that Mwanzamutanda river could not discharge water into the Zambezi river and water begins to accumulate at the confluence of Mwanzamutanda and Zambezi leading to flooding in the area. It can there, be attributed to poor regulations by relevant authorities regarding river and/or dam overflowing so as to obviate disasters which can befell vulnerable communities.

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3. Effects of floods

3.1 Social effects

The floods that rural Zimbabwe has experienced in the recent past imposed numerous social effects on communities. Social and economic impacts as a result of floods are intrinsically intertwined and negatively impact on the social fabric of the community and well-being of the individuals, families and communities. In this paper, four major social and economic effects that result from floods are discussed. These are displacements, malnutrition, food shortages and disease.

3.1.1 Displacements

The current study has discovered that in every community where floods occurred, people were displaced. In most instances, the concerned stakeholders such as NGOs, government and churches would provide humanitarian support in the form of temporary shelter, food parcels and in extreme circumstances, health promotion services. For example, in Tokwe Mukosi around 4,500 villagers living along the flood basin of the dam were evacuated after the floods and an estimated 2,500 households who lived upstream of the Dam were displaced to Chingwizi, Chisase and Masangula Relocation sites of Nuanetsi Ranch in Mwenezi District (Sachiti, 2014). Displacements as a result of natural disasters particularly floods are common worldwide. The United Nations University Institute for Environment and Human Security (UNU–EHS) reported in 2005 that there were more than 20 million "environmental refugees" worldwide and they doubled the number of those displaced by war and political repression combined (Myers, 2005).

A study by Rabalao (2010) on social, psychological and economic impact of flooding in the North West province of South Africa discovered that one of the serious challenges faced by flooding communities is displacements and its concomitant effects. The practice of offering support to affected families by the mentioned stakeholders is in line with the sustainable livelihoods approach. For example, the approach emphasizes that a livelihood is sustainable if it can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for future generations (Chambers & Conway, 1992). Hence, receiving support after displacements was a positive development towards recovering from the shock of the disaster. However, political interferences during such crises situation complicate the smooth humanitarian aid extended to displaced people.

Furthermore, Rabalao (2010) asserted that flood victims face numerous social, psychological and economic challenges. These include relocation and in most cases people who are relocated feel alienated and often could not get nutritious food because of displacement from their villages. They are also exposed to Post-traumatic Stress Disorder and other psychological pathologies. Their means of survival due to these floods are eroded and abject poverty becomes highly visible. On the same wavelength and in agreement, Mwape (2009 p11) asserts that Zambia "suffered floods for three (3) consecutive rainfall seasons namely; 2005/06, 2006/07 and 2007/08. The 2007/08 season has been described by the community as the worst in terms of the amount of rainfall received and level of impact." The floods resulted in the displacement of people from their homes and this imposed numerous impacts on infrastructure, crops, health, education, environment as well as damage to property. Moreover, various scholars have established that flood fatality differs depending on socio-economic class or location of individuals (Abbas;2014; Rufat, 2015; Tellman et al. 2020). Individuals who are considered to be at high risk of flood Afatality in lower income countries are females and the poor (Tellman et al. 2020).

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3.1.2 Food Shortages and malnutrition

Communities that are affected by floods depend largely on aid because during floods food storages and gardens or farmlands are destroyed. However, the food that they receive from aid is often not enough or sufficient for all. In Tokwe Mukosi it was reported that flood victims were often affected by food shortages just like in other areas that were affected by floods. The major reason for this as indicated by Sachiti (2014) was that the government and the donor community were failing to avail an average of 123 tonnes of maize required monthly to feed them. Rather, the families each initially received 500g dried beans, 2 kg flour; 2 kg sugar; 2 litres cooking oil; 500g salt; a packet of candles, 1 kg kapenta. The food was supposed to last them a week but could not because of the number of family members. In support of this finding, IRIN (2008) asserts that in 2008, many people were affected after floods submerged hundreds of hectares of farmland in the north-eastern region of Zambia.

The farmland which supported some 1,200 families had their livelihoods and food security disrupted. Due to the fact that floods possible leads to displacement, people have lost their valuables including their nutritious foods. Therefore, malnutrition is another challenge that is faced by communities after experiencing floods. In all the communities mentioned in this study namely Tokwe Mukosi, Tsholotsho and Kanyemba Mbire district cases of malnutrition were recorded (Bosongo, 2011; Sachiti, 2014) The major cause is that due to displacements families rely on handouts from well-wishers and in most cases the food that they receive is neither sufficient nor healthy. It is just food needed for survival. In support of this finding, United Nations Framework Convention on Climate Change [UNFCCC] (n.d.) asserts that increases in tropical cyclones, flooding, and drought are likely to have numerous effects on human health which include drowning, injuries, increased disease transmission and subsequent malnutrition.

3.1.3 Diseases

Outbreak of disease including water-borne diseases are some of the major effects of floods. In flood-affected areas, people are relocated to temporary homes, which are usually in form of tents, and they live as a community. Due to overcrowding and sometimes lack of sufficient water and toilets diarrhoea and water borne diseases are prone to affect the community. Sibanda (2014) asserts that in Tokwe Mukosi as in other flood affected areas the place was overcrowded and unhygienic as well as punctuated with a lack of sanitary wear, drinking water and proper toilets. Mwape (2009) asserts that floods that affected Zambia in 2008 saw numerous cases of diarrhoea, cholera and other diseases, which increased remarkably during and after floods. In support of that, Mwape (2009, 38) posited that "In the long-term, affected areas had to deal with the spread of infections and water borne diseases, cholera, dysentery and diarrhoea which increased the need for safe drinking water and the provision of water purification tablets" Apparently, floods breeds unpalatable results to the human livelihoods.

3.2 Economic Effects

Numerous economic impacts are witnessed in communities that are affected by floods. According to Investorwords (2017) economic effect refers to,

"The effect that an event, policy change, or market trend will have on economic factors such as interest rates, consumer confidence, stock market activity or unemployment. Events such as regulatory change, supply shortages or natural disasters can have a significant economic impact due to the way they affect business activities". (p.1).

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Property damage that result from floods constitute an important form of economic loss. It forms a significant component of total economic loss in flood prone communities. Other economic impacts that were established in this study are job loss, damage of crops, costs of relocation and migration.

3.2.1 Erosion of source of income and Unemployment

Excessive rains lead to displacement, people losing their means of survival and possible unemployment as available industries, factories and commercial farms are affected. The current study found that unemployment is one of the major economic effects of floods in rural communities. Bola, Mabiza, Goldin, Kujinga, Nhapi, Makururira and Mashauri (2014) assert that agriculture accounts for about 70 per cent of employment in Kanyemba Mbire district. This is because of the prevalence of manual jobs such as farming in rural communities. Hence, the major challenge of such jobs is that in the event of floods, fields are destroyed and farmers are left without employment. In support of this the Environment Agency Flood and Coastal Erosion Risk Management Programme [EAFCERMP] (2005) asserts that there is significantly more self-employment in rural than urban areas, hence, impacts on employment could be significant in some rural areas. Du Plessis (1988:11) asserts that in South Africa, "the farming sector had been particularly hit by the successive floods of 1983, 1984 and 1985. Various farming products had to be imported to supply the domestic market". As a result, in certain areas, farmers obtained no income and inevitably built up debt. The dwindling income of farmers meant that they had invested less in farming implements, reduced their sowing and purchased less fertilizer. This implies that many farmworkers were left unemployed. Hasan and Zaidi (2012) assert that Pakistan's economy struggled hard to regain steadiness and stability since enduring floods in 2007 to 2008. The extra ordinary negative economic fallout is expected to have brought about substantial unemployment issues.

3.2.2 Agriculture production

Floods have a grave economic effect on agriculture. Since agriculture forms the backborn of subsistence economy it means that if it is affected by floods the community is at risk. In Kanyemba Mbire district households have adopted different livelihood activities. Some of the adaptation measure that were employed by households include adopting rain-fed farming in the uplands and engaging in flood recession agriculture. In Kanyemba Mbire district, a majority of households had two fields in the flood plain where they grow maize and groundnut, and one field in upland where they grew mostly groundnut and sorghum. This was their preferable method of adaptation to the effects of floods (Bosongo, 2011).

4. Adaptation to the changing environment

4.1 During disaster/event Strategies

Floods expose communities to various socio-economic challenges. Therefore, the post flood period requires sustainable adaptation measures for communities to get back to their feet. Adaptation to the changing environment due to floods takes two forms. These are residents adapt through the ability to move forward after numerous disturbances to their normal lifestyle. This talks to their resolve to be resilient in the face of disaster. Second, the other way through which residents adapt is availability of humanitarian support from business, NGOs and the government. Davies (1993) defined coping mechanisms as the way in which people act within the limits of existing resources and range of expectations in order to achieve various ends. Coping strategies for the management of extreme events such as floods are usually transmitted from generation to generation in different communities and households (Devereux 1997).

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Crafting coping strategies is important because disasters follow a common pattern and people's earlier actions can significantly be used as reasonable guide to withstand the impact of subsequent events (Kelly 2001). It has been established that there is no direct correlation between the occurrences of extreme events such as floods coping methods that are executed by various groups of people within their socio-cultural contexts (Bantilan 2002). There are numerous categories of adaptation measures which include post event strategies, recovery strategies and destitution or migration. The study identified the three because they suit immensely well in a rural setting.

4.2 Post disaster/event strategies

These are the mechanisms put into practice to address the immediate needs of the family. These include provision of food and shelter, which victims cannot survive without. On psychosocial level, social support undergird by the philosophy of Ubuntu makes it possible to pull through. One of the tenant of Ubuntu is sharing and this what Africans believe and binds them together. For example, Sibanda (2014) asserts that victims of floods in Tokwe-Mukosi received a $1million grant donated by the Japanese government. The fund was donated to assist the families that were grappling with food shortages, water and sanitation facilities.

4.3 Recovery strategies

Recovery strategies ensure temporary or permanent reconstruction and rehabilitation. Grounded in their resolve to be resilient against all odds, social support enables people to rebuild their lives. For example, in Tokwe Mukosi, thousands of school children at the four schools build by government for the flood victims were also battling a shortage of textbooks and other learning materials. However, schoolchildren received learning materials such as textbooks and exercise books from the Japanese grant and the development improved the morale amongst the families (Sachiti, 2011).

4.4 Migration

Torrential rains in low-lying areas leave government with no option but to forcefully relocate people to more habitable areas. The other way in which communities adapt to the changing environment is by relocating to unaffected communities. Migration is in two ways namely one, individuals might decide to relocate or two, responsible authorities such as the government may relocate affected individuals to location they deem safe. For example, Pindula news (2017) asserts that during the 2017 tropical storm Dineo in communities in the confluence of Tugwi and Mushandike rivers of Masvingo victims of floods were rescued and relocated to areas that were not affected

5. Concluding remarks

The study has established that a combination of anthropogenic and natural causes are responsible for the floods presented in the study. The study has established that the ability of rural communities to adapt to the shocks of floods either through their indigenous practices or support from concerned stakeholders has always provided them with a spring board from which to leap forward. The socio-economic vulnerability presented in this study include high rate of crop production failure, unemployment, food shortages, malnutrition and disease. In response to these challenges, households have adopted a number of mechanisms to address floods vulnerability. In addition, various stakeholders such as government and NGOs intervene in flood situations to help communities cope with the floods. This kind of interference has been

witnessed in Tokwe Mukosi, Tsholotsho and Kanyemba Mbire district which were used as case studies.

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