APPROPRIATENESS OF EARLY WARNING SYSTEMS IN THE MANAGEMENT OF CLIMATE CHANGE IMPACTS IN MT. ELGON REGION IN EASTERN UGANDA

MAGOLO JOHN FAITH

2013/PhD/070

SUPERVISORS:

1. **REV. FR. DR. OBUDUKER PICHO EPIPHANY**
2. **PROF. BENON C. BASHEKA**

A PhD PROPOSAL SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A DOCTOR OF PHILOSOPHY IN DEVELOPMENT STUDIES OF MBARARA UNIVERSITY OF SCIENCE AND TECHNOLOGY

November 2014

CHAPTER ONE:

INTRODUCTION

1.1 Introduction

This study seeks to analyse the appropriateness of the Early Warning Systems (EWS) in the management of Climate change impacts in Uganda. The appropriateness of the EWS in this study is conceived as an independent variable while the management of Climate Change impacts is the dependent variable. The EWS shall be measured in terms of risk knowledge among the study population, availability of technical monitoring, and communication about the risk and the response capabilities of the concerned population (UNISDR, 2009).

The management of the impacts of Climate change calls for appropriate actions through Mitigation, preparedness, Relief assistance, and reconstruction. Thus, the study shall seek to establish the existence of the Plans for managing climate changes; community efforts to organize in preparation for climate changes, capacity to influence the implementation of activities to mitigate the impact of climate change and ability to control emergency activities for community recovery and reconstruction. The impacts of climate change shall refer to droughts, desertification, floods, soils erosion and all other climate change induced disasters and landslides that have rocked the globe and more so the population under study (Summers, 2009). The focus of this study shall be on the disasters that are frequent within the geographical scope of the study and shall seek to understand how both the independent and dependent variables interface and how these have acerbated or reduced risk.

This introductory chapter unravels the background to the study where the historical, theoretical fundamental concepts as well as the context of the study are discussed. The historical is handled under global, African and Ugandan perspective. The chapter then states the problem, the purpose of the study, the objectives, research questions and hypotheses. It then covers the significance, scope of the study; justification and gives some operational definition of key terms as they will be used in the study.

1.2.1 Historical Background to the Study

Globally, climate change is the leading human and environmental Challenge of the 21st Century (IPCC 2012). Every year, disasters related to climate hazards cause significant loss of life and property rolling back social and economic development for decades. Similarly, global predictions of extreme weather conditions (Summers, 2009; IPCC, 2012) is likely to lead to extreme events hence greater impact on sectors with closer links to climate such as water, health, agriculture and food security. In 2004, the Tsunami killed over 200,000 people (De jin& Lin, 2010) and this led to an economic loss in billions of dollars in 12 countries around the Indian Ocean.

In 2011, 138 people died in Arizona due to deep heat (Climate and Development Knowledge Network, 2012) and 40,000 wild fires torched thousands of acres of farmland in the United States (Prud'Homme, 2011). From the 1980s till 2012, 8,866 natural disasters have been recorded globally, with a loss of over 4 million lives (ISDR, 2009; Climate and Development Knowledge Network, 2012), with 78% accruing from the changing climate patterns (IPCC, 2012).

The early-warning idea was originally conceptualized in the 1950s' by military and Governmental agencies in order to identify and offset national security threats (Hedin & Kovero, 2006). During the Cold War of the 1960s, the Soviet Union and the United States deployed sophisticated systems and gave them prominent roles in providing early warning of ballistic missile attacks before they reach their targets (Podvig, 2002). However, the systems, suffered a setback in terms of relevance due to high maintenance cost and reliability issues related to false alarms (Saad et al, 2013; Podvig, 2002).

In spite of the above expressed limitations of a system as a military strategy, the EWS has been adopted in different fields and is very contextual in application. Today, early warning systems are found in the fields of business (Cargata, 1999) for a systematized business control in handling external and internal risks (Hedin & Kovero, 2006; Gaytán & Johnson, 2002), disease control (Bellomo, 2012; Georgaka, Mparmparousi & Vitos, 2012), environmental science (Baxter, 2000) and disaster management (ISDR, 2008; IPCC, 2007). The concept has however been re-discovered after a series of disasters and crises rocking the globe leading to loss of life and property. EWS is being used in all these fields to mean the provision of information on an emerging dangerous circumstance to induce response that minimises disaster (ISDR, 2008; Saad et al, 2013).

Through history disasters have destroyed lives and livelihoods, killing people and damaging homes and businesses (UNEP, 2012). Disasters in the past 35 years have taken an estimated 2.5 million lives and cost more than US$1.5 billion, mainly in developing countries (Pearson, 2012).

Due to this negative impact, EWS has received global attention as a critical value for disaster risk reduction (EWC, 1998; Baxter, 2000; UNEP, 2012).

Globally, many lives would have been saved if there was an effective Early Warning System to alert those at risk (De jin & Lin, 2010; HFA, 2005; Thomalla & Larsen, 2011) during a disaster. EWS are monitoring devises designed to avoid or minimise the impact imposed by a threat on life, property, environment or livelihoods (Cetina & Nadime, 2008; Intrieri, *et al*., 2012). The United Nations International Strategy for Disaster Reduction (UNISDR) defines EWS as a set of capacities needed to generate timely and meaningful warning information to enable individuals, communities and organisations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of loss or harm (UNISDR, 2009). Some of the most popular global systems are the Tsunami EWS, the Earthquake EWS and the Fire EWS (Bartosz, *et al*., 2011).

The United States experiences a variety of natural disasters throughout the year, particularly the hurricanes on the pacific, Atlantic and the Gulf of Mexico coast (McMillan, 1998). McMillan further asserts that the United States as a result suffers approximately $1billion in losses per week (McMillan, 1998). In response to these experiences, the States have embraced the EWS to minimize risk as well as provision of development plans, generate communication and medical resources, and aid in rehabilitation and post-disaster reconstruction (Toomey & Kennedy, 2011). Anheuser-Busch a linker company invested $15 million to guard the facility against the earth quake. In 1994, an earthquake whose epicentre was 12 miles away from the facility hit, however because of the prevention the company took, it saved an estimated $300 million in damages (McMillan, 1998).

In 2004, the Indian Ocean tsunami focused the World's attention on EWS because there was no such a system in place that bound global states into action (Thomalla & Larsen, 2010; IRC, 2009). This attention led to the adoption of the Hugo Framework for Action (HFA) 2005-2015 (Thomalla, 2010) which recognizes early warning as an effective tool to save lives, reduce vulnerability and to improve preparedness and response to hazards. The action therefore binds all the states that subscribes to the United Nations to reduce disaster risks that are enhanced aggravated poverty, environmental degradation and weak institutional capacities (UN, 2006)

The Germany-Indonesian Tsunami EWS project after the 2004 Tsunami experience developed a new set of hard and software (Rudloff, et al., 2009) for Indonesia to detect and warn in case of a similar occurrence. Though good in its way, the hard and software technology for early warning was found inadequate (De jin & Lin, 2010) without human involvement for awareness raising and a sustainable hazard mitigation. Besides, the development of the effective tsunami EWS is challenging (Bartosz et al., 2011; De jin & Lin, 2010) due to its inability to know the magnitude and the intensity of the earthquake that triggers the event.

Bartosz et al., (2011), highlight that these highly sophisticated EWS generate demand for computational power and this is dependent upon unpredictable factors. The computerization demands of the system are not sustainable due to the high installation and maintenance costs hence leaving gaps in the system (De jin & Lin, 2010) for timely and appropriate information. The definition of EWS lays emphasis on the people's response as a determinant of the effectiveness of the system. Distancing humanity from the system that is meant to deliver him and his surrounding will make it fail however sophisticated. A correct education of the people is

by far the most cost effective (Intrieri et al., 2012) means of reducing risk. The analysis of the Ruapehu volcano in New Zealand revealed a moderate awareness of actions during a warning and failed to respond effectively (Leonard, *et al*., 2008) in spite the high levels of risk perception. Leonard et al.,(2008*)* suggested a five step model for an effective EWS, thus; hardware and public notification, planning, discussion, communication and participation, education and engagement and lastly exercises and blind tests (Leonard et al, 2008). The EWS analyzed so far emphasizes the interaction between the scientific and social dimensions of the system and in spite the advanced technology that has been invested in the system; gaps of effectiveness are observable leaving the system inappropriate. The visible pitfalls in the system as identified in the literature justify a study to bridge the gap between the scientific and the social dimensions for appropriateness.

The appropriateness of the EWS is determined by how knitted the system is in the economic development decisions (De jin & Lin, 2010) that are driven by the socio-economic characteristics of the community. This is due to the fact that natural disasters are a joint product of natural and human activities (ISDR, 2006), such as where and how to build houses, what industries to develop, investment in natural hazard mitigation, and protections of the ecosystems. The decision to evacuate the people in the coastal city of Theseus in France (Hissel et al., 2013) in response to the warning of the impending flood was hampered by human, organisational and economic consequences. This implies that the appropriateness of any EWS is beyond the technological advancement and may include soft approaches that meets man's immediate survival need as well all those on the continuum of need as advocated for by Maslow's Theory of

motivation (Maslow, 1943). The theory demonstrates that if a person is dominated with physiological needs, all other needs are pushed to the background (Maslow, 1943, pp 10).

In the Sub Sahara region, Mauritius was hit by cyclone Carol in 1960 which resulted into 41 deaths, destroyed more than 40,000 homes, rendered homeless more than 100,000 people, damaged most sugar factories and destroyed 60 percent of plantations (ISDR 2008). The government responded by replacing old buildings with concrete infrastructure that was cyclone proof and affordable. Besides, the meteorological department introduced different warning levels and adopted the practice of issuing regular radio and TV cyclone warning bulletins in all local languages (Mauritius, 2011). This infrastructural response with updated and regular warning messages reduced the effects of the 1994 cyclone to 2 deaths and 1084 refugees (ISDR 2008, EWC11, 2004). On the contrary the Goma volcanic Eruption in 1977 killed 70 people and the similar occurrence in 2002 killed 95 people damaged 14 villages and displaced 400,000 people. The high toll was mainly due to the EWS failure (EWC11, 2004). Though the monitors signalled the eminence of the hazard, the messages were communicated late; there was no pre-planned response after the previous eruption and there was no education and awareness creation on evacuation and safety procedures (ISDR 2008, EWC11, 2004). This Goma scenario' is suggestive that the EWS though in place played a reactive role than being proactive, hence putting the system's appropriateness in a spotlight.

Between 1999-2001, Kenya faced a drought which affected 4.5 million people (Venton et al, 2012), decimated nearly 60-70% of livestock in the Arid and Semi-Arid areas of Saburu and Turkana land, caused crop failure in most parts of the Rift Valley, Coast, Eastern and Central

Provinces, resulting in substantial agricultural and industrial losses, and this cost the economy USD 340 million (Venton et al, 2012). Studies in Early disaster response in Kenya revealed that if there was a drought EWS in place, only USD 171 million would have been sufficient in effectively handling the disaster (Kenya, 2009; UNDP, 2002; Venton et al, 2012). This implies that an effective EWS if in place could have saved the extra cost due to preparedness in response to early warning messages. Since then, Kenya has adopted a vigorous EWS policy in recognition of early warning as major element of disaster risk reduction (Nyandiko, 2004).

Uganda is highly vulnerable to climate change and variability; its economy and the wellbeing of its people are tightly bound to climate, with a likely average increase in temperatures by up to 1.5 ºC in the next 20 years and by up to 4.3 ºC by the 2080s (Hepworth, 2008). These changes in temperature have had significant implications for water resources, food security, natural resource management, human health, settlements and infrastructure. In particular, climate change has led to increased food insecurity; shifts in the spread of diseases like malaria; soil erosion and land degradation; flood damage to infrastructure and settlements and shifts in the productivity of agricultural and natural resources (Orindi and Eriksen, 2005; Orind and Murray, 2005; Goulden, 2008; MWE, 2007). During the floods that rocked the country in 2007 as a result of heavy rains, vital infrastructure was destroyed and this presented urgent need for emergency response. This situation led president Museveni to declare a state of emergency in northern and eastern parts of the country in 2007 qualifying vulnerable and displaced people to access aid outside Uganda's boundaries (IRIN, 2007).

In Uganda, EWS were established in 1977 as a specialized Department of Government responsible for the implementation of national and international policies for the provision of meteorological services. These services included the establishment and maintenance of weather and climate observing network, collection, analysis and production of weather and climate information and products and warning to support social and economic development. The key sectors served by the department include Transport; mainly Aviation, Defence, Agriculture, Disaster Preparedness, Environmental and Water Resources Management, Tourism and Construction Industry. The 1995 Uganda constitution under Paragraph XXIII of the National Objectives recognises the importance of risk reduction, hence the establishment of the department of Relief, Disaster Preparedness and Management in the Office of the Prime Minister. The department is under a political leadership of both a cabinet and a Minister of state (Occira, 2011). The department is the lead agency responsible for disaster preparedness and management, coordinating risk reduction, prevention, preparedness, mitigation and response actions in consultation with other line ministries, humanitarian and development partners, Local Government and the Private sector (Nakabugo, 2014). In the five districts within the Mt. Elgon region, coordination is done by District Disaster Preparedness and Management Committee (DDPMC) and at the Sub-County is done by Sub-County Disaster Preparedness and Management Committee as well as Parish structures (Occira, 2011). Furthermore, on the 18th of August 2013, the Minister of Disaster preparedness launched the national disaster preparedness policy, with a goal to fast track response to disasters and as much as possible ensure prevention through EWS (Kakembo, 2013).

1.2.2 Theoretical Perspective

The theoretical understanding of disasters also referred to as climate change impacts in this study and the EWS is traced in the larger context of emergency management. In the 1990s, disasters were deductively seen as an intersection of society and nature. This argument traced the causal factors of disasters to the social order, its interaction with the habitant, and larger historical circumstances that help shape society. Disasters as a social order subscribes to Jean-Jacques Rousseau's pronouncements in 1755 (Meier, 2009) that a hazard can only turn into a disaster when it intersects with social processes. Currently, disasters are being seen as avoidable human creations and a reflector of social injustice and growing vulnerability (Dombrowsky 1998; Blast, 2010; Hakam, 2011). There are theoretical justifications which prompt the need for EWS to provide essential information and priorities' setting for mitigation and prevention strategies as well as systems with monitoring and predicting capabilities (UNEP, 2012) of the communities, economies and the environment as a means to reduce climate change impacts. These theories include the Anthropogenic Global Warming (AGW) theory, the human forcings theory, the radical and the conservative's theory (Blast, 2010; McEntire, 2004; Hewitt, 1983).

The anthropogenic Global warming theory contends that human emissions of greenhouse gases, principally carbon dioxide (CO2), methane, and nitrous oxide, are causing a catastrophic rise in global temperatures (Blast, 2010). Energy from the sun travels through space and reaches Earth. Earth's atmosphere is mostly transparent to the incoming sunlight, allowing it to reach the planet's surface where some of it is absorbed and some is reflected back as heat out into the atmosphere. However, the greenhouse gases in the atmosphere absorb the outgoing reflected thermal radiation, resulting in Earth's atmosphere becoming warmer than what it would have been. Human activities such as burning wood and fossil fuels, cutting down or burning forests

have increased the concentration of CO2 in the atmosphere by approximately 50 percent, and unregulated continued burning could double the amount of CO2 in the atmosphere by 2100 (Drabo and Mbaye, 2011). The human forcings theory (Pielke, 2009), holds mankind responsible for climate change due to his activities of transformation of the earth's surface. Mankind's transformational activities include deforestation, irrigating deserts, and building cities. Pielke asserts that cities tend to be warmer than suburbs, and suburbs warmer than rural areas, because they have greater concentrations of energy-producing machines and vehicles and large amounts of concrete, asphalt, and other building and road materials that absorb solar energy and then re-emit thermal energy. The proponents of the AGW and human forcings theory believe that man-made CO2 and Mankind's earth transforming activities are responsible for floods, droughts, severe weather, crop failures, species extinctions, spread of diseases, ocean coral bleaching, famines, and literally hundreds of other catastrophes (Blast, 2010; Stern 2007). The theories suggest that an effective EWS is necessary to predict and inform those at risk of the pending threats (UNEP, 2012; Blast, 2010). The more accurately the EWS predictions are done, the more likely the management and mitigation of impact on society, economies, and environment becomes possible.

In the development perspective, the radical and cultural theories presented by Karl Marx and Max Weber respectively have had a profound impact on disaster prevention scholarship (McEntire, 2004). The radical development theory as proposed by Karl Marx asserts that poverty is the major causal explanation of disasters. He therefore advocates for a restructuring of social political and economic relations as a means to reduce the impact of hazards. Such changes may include conditions at work, alteration of industrial and commercial societies to avail people

sufficient time and means to minimise the possibility of disaster. This is because disasters are a reflection of social order processes and the historical circumstances that shape and sustain such processes (Hewitt, 1983). On the contrary, the conservatives assert that culture is the determinant cause of disasters as it constrains effective and sustainable adaptation to natural hazards (McEntire, 2004). A shift in thinking and behaviour along with possible alterations in beliefs and increased rationalisation and bureaucratisation are therefore seen as the only mitigation and preventive measure against hazards. Attitudes, values and behaviour have been implicated in increasing disaster costs (Mileti, 1999). People's belief in technology motivates them to settle in risky areas. Besides, peoples' development preferences produce and acerbate hazardous conditions because such settlements destroy ecosystems that could have provided protection from natural perils (McEntire, 2004). This school of thought rejects settlement for short term goals in favour of gaining risk knowledge, building a data base for disasters losses, provision of education and training, measuring progress and sharing of knowledge. This conservative perspective lays a soft spot for land use planning, warning systems, engineering and building codes as well as insurance and use of technology. Given the fact that that EWS is this study will be focused on ensuring risk knowledge, monitoring, communication and response capability, it can be noted that the AGW and human forcings theory as well as the two development theories of radicalism and conservatives greatly contributes to the understanding and shaping the study.

1.2.3 The conceptual perspective

Appropriateness of EWS is understood as the provision of timely and effective information that allows individuals exposed to hazard to take action to avoid or reduce their risk and prepare for

effective response (UN, 2006). EWS in this study shall precisely mean an integration of four elements, thus risk knowledge, monitoring and predicting capabilities, information dissemination and response capability (Villagran de León & Bogardi, 2006; UN, 2006). If communities are Knowledgeable about the impending risk, they are most likely to develop appropriate prevention responses (Grasso, 2007). The possession of monitoring and predicting capabilities among the study population shall mean timely provision of estimates of potential risks (Entwicklung & Ländlicher raum, 2006). Monitoring shall be assessed through the analysis of the metrological services. The Metrological services in the study shall serve as an important source of weather, climate and water information (Rogers and Tsirkunov, 2013). The information passed on to the population at risk is meant to make them aware of the impending hazard and its likelihood of turning into a disaster. The Metrological services in practical terms shall mean the provision of shared exchange of knowledge, advisory information, technical material and organizational support to help develop community response capabilities (Obasi, 2009)

Dissemination and communication shall mean the ability to give accurate and timely messages about potentially risky locations. On the Other hand, response capability shall mean people being aware of the impending hazard in a timely and accurate manner with clearly demarcated most at risk areas; and the population has the capacity to respond effectively (Entwicklung & Ländlicher raum, 2006; Grasso, 2007). The four elements have to span continuously without a fault line as "end to end" ((Phaiju et al., 2010, p.24) in order to prevent life loss and the reduction of economic losses to a minimum (Löwe et al, 2013). Therefore, EWS shall be considered appropriate when economic losses, injuries and death rate is minimized as a direct result of the execution of an anticipated response by the people and institutions once a warning is issued.

On the other hand, climate change impacts shall mean droughts; desertification, floods, storms and soil erosion, and all those natural occurrences that affecting agriculture and food security, Health problems, conflict migration and education. Globally, Asia has registered more than half of the disasters in the world, making the region the most vulnerable on the face of the earth (Yazdanipour, 2012). The frequency of these disasters has been tagged to population explosion (summers, 2009), rapid and uncontrollable urbanization (Wilbanks, 2010), unplanned land use and global warming (Yazdanipour, 2012).

Management of the climate change impacts shall be viewed as a continuous and integrated process of preparedness, Mitigation, adaptation, response and reconstruction (ISDR, 2008). Preparedness shall refer to an integrated processes and measures taken to prepare for and reduce the effects of disasters, that is, to predict and, where possible prevent them, mitigate their impact on vulnerable populations, and respond to and effectively cope with their consequences. Being an integrated process, preparedness shall mean a range of activities and resources hence increasing efficiency, effectiveness and impact of responsiveness to the early warning at community and national level. Preparedness shall therefore include activities such as the development and testing of warning systems and plans for evacuation, education and training of the population at risk, training of first aid and emergency response teams and the establishment of emergency response policies, standards and operational plans to be followed after a disaster. Preparedness shall further mean the development of activities intended to address everyday risks that communities face and for responding to disaster situations. For example, first aid or social welfare programs that have components useful for disaster reduction and response. Preparedness shall involve the development and regular testing of warning systems (Chatfield et al, 2013) and

plans for evacuation or other measures to be taken during a disaster alert period. Therefore, any minimal life loss and physical damage (Ravindranath & Sathaye, 2002) that shall be realised as a direct result of a response to warning messages shall be considered as a situation well managed.

Table 1.1: Various dimensions of a preparedness strategy

Hazard, risk and vulnerability Assessments	Response mechanisms and strategies	Preparedness Plans
Coordination	Information Management	Early warning Systems
Resource mobilization	Public education, training, & rehearsals	Community-Based disaster preparedness

Source: (IRC, 2000, P.10)

Mitigation shall mean the process of identifying actions meant to minimize hazards, risks, and vulnerabilities as well as the establishment of strategies to implement those actions (Jackman and Beruvides, 2013, Wattegama, 2007) The process shall involve the analysis of the developments in the immediate aftermath of a disaster, evaluating the damage and determining what facilities are required to be reinforced for construction or relocation purposes as well as legislation that prevents building structures in disaster prone areas. The process of developing disaster mitigation plans is unique to each community or Country, though certain elements are essential to mitigation as a process. These include building awareness and understanding of risk; involving key stakeholders; community participation, and implementation issues including prioritization, cost-benefit analysis, and resource mobilization. Legislative planning and regular scheduled vulnerability and risk assessment are equally part of the mitigation process. Mitigation in the study shall mean the ongoing effort to reduce the impact the disasters have on people and property.

Adaptation in this study shall mean responses to actual or expected climatic stimuli or their effects. Such responses shall include changes in processes, practices or structure either voluntarily or planned to minimize potential damages or to take advantage of opportunities associated with changes in climate (AfDB *et al*, 2004). Effective adaptation shall imply a reduction in the present and future vulnerability of communities under study to climate change and shall include coping strategies or changes in practices and processes in light of the perceived climatic change. Such actions can be taken by individuals, households, governments and other stakeholders. Accordingly, Adaptation measures shall aim at Disaster response, Disaster risk reduction and disaster risk management and Adaptation to slow onset climate change. These measures are intended to reduce vulnerability and enhance adaptive capacity within communities (DFID, 2004; World Bank, 2012).

The disaster response shall mean the organization of activities used to respond to the disastrous event and its aftermath. The response primarily focuses on emergency relief: saving lives, providing first aid, minimizing and restoring damaged systems meeting the basic life requirements of those impacted by disaster, particularly food, water, and shelter as well as providing mental health, spiritual support, comfort and care (Villagran de León & Bogardi, 2006)

Reconstruction in the study shall focus on the stabilization and return of the community to its pre-impact status. The activities of the reconstruction ranges from rebuilding damaged buildings and repairing a community's infrastructure to relocating populations and instituting intermediate and long-term mental health interventions (Jha et al, 2010). Reconstruction shall further mean seeking to understand the context and impact of the disaster, local governance structures, the identification of beneficiaries, the determination the most appropriate modes of assistance,

recognition of hazards which pose a future risk as well as capturing the objectives, timescales, resources and risks in the program plan (Silva, 2010; Jha et al, 2010). Management shall therefore mean the analysis of potential threats and protecting communities against those threats through the development of contingency plans (Ravindranath & Sathaye, 2002) for recovery and re-construct of any damage sustained (Yazdanipour 2012).

1.2.4 Contextual perspective to the study

EWS make a very significant contribution in protecting lives and support sustainable economic development and early detection of undesirable situations. In Ethiopia and Kenya, many lives have been saved and deaths significantly reduced through the development of early warning systems (Nyandiko, 2004; Teshome, 2012). Subsequently, the absence of EWS results in heavy losses to human lives and economic entities when disasters strike. Studies have demonstrated that disaster prevention through EWS can pay high dividends and found that for every dollar invested in prevention, there is a double return in terms of avoided or reduced impacts on life, property, the economy and the environment (Melcher, 2005; White and Rorick, 2010). Uganda has climate monitoring services across the country under the department of meteorology. These meteorological services have a mandate to develop and maintain station networks, monitor weather and climate and provide weather forecasts and advisories to the citizens for use in sustainable development. These include; 300 rainfall services, 11 Synoptic station, 20 agroMet, 18 Hydromet stations, 1air station at Entebbe airport (Muwembe, 2011).

Considerable research has been done to establish the causes of climate change impact, particularly the landslides within the Mt. Elgon Region (Kitutu, 2010; NEMA, 2010; Claessens et al, 2007; Formo and Padegimas, 2010; Tenywa, 2011). They identified hill steepness,

precipitation level and soil properties as the natural causal factors and anthropogenic factors including population pressure and related issues such as pressure on land, land fragmentation and deforestation as major factors that have increased the occurrence and impact of disasters over the last decades.

Studies by Gorokhovich et al (2010) sought to establish the vulnerability context of the populations living on Mt. Elgon slopes, and the results indicate that thousands among these communities are living in a critical situation that could trigger massive landslides, silting, flooding and the destruction of infrastructure in face of heavy downpour (Gorokhovich et al, 2010). However, with all these aforementioned studies, little is known about the warning systems and their role in providing risk knowledge, technical monitoring, information dissemination and response capability and how these can be used to induce preparedness and mitigation of climate change impacts within the Mt. Elgon region. This confirms the assertion that historic climate data for the region is patchy, resulting in high uncertainty levels of climate change scenarios (Mbogga, 2012). In the North Eastern Uganda, the most pronounced information giving system is the drought EWS based in the Karamoja sub-region (ACTED, 2012). The drought EWS came into place in response to the 2006- 2009 drought that hit Karamoja and drastically reduced the capacity of the population to cope with the usual unfavourable conditions of limited access to basic services like health, safe water, education, poor infrastructure, insecurity, and environment degradation. Since 2009, disaster EWS have continued to play a valuable role in ensuring timely and reliable information for the affected communities as well as the governments and the development partners for use to inform their activities and planning (ACTED, 2012).

The Government in recognition of the importance of disaster risk reduction and EWS in particular made it its third topmost priority in the Poverty Reduction Strategic Framework, the Poverty Eradication Action Plan (PEAP). The PEAP is the National Development Policy Framework and Medium Term Planning Tool that guides the formulation of Government policy and implementation of Government programmes in line with the Millennium Development Goals (OPM, 2005). The PEAP guides and strengthens the operations of the department of disaster Preparedness and management in fulfilling its task to coordinate risk reduction, prevention, preparedness, mitigation and response actions in the country (OPM 2012). On the 18th of August 2013, the Minister of Disaster preparedness launched the national disaster preparedness policy, with a goal to fast track response to disasters and as much as possible ensure prevention through EWS (Kakembo, 2013).

The reinforcement of disaster prevention efforts within the Mt. Elgon region is evident with implementation of the Territorial Approach to Climate Change project in 2010/13. The project was implemented in Mbale, Manafa and Bududa in a collaborative partnership with the United Nations (UNDP and UNEP) and the Ministry of Water and Environment (UNDP, 2011, Masiga, 2012). The aim of the project was to support local low-carbon and climate change-resilient development by supporting local decision makers and planners to design integrated climate change policies, strategies and formulate solid action and investment plans that promotes long-term sustainability and poverty reduction (UNDP 2011).

During the launch of the Disaster management policy, the line Minister decried lack of EWS in the Mt. Elgon region for landslides, Kasese for floods and Teso and Karamoja region for

droughts as this is steadily reducing the development gains in the country over time (Kakembo, 2013). On the other hand, the news reports indicate that the EWS in the Mt. Elgon region exists and that the information about these disasters where communicated to the regions through the national media, particularly on Televisions, radios and newspapers (OPM, 2012). The ministerial statement indicating absence of EWS and the media reports that indicate the existence of EWS justifies a study to be undertaken to clear this contradiction. Any trace of the EWS in place shall be assed for appropriateness in terms of ability to reduce risk and vulnerability. Besides, with a ministry and a policy framework in place, Uganda should be able to mitigate, adapt, prevent, provide relief Assistance, and reconstruct. However, these recent disasters that have occurred indicate a missing link between the EWS and the management of Climate Change Impacts.

In view of the above discussion, the study seeks to find answers to a number of questions; for instance, how does risk knowledge, technical monitoring, dissemination and communication as well as response capability affects the development of appropriate prevention responses during a hazard? On the other hand, how does timely provision of estimates of potential risks affects the processes of preparedness, adaptation, prevention, mitigation, relief assistance and reconstruction as a way to manage impacts of climate change? Does information dissemination about potentially affected locations and response leads to the development of appropriate action plans? These and several other questions pertaining to the existence of early warning soft and hardware in Eastern Uganda, early warning signs acting as precursors, credibility and packaging, accessibility, translation and utilization of the warning messages poverty and cultural influence on responses to warning, need an empirical study to offer a sound explanation on the

appropriateness of EWS in the management of climate change impacts within the Mt. Elgon region.

1.3 Problem Statement

In spite of the colossal investments and efforts to promote EWS within the country; Uganda has continuously faced the impacts of climate change. The Mt. Elgon region in Eastern Uganda has been mired with various disasters in the recent past and these have led to loss of lives, destruction of property and disruption of the social-Economic fabric of the communities (Knapen *et al*, 2005). In 1997, at least 48 people were killed due to landslides, the crops and dwellings of 885 families disappeared, 10,000 people were displaced (Kitutu *et al*., 2004; Kitutu, 2010) and arable land was reduced causing land-scarcity, property conflicts and food shortage. In 2004, over fifteen thousand people were displaced and landless within the Mt. Elgon region, giving a rate of 700 internally displaced persons per year (Kitutu et al, 2009). In March 2010, following the heavy rains, over 400 lives were lost in a mudslide in Bududa district, and 5,000 people were displaced (Atuyambe *et al*, 2011; NEMA, 2010) and in August 2010, 30 lives were lost in Bulambuli district due to landslides (NEMA, 2011; Hal, 2011). In August 2011, 35 lives were lost due to landslides in Bududa, and further 30 in June 2012 (OPM, 2013). Currently, over 300,000 people are at risk of landslides in the region (OPM, 2013). In addition, damage to infrastructure constrains the region in development initiatives (Mugagga, 2011; Kitutu et al, 2009), for instance, the economic costs to restore the infrastructure after the 1997 heavy rains was 1,273,000 US Dollars (Knapen *et al*, 2005).

A number of studies have been carried out in Uganda and within the Mt. Elgon region (Kitutu, 2010; NEMA, 2010; Claessens et al, 2007; Formo and Padegimas, 2010; Tenywa, 2011;

Gorokhovich et al, 2010) to establish the causes and impacts of the Climate Change but none has tackled the issue of EWS and the management of Climate Change Impacts. Therefore, this leaves a knowledge gap that this study seeks to fill.

The pertinent question in all this is whether the EWS are appropriate in managing the climate change impacts in face of all the resources that have been and are being invested in establishing and maintaining them across the country and within the Mt. Elgon region. Therefore, this study on the EWS and management of climate impacts becomes important for development practitioners and particularly those interested in disaster risk reduction. If the issue of EWS and Management of Climate Change impacts does not attract the attention it deserves, then the region and Uganda as a country shall fall way below line in achieving the MDGs and its effort to become a middle income country as described in vision 2040 is a myth.

1.4 Purpose of the Study

The purpose of the study is to establish the appropriateness of Early Warning Systems in the management of the impacts of Climate Change in the Mt. Elgon region of Uganda.

1.5 Objectives of the Study

1. To find out the level of risk Knowledge in the management of the impacts of Climate change in the Mt. Elgon region in Eastern Uganda.
2. To establish the level of technical monitoring in the management of the impacts of climate change in the Mt. Elgon region in Eastern Uganda.

3. To investigate the appropriateness of communication on the management of the impacts of climate change in the Mt. Elgon region in Eastern Uganda.
4. To establish the appropriateness of response capability on the management of the impacts of climate change in the Mt. Elgon region in Eastern Uganda.

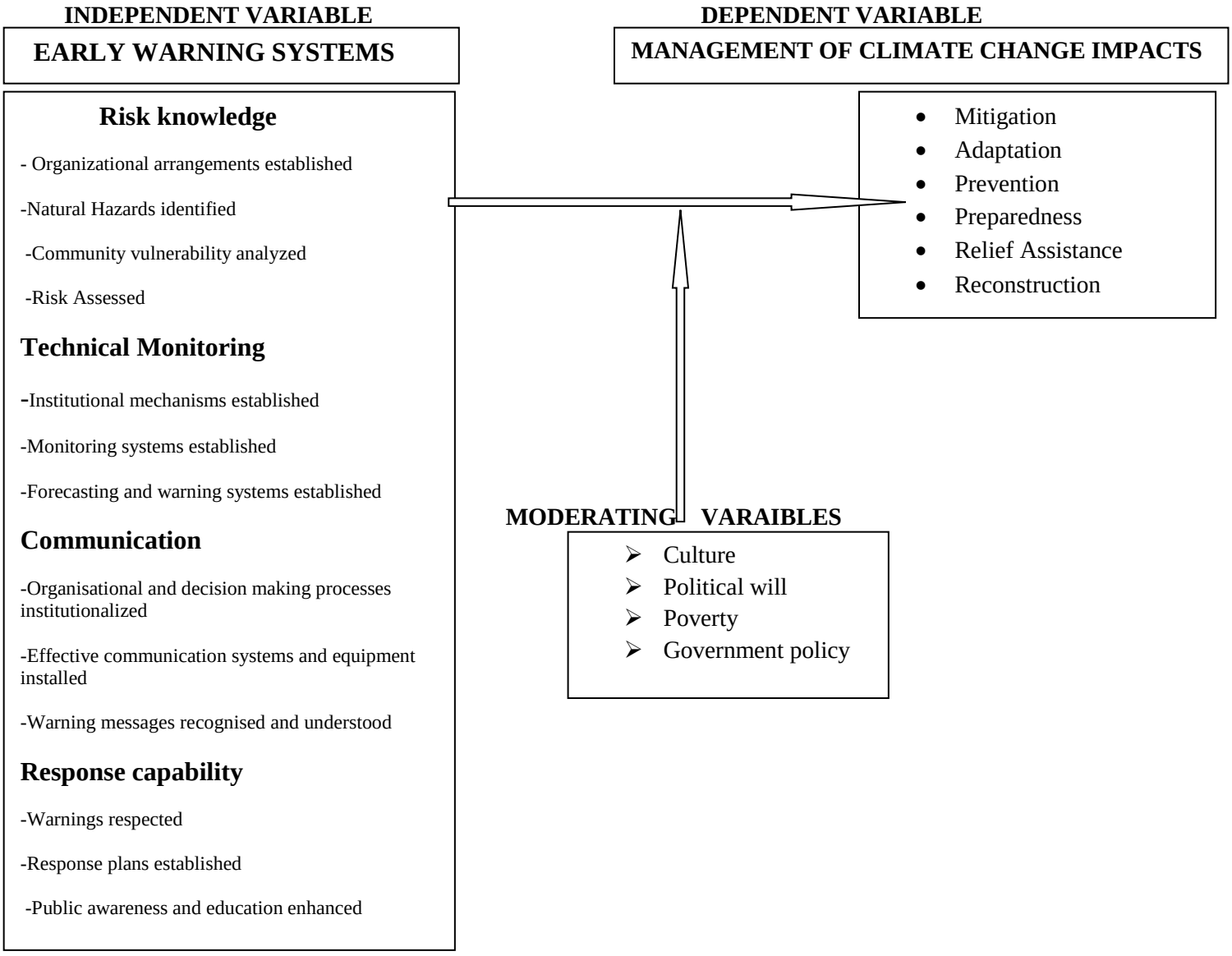
1.6 Research Questions

1. How appropriate is risk knowledge in the management of the impacts of climate change in the Mt. Elgon Region in Eastern Uganda?
2. How appropriate is technical monitoring and predicting in the management of the impacts of climate change in the Mt. Elgon Region in Eastern Uganda?
3. How appropriate is communication in the management of the impacts of climate change in the Mt. Elgon Region in Eastern Uganda?
4. How appropriate is the response capability in the management of the impacts of climate change in the Mt. Elgon Region in Eastern Uganda?

1.8 Hypothesis

1. H1. Risk knowledge has a positive relationship on the management of climate change impacts in Mt. Elgon region in Eastern Uganda
2. H2. Technical monitoring has a positive relationship on the management of climate change impacts in Mt. Elgon region in Eastern Uganda
3. H3. Communication has a positive relationship on the management of climate change impacts in Mt. Elgon region in Eastern Uganda
4. H4. Response capability has a positive relationship on the management of climate change impacts in Mt. Elgon region in Eastern Uganda

1.7 The Conceptual Framework



Source: Reviewed Literature: (Thomalla & Larsen, 2010; Supper & Baron, 2010 and Grasso, n.d)

The conceptual framework above presents the relationship between the independent variable (EWS) and the dependant variable (Management of climate change impacts). EWS in this study is measured in form of the system's ability to provide risk knowledge, provide technical monitoring, and ensure dissemination and communication of warning messages and the response

capability while management of climate change impacts is in form of mitigation, adaptation, prevention, preparedness, relief assistance and reconstruction. This study is aimed at establishing the appropriateness of the EWS in the management of Climate change impacts in Uganda using the Mt. Elgon region as a case.

However, there are other factors that may influence the management of climate change impacts negatively or positively other than the EWS (intervening variable). These other factors include culture, Poverty, political will and government policy. The management of climate change impacts also depends on the cultural orientation of a given society. The communities that have a high level of cultural awareness are more resilient in face of climate change impacts than those that are not (Quinn, 2012). Cultural awareness is an essential component in promoting good practices in a community that tap on the traditional organizational structures and mechanisms towards a wide range of appropriate, innovative and do-able mitigation solutions, which are cost-effective and sustainable (Victoria, n.d). Political considerations are a significant factor in the preparation for, response to, recovery from and mitigation of disaster events. This is because disasters affect people and invariably invite public interest. Politicians appropriately have to respond to that kind of interest and scrutiny (Selves, n.d). This explains why response to a disaster is more attractive to politicians than preventive processes of preparedness and mitigation. The management of climate change impacts may also be affected by the prevailing government policy. . How well or how poorly mitigation and preparedness, response to and recovery from disasters are directly related to how well the disaster policy is created, maintained and implemented.

Poverty contributes to the growth in disaster risk conditions since in most cases it leads to environmental degradation, occupation of unsafe sites, the use of inadequate building techniques and the development of environmentally inadequate or non-resilient livelihood options. Besides, being poor often means marginalisation or exclusion from social protection mechanisms and risk reduction instruments (Lavell, 2008). However, in spite the fact that these intervening variables potentially affect the EWS appropriateness in the management of the climate change impacts, they are out of scope for this study.

1.9 Significance of the Study

The study shall be significant in the development of appropriate disaster preparedness messages that shall inform the practices, values and beliefs geared towards risk reduction in the area of study as well as guide policy makers in developing integrated policy guidelines that focus on disasters as a development issue than just a geographical/technical occurrence. Vulnerability mapping shall guide the community in creating awareness of situations that makes them more susceptible to hazards and how to avoid being victimised. The study shall furthermore make a contribution on the body of knowledge in promoting appropriate messages to minimise the impacts of climate change.

1.10 Justification of the Study

The study geared towards EWS and the management of climate change impacts comes at a time when the frequencies of natural hazards that have culminated into disasters are on the increase in many areas of the country with no indicators of ceasefire. In March 2010, following the heavy rains, over 400 lives were lost in a mudslide in Bududa district, and 5,000 people were displaced,

the highest form of destruction for both human life, property and the environment at one go on Mt. Elgon (Atuyambe *et al*., 2011; NEMA, 2010**)**. In August 2011, 35 lives were lost due to landslides in Bududa, and further 30 in June 2012 (OPM, 2013). Currently, over 300,000 people are at risk of landslides in the region (OPM, 2013). With the increase in heavy and stormy rains, floods, landslides hailstorms, the study is vital in making a contribution on how the communities under investigation can be more prepared in managing such impacts.

1.11 Scope of the Study

Content wise, the study intends to investigate the relationship between the EWS detailed as risk knowledge, technical monitoring, communication and response capability in the management of Climate change impacts in the Mt. Elgon region. Management shall be measured in terms of preparedness, mitigation, adaptation, prevention, relief assistance and reconstruction. In the study, culture, political will, poverty and government policy herein referred to as the moderating variables shall be held as a control.

Geographically the study shall be carried out in Eastern Uganda, within the Mt. Elgon districts of Mbale, Manafa, Bududa, Sironko and Bulambuli. The five districts shall be considered for investigation because of the high frequency of climate change impacts they have faced (Atuyambe *et al*., 2011; NEMA, 2010; OPM, 2013).

In terms of time, the study shall be carried out from 2014 to 2016, and the crucial time of analysis shall be 2008-2013. These 5 years of focus are vital in this investigation since the available information show that the region under investigation has been frequented by the climate variability (Atuyambe *et al*., 2011; NEMA, 2010; OPM, 2013). However, the study shall

remain open to all relevant literature that shall deem useful in the analysis of the appropriateness of the EWS in the management of the impacts of climate change.

.

1.12 Operational Definitions

Early Warning: Shall mean provision of timely and effective information through recognized institution. The variable shall be analyzed in Light of indicators, such as Community risk knowledge, capability to monitor and predict potential risks, delivered messages to potentially affected areas and persons as well as plans for appropriate action to be taken in response to the information received.

Early Warning Systems in this study shall mean meteorological, remote sensing techniques, rain gauge services and early warning signs that are assumed to be existent in the region of study.

Appropriateness: shall mean timely, relevant, cost effective affordable, suitable, fitting, relevant, benefitting and well-suited. EWS shall be termed appropriate when the decisions taken using information from early warning is used/utilised effectively to manage the impacts of climate change.

Management: This shall mean planning for emerging climate changes, organizing communities in preparation for climate changes, influencing the implementation of activities to mitigate impacts of climate change and coordinating emergency activities for community recovery.

Climate change impacts: shall mean the effects of natural disasters that are common in the region under study. The natural disasters shall include landslides, mudslides, floods and soil erosion.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents insights into existing literature on the Early warning systems and the theoretical foundations that shall inform this study. A review of Early Warning systems and its constructs is presented and how they influence the management of the climate change impacts. The review of the literature is organized alongside the objectives of the study; thus the risk knowledge, monitoring and prediction, Dissemination and communication and response capability and how appropriate they are in the management of climate change impacts.

2.2 Theoretical Review

Besides the anthropogenic Global warming, the Human forcings, the radical and the conservative theory that offers a theoretical understanding of the underlying causes of climate change and how its impacts can be mitigated the systems' theory shall guide the study by putting the different elements of early warning together. The systems design approach defines situations as a system of interconnected, interdependent, and interacting problems (Laszlo & Krippner, 1998). The theory believes in synergy, interdependence interconnectedness within a phenomenon and between the phenomenon and the environment (Stichweh, 2012). The theory came out of Von Bertalanffy's ideology that there is a general trend towards integration in all fields of study (Von Bertalanffy, 1968). Systems are therefore perceived as a structured set of interacting components that conserves an identifiable set of relations (von Elverfeldt, 2012; Laszlo & Krippner, 1998).

The system's theory provides an analytical framework for viewing a phenomenon descriptively or explanatory. In regard to the analysis of perception, systems theory can model "human/nature interactions without reducing perceptual phenomena to the level of individual stimuli" (Laszlo & Krippner, 1998, p.7.). Early Warning Systems in this study composed of risk knowledge, monitoring and prediction, dissemination and communication and response capability as its constituents shall be reviewed descriptively and empirically under this framework in order to establish the cause and effect relationship between EWS and the management of Climate change impacts. The approach shall focus on the phenomenon (EWS) as a whole as well as the complexities (constructs) that constitutes it. The constructs shall then be subjected to empirical analysis in order to contribute to the body of knowledge. This pursuit makes the approach relevant as a multi-disciplinary guide to theory development and search for knowledge (Laszlo & Krippner, 1998).

In this study, Early warning systems are going to be analyzed in light of how they influence the management of climate change impacts. This concurs with the assertion that the systems are interdependent and their actions and outcomes collectively emerge from the actions and interactions of the individuals that make up the collective (Von Elverfeldt, 2012).

2.3 Conceptual Review

Miles and Huberman (1994) highlight that a conceptual framework is a written or visual presentation that explains either graphically, or in narrative form, the main concepts or variables to be studied and the presumed relationship among them. It provides the structure/content for the whole study based on the literature reviewed. The conceptual framework under 1.8 presents

EWS as an independent variable and has been hypothesised to have influence on the management of climate change impacts. EWS have been defined as the provision of risk knowledge, monitoring and prediction, communication and dissemination and response capability. The framework suggests that the level of appropriateness of EWS have an effect on preparedness, mitigation, adaptation, Relief assistance and recovery processes during a disaster. The collection of data, analysis and discussion of the findings of this study will be based on this framework. Reviewing of literature for the study is going to done in accordance with the research objectives which hinge on the constructs of EWS.

2.3.1 Risk Knowledge and Climate Change Impacts

There is a wide acknowledgement that risk knowledge takes on a pivotal role in ensuring preparedness, adaption and mitigation of the climate change impacts and achieving human security towards sustainable development. Due to this acknowledgement, the UN Hugo framework for Action, priority 3 seeks to promote knowledge dissemination (Shaw, et al, 2008) through tools such as printed materials and non-printed such as games, activities and practices for use at home, school and community (Mulyasari, et al, 2008; Rodriguez and Edwards, 2008). Shaw et al asserts that risk knowledge impartation is the most important process in ensuring disaster learning and it needs to be innovative in linking theory to practice (Shaw et al, 2011).

To contextualize the importance of risk knowledge in the management of climate change impacts, Rodriguez and Edwards (2008) sought to know the types of knowledge and how they are created so as to seek ways of ensuring a risk knowledgeable community. Tacit knowledge is represented by experience, beliefs and technical skills accumulated in the people's minds why explicit knowledge is the knowledge expressed in documents, data and other codified forms

(Rodriguez and Edwards, 2008; Davenport and Prusak, 1998). The movement and the interaction between the tacit and explicit generate knowledge creation among individuals and communities. Shaw et al, (2011) opines that education, a typical form of explicit knowledge plays a pivotal role in reducing disasters and achieving human security. The reviewed literature further reinstates that the advancement, transfer and sharing of knowledge is a basic tenet of climate change impacts management (Shaw et al, 2011; Rouhban, 2007; Rodriguez and Edwards, 2008).

Leonard et al (2008) carried out an assessment on the effectiveness of public education in mitigating the impacts of disasters within the Mt. Ruapehu region in New Zealand. Findings indicated that well-designed public education initiatives increase public hazard knowledge and warning responsiveness. These findings concur with Shaw et al' who opines that Public education through built upon engagement with the media, brochures/posters, meetings and internet resources are critical to understanding of warning system details and the range of suitable responses. The findings from the study highlighted that public education at its best should address pertinent issues such as who will issue the warning message(s), its content, its timing, and the media used to communicate risk messages (Shaw et al, 2011; Leonard et al 2008).

Studies carried out by Rouhban (2007) and Bamdan, (2005), faulted professionals who carry out vulnerability assessments with almost no input from local stakeholders. The literature highlights that the existence of information coordination and sharing gap due to the fact that the knowledge and experiences of the experts remain with individuals or in the institutional domains (Mohanty et al, n.d; Rouhban, 2007). This arrangement potentially puts appropriateness of risk knowledge

among communities in a spotlight and posses potential losses due to this narrow information flow spectrum. Further studies however calls for a conscious effort to relay risk knowledge through an organised common platform to capture, share and create a versatile interface among policy-makers in the Government and disaster managers at National, District and Community level. This potentially knits stakeholders towards better disaster response, empowered public disaster management departments, integration into mainstream development and promoting good practices among the disaster prone communities (Mohanty et al, n.d). This kind of knowledge platform that seeks participation and integration contributes not only to the success of intervention, but more importantly to its sustainability in the longer term (Shaw et al, 2008).

Bamdan, (2005), highlights that the people knowledge model believes in the distribution of knowledge among community members. The effectiveness of this dissemination thrives on the ability and willingness of the national legislature or government policy to do vulnerability community mapping and establishment of national standards for the systematic collection, sharing and assessing risks and vulnerability information (UNISDR, 2006). Public education campaigns (through electronic media like radios' TVs and mobile forms), formation and training of community response teams is noted for creating public awareness in the promotion of an informed, alert and self-reliant community (IFRC&RCS, 2000). Although, electronic media is highlighted as essential in transmitting risk knowledge, direct instruction that is sensitively designed may be more effective as this reflects one's passion and emotional attachment to the message. The study in this line of thought will look out for the benefits associated with direct instruction and how these can enhance realistic perception of risk knowledge in the Mt. Elgon region.

Realistic perceptions of risks will lead to a comprehension behavioural change, such as preparing a disaster kit or looking up for safer shelter locations in face of a hazard. Behavioural change is important for households, educators, emergency managers, and first responders in determining the best strategy for reaching out to each other and all community members in the most effective way (FEMA 2010). Practices that reflect behavioral change among the households in the community under investigation shall be viewed as indicators of the level of knowledge that the community holds as an insurance against risks.

Wongbusarakum and Loper (2011) in their study findings indicated that risk knowledge is enhanced by identifying and mapping areas of greatest risk. This is done through the interaction of hazards and vulnerabilities to determine risks faced by different regions within the community (Wongbusarakum, S. & Loper C. 2011, UNISDR, 2006). The community needs to be consulted intensively to ensure that the information is comprehensively extended to include historical experiences, local knowledge and information. The activities that increase risk in this case are identified and evaluated. On the contrary, practices that reduce disaster risks for instance wise land use and environment management, improving preparedness and early warning takes precedence (IFR & RC, 2012) and the results of the risk assessment are integrated into the local risk management plans and warning messages. Risk assessment, however is challenging at local level ranging from inadequate climate data to a highly dynamic and complex interplay between capacities in communities and the challenges they face (IPCC, 2012). The assessment of the risk knowledge and its appropriateness in managing climate change shall seek to find out how much information is available to the communities under investigation as well as offering an analysis on the interplay between community capacities in terms of community power relations and the challenges in terms of the several aspects of vulnerability.

2.3.2 Monitoring and the Management of Climate Change Impacts

Monitoring, prediction and warning services in mitigating climate change impacts cannot be over emphasized. Though climate change impacts cannot be avoided, timely and accurate prediction of climate extremes helps societies to prepare for and mitigate impacts to reduce losses in life, infrastructure and productive activities (UNISDR, 2012). Monitoring devices of the system essentially provides lead time which together with public awareness, education and preparedness enables quick response to hazard information. The effectiveness of any EWS is to ensure that hazards are detected, monitored, forecasted and hazard warnings are developed (IFRC, 2013, GFDRR, 2011). This should go along with a standardized and coordinated process as well as clear roles and responsibilities of all those responsible. The community and all stakeholders should be aware of which agencies are responsible for communicating the warning messages and channels for technical warning services. The monitoring devices of the EWS include the meteorological services and the remote sensing techniques and model predictions through assimilation to enable the development of up-to-date monitoring and prediction systems (IFRC, 2013).

Opendeyi (2009) carried out a survey to enable understanding of good international practice on the use of monitoring systems for early warning and their relevancy and adaptability in the Caribbean. Findings indicated poor sound knowledge of the meteorological services mainly due to lack of data and short supply of technical personnel. Elsewhere, the 1940 Aleutian Island Tsunami killed 161 people in Hawai and Alaska and several hundred in 1993 in Alaska (Chang Seng, 2012). Since then, pacific Countries have adapted their development plans to mitigate the

Tsunami risks. The application of climatologically and hydrological knowledge to the assessment of risk and to the land use planning contributes to disaster mitigation preparedness, response and recovery (Leonard et al, 2008). The forecast and warnings of severe weather conditions extreme temperatures contributes to preparedness (GFDRR, 2010) while updated warnings, forecasts, observations and consultations with emergency agencies contributes to the response phase. Special forecasts as well as advice from experts contribute to the recovery operations.

Reviewed literature shows that in spite of the existence of the metrological centre to monitor local and regional seismicity in Indonesia, the system is too slow to ensure timely warning (Travis, 2013; Chang Seng, 2012). Study findings by Travis (2013) underscored People's limited understanding and knowledge of warning signs, besides the absence of institutional arrangements to handle Tsunami risks (Chang Seng, 2012). The Metrological services are practically meant to provide the means for shared exchange of knowledge, advisory information, technical material and organizational support to help develop national capabilities (Obasi, 2009), though this was not the case in Indonesia. This confirms Obasi (2009)'s assertion that Metrological Service forecasts are sometimes far from reality in regard to connectedness with local conditions. Such assertions about forecasts and warnings as well as limitations of the MHS's services shall be validated in the process of conducting this study. However, preparedness arrangements have been established since then to avert any similar hazards (Rudloff, et al., 2009, Thomalla & Larsen, 2010; IRC, 2009) culminate into disaster.

Studies carried out by Helmore, (2013) in Kenya, sought to find out how the country has incorporated adaptive policies into the national development plans in the effort to manage climate change impacts. Findings indicated that the climate change projections have been fed into the national "vision 2030" and the adaptation initiatives have been incorporated into planning, agriculture and natural resources (Helmore, 2013, p. 8.). In Lesotho, meteorological data supported the development of a draft policy document on renewable energy. These efforts to mainstream climate change management hedges on the premise that accurate estimates of extreme precipitation are useful for agricultural and water land use planning and public works programs management (Sergio et al, 2010; Obasi 2009). In other words, appropriate meteorological data enables evidence based policy Development.

In Uganda, the priority sectors are agriculture and food security, tourism and wildlife (EAC, 2008) and inter or intra-seasonal variations in weather carry a considerable impact on the timing as well as the efficiency of the routine agricultural operations, such as planting and harvesting (Sivakumar, 2006). Therefore, it is paramount to know the detailed climatic conditions in order to make the best possible decisions in land use. The forecasts that relay knowledge of extreme meteorological events (Ogbuene, 2010) such as floods and drought with their potential disruptions of socio-economic life can help farmers take remedial measures to avoid or minimize such impact (Sivakumar, 2006) . Meteorological data in Uganda has led to the development of a wide range of high yielding and climate appropriate crop varieties as well as encouraging shading and other temperature reducing techniques (ARCC, 2013). However, it is important to note that the benefits of forecasts depend largely on their accuracy and on the trust of the population (Hallegatte, 2012)

Meteorological services are used to monitor and provide early warning on several hazards which when not averted turn into disasters. El Niño associated with worldwide anomalies in patterns of precipitation hit Uganda in 1997 (ARCC, 2013) and imposed considerable stress and development retardation. Notable impacts included soil erosion and floods. These could have been averted if there was existence of improved data management and forecasting system was in place since signals occur well in advance (EAC, 2008). In spite the argument presented in the reviewed literature (UNISDR, 2012; Sivakumar, 2006; Ogbuene, 2010; Hallegatte, 2012; Sergio et al, 2010; Obasi 2009; Helmore, 2013; Chang Seng, 2012) outlining the existence and the importance of monitoring and prediction as a sound means of preparing and mitigating disasters and reduction in losses in infrastructure and productive activities, there is little evidence if any that this has happened within the Mt. Elgon region. This assertion justifies this study to enable the analysis of monitoring and prediction and how this has affected the management of climate change impacts within the area of study.

2.3.3 Communication and the management of Climate Impacts

History has portrayed communication as a vital component in disaster management in providing information in emergency situations. In the events surrounding the sinking of the Titanic in 1912, Radio communication was instrumental in soliciting support and rescue assistance from California (Collins, 2012; NDMICS, 2012). At the intergovernmental conference on emergency telecommunications in Tempere, Finland in June 1998, 75 countries assented to a treaty to reinforce telecommunication resources within the jurisdictions. The signing of this treaty was on the premise that the timely deployment and use of telecommunication resources play a crucial role in saving life, disaster mitigation and relief operations.

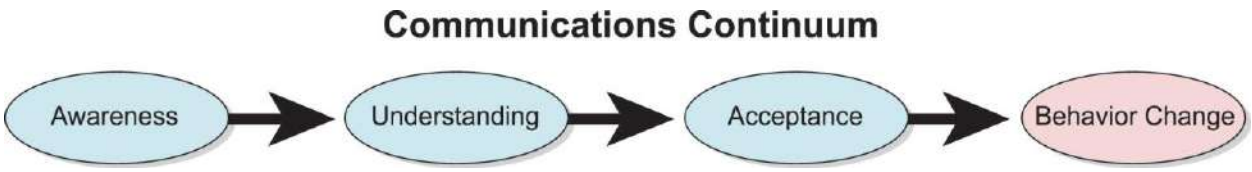
In India, the National Disaster Management Information and Communication System (NDMICS), highlights that 10,000 lives were lost during the cyclone that hit Andhra Pradesh in 1979 however, due to improved communication techniques, less than 1000 lives were lost during the May 1990 cyclone of similar intensity in the same state. In Bangladesh, a cyclone killed more than 300,000 people in 1970s, however, after the country put in an extensive communication and dissemination systems, a cyclone of similar intensity resulted in loss of 3,000 lives (NDMICS, 2012).

Risk communication and dissemination provides a foundation for risk identification and assessment and its failure can contribute to community vulnerability and disaster risk. Van Aalst et al (2008), opines that well packaged and disseminated information determines how people perceive and respond to a specific risk or hazard. Effective communications systems are those tailored to individual community needs and are disseminated in the mode familiar to the intended recipients of all categories (UNISDR, 2006). Short of this leads to inadequacies and the outcome is disastrous. Risk communication failures leading to the loss of trust in official institutions responsible for early warning have been blamed for past disasters, such as Hurricane Katrina in 2005 or the Pakistan floods in 2010 (DKKV, 2011; IPCC, 2012).

Collins (2012) in his study analysed the effectiveness of preparedness and mitigation, as principles of Disaster Risk Reduction. In his findings, he cited communication as an essential operating mechanism towards adaptation and resilience. To him, a state of art communication is that which is able to preserve the integrity of the message being communicated. Disaster communication is in part dependent on who informs and who is informed, and what techniques are available to transmit the information. Risk communication therefore is the intentional effort by one or more legitimate sources (Government, civil society, national or international agencies)

to provide information about a hazard through a variety of channels to different audience segments (IPCC, 2012). Similarly, the way information is portrayed and received determines the reaction that may result (IFRC, 2010; Collins, 2012). Arguably, interpretations of hazards, risks, vulnerabilities, adaptation processes and the capacity to deal with climate change impacts are subject to the chain of communication (IFRC, 2010).

Figure 2.1



Source: (NOAA, 2010)

Communication and dissemination systems ensure that communities are warned in advance of the impending hazards to create awareness, understand the impacts of the occurrence on family and community, accept that not heeding to the warning message may result into injury or death, hence take action (, NOAA, 2010; UNISDR, 2006).

The effectiveness of the communication is dependent on the structural and institutional coordinateness where a warning dissemination chain is enforced. The recognized local authorities, fully equipped and empowered to disseminate warning messages in line with the areas of their expertise is a prerequisite in getting the information across communities and households. Risk communication involves reaching different audiences to make risk comprehensible by understanding and respecting audience values, predict response to the communication and improving awareness and collective and individual decision making (IPCC,

2012). These logical sequences of construct to be aware of places risk communication as a social process dealing with perceptions and local framing of risk. Risk Communication as a social process is therefore a tool to upscale local knowledge and needs as it engages different stake holders in the definition of the problem and the identification of respective solutions (van Aalst et al, 2008; IPCC, 2012).

IPCC (2012) highlights that information quality in terms of being specific, consistent and source certainty is likely to gain acceptance with a significant impact on local adoption. A warning communication chain should therefore be enforced right all through the government policy to emergency department managers and to the communities to ensure this desired information quality. EWS achieved through this format also needs to attract public interest, leadership and acceptance. Therefore, all community stakeholders, decision makers, scientists and civil society have to act in accordance with the media requirements concerning news production, public discourse and media consumption for consistence purposes (IPCC, 2012). The mass media is however limited in terms of accessibility to information due to literacy and income challenges that tend to fix people in these areas to survival needs. To many, radios, TVs and printed media is simply a luxury. Besides, mass media is more of a political awareness tool and it is framed by the editorial norms and priorities hence limited provision for communicating disaster risk related information.

Additionally, communication is more effective when the information regarding the risk does not exceed the capacity for coping; otherwise the benefits of the efforts are jeopardized. The questions to be addressed in the study is whether there are structural arrangements through which risk information is co-ordinately disseminated, the interactive nature of the messages to verify that the messages have been received and whether the community has the capacity for

coping. The inadequacy of these arrangements among the people in the Mt. Elgon region may justify the assertion that risk information is not available at local level (IFRC, 2013),where it is much needed to better understand vulnerabilities, raise awareness and effectively manage risks

2.3.4 Response capability and management of climate change impacts

The EWS is considered useful if the people receiving the warning message have the capacity to respond positively. Response capability aims at strengthening the ability of communities to respond to natural disasters (UNISDR, 2006, IFRC, 2012) through enhanced education of natural risks, community participation and disaster preparedness. The foundation of response capability is a position where each level (Household, community, local government, national, Regional and global) is able to reduce risk once trends are spotted and announced.

Response capability is gained steadily through activities that strengthen the capacity of at risk communities to receive, analyze and act on the warning. This can be achieved through the integration of early warning into the ongoing strategic (Claude, Miller, Bradley, Adame, Scott and Moore, 2013; Bouwer, 2011) and Disaster Risk Reduction programmes. The success for any response action greatly relies on community knowledge and locally available resources. Once these action responses are established, they should be incorporated into contingency plans and empowered by law. The contingency plans negotiated at community level require regularly updates (Pearson 2012) with a clear inventory on who does what, when, and how in an emergency.

The response should move downwards from community to household level by encouraging then to develop individual response plans as the engagement at this level makes the experience

personal. The response activities at all levels should then be mandated by law or policy to make it legitimate. Capability is also a question of practice as a way to test drives the response actions. Drills and simulations should then be conducted to test the appropriateness of the response options and their effectiveness (IFRC, 2012; Mina, Yazdanipour, Marzieh and yazdanipour 2012). In the event that the only good response to a warning is evacuation or seeking shelter in a safer place, the evacuation routes should be created and well-marked and develop convincing messages to persuade people to leave their home.

Notably, response capability is not a stand-alone, as it is connected to warning dissemination and is on-going through public awareness and education built into school curricular from primary to university. In light of this argument, the government has a responsibility to coordinate the activities of EWS and these should be mandated to public institutions by law and clear policy accompanied with resource allocation (IFRC, 2012).

2.4 Synthesis of the Literature Review

There is a general consensus that the impacts of climate change are enormous and the EWS as a major element of disaster risk reduction is a possible remedy, particularly in guiding decisions to support and save life and property. Timeliness in issuance of status information and reliability of warning messages in this case becomes a necessary condition.

The Literature reviewed on EWS and their appropriateness in the management of climate change impacts has established its theoretical basis on the systems theory. The theory is relevant to this study given the interdependence of actions within systems and the outcomes at a collective level which emerge from the very actions and interactions of individuals that make up a collective. Therefore if the synergies and the interactions of the constructs under the variable in question are

appropriately aligned and directed shall yield positive results as far as the management of climate change impacts are concerned. Just as the systems theory states, all these triggers affect and are affected by each other as they interact.

On the global scene, climate change coupled with high population explosion, rapid and uncontrolled urbanisation and unplanned land use has triggered disasters with Asia having the greatest causalities. Just as the systems theory states, all these triggers affect and are affected by each other as they interact and requires a multi-dimensional management approach in attempt to put the situation under control. On the other hand, the European Union has expressly acknowledged the contribution of the EWS in saving hundreds of lives, over 2.7 billion Euros and has had a significant impact on weather sensitive sectors with an annual monetised benefit of over 34 billion Euros. The benefits are as a result of timely weather forecasts that enables preparation for extreme events. Being ready for extreme events means preparedness, mitigation, adaptation, relief services and recovery processes. These measures are vital in promoting the activities that promote risk knowledge, the development and regular testing of warning systems, plans for evacuation and community capacity building. Accordingly, accurate estimates of extreme precipitation are useful for agriculture, water, land use planning and public works management. This is possible through a proper analysis of threats which leads to the development of contingency plans and reconstruction in case of damage.

On the regional basis and indeed in Uganda, forecasts that relay knowledge of extreme events have led to the development of a range of high yielding and climate change appropriate varieties, crops shading and other temperature reduction techniques. On the other hand the high installation and maintenance costs for EWS make them unaffordable to many developing economies. The systems have also registered significant reliability concerns due to false alarms

and the climate information presented is always in probabilities and statistics which makes the massages hard to understand. This therefore makes the communication chain inappropriate. It is this inappropriateness of systems that have posed the need for this study to enable coming up with workable and user friendly measures.

The literature has further suggested the application of non-structural measures which in actual sense are inexpensive and self-sustaining since they are internally instigated. This is of paramount interest to this study since there is no evidence that these non-structural measures are anywhere particularly within the jurisdictions of the study area. The non structure measure involves the acknowledgement of capacities of the affected people's abilities and strengthening them through institutional partnerships towards effective development planning.

CHAPTER THREE:

METHODOLOGY

3.1 Introduction

This chapter details the methodology that the study shall employ and shall be divided into the subthemes of research design, population of study, determination of the sample size, sampling techniques and procedure, procedure of data collection and data analysis.

3.2 Research Design

The study shall use the descriptive cross sectional research design, where the researcher shall have a onetime interaction with the study population. This is a research design concerned with the description of the characteristics of a particular individual, group or phenomenon (Kothari, 2004) in order to understand and explain the conditions of the present. The design is further inclined to making predictions, narration of facts and characteristics concerning an individual or group of individuals (Babbie, 2011). The design shall be used as a methodology of data collection describing EWS and then shall organize, tabulate, depict, and describe the data collection. The researcher has considered the descriptive survey design because of its ability to enable the description of risk knowledge, monitoring, dissemination and communication, and response capability and how appropriate they are in the management of the impacts of climate change. The description of events shall illuminate knowledge that might not otherwise be noticed or encountered (Amin, 2005). The descriptive design shall draw from both the qualitative and the quantitative approaches. The qualitative approach shall look out for perceptions, values and practices of the study population and shall use designs, techniques and measures that do not produce discrete numerical data. The qualitative data collection procedures shall be used for the

study due to their ability to handle diversity of realities (Amin, 2005; Mugenda and Mugenda, 1999). On the other hand, quantitative approach shall be used in the determination of the appropriateness of the EWS in the management of climate change impacts. This shall involve the collection of quantitative data that shall describe the systems and events (Jonassen, 2001) and shall then be tabulated along a continuum in numerical form.

3.3 Population of Study

The population of study shall be derived from the 5 districts of the Mt. Elgon region, thus Mbale, Sironko, Manafa, Bududa and Bulambuli. The study population shall include the district senior staff comprised of the 5 Chief Administrative officers (CAOs), 5 District Environment officers (DEOS), 5 District water officers (DWOs), 25 members of the Districts Disaster Management Committees (DDMC),590 members of the Sub-County Disaster Management Committee(SDMC), 118 Community Development Officers (CDOs) 5 Directors of Natural Resources (DNRs) 5 respondents from the Ministry of Disaster Preparedness and Management, 5 Metrological Officers at the Districts (DMO), 5 respondents from the National Meteorological Organisation (NMO) and 5 staff from the Uganda Red Cross Society (URCS) attached to the districts. These will total 1835 as the target population (District registry, 2014).

Table 3: 1 showing the study Population

District/Dept	CAO	DEO	DWO	DDMC	SDMC	CDOs	LCs	DNRs	DMO	NMO	URCS	MODP	TOTAL
Mbale	1	1	1	5	155	31	279	1	1				
Sironko	1	1	1	5	105	21	189	1	1				
Manafa	1	1	1	5	150	30	270	1	1				
Bududa	1	1	1	5	85	17	153	1	1				
Bulambuli	1	1	1	5	95	19	171	1	1				
NMO										5			
URCS											5		
MODP												5	
Totals	05	05	05	25	590	118	1062	5	5	5	5	5	1835

Source: District Registry, 2014

3.1.3 Determination of the Sample Size

The sample size for the study shall be determined by identifying and defining the population (Amin, 2005) after which the population shall be subjected to Slovin's formula, as here in expressed $n=\frac{N}{1+N(e)^2}$, thus n= sample size, N= Total Population, e= level of precision/ sampling error. The total population for the study as tabulated in table 3.1 shall be 1835. The sample size therefore shall be

$n=\frac{1835}{1+1835x0.05x0.05}$ = $n=\frac{1835}{1+4.6}$ = $n=\frac{1835}{5.6}$= 327.6

This therefore means that 328 are the minimum number of respondents who can be included in the study hence the sample size as presented in table 3.2.

In order to determine the proportions of each category of respondent, simple proportion or ratios will be used. Thus, Table 3.3 presents the sample size for each category

Table 3.2: Showing the Target Population and sample size of the Study

Category	Target Popn	Sample Size	Sampling Method
CAOs	5	5	Purposive
DEOs	5	5	Purposive
DNRs	5	5	Purposive
DWOs	5	5	Purposive
DMOs	5	5	Purposive
URCS	5	5	purposive
NMD	5	3	Purposive
DD MC	25	13	Simple random sampling
SDMC	590	105	Simple random sampling
CDOs	118	21	Simple random sampling
O. Leaders	5	5	convenient sampling
LCs	1062	190	convenient sampling
TOTALS	**1835**	**367**	

3.1.4 Sampling Techniques and Procedure

The research shall employ both probabilistic and non probabilistic sampling methods. Probabilistically, simple random sampling will be used while for non-probabilistically, purposive and convenient sampling will be used. The CAOs, Environment officers National Meteorological department staff, staff from the ministry of Disaster Preparedness, District Meteorological officers and Directors Natural Resources Department will be selected purposively because they are directly involved in the management of Climate change impacts at the district and national level. Due to their involved, in disaster management, the researcher perceives this category as being knowledgeable about the EWS and their contribution to the management of Climate Change impacts in the region. Accordingly, purposive sampling is appropriate because it allows the use of units that have the required information with respect to the objectives of the study (Amin, 2005; Babbie, 2011).

Simple random sampling will be applied in selecting community development officers, District and sub county disaster management committees. This is a technique where each respondent shall have an equal chance of being selected independent of any other and is useful in avoiding bias (Babbie, 2011; Mugenda and Mugenda, 2005). Convenience sampling shall be engaged in selecting opinion leaders and the LCs. This is a technique that involves selecting respondents as they become available to the researcher (Mugenda and Mugenda, 2005). The technique shall be useful in acquiring information from respondents within their natural environment and shall have no ground to demand transport refund hence minimising the cost of the study.

3.1.5 Data Collection Methods

The data collection methods to be used in this study shall majorly be questionnaires, and face to face interviews. A questionnaire is a set of questions sent to a person concerned with a request to offer answers and return the questionnaire (Kothari, 2004). The method is appropriate because it is cost effective and free from the interviewer's bias (Babbie, 2011). For this reason, questionnaire shall be administered to the district technical staff, the Chief Administrative officers and Community Development Officers. The questionnaire shall be structured and shall constitute five sections; ie the general background, and the four research questions as stipulated in chapter one of this proposal, risk knowledge, Technical Monitoring, communication and response capability.

Interviews will be used to collect data from Lcs, Opinion leaders and the, district heads of department and the weather focus analysts. This is an oral administration of a questionnaire (Mugenda and Mugenda, 1999), where the information is obtained through inquiry and recorded by the interviewer (FAO, 1998). The reason for the choice of interviews as a method is due to its ability to yield higher response rates. The decision to use different data collection methods is to allow for triangulation of views collected from the different respondents. This increases on the reliability and validity of the findings (Denzin & Lincoln, 2003).

3.1.6 Validity and Reliability

Validity is described as the accuracy, and meaningfulness of inferences based on research results; the ability to come up with findings that are consistent with the theoretical values (Amin, 2005; Mugenda and Mugenda, 1999). It refers to the mechanism that ensures that the process

implemented to collect data has collected the intended data successfully (Wolman and Kruger 2001). It is the extent to which an empirical measure adequately reflects the real meaning of the subject under investigation. Validity is important in analyzing the appropriateness, meaningfulness and usefulness of research findings Babbie (2011).

Validity of an instrument is measured as an index – content validity index (CVI). Therefore, the level of accuracy of the instruments will be determined through consultation with the supervisors and computation of content validity index (CVI), an indicator of level of accuracy of instrument. The supervisor will be requested to rate the items in the instrument as Very Relevant (VR), Relevant (R), Note Relevant (NR) and Somewhat Relevant (SWR). Validity Index (CVI) is here by presented as

$\frac{CVI=VR+R}{TOTAL}$ Where, CVI = VR (Very Relevant); R = Relevant; NR=Not Relevant; and SWR=somewhat Relevant

The CVI obtained will be interpreted basing on the scale designed by George and Mallery (2003). This shall be done before the process of data collection commences.

George and Mallery (2003) provide the following rules of thumb as:
"> .9 – Excellent, > .8 – Good, _ > .7 – Acceptable, _ > .6 – Questionable, _ > .5 – Poor, and _ < .5 – Unacceptable" (p. 231).

On the other hand, reliability is dependability (Amin, 2005), repeatability or consistency of findings (Mugenda and Mugenda, 1999). It's a measure of the level of consistency of an instrument. In this study, reliability will be assessed by piloting the instrument and computing the reliability coefficient using Pearson formula. The value of reliability coefficient will be interpreted basing on George and Mallery scale as in Validity.

Pearson's correlation is computed by dividing the sum of the xy column (Σxy) by the square root of the product of the sum of the x^2 column (Σx^2) and the sum of the y^2 column (Σy^2). The resulting formula is:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{\left[n\sum x^2 - (\sum x)^2\right]\left[n\sum y^2 - (\sum y)^2\right]}}$$

Where,
r = Pearson correlation coefficient
x = Values in first set of data
y = Values in second set of data
n = Total number of values.

The value of reliability from the above formula is half since there is splitting of the items in the questionnaire. Therefore to reconstitute the computation of correlation, the spearman Brown correction formula will be used. The formula is given below

$$p = \frac{2r}{1 + r}$$

The values obtained from the spearman brown formula shall be interpreted basing of George and Mallery scale.

3.1.7 Ethical Issus

Ethical issues shall fully be addressed during the processes of data collection administration and analysis. A through introduction of the researcher shall be done and the purpose of the study shall be fully explained to the respondents to enable them resolve any potential problems that may arise from the misconception of the topic and purpose of the study. The researcher shall ensure that the respondents are assured of anonymity and confidentiality. This is to ensure trust

and openness during the interview process. Communication of confidentiality to the respondents and obtaining their consent is a key ethical issue (Sharlene and Laevy, 2011). During interviews especially with the political and technical officials, I will seek the mandate of the senior members of staff to introduce me to the lower leaders as a matter of procedure.

3.1.8 Procedure of Data Collection

The data collection procedure shall start with the designing the Research instruments. These are the tools meant to translate attributes of a phenomenon to quantities (Amin, 2005). These instruments shall be tested for validity and reliability, to eliminate ambiguous instructions to respondents and to ensure accuracy in coding (Mugenda and Mugenda, 1999). The researcher shall select the sample for the study which shall be determined using Slovene's formula (Amin, 2005) as explained in 3.1.4 above in order to reduce personal bias.

The letters of introduction to the field shall then be solicited from the University and this shall be preceded by making appointments with respondents. The researcher shall then identify and training research assistants on how the data collection will be done analyzed and finally report writing. The training helps to minimize variations in data collection procedures (Mugenda and Mugenda, 1999). The researcher shall then move ahead to collect data, both quantitatively and qualitatively. After the researcher has met his goal of size of sample, the data analysis shall then proceed.

3.1.9 Data Analysis

Both qualitative and quantitative methods shall be used in the analysis of the data collected. The data shall be cleaned, coded and analyzed thematically by use of descriptive and inferential

statistics generated by Statistical Package for Social Science (SPSS) to generate descriptive statistics ie mean standard deviation and then use regression as inferential statistics (Amin, 2005) in order to determine the level of appropriateness of the EWS in management of CCI

3.1.10 Measurements of Variables (Quantitative Studies)

Measurement will be based on scales derived from the Liekert scale such that 3.1-4.0= SA and the interpretation is Very Appropriate; 2.1-3.0= Agree meaning appropriate; 1.2-2.0= disagree, meaning moderate; 0.1-1.0= Strongly Disagree meaning Not appropriate. This scale will be used to measure the means derived from the questionnaire.

The Second scale and measurement shall be that of George and Mallery which is 0.9-1.0 meaning excellent; 0.8-0.89, meaning Good; 0.7-0.79, meaning acceptable; 0.6-0.69, meaning low and below 0.59 meaning not acceptable. This will be used in measuring the level of validity, reliability, and coefficient.

In order to interpreter regression, the value obtained will be interpreted basing on the standard value of 0.005. Any value obtained which is less than 0.005 means there is a significant effect of the EWS and any value above 0.005 shall mean that there is no significant effect of EWS.

REFERENCES

Abebe, G.A. (2013). Quantifying Urban Growth partner in developing Countries using Remote sensing and spatial metrics; A case of Kampala.

Adera, E. & Finlay A. (nd) Developing Country Experiences and Emerging Research priorities; Application of ICTs for Climate Change Adaption in the water sector.

Al-Mahdi A.M. & Maina, M.L (2013). The Role of GIS and Remote Sensing in Mapping the Distribution of Greenhouse Gases, European Scientific Journal December 2013 edition vol.9, No.36

Amin, E.M. (2005). Social Science Reserch; Concepts, Methodology & Analysis, Makerere University, Kampala.

ARCC (2013). Uganda Climate Change, Vulnerability Assessment Report, African and Latin American Resilience to Climate Change Project.

Atuyambe, L.M. Ediau, M. Orach C.G. Musenero, M. & Bazeyo, W. (2011) Land slide disaster in eastern Uganda: rapid assessment of water, sanitation and hygiene situation in Bulucheke camp, Bududa district

Babbie, E, (2011) The Basics of Social Research, Amazon.

Bamdad N (2005). The Role of Community Knowledge in Disaster Management: The Bam Earthquake Lesson in Iran, Institute of Management and Planning Studies, 10 Mokhtar Asgari St, Niavaran: Tehran.

Bartosz . B., Kasztelnikb, M., Bubaka, M., Bartynskib, T., Gubałab, T., Nowakowskib, P., Broekhuijsenc, J. (2011). The Urban Flood Common Information Space for Early Warning Systems: International Conference on Computational Science, ICCS, Procedia Computer Science, Elsevier 96–105

Baxter. J. F. (2000). Early warning detection and notification network for environmental Conditions.

Bellomo R. (2012). Well-implemented Early Warning Scores can help Rapid Response Teams in improving outcomes: Philips Healthcare

Blast, T.L (2010). Seven Theories of Climate Change: why Climate change? What is Man's Role? What do leading scientists Believe? Chicago, Illinois.

Bouwer, L. M. (2011). Have Disaster losses increased due to anthropogenic climate change?

American Meteorological Society, DOI:10.1175/2010BAMS3092.1

Cargata, P. J. (1999). Business Early Warning Systems – A guide for managers, executives & Investors, Butterworths

Carol S. North, C.S Betty Pfefferbaum, Barry A. Hong, Mollie R. Gordon, You-Seung Kim,

Cetina, Z., Nadim, F., (2008). Stochastic design of an early warning system. Georisk:

Assessment and Management of Risk for Engineered Systems and Geohazards, 2: 223–236.

Chatfield, A.T. Scholl, H.J. Brajawidagda, U. (2013). Tsunami early warnings via Twitter in government: Net-savvy citizens' co-production of time-critical public information services, Government Information Quarterly 30 (2013) 377–386.

Chatham, A. C., Defrancisco, V. P., Hall T., Martin, C.R, Palczewski, C.H. (n.d). Foundations of

Communication Research Methods: Qualitative, Quantitative & Rhetorical Approaches to the Study of Communication

Chuvieco, E. (2008) Earth Observation of Global Change; The Role of Satellite Remote Sensing

in Monitoring,the Global Environment, International Efforts on Global Change Research, Springer, University of Alcalá.

Climate and Development Knowledge Network (2012) Managing climate extremes and disasters in Africa: Lessons from the SREX report. CDKN: available online at www.cdkn.org/srex.

Chuancheng, Z. Shuxia, Y. Yongjian, D. Baisheng, Y. Jian, W. (2011) A Improvement Method for Combined Satellite and Rain Gauge of Precipitation over Qinghai, International Conference on Asia Agriculture and Animal, VOL. 13, IACSIT Press.

Chuvieco, E. (2008) Earth Observation of Global Change; The Role of Satellite Remote Sensing in Monitoring the Global Environment, International Efforts on Global Change Research, Springer, University of Alcalá.

Claude, H. Bradley M. J. Adame, S. Moore, D. (2013). Vested Interest theory and disaster

Preparedness Disasters, Vol. 37 Issue 1

Collins, A.E (2012). Applications of the disaster risk reduction approach to migration influenced by environmental change, Environmental Science and Policy Issue 27 Elsevier Ltd

Coning, E. & Poolman, E. (2011). South African Weather Service operational satellite based precipitation estimation technique: applications and improvements, Hydrology and Earth System Sciences.

Conner, J. R. (1991). A Historical Comparison of the Resource-Based Theory and Five Schools of Thought Within Industrial Organization Economics: Do We Have a New Theory of the Firm? Journal of Management (17:1), 1991, pp. 121-154.

Dangermond, J. & Matt, A. (2010). Climate Change is a Geographic problem; the Geographic Approcahe to Climate Change,

Davenport, T., and Prusak, L. (1998). Working Knowledge. Boston: Harvard Business School Press.

Denzin, N.K. & Lincoln, Y.S, (2003). Collecting and Interpreting Qualitative Materials, the third volume in the paperback version of the Handbook of Qualitative Research, 2nd Edition, SAGE Publications, London.

DKKV, (2011). Adaptive Disaster Risk Reduction – Enhancing Methods and Tools of Disaster Risk Reduction in the light of Climate Change. DKKV Publication Series no. 43, German Committee for Disaster Reduction, Bonn, Germany, www.dkkv.org/de/publications/schriftenreihe.asp?h=5.

Doberstern, B. & Stager, H. (2013). Towards guidelines for post-disaster vulnerability reduction in informal Settlements Disasters, Vol 37 Issue 1

Drabek, T. E., (2004). Theories Relevant to Emergency Management Versus a Theory of Emergency Management: A paper presented at the annual Emergency Management Higher Education Conference, National Emergency Training Centre, Emmetsburg, Maryland, June.

El-Sayed, E.A. & Habib, E. (2008). Advanced Technique for Rainfall-Runoff Simulation in Arid Catchments Sinai, Egypt, The 3rd International Conference on Water Resources and Arid Environments and the 1st Arab Water Forum

Entwicklung, J.C. & Ländlicher raum, (2006). Early Warning Systems in the context of Disaster Risk Management

EWC11 (2004). Early Warning as a Matter of Policy; The Conclusions of the Second International Conference on Early Warning 16-18 October 2003, Bonn, Germany.

FEMA (2010) .Community Resilience through Civic Responsibility and Self-Reliance: Citizen Preparedness; Bringing Youth Preparedness Education to the Forefront: A Literature Review and Recommendations, Washington. www.citizencorps.gov

Flanagan, J. (1999). Area warning system for earthquakes and other natural disasters

Formo, R.K., & Padegimas, B. (2012). Feasibility study Report; Mt. Elgon landslide Information Needs;Landslide Hazards Program. http://landslides.usgs.gov/learning/prepare/

Gaytán, A. & Johnson, A. C. (2002) .A Review of the Literature on Early Warning Systems for Banking crises: Central Bank of Chile Working Papers N° 183.

Georgaka, D. Mparmparousi, R.N. Vitos, RN. (2012) Early Warning Systems: Hospital Chronicles, VOL.7, Supplement 1: 37–43.

George, D. & Mallery, P. (ED) (2003). SPSS for Windows Step by Step; A simple Guide and Reference, *11.0 update* (4th ed.). Boston: Allyn & Bacon.

Grant, M.G. (1996). towards a knowledge based Theory of the Firm. Strategic Management Journal, Vol. 17, Issue: (winter special) Knowledge and the firm, 109-122.

Grasso, V.F. (n.d) Draft report United Nations Environment Programme (UNEP) Early Warning Systems: State-of-Art Analysis and Future Directions.

Golnaraghi, M., (2009) Global assessment report on disaster reduction thematic progress Review subcomponent on early warning systems, WMO.

Grassl, H. (2009) Climate Change and Human Health: Extreme Environmental Events Complexity in Forecasting and Early Warning.

Hakam, S. (2012). Acts of God and Acts of Nature: A Short History of Natural Disasters in China.http://saifulhakam.blogspot.com/2011/01/acts-of-god-and-acts-of-nature-short.html.

Hedin, H. & Kovero, K. 2006) Does Your Business Radar Work? Early Warning/Opportunity Systems for Intelligence GIA White paper 1.

Himayatullah, K., Giurca, L., and Asmatullah, K. (2008). The Disaster Management Cycle- A Theoretical Approach. www.mnmk.ro/documents/2008/2008-6.pdf.

Hallegatte, M. (2012). A cost Effective Solution to Reduce Disaster Losses in Developing Countries. Hydro-Meteorological Services, Early Warning, and Evacuation, Policy Research Paper, 6058.

Haque C. E, & Uddin, M. S. (2013). Disaster Management Discourse in Bangladesh: A Shift from Post-Event Response to the Preparedness and Mitigation Approach Through Institutional Partnerships, Natural Resources Institute, University of Manitoba, Winnipeg

Hewitt, K. (1983a), "The idea of calamity in a technocratic age", in Hewitt, K. (Ed.), Interpretations of Calamity: From the Viewpoint of Human Ecology, Allen & Unwin, Boston, MA, pp. 3-32.

Hissel, F. Morel Morel, G., Pescaroli, G., Graaff, H., Felts, D., Pietrantoni, L., (2013). Early warning and mass evacuation in coastal cities, Coastal Engineering, Elsevier. http://dx.doi.org/10.1016/ j.coastaleng.2013.11.015

IFRC (2012). Community Early Warning Systems: Guiding principles. www.ifrc.org

IFRC (2012) Disaster Risk Reduction mapping Increasing investment in building community Resilience. www.ifrc.org.

IFRC & RCS, (2000) Introduction to Disaster Preparedness: disaster preparedness Training Programme

IIDE. (2009). Participatory Learning and Community based adaption to Climate Change, Russell Press, Nottingham.

IRC (2009). World's Disasters Report: Focus on Early Warning, Early Action. www.irc.org.

IRC (2011) International Disaster Response Law; An analysis of Uganda's legal preparedness for regulatory issues in international disaster response, www.ifrc.org

ISDR (2009) Global Assessment Report on Disaster Risk Reduction. United Nations, Geneva, Switzerland.

Intrieri et al (2012). Design and implementation of a landslide early warning system, Engineering Geology, pages 124-136, Elsevier.

International Security, Peace, Development and Environment (n.d). – Vol. II Jacobs, K. & Wilbanks, T. (2010) Adapting to the impacts of climate change, National Research council, Washington DC. Available at http://www.nap.edu/catalog/12783.html

Jackman, A.M. and Beruvides, M.G. (2013) Hazard Mitigation Planning in the United States: Historical Perspectives, Cultural Influences, and Current Challenges

Jha, A.K. Barenstein, Duyne, J. Phelps, Priscilla M., Pittet, D., Sena, S. (2010). Safer Homes, Stronger

Communities: A Handbook for Reconstructing after Natural Disasters. World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/2409 License: CC BY 3.0 IGO."

Jonassen (2001). Handbook of Research for Educational Communications and Technology; A

Project of the Association for Educational Communications and Technology

Karen, I. & Sudmeier, R. (2013). Resilience – an emerging paradigm of danger or of hope?

Article type: Conceptual paper

Keys, H.J.R. (2007). Lahars of Ruapehu Volcano, New Zealand, and risk mitigation. Annals of Glaciology 45, 155–162.

Kitutu, M. G. Muwanga, A. Poesen, J. & Deckers, J.A. (2011). Farmer's perception on landslide occurrences in Bududa District, Eastern Uganda; African Journal of Agricultural Research Vol. 6(1), pp. 7-18

Kirk, R. (n.d).Disaster, Planning and Development: Managing Natural Hazards to Reduce Loss, Washington, D.C.

Kothari, C. R. (Eds.).(2004). Research Methodology, Methods and Techniques. New Delhi. New

International Publishers.

Knapen A., Kitutu M.G., Poesen, Breugelmans, W. Deckers, J., Muwanga A. (2005) Landslides in a denselypopulated county at the footslopes of Mount Elgon (Uganda): Characteristics and causal factors; Geomophology 73, 149-165

Kreps, A. G., Berke, p., Birkland, T., Chang, S., (2006). Facing Hazards and Disasters;

Understanding Human Dimensions, Washington: National Academic Press.

Lacruz, L., Serrano, V., Moreno, L., Beguería, S. García J. & Cuadrat, M. (2010). The impact of droughts and water management on various hydrological systems in the headwaters of the Tagus River (central Spain), Spanish Research Council.

Laszlo, A., & Krippner, S. (1998). Systems Theories: Their Origins, Foundations, and Development. In Jordan (Ed.), Systems Theories and A Priori Aspects of Perception Amsterdam: Elsevier, pp. 47-74.

Lavell, A., M. Oppenheimer, C. Diop, J. Hess, R. Lempert, J. Li, R. Muir-Wood, and S. Myeong,

2012). Climate Change: New Dimensions in Disaster Risk, Exposure, Vulnerability, and Resilience.

Lavell, A. (2008). Relationships between Local and Community Disaster Risk Management & Poverty Reduction: A Preliminary Exploration for ISDR, Global Assessment Report on Disaster Risk Reduction

Lawal, M., Salau, S. A. and Saka, A.Y. (2012). Assessment of Vulnerability of Farming Households to

Climate Change In Ekiti, State, Nigeria, Ethiopian Journal of Environmental Studies and Management EJESM Vol. 5 No. 2.

Leonard S.G, Johnston, M.D., Paton D., Christianson A, Becker J., Keys, H. (2008). Developing effective warning systems: Ongoing research at Ruapehu volcano, New Zealand; Journal of Volcanology and Geothermal Research, Elsevier 172, 199–215.

Lisa, L. & Pollio, D. E. (2013). Workplace response of companies exposed to the 9/11 World

Trade Center attack: a focus-group study Disasters, Vol 37 Issue 1

Lisette, M. B., Maarten, K. Van. A., Mason. S.J., Suarez, P., Chellouche, Y. A., Tall, A. (2013).

Climate forecasts in disaster management: Red Cross flood operations in West Africa, 2008 Disasters, Vol 37 Issue 1

Löwe, P. Wächter, J. Hammitzsch, M. Lendholt M. & Häner, R. (2013). The Evolution of Disaster Early Warning Systems in the TRIDEC Project, Centre for Geo-information Technology, GFZ German Research Centre for Geosciences, Potsdam

Pearson. P. (2012). Early Warning of Disasters: Facts and figures, Science Development Network McMillan R. C. (1998), Natural Disasters: Prepare, Mitigate, and Manage,

Maslow, A. (1943). A theory of Human Motivation.

Mastrandrea, M.D. & Schneider S. H, (2010). Preparing for Climate Change, London: Cambridge Mass.

Masato, M. (2008). Application of Earthquake Early Warning Systems for Disaster Prevention In Schools, the 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China.

Mauritius (2011). National progress report on the implementation of the Hyogo Framework for Action

Mbogga, M.S. (2012) Climate Profiles and Climate Change Vulnerability Assessment for the Mbale Region of Uganda. Report to the TACC Project, UNDP, Uganda.

Meier, P.P. (2009). Disaster Theory for Techies, http://irevolution.net/2009/05/15/disaster-theory-for-techies

Maidment, R.I., Grimes, D. I. F. Allan, R. P. Greatrex, H. Rojasb, O. & Leob, O. (2012).

Evaluation of Satellite-based and model re-analysis rainfall estimates for Uganda, Royal Meteorological Society.

McEntire, D.A. (2004) Development, disasters and vulnerability: a discussion of divergent theories and the need for their integration; Disaster Prevention and Management, Volume 13 · Number 3, Texas, 193-198.

Messinger, D., McKeown, D., Raqueño, N., (2011). Remote sensing aid to the Japanese

Earthquake and tsunami relief effort.

Meyers R.A. (2009). Extreme Environmental Events Complexity in Forecasting and Early Warning

Miles, M. B., & Huberman, M. A. (1994): "Qualitative Data Analysis: An Expanded

`Source book" (2nd edition). Beverley Hills, Sage.

Mileti, D.S. (1999), Disasters by Design: A Reassessment of Natural Hazards in the United States, Joseph Henry Press, Washington, DC.

Mugenda O. M & Mugenda A.G (1999). Research Methods; Qualitative and Quantitative Approaches, ACTS, Nairobi

Mohanty, S., Panda, B., Karelia, P., Isaar, R. (n.d) Knowledge Management in Disaster Risk Reduction- the Indian Approach

Muwembe, K.Y. (2011). The Uganda Meteorological Services Data Observations, Management, Seasonal Forecasting and Early Warning System for Extremes, Uganda Department of Meteorology, Kampala

Mulyasari, F., Takeuchi, Y. and Shaw, R., (2008). Implementation Tools for Disaster Education

NDMICS (2012) National Disaster Management Guidelines National Disaster Management Information and Communication System, Enclave, New Delhi

NOAA (2010). Flash flood Early Warning System reference guide, University Corporation for Atmospheric Research. Available at: www.meted.ucar.edu/hazwarnsys/haz_fflood.php.

Noson, L. (2002). Hazard Mapping and Risk Assessment: Regional Workshop on Best Practices in Disaster Mitigation, Bali, Indonesia. www.adpc.net/audmp/rllw/announcement2.pdf

Ogbuene, E. B. (2010). Impact of Meteorological Parameters on Rice Yield: An Approach for Environmental Resource Sustainability in Ebonyi Rice Farmland, Nigeria, Journal of Environmental Issues and Agriculture in Developing Countries, Volume 2 Numbers 2 & 3,

OPM (2013). www.unisdr.org/files/32476_opmpresentation.pdf

Orindi, O. V. & Eriksen, S. (2005). Mainstreaming adaptation to Climate Change in the Development process in Uganda, African Centre for Technology Studies (ACTS) Eco policy Series no. 15

Ouayoro, E. & Bannon, I. (2008). The Report on the status of Disaster Risk Reduction in Sub-Saharan Africa Region.

Phaiju, A., Bej, B., Pokharel, S., Dons, U. (2010). Establishing Community Based Early Warning Systems, Practitioners Handbook, Mercy Corps and Practical Action**,** Kathmandu, Nepal

Pierdicca, N. (2002). Bayesian Techniques in Remote Sensing; Remote Sensing of Atmosphere and Ocean from Space: Models, Instruments and Techniques, Vol. 13 Dept. Electronic Engineering, University "La Sapienza" of Rome.

Podvig, P. (2002) .History and the Current Status of the Russian Early-Warning System, Science and Global Security, Taylor and Francis

Pollner, J. Watson, J. K. Nieuwejaar, S. (2010) Disaster Risk Management and Climate Change Adaptation in Europe and Central Asia, Sustainable Development Department, World Bank.

Quinn, T. (2012). The Importance of Cultural Competency in Emergency Management under medical Reserve Corps.

Ravindranath, N.H. & Sathaye, J. A. (2002). Climate Change and developing countries; Advances in Global Change Researches, Kluwer, London.

Rudloff, A., Lauterjung, J., Munch, U., Tinti, S., (2009). The GITEWS project Germane Indonesian Tsunami Early Warning System). Natural Hazards and Earth System Sciences 9, 1381-1382

Ruhanga, I., A. and Manyindo, J. (2010). Uganda's Environment and Natural Resources:

Enhancing Parliament's oversight, UWS/UNEP, Barklend Trykeri. Available on www.grida.no and on www.uws.or.ug

Rodriguez, E. and Edwards, J. S. (2008). Before and After Modeling: Risk Knowledge Management is required

Rosenzweig, J. (2009). Climate Change and Agriculture: Extreme Environmental Events Complexity inForecasting and Early Warning, Springer, New Yolk.

Rouhban, B. (2007), "Knowledge Management and Education for Disaster Reduction" at: http://www.environmenttimes.net/article.cfm?pageID=142

Saad, M., Mazem, S., Ezzart, E., Zaher, H. (2013). Towards a Conceptual Framework for Early Warning Information Systems (EWIS) for Crisis Preparedness; Advances in Intelligent Systems and Computing Volume 206 2013, pp 523-534, Springer.

Sarantakos, S. (1998). Social Research (second edition ed.). Melbourne: MacMillan Education.

Senthi Vadivel , S. Bhupatthi Rav (2010) Disaster Management: A Global Issue, International Journal of Civil and Structural Engineering Volume 1, No 1, 2010.

Sergio, M., Serrano, V., Beguer´ıa, S. L´opez-Moreno, J., Garc´ıa-Verac, M. & Stepanekd, P. (2010). A complete daily precipitation database for northeast Spain: reconstruction, quality control, and homogeneity, International Journal of Climatology, 1146–1163.

Selves, M. D (n.d). The Politics of Disaster; Principles for Local Emergency Managers and Elected Officials

Shaw R, Uy, N., Baumwoll, J. (2008) Indigenous Knowledge for Disaster Risk Reduction: Good Practices and Lessons Learned from Experiences in the Asia-Pacific Region, Bankok.

Shaw, R., Shiwaku, K., Takeuchi, Y. (2011) Community, Environment and Disaster Risk Management Vol. 7; Disaster Education, Emerald, Bingley BD16 1WA, UK

Sivakumar, M.V.K. (2006). Dissemination and communication of agro-meteorological Information—global perspectives; World Meteorological Organization, 21–30

Skoufias, E., Rabassa, M., Sergio, O., Brahmbhatt. M. (2011). The Poverty Impacts of Climate Change. World Bank, Washington, DC. Available at www.openknowledge.worldbank.org

Stacy L. P., Collins, M.L. (2013). Disaster management and the critical thinking skills of local

Emergency managers: correlations with age, gender, education, and years in occupation Disasters, Vol. 37 Issue System, Science and Global Security, Vol. 10 no. 1, page(s) 21-60

Stevens, M. (2003). Selected Qualitative methods, Interactive Textbook on clinical Research.

http://painconsortium.nih.gov/symptomresearch/links.htm

Stichweh, R., (2002). Inclusion/Exclusion and Socio-cultural Identities: Systems Theoretical and Poststructuralist Perspectives, Stuttgart.

Subbiah A.R., Bildan, L., Narasimhan, R., (2008) Background Paper on Assessment of the Economics of Early Warning Systems for Disaster Risk Reduction

Summers, M. (2009). Solving the Puzzle: Researching the impacts of climate change, around the world, National Research Council, Washington DC

Supper, R. & Baron, I. (2010). Land slide Monitoring Technologies and Early Warning Systems; Current Research and Perspectives for the Future. GGeological survey of Austria

Symeonakis, E., Bonifacio, R., & Drake, D., (2008).Validation of Satellite and Rain-Gauge Data for Parameterising A SoilErosion Model For Sub-Saharan Africa, International Archives of Photogrammetry and Remote Sensing.

Teisberg , T. J. & Weiher, F. R. (2009). Background Paper on the Benefits and Costs of Early Warning Systems for Major Natural Hazards.

Thomalla, F. & Larsen R. (2010). Resilience in the context of tsunami early warning systems and Community disaster preparedness in the Indian Ocean Region; Environmental Hazards, Human and Policy Dimensions, Research Paper 9 pp 249–265.

Uganda (2011) Policy Briefs: Climate change, Environment and Human Welfare: Lessons Learned From The Lake Kyoga Catchment Area, Nairobi

Tol, R.S (2009). Climate Change, Economic Costs of Extreme Environmental Events Complexity in Forecasting and Early Warning, Springer New Yolk.

UNEP (2012). Early Warning Systems: A State of the Art Analysis and Future Directions: Division of Early Warning and Assessment (DEWA), United Nations Environment Programme (UNEP), Nairobi.

UNEP (2013). 2012 Annual Report: available at www.unep.org/annual report

UNDP (2013). Crisis Prevention and Recovery. Available at www.undp.org/cpr

UNISDR and WMO (2012). The Role of Hydro meteorological Services in Disaster Risk

Management, Washington, DC.

Victoria, L.P (n.d). Community Based Approaches to Disaster Mitigation; Center for Disaster Preparedness.

Van Aalst, M.K., T. Cannon, and I. Burton, (2008). Community level adaptation to climate change: The potential role of participatory community risk assessment. Global Environmental Change, 18, 165-179.

Van Westen (2000). Remote sensing for Disaster Management, International Institute for Aerospace Survey and Earth Sciences, ITC, Vol. XXX111, The Netherlands Division of Applied Geomorphologic Surveys.

Vila, D, Garcia, L. C. (2009). Application of a Combined Daily Rain Gauges and Rainfall Satellite Estimates Scheme for Basin Management.

Von Bertalanffy, L. (1968). General System Theory: Foundations, Development, Applications, New York: George Braziller.

Von Deck, T (2007). Remote Sensing for Disaster prediction, detection, Response and Relief, Workshop on the Role of Telecommunications/ICT in Disaster Mitigation Bandung, Indonesia 28 March 2007

Von Elverfeldt, K. (2012). System Theory in Geomorphology Challenges, Epistemological Consequences and Practical Implications, Springer.

Wattegama, C. (2007) ICT for Disaster Management/ICT for Disaster Prevention, Mitigation and Preparedness:www.en.wikibooks.org/wiki/ICT_for_Disaster_Management/ICT_for_Disaster_Prevention,_Mitig...

WMO (2013). Summary of Current Climate Change Findings and Figures, WMO,

Yazdanipour, M. (2012). Survey on Disaster Management in Developing Countries and Developed Countries, Proc. of the Intl. Conf. on Advances in Electronics, Electrical and Computer Science Engineering.