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ROLE OF GOVERNMENT AND COMMUNITY IN LANDSLIDE RISK AND VULNERABILITY REDUCTION: A CASE STUDY OF GAKENKE DISTRICT, RWANDA.

BY

JEAN FELIX NIZEYIMANA

(10640196)

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DECLARATION

I declare that this work entitled "Role of government and community in landslide risk and vulnerability reduction": a case study of Gakenke District, Rwanda is my work and it has not been presented or submitted for any degree in any other institution or University.

Jean Felix Nizeyimana

Signature ……

Date 22-10-2020 ……

MAIN SUPERVISOR

Dr. Jesse Sey Ayivor  ……

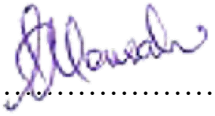
Signature

22-10-2020

Date

CO-SUPERVISOR

Dr Adelina Maria Mensah



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22/10/2020 …….

Date

DEDICATION

I dedicate this work to my family, especially to my beloved mother Uwamaliya Clémence

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I am honored to have Dr. Jesse Sey Ayivor and Dr. Adelina Maria Mensah as my supervisors whose constant valuable suggestions and inputs have added worth to my study. I am also very thankful to Intra- ACP through TRECCAFRICA programme which supported me financially to undertake this academic programme. I am very grateful to IESS staffs for the quality knowledge they provided to me and the love and kindness showed me during the academic period. I am also thankful to several individuals who came across my path during the completion of this research. I am grateful to him. I would like to thank everyone who helped me to climb the Gakenke's hills and assisted me in data collection. I also owe a note of appreciation to the participants from Gakenke District, for the valuable information they shared with during fieldwork.

ABSTRACT

The frequency and the severity of landslides have increased in recent times globally, with serious implications for human lives and property, as well as national economies. In many disaster response initiatives, community-based disaster management approach is adopted as a quick solution to emergency response. This study was carried out in Gakenke District in the Northern Province of Rwanda, which is highly prone to landslide disasters. It investigated the role of government and local communities in landslide risk and vulnerability reduction. Quantitative and qualitative data were obtained from structured questionnaires, interviews and on-site observation. In total, 180 respondents participated in the questionnaire administration and an additional 10 disaster managers in interviews sessions. Quantitative data were input into SPSS software and analyzed using Chi-square and graphical techniques, while qualitative data was analyzed using content analysis technique. The study revealed that communities of Gakenke District have basic knowledge about landslides including warning signals, causes and effects of landslide disasters, as well as mitigation measures. Over half (54.71%) of respondents pointed to torrential rainfall as the main warning sign for the occurrence landslides in the district, The study revealed also that the major reasons for vulnerability to landslides are poverty, lack of awareness, sitting of buildings on sloppy areas, deforestation, quarrying activities and inappropriate building codes. The results further showed that though 94.71% of respondents were aware of areas classified as landslide-prone areas, as much as 31.29% still settled in these areas. On community/ government collaboration, 97.06% of the respondents confirmed that they collaborate with local government officials at different levels regarding landslide risk reduction. One major conclusion was that the communities and local government officials collaborate extensively at different levels to address issues related to landslide disaster awareness, emergency response and measure to reduce disaster risks. This collaboration has helped in reducing landslide disaster impacts in the Gakenke District.

LIST OF ABBREVIATION AND ACRONYMS

ADPC	Asian Disaster Preparedness Center
AU	African Union
CBDRR	Community Based in Disaster Risk Reduction
DDMC	District Disaster Management Committee
DDP	District Development Plan
DRC	Democratic Republic of Congo
DRR	Disaster Risk Reduction
FAO	Food and Agriculture Organization
HFA	Hyogo Framework for Action
IEDM	International Environmental and Disaster Management
IIRR	International Institute of Rural Reconstruction
ISDR	International Strategy for Disaster Reduction
JICA	Japan International Cooperation Agency
MIDIMAR	Ministry of Disaster Management and Refugee Affair
MINIRENA	Ministry of Natural Resources
NDMEC	National Disaster Management Executive Committee
NDMTC	National Disaster Management Technical Committee
NEMA	National Environmental Management Authority
NGOs	Non-Governmental Organizations
NISR	National Institute of Statistic of Rwanda
NSDRM	National Strategy for Disaster Risk Management

NSMP	Nation Slope Master Plan
SDMC	Sector Disaster Management Committee
SPSS	Statistical Package for Social Sciences
TVET	Technical and Vocational Education and Training
UNDP	United National Development Programme
UNISDR	United Nations International Strategy for Disaster Reduction
USA	United States of America
USGS	United States Geological Survey
VUSSC	Virtual University for Small States of the Commonwealth

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CHAPTER ONE: GENERAL INTRODUCTION

1.1 Background

Landslides occur all over the world both in developed and developing countries (ISDR, 2015). The term landslide is defined as the downhill movement of earth materials, ranging from rapidly moving rock and debris flows on mountainous regions to more slowly moving earth slides and other ground failures (Maina- Gichara et al., 2013). The main causes of landslide are geological factors, physical factors, morphological factors, and human-associated activities. These factors have a great influence on gravitational force, which has the tendency of pulling materials vertically downward (Usamah, 2017). Landslides result in vulnerability risk on nearby communities, with potential negative impacts on human lives, property and national economies. Vulnerability is defined as the capacity of individuals or communities to mitigate cope with, anticipate and recover to the impacts of landslide (Amaratunga &Pathirage, 2010). Vulnerability risk can be minimize by increasing awareness, adopting land use planning and educating communities on early warning and preparedness. Disaster risk management refers to systematic process of using administrative decisions, employing operational skills of organizations and building capacities to implement policies, strategies and coping of the community to reduce the impacts of disasters (NEMA, 2012). Landslide Risk is also defined as combination of the probability of a landslide to happen as well as its negative impacts to the communities and environment (WHO, 2015).

Birkmann (2006), reported that over the decades, disasters have affected more than 3 billion people. More than 750,000 people were killed, and properties valued at approximately US$ 600 billion were damaged and these are alarming statistics considering that the full impacts of natural disasters are not always documented. According to Nsengiyumva et al., (2018), landslides are the

third most dangerous disaster in the world because of the number of deaths and destructions associated with them. According to USGS (2011), around 30,000 lives were lost to landslides worldwide between 2004 and 2010, and in the USA alone, between 25 and 50 people lose their lives as a result of landslides every year. Furthermore, in 2015, 4,369 people globally were killed by landslides, with 150,332 directly or indirectly affected. The death toll in 2016 increased to 32,322 (Mcadoo et al., 2018). In Sri Lanka which is prone to landslides, 50,000 people have been affected by landslides within the past five years (Mcadoo et al., 2018). In Asia, statistics show that landslides increased more than five times since the 1970s. Landslides totaling 88 were counted between 2000 and 2009 which resulted in the deaths of 5,367 people (Keith & Jeremy, 2013).

Landslides are usually triggered without warning signs, giving less time to prepare, resulting in the direct impact on communities. Landslides cause a significant loss of life and destruction of agricultural lands, infrastructure, and houses. Economic losses have been increasing over the years mainly due to increasing investment in landslide high-risk zones and increased unplanned development (Perera et al., 2018). Landslides also have geomorphologic and socio-economic impacts (Inagaki & Sadohara, 2006). Their occurrence leads to soil degradation, which in turn, affects agricultural production. Low productivity in agriculture affects livelihoods and this can also lead to poverty and other social-economic impacts (ADPC, 2003). In many countries, landslide risk reduction policies and programmes are developed and implemented at different levels to minimize the risks and damages associated with landslides (Graff & Mcconnell, 2016).

According to ISDR (2015), when the strength of a mountain is less than the gravitational force acting on it, landslides may occur. This phenomenon is due to certain internal drivers such as chemical weathering and external forces notably toe cutting, vibrations or seismic and slope

loading (VUSSC, 2007). Other major factors that contribute to landslides include slope angle, land use, geology, rainfall, geomorphology, slope length, drainage density, internal relief, precipitation and seismicity (Nsengiyumva et al., 2018). Landslides can be classified into two categories namely natural and anthropogenic (Maina-Gichaba, 2013). Some of anthropogenic activities leading to landslides include deforestation, poor mining activities, hill cutting, irrigation of paddy fields and poor water storage ponds (Tanya et al., 2001). The risk of the landslide is influenced by the duration, intensity, and frequency of rainfall (Malcolmg et al., 2013).

Landslide disasters are not equally distributed in all parts of the world as the distribution depends on the geological aspect, population, and amount of rain received and landscape of the regions (Nakileza, et al., 2017). Several areas have been identified as prone to landslides on a global scale. Asia, in particular, has five areas identified as landslide-prone areas such as the Southern edge of Himalaya, Central China, Taiwan, and Indonesia (Keith & Jeremy, 2013) In the USA, the Appalachian Mountains, pacific coastal ranges and the Rocky Mountains are known to be sensitive to landslides (UCGS, 2014). In the Eastern Caribbean, landslides frequently occur in unplanned settlements, cities and rural regions located on mountainous areas (Anderson et al., 2011). In Africa, many regions are identified as landslide-prone areas. These regions are Equatorial Africa, East Africa especially Congo Nile Crest and Rwenzori Mountains, Cameroon Volcanic Line, Elgon regions in Uganda and the Kivu region in Democratic Republic of Congo (Mertens et al., 2018).

The active commitment of a local government is important for disaster risk reduction. Thus, the implementations of policies and involvement of stakeholders are important to minimize landslide risks. This collaboration of government and multi-stakeholders has a greater positive impact on

the reduction of landslide risk through different disaster management phases. These include prevention, preparedness, response, and recovery (ISDR, 2010).

Government plays a central role in landslide risk reduction through its agencies and institution responsible for landslide disaster risk reduction (Amaratunga & Pathirage, 2010). In Hong Kong, for instance, geotechnical control office was established by government to investigate existing slopes which pose a potential risk to life, establish warning system and emergency services, advise on land use plans to minimize landslide risks and control geotechnical aspect of building and civil engineering works (Malone, 2016).

Landslide mitigation and response is thus, a multi-agency and multi-sectoral activity and most governments have established national disaster response agencies, which may be decentralized to regional, district and village levels (Shi, 2012).Government is the first responder and the one responsible for community development and sustainable landslide risk reduction (ISDR, 2010).Government further empowers the local government as a key priority to encourage decision making involving the citizens and key stakeholders at the local level in order to ensure effective implementation of landslide risk reduction measures (Amaratunga & Pathirage, 2010).

The role of community in disaster management can be seen by their involvement in all disaster management phases, as well as their involvement in formation of landslide risk reduction policies, strategies and plans at the local level. Birkmann, (2006) pointed out how communities participate also in rescue and recovery operations, as well fund raising to support victims and rehabilitation activities. The mountainous region of Rwanda is home to 40 percent of the total population of the country. Over 86 percent of populations rely on subsistence agriculture and animal husbandry (DDP, 2013).

Landslides are a major global hazard which frequently occurs in mountainous regions, however, research on its risk and vulnerability reduction is limited. It is against this background that the study seeks to investigate the role of government and community in landslide risk and vulnerability reduction in the Gakenke District in Rwanda.

1.2 Problem statement

The East African Rift Valley has been classified as an area that is vulnerable to landslides because of continuous deforestation, the mountainous nature of the region, high rainfall, growing population, slope disturbance due to mining activities and poor irrigation (Novotny, 2013). Located in Eastern Africa's Rift Valley is the mountainous state of Rwanda, known as a country of a thousand hills. The Congo-Nile Crest divides the drainage system of Rwanda into two parts: the eastern water bodies that flow into the Nile basin and western water bodies, which flow into the Congo basin (MINIRENA, 2004).

The government of Rwanda has the responsibility to coordinate various levels of stakeholders in order to promote landslide risk reduction as well as other disasters because they affect socio-economic activities and the wellbeing of people of Rwanda especially people living in mountainous region of Northern and Southern provinces of the country (Parkash, 2012).

Rwanda is highly exposed to landslide because of its topography, geology and rainfall patterns (Dibanga et al., 2016). The Western, Northern and Southern provinces of the country are highly vulnerable to landslides (MIDIMAR, 2015), with the greatest number of the population exposed to landslides because of the mountainous nature of these provinces. In general, about 40% of the country's population is exposed to landslides of different scales and this includes about 15% who are poor and vulnerable (MIDIMAR, 2013). The districts most affected by landslides include

Nyabihu, Gakenke, Burera, and Ngororero, where the landscape is sloppy and susceptible. In these regions, about 234 health facilities, 1,478 schools, and about 39% to 45% of national transportation networks are exposed to landslides (MIDIMAR, 2015).

In terms of the human population, Rwanda is one of the most densely populated countries in Africa with over 519 persons per km^2, and a population growth rate of 2.45% (NISR, 2018). The increasing population trend is associated with increasing demands for firewood, farmland, land for settlements, and infrastructure development. These activities have direct and indirect effects on land cover, soil and the environment which can lead to landslides (MIDIMAR, 2012a).

The government has a significant role to play in implementing landslide disaster risk reduction initiatives. However several incidents have been reported on inadequate contribution of government in landslide risk and vulnerability reduction activities (Amaratunga & Pathirage, 2010). Government has responsibilities of identifying landslide prone areas, to establish landslide warning system and, emergency services, land use planning and control building and civil engineering works. But some governments do not participate enough in all activities as it should be, which is considered as weakness on their part (Malone, 2016).

Government established master plan of each district, but some of local leaders allow people to build new house on landslide prone areas that leads to increase number of people living in landslide prone areas. Even government has established master plan, set policies and strategies to minimize landslide risk implementation of them is still problem. Once master plan is available, government can implement a disaster prevention measures and make flow up of its implementation (ISDR, 2010).

Culture of settling on grandfather's lands is also contribute on the increase of number of people living on landslide prone areas, people do not want to leave their land because it is the source of their income as more people in Gakenke District rely on agriculture activities. About 86% of the district's populations are farmers, 75% of them operate on their father's land as heritage (DDP, 2013).

Landslide is not uniformly distributed. Some populations and geological areas are more vulnerable than others; this is a case of Gakenke District, the focus of this study. Gakenke District is located in a mountainous region of Rwanda called Congo-Nile Crest. Its altitude ranges from 1700m to 2648m above sea level. This high altitude has invariably contributed to frequent landslide occurrences in this region. Gakenke District covers 704.06 km2 with a population of 345,487 and a population density of 480 per Km^2 (DDP, 2013). The increasing population per surface area contributes to landslides, because it leads to land cover change, increases the burden on soil and disturbance of geological equilibrium which results directly or indirectly to a landslide (NISR, 2018).

In the Gakenke district, the annual rainfall ranges from 1100 mm and 1600 mm per year. Available data indicates that heavy rains are experienced from October to March each year. It is important to note that rainfall coupled with high altitude and geological features is a contributory factor to landslides occurrence in the Gakenke District (DDP, 2013). Records reveal that landslides in the region have affected about 8,000 people from 1963 to 2010 resulting in about 45 deaths and extensive loss of property (Nsengiyumva et al., 2018).

From 2013 to 2016 alone, there have been 174 deaths, 122 injuries and more than 5,000 collapsed houses, as a result of landslides (Nsengiyumva et al., 2018). Several hectares of farmlands were also affected leading to massive loss of crops within the period. Such a condition

stresses the rationale to conduct a detailed landslide susceptibility study for Rwanda to overcome all these losses and curb the impacts (MIDIMAR, 2015).

The role of the government and communities to landslide risk reduction is very important in such vulnerable regions because potential impacts of the landslides. Though reference may have been made about the role of community and local government in landslide risk and vulnerability reduction in the literature; local government has a key role of encouraging the citizens and all key stakeholders at the local level, to ensure effective implementation of disaster risk vulnerability reduction measures, and ensure local disaster information is promptly given to the District Disaster Coordinator also local government involve in enhancing awareness of people about landslide risk reduction (Amaratunga & Pathirage, 2010). Local government also has responsibilities of identifying landslide prone areas, to establish landslide warning system and emergency services, land use planning and control building, and civil engineering works (Malone, 2016).

While community involve in formation of landslide risk reduction policies, strategies and plan. Also They participate in rescue and recovery operations, as well community involve in rising fund for helping affected people and rehabilitation activities (Birkmann, 2006). In Japan, after introducing community based disaster management, community rescues the people lot more than rescuers do. Also local communities participate in implementation and follow up of landslide policies and rescue activities (NEMA, 2012). It appears these efforts are insufficient. This makes it difficult for action to be taken in providing reasonable solutions to landslide related issues because there is no specific landslide risk reduction programme. This research focuses on the role of government and community in landslide risk and vulnerability reduction and investigates

the level of their collaboration with the ultimate aim of recommending policy measures to ensure its effectiveness.

1.3. General Objective

At the general level, the study investigates the role of government and local community members in landslide risk and vulnerability reduction, with a view to enhancing our theoretical understanding of landslide risk reduction and to make recommendations that would inform policy makers about the best strategies to reduce vulnerability and reduce landslide disaster risks.

1.3.1 Specific objectives

The specific objectives of this study are to:

a. investigate community knowledge on pre-disposing factors to landslides in Gakenke district;
b. identify government and community preparedness to landslide disaster events;
c. assess responses of government and communities to landslides risk and vulnerability reduction;
d. establish the level of collaboration between local government and community in landslide risk reduction;

1.4 Research questions

a. Are communities and local leaders aware of landslide occurrences and do they get information on time to reduce the impacts of landslide?
b. Is government and communities collaborating in putting in place appropriate measure and plans in preparedness to landslide risk disaster?
c. What management plans are put in place before, during and after landslide for reducing landslide risk?
d. Are local and community leaders cooperating in efforts to reduce landslide impacts?

1.5 Justification of the study

This research is very important to disaster managers and private institutions in Rwanda because it will equip them with evidence-based information on the role of government and community in landslide risk and vulnerability reduction. Hence, this will help them to achieve a high level of success in landslide management through community-based disaster management. This study will also be very beneficial to many other stakeholders including researchers, universities and the affected communities. The research will contribute also to the reduction of impacts caused by landslides. Based on the findings, it will show how the government and communities collaborate in achieving sustainable management of landslides disasters in Rwanda and other developing countries.

The research also has great significance in enhancing the theoretical understanding of issues related to landslide disaster risk reduction thereby adding to the existing literature. Both qualitative and quantitative data from the research will be made available to the government and thus, serve as a guide in future policy formulation and implementation. It will also serve as

material for both university students and other researchers who may need information and reference for their research in relation to landslide risk reduction and other related fields.

1.6 Definition of key concepts

Landslide: A landslide is defined as the movement of earth forming materials from upper to lower levels of slopes. These materials may move in different forms including falling, sliding, rolling and flowing, either quickly or slowly from one place to another (Florence, 2015*)*. Landslides occur when shear stress exceeds shear strength acting on particular Earth's materials (Wangari, 2011).

Hazards: A disaster is defined as an event that disrupts the functioning of a community or society and causes human, material, and economic or environmental loss that does not exceed the society's ability to cope with using its resources (ISDR, 2015).

Disaster: This is a serious disturbance of the functioning of a community or a society resulting in loss of life, material, and other economic and environmental losses, which exceed the capacity of the affected community to cope using its resources (ISDR, 2010).

Risk: This is the potential of losing something of value such as physical health, social status, emotional well-being or financial wealth that can be lost when an unexpected event takes place in the community (Raya & Lutz, 2014).

Vulnerability: This is defined as a "weakness or diminished capacity of an individual or group to anticipate, cope with, resist and recover from the impact of a natural or man-made hazard conditions (Okoyee, 2000).

1.7 Work outline

This work composed with six chapters, the first chapter is general introduction that presents background of the study, problem of the study, general objectives and specific objective of the study, research questions, and justification of the study and definition of the key concepts.

The second chapter is the literature review that presents the views of researchers about causes, nature and impacts of landslides, and disaster management cycle. It also presents factors contribute to landslide in Rwanda, push and pull factors in landslide prone-areas, landslide resilience measures at the community level, historical landslide in Rwanda, and responsibility of Ministry of disaster Management Refugees Affairs. Chapter two also decentralization management, institution framework for disaster management in Rwanda, the role of community in landslide risk reduction approach, role of government in landslide disaster risk and vulnerability reduction and the theoretical framework of the study.

Chapter three is the research methodology. It presents the study area, research design, study population, sample size determination, sample collection technique, data collection technique, data processing, and analysis techniques and limitation to the study.

Chapter four is the analysis and interpretation of the findings. It presents a profile of respondents, perception of people on landslide risk and vulnerability reduction, the role of community and government on landslide risk reduction.

Chapter five constitutes the discussion section of the thesis. It presents key findings with supporting points from different literature and the theoretical basis of the major findings.

Chapter six is the concluding section, which include a summary of the research, conclusions and recommendations.

CHAPTER TWO: LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction

This chapter comprises the review of existing literature on landslide and disaster at local, regional, national and international levels. The review discussed the different measures adopted to respond to landslide risk reduction, as well as disaster preparedness and mitigation at both national and international levels. The review was aimed at identifying gaps that provided the basis for the research questions of this study.

2.2 Landslides

Landslides are defined as the downward and outward movement of earth's materials moving in different form such as debris, mud, falls and rocks. They are characterized by almost permanent contact between the moving masses and sliding plane (Mcadoo et al., 2018). Landslides cause serious problems in society that include loss of life, the destruction of infrastructure, environmental degradation and crop damage (Westen, 2007).

Landslides increase in mountainous regions and unplanned cities due to unplanned settlements, the rapid increase of population, cutting hill toes and urbanization (Dai et al., 2002). The landslide has smashed and damaged numerous properties and infrastructure in hilly sloped areas (UNISDR, 2013). Landslides have killed 100,000 people and damaged properties estimated US$1- 2 billion in the United States of America alone (Tanya, 2001). Most landslides that occurred in the 1990s and 2000s were caused by heavy rainfall due to climate change (Novotny, 2013). Anthropogenic activities such as deforestation, excavation for building infrastructures and

agricultural activities and tectonic activities also contributed to those landslides (Maina-Gichaba et al., 2013).

2.2.1 Types of landslide

According to Maina-Gichaba et al., (2013) there are five types of landslides. They are falls, slides, topples, spreads, and flows.

Fall landslide is defined as the movement of soil mass, rock, and debris that breakdown from hills (Uniyal, 2017). Fall landslides occur as a result of mechanical weathering, earthquakes, and force of gravity applied to the weak particles on the sloped area that lead to the downward movement of those materials (Njoki, 2014).

Slide landslide is a movement where the moving materials break away from stable materials and move down in a horizontal motion. This type of landslide is rotational and transitional (MIDMAR, 2012b).

Topple landslide occurs when topples fail. Topple failure causes movement of mass rocks and debris mud from a slope. This type of slope failure takes place around an axis near or at the bottom of the block of rock. These materials are known as Talus (Westen, 2007).

Spread landslide is commonly known as horizontal spreads and takes place on gentle topographies via lateral extension followed by stretched fractures that lead to failure of a hill (Maina-Gichaba et al., 2013).

Flows landslide is categorized into five; earth flows, debris avalanche, debris flow, mudflows, and creep, which happen seasonally, continuously and progressively (UNISDR, 2013).

2.2.2 Causes of landslide

The causes of landslide are classified into two main categories namely natural and anthropogenic (Malcolmg et al., 2013). The natural causes include climate-related phenomena, earth movements and the nature of slope. The anthropogenic causes relate to human activities such as human settlements, agricultural and mining activities.

2.2.3 Natural causes of landslide

Generally**,** climate-related events such as drought and torrential downpours have a significant effect on soil stability and quality (JICA, 2008). This may result in a landslide. These extreme conditions may affect soil plasticity and cause a weakness in soil structure which leads to the failure of slope stability. Torrential rainfall and increased run-off particularly in sloppy areas may also affect soil stability and a loss of mechanical support of soil. Earth movements notably earthquakes, and weathering according to (Gautam et al., 2016) also contribute to landslides. Seismic activities result in the development of cracks and fissures that may serve as channels for deepwater seepage thus, engendering lines of weakness. In the event of an earthquake, these lines of weakness slip leading to landslides (Abebe et al., 2010). Weathering of rocks may also fuel the occurrence of landslides. Weathering is the natural procedure of rock deterioration caused by the biological, chemical and physical process of weakening rocks enough to cause instability of sloped areas which may lead to landslides (Graff et al., 2016). Steep slopes increase the gravitational force of objects sliding downhill and increase the impact of the landslide. It is an important factor that contributes to landslide especially in sloppy areas where unstable materials can roll down easily due to the gravitational force (Parkash, 2012).

2.2. 4 Anthropogenic causes of landslides

According to Westen, (2007), the increase in unplanned settlements, urbanization, development activities in landslide-prone areas and an increase in deforestation in landslide-prone areas are the main causes of landslides. Other anthropogenic activities such as the overuse of land also contribute to landslide occurrence (Mcadoo et al., 2018). Furthermore, mining contributes more to the occurrence of landslides because mining activity needs excavation and digging to explore for mineral in the earth. All these activities make the soil weak and unstable and contribute to the occurrence of landslides in the area that mining takes place. Mining that uses blasting techniques contributes to landslides also. The vibration from blasts can decline the attachment of soil structure and develop cracks in the soil that later contribute to a landslide (Tanya, 2001). Slope overloading is another cause of the landslide. Slope overloading is an increase of burden on certain areas caused by human activities such as waste dumping, construction of heavy buildings. When waste is dumped year after year, it piles up to create slope overload (Njoki, 2014).

2.3 Impacts of landslide

Landslides have a multiplicity of effects, which affects the national economy, human lives, infrastructure, and the landscape. Concerning the economy, the combined effect of landslides generally has a great toll on national budgets and other state resources. Apart from damaged private property that has to be fixed by individuals, government funds that would have been used for development are channeled into the rehabilitation of damaged state properties and for rescue activities. For example, the USA's annual loss as a result of landslides is estimated to be $1.5 billion (Westen, 2007).

The most affected communities are situated on the base of the mountain where the mud, heavy debris and big rocks flow (Amare et al., 2018). For instance, in the first two weeks of May 2018, landslides killed 18 people in the Northern and Western provinces of Rwanda as confirmed by the Ministry of Disaster Management and Refugee Affair (MIDIMAR, 2018). Also, from January to May 2018, the total number of people who died due to landslides in Northern and Western Province in Rwanda reached over 200 due to an increase in torrential rainfall (Nsengiyumva et al., 2018). Aquatic life is also impacted by landslides because soil, debris, and rock slide toward rivers and block the natural flows affecting the water ecosystem due to a disturbance of physical and chemical quality of water (Parkash, 2012). Many river habitats such as fish and other aquatic biodiversity can die due to the interference of natural flow and an increase of sediments and chemical compound that lead to the reduction of water quality.

2.4 Disaster management cycle

Disaster management is a systematic framework that aims to reduce the impacts of disasters (Raya & Lutz, 2014). Disaster management has three stages which include pre-disaster stages, during disaster and post-disaster or recovery phase (Smet et al., 2011). Through disaster management, measures to avoid impacts of disasters and provide assistance to victims of disaster, in order to achieve rapid and effective recovery measures are taken (MIDIMAR, 2012c).

In all phases of the disaster management cycle, the contributions of government, community, and NGOs are needed for planning and reducing the impacts of the landslide (Warfield, 2005). The disaster management cycle comprises of four phases. These four phases include mitigation, preparedness, response, and recovery. All these phases are grouped into three stages pre-disaster,

during and post disaster (Smet et al., 2011). The mitigation phase includes the following activities relating to the reduction of vulnerabilities to landslides and the effects of other disasters such as deaths, loss of properties, damage of infrastructures and loss of valuable properties. In this phase, community and government might involve in activities that make a community resilient to landslide and other disasters. These activities include improving building code, creation of water canal, building retaining hall and land use management (Lassa, 2018).

The preparedness phase focuses on raising awareness of people in the community through education, and training to build their capacity as well as train them to use that knowledge to respond to and recover from hazards. In this phase, governments and communities engage themselves in preparedness activities (UNISDR, 2017). Response activities address immediate threats caused by the landslide hazard. These activities include rescue activities, first aid for affected persons, meeting humanitarian needs, resource distribution, cleanup, and damaged assessment. As the response period progress, focus shifts from dealing with the immediate hazards to conducting repairs, restoring utilities and finishing the cleanup process (Lassa, 2018). The recovery phase which is the last phase in disaster risk management is about the restoration of all features affected by the hazard and restoring the community to normalcy. At this stage, the affected community has attained a certain level of physical, environmental and socio-economic stability (Flentje & Chowdhury, 2018).

2.5 Factors contribute to landslide in Rwanda

According to MIDIMAR (2015), many factors contribute to landslide; however, these factors vary according to the geological formation of a certain region that makes some regions to be highly vulnerable to landslide than others. Seven factors contribute to landslides in Rwanda and

they include distance to roads, lithology, soil type, land cover, soil depth, rainfall and slope angle (FAO, 2006).

2.5.1 Land cover

Normally, lands covered by vegetation are less affected by landslide occurrence as compared to bare lands. Many studies conducted to the contribution of vegetation cover to slope stability revealed that land well covered by vegetation can resist a landslide compared to bare areas (Abdullah & Malcolm 2013). In Rwanda, land use and its potential to the landslide are classified into six categories include land cover, open land, open and closed agriculture, a forest plantation, natural forest and irrigation/runway (FAO, 2006). The score of each category is summarized in Table 2.1.

2.5.2 Rainfall

Rwanda receives enough rainfall that influences landslides especially in the mountainous region of Northern, Western and some parts of Southern Provence. Rainfall is considered as first of the triggers of the landslide in Rwanda (MINIRENA, 2006).Table 2.2 shows the contribution of rainfall to the occurrence of landslide according to annually rainfall received.

Table 2. 1: Scores of land cover in fueling landslides in Rwanda

Land cover	Score
Open land	10
Open agriculture	8
Closed agriculture	7
Forest plantation	3
Natural forest	2
Irrigation/runway	1

Source: FAO, 2006

Table 2. 2: Annual rainfall and its potential to landslide

Annual rainfall	Score
<1000	1
1000-1200	4
1200-1400	6
1400-1600	8
>1600	10

Source: FAO, 2006

2.6 Push and pull factors in landslide-prone areas

This point focuses on the reasons that many citizens cite as to why they continue to settle in landslide-prone areas.

2.6.1 Economic vulnerability

The economic capacity of individuals, families, and communities push people to live in landslide-prone areas where their economic status determines where people settle (Abebe-Bekele et al., 2010). Tova et al.,(2000). Revealed that plots located in landslide-prone areas are cheaper than plots located in safe areas. The poor people cannot build strong houses that can resist landslides (Anderson et al., 2011). Thus, poor people are more exposed to landslides hazards in society than rich people (Rajib, 2016). The economic factors that contribute to exposing people to landslide hazards are: social-economic infrastructure, loss of diverse job opportunities, and supplies, access to credit and loans that expose people to landslide and disaster in general (ISDR, 2010). Poor people are pushed to build homes in slums using poor building codes and unplanned settlements expose them to landslide and other disasters (Smith, 2016).

2.6.2 Social vulnerability

Social vulnerability is defined as the capacity of individuals and communities to mitigate, cope with, anticipate and recover to the impacts of landslide and other disasters (Amaratunga &

Pathirage, 2010). Social vulnerability is a concept that can be used to identify the knowledge of society to deal with disasters (Anderson, et al., 2004). Social vulnerability leads people to work and live in areas that have inadequate intervention measures of mitigation and coping with disaster impacts in all phases of disaster management such as pre-disaster, during and post-disaster or recovery.

Social vulnerability is also linked to people's characteristics such as age, gender, health, source income, and type of house. These social vulnerability factors contribute directly and indirectly to

push people to live in high-risk zones of certain hazards (Vlaeminck et al., 2015). Some classes of people are vulnerable more than others. Such groups of people are poor people, refugees, very old and ethnic minorities (Tsinda, 2010).

2.6.3 Environmental and Physical vulnerability

According to FAO (2017), environmental degradation, the indiscriminate exploitation of natural resources contributes to landslides and other hazards. While Physical vulnerability is related to physical susceptibility to the disasters (Tova et al., 2000). Physical vulnerability exposes individuals, properties, physical properties, and communities (Flentje & Chowdhury, 2018). It also has a relation with laws and policies of disaster management and engineering standards such as building codes, land use planning, access to infrastructure and emergency services. All those are the factors that contribute to the increasing number of people that are susceptible to landslides (Manita, 2014).

2.6.4 Political vulnerability

Political factors such as the social-economic status of people, education status, use of resources, human rights, stability and access to information about upcoming hazards expose people to landslides (Shi, 2012). Vulnerability conditions are determined by physical, social-economic and environmental factors that weaken the community's ability to cope with the impacts of the landslide (African Union Commission, 2015).

2.7 Landslide resilience measures at the community level

Community resilience is a practical exercise that determines the ability of individuals and society to deal with incoming disasters using their resources (Nakileza, et al., 2017). Resilience is the resistance capacity of the community to prepare themselves to reduce the impact of landslide and other catastrophes by protecting their properties such as houses, crops, infrastructure and their lives (Col, 2007)**.**

2.8. Historical landslide in Rwanda

Rwanda has experienced many landslides in the past. Impact resulting from landslides includes loss of life, injuries, loss of crop productivity and destruction of houses and infrastructure. Before 2010, the Royal Museum for Central Africa (RMCA) was the only source of disaster data of Rwanda. As a result of this insufficient literature and data exist regarding landslides in Rwanda. There is therefore a gap in landslide data recorded (MIDIMAR, 2012b). In 2010, the government of Rwanda established MIDIMAR as the order of Prime minister no75/01 of 08/07/2011 defining responsibilities, mission, functions and the organizational structure of MIDIMAR (Gazette, 2011).

2.9 Responsibility of Ministry of Disaster Management Refugees Affair

MIDIMAR has the mission of developing proficient mechanisms and policies for preventing, mitigating, recovering, securing, monitoring and responding promptly to promote the management of natural and anthropogenic disasters. MIDIMAR has the responsibility of formulating, disseminating and coordinating the implementation of policies, strategies, and

programs through formulating good governance policies and programs in the field of disaster management. It also provides standards for harmonization of legal and institutional practices related to disaster management and refugees in the region, developing a regional action plan for disaster mitigation and management and refugee affairs and establishing a legal framework for the free movement of goods and personnel for assistance. They also look to develop institutional capacity and public education in the disaster management sector through coordination and development of education, sensitization of the public, strategic planning, and oversight of all strategies of disaster management and refugee affairs through improved training, training of trainers, and improved training materials.

2.10 Decentralization of Disaster Management

Decentralization is defined as transfer responsibility, authority and decision making of the central government to the private and local government level (Worldbank, 2012). In disaster management, it is important to give power to the local government in order to reduce the risk of landslides and other hazards (Zubir, 2016). In the case of disaster risk reduction, the government should build the capacity of local government and community resilience to landslide and other disasters, to enhance coping and mitigation capacities of the community (VUSSC, 2007).

Decentralization gives power and capacity to the local government and private sectors to cope, prepare, mitigate, and engage the community in disaster risk reduction because central government provides enough resources and skills to the local government that are at the heart of implementation of policies and plans that relate to hazard risk reduction (Blackburn, 2011). The decentralization of disaster management plays a vital role in disaster risk management where the

central government provides power to the local government for the training of the population in coping and reducing disaster risk management (Williams, 2011).

2.11 Institution framework for disaster management in Rwanda

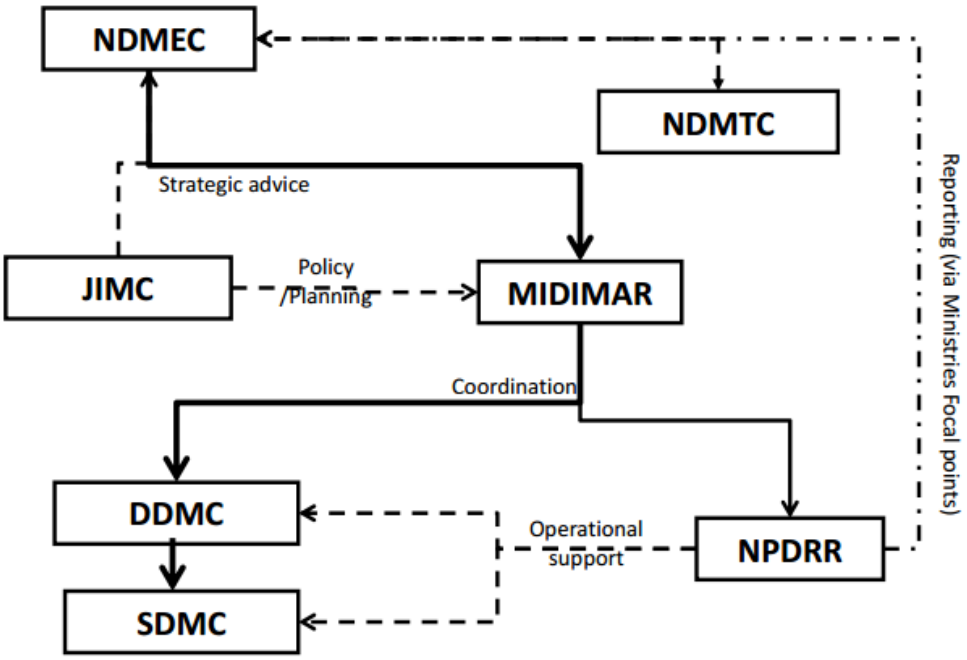

Figure 2.1 Institutional arrangement for disaster management in Rwanda

2.11.1 National Disaster Management Executive Committee (NDMEC)

NDMEC is the highest level of disaster management in Rwanda. They make decisions on the national level and advise government to conduct response for an emergency. They provide policy guidance and preparedness measures at the national level. NDMEC is an advisor to the Government regarding disaster management. They also deal with disasters that exceed government capacity.

2.11.2 National Disaster Management Technical Committee (NDMTC)

NDMTC has the responsibility of planning, implementing, developing programs and policies of disaster management, advising all public institutions in charge of disaster management to develop and implement strategies of disaster management and reporting to the national disaster management executive committee.

2.11.3 District Disaster Management Committees (DDMC)

District disaster management committee is responsible for giving timely information to the ministry of disaster management and refugee affair for all problems associated with disaster management. It is also required to coordinate all stakeholders and emergencies in the district by establishing a district disaster management plan, providing and supporting disaster management planning with disaster experts, stakeholders and volunteers. It also works with the community and various individuals who have experience with disaster management in raising awareness.

2.11.4 Sector Disaster Management Committees (SDMC)

Responsibilities of SDMC are to provide warning information and reports to sectors and the district, spread disaster information, plan and mobilize to ensure the participation of committee in disaster management through bottom up decision making. The SDMC also encourages the local leader to be active in disaster management and participate in relief work such as rescues and search exercises.

2.12 Landslide management policies and law in Rwanda

The Government of Rwanda has established different law and policies for landslide risk reduction. These laws and policies include areas that are classified as landslide-prone and are strictly prohibited for building new homes. These policies support the relocation of all community settled in landslide-prone areas and promote the policy of forestation.

2.13 Role of community in landslide disaster risk reduction

Over many years back, before the existence of most of the states; Communities were taking care of themselves through collective actions during the disasters. After formation of states, government based disaster risk reduction program started, which failed to serve the needs of the people and communities. For the past 30 years, the need of community based disaster risk reduction is taking into account (Habiba & Abedin, 2017). The community is the main point of consideration with regards to disaster risk reduction because they are the ones greatly affected by the disasters and they are the reasons disaster management specialists, government agencies and national and international NGOs intervene in landslides and disaster management thus they are obliged to fight against disasters (Sodnom, 2012). To build community resilience to landslides, the initiatives of raising community awareness is an important area the government should focus on (African Union, 2014). Every community is exposed to certain hazards such as a landslide in an unpredicted way (Ebinezer, 2010). Landslides may be caused by anthropogenic activities such as the construction of infrastructure, mining, poor agricultural practices and unplanned settlements. There are also disasters from natural causes such as earthquakes, volcanic eruptions, weathering processes and geological processes.

In 1965, a Sri Lankan family was relocated by force from Nwalapitiya commercial central area to a mountainous area where landslides are likely to occur in Soysakelle as a temporary shelter. Since the family had fears of landslides taking place on this hill, they got an idea of building water channels that connect water from community houses and water from the hill to downhill as mitigation measures of the landslide (ADPC, 2003). The community should apply the system of back sloping and built retaining wall. This is the strategy of reducing the slope angle of remaining land after building the house. The reduction of the slope angle leads to an increase in slope stability and an increase of shear strength (Mertens et al., 2018).

2.14 Community based in disaster risk reduction approach

A number of landslides are very common in different countries. This has substantial effect on the community. In each landslide occurs, people within the community suffer most to landslide impacts and they are the first front line responders to survive with landslide (Kervyn et al., 2015). During or after landslide period, it has been often seen that external support comes later to rescue community members affected by landslide. In this regard, Community Based Disaster Risk Reduction (CBDRR) is a new concept that provides an opportunity to fit together indigenous knowledge for disaster risk reduction and settle strategy to mainstream risk reduction at the community level (Habiba & Abedin, 2017). The main purpose of CBDRR is to reduce disaster risk and vulnerability by strengthening individuals and communities by considering factors, processes, and causes of vulnerabilities brought by poverty, social inequality, and environmental resource depletion and climate change (Okoyee, 2000).

2.14.1 Characteristics of community resilient to landslide disaster

- ✓ **Aim of resilience**, this may be achieved by putting in place risk reduction, prevention, preparedness, capacity building measures to reduce impact of landslide impacts and reduce time taken for recovery through providing adequate resources and skills to the community.
- ✓ **The Nature of Resilient Communities**, A resilient community is one that has certain capacities in three phases: phase one is ability to take up the impacts of Landslide, phase two is the capacity of bounce back during and after of landslide phase three is the opportunity for change and adaptation following a landslide (Okoyee, 2000), (Habiba et al., 2017).

2.15 Role of government in landslide disaster risk and vulnerability reduction

The government is normally the leader in formulating the whole system of governance including policy establishment and implementing strategies for integrated disaster risk management in the country (Shi, 2012). According to UNISDR (2015), in order to build community resilience to landslides or other disasters, the government should consider providing resources, information, skills and increased awareness of the community members. The role of government in disaster risk reduction is to build the community's resilience to landslides and /or disaster and to integrate disaster management in their development plans and in the big projects (UNISDR, 2010).

According to (ISDR, 2010), the following are the roles of government in disaster risk reduction.

- Government has responsibilities to coordinate various stakeholders and promote hazard risk reduction measures and policies in their territorial and region.

- Government plays a role in integrating people and local communities in disaster risk reduction exercises in all disaster management phases.
- Government has duties to strengthen their institutional capacities for implementation of disaster risk reduction programs, in terms of skills and budget capacity.
- Government has a role to plan and implement new practices, techniques, and innovation that are successful elsewhere around the world that can help the country to fight against disaster in the country.

According to UNISDR, (2013) Hyogo framework has four priorities in their action plan starting from 2015 to 2030. These priorities are to make sure that nations give priority and strengthen their institutions to implement programs and policies for reducing the impact of the disaster in the community. This should be achieved by providing power and resources to the national institution for disaster reduction and to engage the community in disaster risk reduction (UNISDR, 2015).

The government has a duty to identify and monitor disaster risks and enhance early warning. To achieve this priority, the Hyogo framework set a few components. Those components are to establish institutional and community capacity for effective risk reduction of disasters, the development of cooperation mechanisms among regions for disaster risk reduction and development information management and building sustainable infrastructures (UNISDR, 2015).

Government has a responsibility to use knowledge, innovation, and education to build a culture of safety and resilience for all. This should be achieved through information exchange and promoting risk reduction in school and community training and increase public awareness (Malcolmg et al., 2013).

They also have a responsibility to reduce the causal risk factors. This can be achieved through the consideration of environmental aspects in developing plans and programs of risk reduction, which also include land use planning in disaster risk management (Williams, 2011). Landslide management teams aim to avoid or reduce losses from disasters and take appropriate measures to plan to minimize the effects of the disaster. In addition, they are providing assistance to victims of disaster, and achieve rapid and effective recovery (Uniyal, 2017).

Malaysia as a country has frequently experienced landslides. The Republic of Malaysia established a slope engineering branch in the public work department. The mission of the slope engineering branch was to establish the Nation Slope Master Plan (NSMP) no later than 2004. They were to build a water retaining wall for stabilizing slopes. The NSMP also set out a strategic plan for slope management in Malaysia (Abdullah, 2013). This slope engineering branch also had duties to establish landslide risk maps, raise awareness and to formulate landslide management policies in Malaysia (Zubir & Amirrol, 2002). Malaysia was faced with numerous landslides before deciding to establish and strengthen the institution in charge of disaster management. The USA government has a center in charge of landslide management called the National Landslide Information Centre. This center has responsibilities to collect all types of data related to landslides, carry out research regarding landslides, provide appropriate training landslide managers and increase awareness of people about landslide (Westen, 2007).

The USA has measures known as planning and control as one way of managing and reducing the impact of landslides in the country. Planning and control have three main areas of focus with regard to meeting the needs of the citizens. They look to relocate families located in landslide-prone areas; discourage new developments in areas classified as landslide high-risk zones and build community resilience to a landslide. Individuals who want to use areas classified as

landslide-prone areas in the USA must request permission (Wfeo & Mada, 2008). The USA uses different ways to correct unstable slopes to reduce the impact of the landslide. These methods are to change slope geometry by filling and by the use of retaining walls to stabilize the slope. These methods are good tools for landslides management when it is well designed and built (UNISDR, 2013).

The Philippine government established a task team in charge of landslide management. The role of government was to form the task team by identifying motivated, knowledgeable individuals who wanted to contribute to landslide risk reduction (Malcolmg & Elizabeth, 2013).

China has laws of emergency management that establish management of emergency response and determines the responsibilities of government and people in disaster management. For government leaders, they have duties of allocating resources at a different level of emergency response, enhance awareness of community, engage the community in disaster risk reduction and enhance the coping capacity of the community to disaster risks (Shi, 2012).

The government must elaborate on programs of development for a country. In Bangladesh, the government has integrated disaster management in the development plan and established the budget of disaster management (Habiba et al., 2017).

Indonesia's government has partnered with United National Development Programme (UNDP) and local partners have made innovations on landslide early warning. The government participated in providing financial and technical support (Zubir & Amirrol, 2002).

The role of government is to engage the local community in landslide risk reduction, raise their awareness and give them priority in decision making in disaster management (Ekotu, 2012).In the El Salvador government, non governments organization (NGOs) and Donors have contributed to improving agriculture that contributes to disaster risk reduction in El Salvador

(UNISDR, 2010). Japan has organized a disaster management program called "mountain watching and town watching" (NEMA, 2012), where communities and schools in Saijo city headed by the government, participate in disaster risk prevention through planting trees, raising awareness of people living in high-risk zones and build water canals that connected water from different areas of the city (Shesh & Zubair, 2012).

Hong Kong has established a program for landslide risk reduction called "slope safety system". This program is for reducing landslide risk to the community through landslide policy enforcement and community based landslide management (Florence, 2015).

Government of Nepal established new approach called community based (CB) and Ecosystem based disaster risk reduction (Eco-DRR) emphasizes ecosystem conservation, restoration, and sustainable management as key elements for disaster risk reduction (Habiba et al., 2017). CB and Eco-DRR approach has four principles to address the impact of landslide disaster risk reduction through community based. This approach combine community base in disaster risk reduction and ecosystem based disaster risk reduction. These principles are:

(1) Governance and institutional arrangements that fit local needs: The government can prioritize local community to participle in decision making to fit local community needs, in keeping Sendai framework; policy should be developed through partnership among local community to global level with attention of local variability (UCGS, 2014). This is because many of the action needed during and disaster response and recovery are rooted in everyday governance and culture of the community (Klein et al., 2019).

(2) Empowerment and capacity building to strengthen community resilience: Community resilience in DRR involves the capability of a community to resist and absorb the impacts of a landslide disaster so that they can recover in a timely manner (UNISDR, 2009). To build community resilience to disaster, government and their partners should participate in enhancing education, health and source of income of the community (Klein et al., 2019). Nepal is a good example used Eco-DRR approach in landslide risk management by building community resilience to landslide through enhancing skills of community in landslide risk management and engaging community in activities of landslide risk reduction and integration ecosystem in DRR measures and project (Raya & Lutz, 2014).

(3) Discovery and sharing of constructive practices that combine local and scientific knowledge: In this principle transparence and collaboration are needed among community, scientists, and practitioners to share and learn together on local strategies, knowledge of hazards and disaster recovery, and ways to implement community based and Eco-DRR, they can craft innovative solution respond to the disaster risks (Klein et al., 2019). Individuals such as village leaders can help in enhancing knowledge of community in order to adapt new strategies for disaster risk reduction (Mcadoo et al., 2018).

(4) Approaches focused on well being and equity: Regardless of local community efforts and government commitment to disaster risk reduction some disasters exceed of community and government capacity to cope with the impacts of disaster. Some international community provides resource for relief (Klein et al., 2019). The Sendai framework calls for women and persons with disabilities to be empowered to take on public leadership roles to improve equity in

DRR planning, response, and reconstruction, Emergency relief should deliver aid to affected areas equitably, which requires trust between local communities and emergency teams (Rana, 2016).

2.16 Conceptual framework

Figure 2.2, shows the various contributions of government and community in landslide risk reduction. It observed that communities contribute in relocation from landslide risk areas. Relocation is a good measure to reduce the impacts of landslide in the community. As reported by Pinnawala (2019), in Japan and Indonesia relocation system was adapted as one of solutions of landslide risk reduction. It also noted that improving agriculture methods like to use lateral terraces and agro-forest method contributes in landslide risk reduction. Also contributions of community in landslide risk reduction include improving housing condition and participating in landslide management activities are organized by government.

It also noted that government is responsible in landslide disaster risk reduction. Government has responsibility of establishment and building institution capacity to reduce the impacts of landslide. As indicated by Malone (2016), government has duties to establish disaster management institutions, provide adequate resources and skills to fight against landslide risk. It is necessary that government get involved in raising awareness and build community resilient to disasters. Awareness of people about landslide disaster risk reduction is the main key in landslide risk reduction, It noted that when the people are aware about the disasters it is easy to cope with the impacts of the disaster (MIDIMAR, 2012a). Also government contributes on policies, laws and regulation on landslide hazard. It is essential that government and community share information on time to respond to the disasters impacts on time and people be informed earlier

about the coming disasters. Government and community also have the responsibility of sharing information related to landslide disaster in order to cope with its impacts on time and rescue affected people.

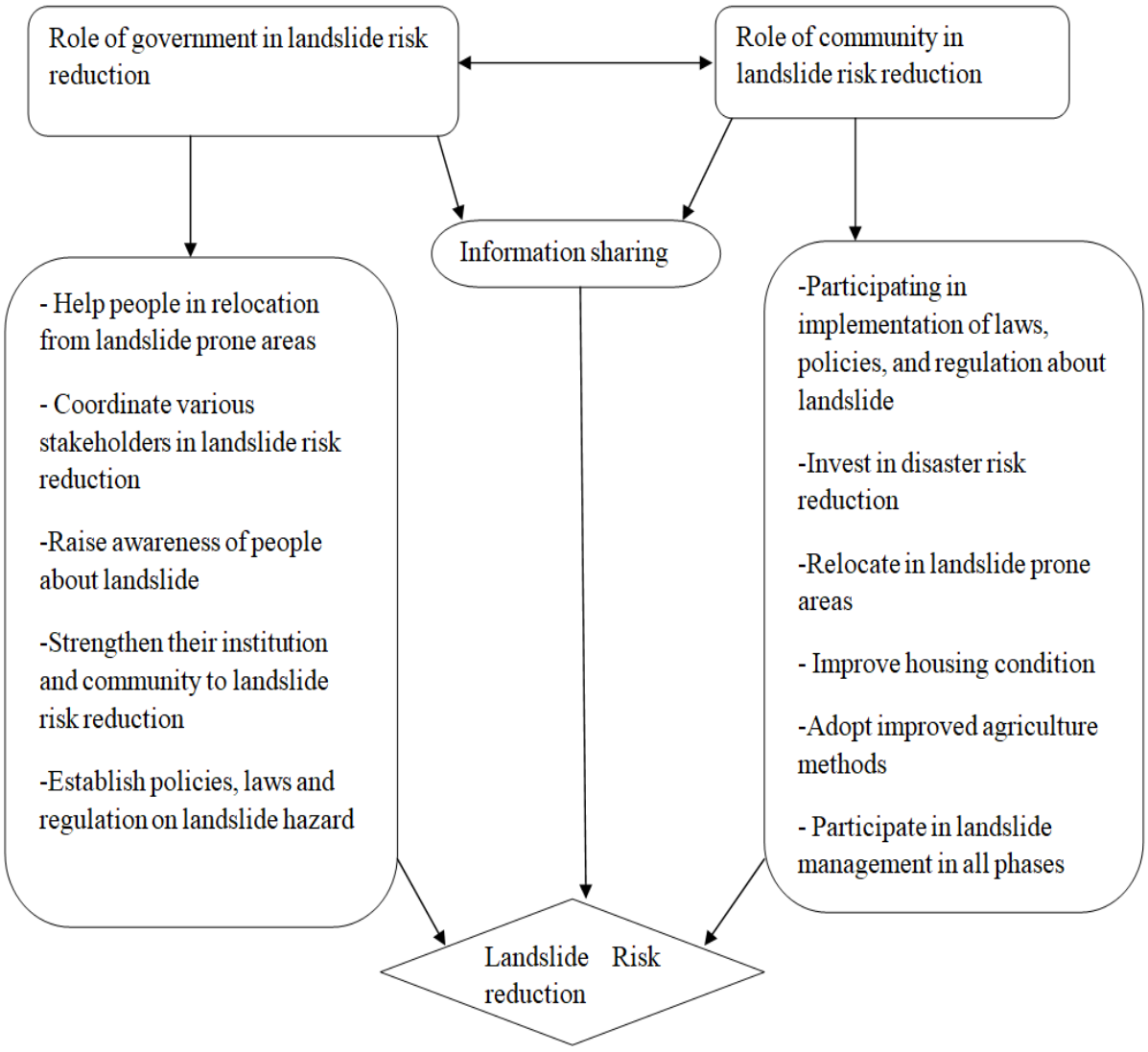

Figure 2. 2 Conceptual frameworks

Source: researcher, 2019 based on literature

CHAPTER THREE: MATERIALS AND METHODOLOGY

3.0 Introduction

This chapter presents a description of the study area and the materials used for the research. It also outlines the procedures taken to determine the sample size, data collection methods and the analytical tools used to obtain the results.

3.1 Geographical context

3.1.1 Location

Gakenke District (Figure 3.1) is one of the five districts of the Northern Province of Rwanda. Located on 1.6909^0S and 29.8352^0E, it is bounded by Rulindo District to the east, Burera and Musanze District to the North, Nyabihu District to the West and Kamonyi and Muhanga Districts to the South. Gakenke District has 19 sectors made of 97 Cells and 617 Villages (*Imidugudu*) and 73,765 Households (DDP, 2013).

3.1.2 Geographical features

Geology

The Geology of Rwanda comprises four types: Mesoproterozoic, Quartzites, Shales and sandstone (MIDIMAR, 2015).The oldest rocks of Rwanda are Migmatites, Gneisses and Mica Schists of the Paleoproterozoic Ruzizian basement overlain by the Mesoproterozoic Kibaran Belt. The Kibaran is composed of folded and metamorphosed sediments, mainly Schists and Quartzites intruded by granites, covers most of Rwanda (MINIRENA, 2000).

Soil

Rwandan soil is characterized by six types of soil derived from schistose, sandstone and quartzite formation. These cover 50 percent of the country's soil. Soil derived from granite and gneissic formation covered 20 percent, soil derived from basic intrusive rock 10 percent, soil derived from volcanic materials cover 14 percent and alluvial soil cover 6 percent of total soil of Rwanda (MIDIMAR, 2012). Gakenke District is dominated with soil derived from the schistose and sandstone (Nsengiyumva, Luo, Nahayo, Huang, & Cai, 2018).

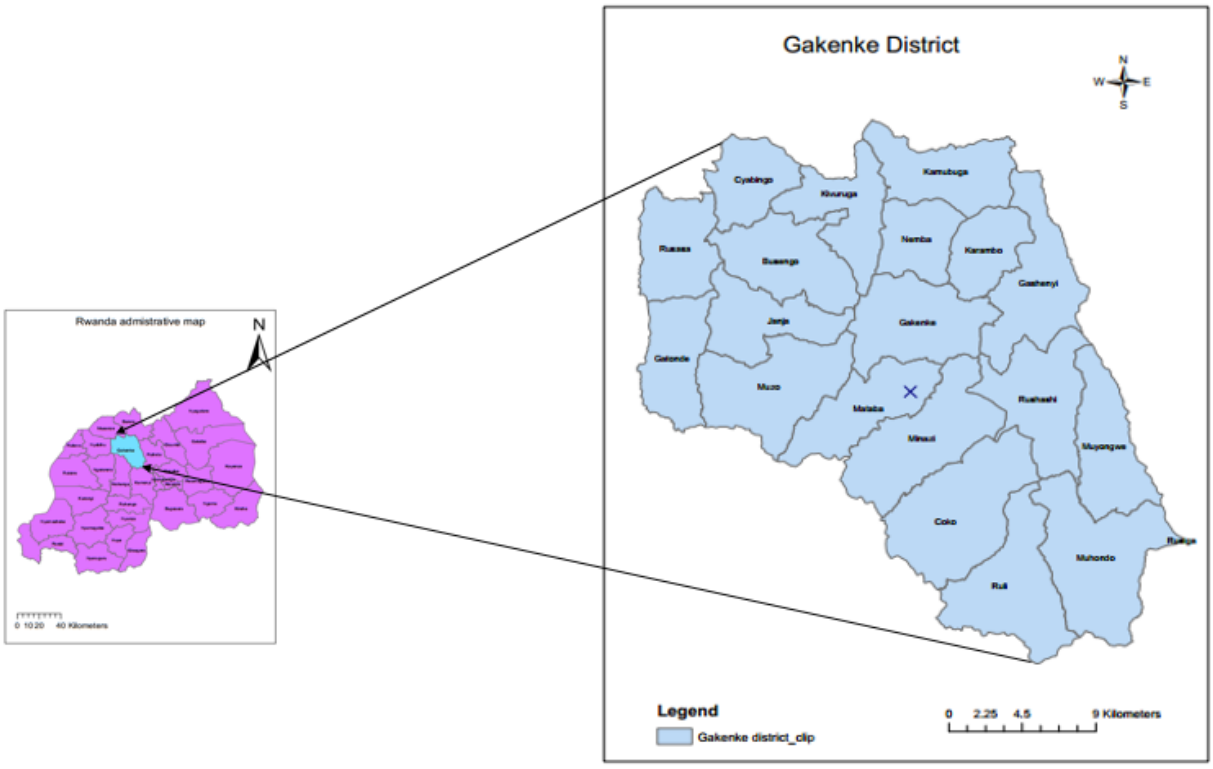

Figure 3.1 Map of the Gakenke District in Rwanda

3.1.3 Topography

Gakenke District is known for its high inclined hills separated by rivers and marshlands. The reliefs comprise two distinctive regions with a high-altitude of mountainous region attaining heights of at least 2648m (Mont Kabuye). The lowest region which is (Base) is characterized by lowly inclined hills of 1700m of altitude, which influences landslide and soil erosion. Marshlands occupy an area representing 361 Hectares. These marshlands are generally exploited during the dry season for agricultural production (May-September). The main crops planted in those marshlands are maize, beans, Irish potatoes and sweet potatoes (DDP, 2013).

3.1.4 Climate

Gakenke is highly exposed to landslides because rainfall patterns of the region ranges from 1100 mm to 1500mm per year (Dibanga et al., 2016). The average annual temperature ranges from 16^0C to 20^0C. The humid wind which comes from the East toward the West contributes to abundant humidity in Gakenke (Gakenke DDP.2013).Gakenke District lost 366.70km^2 of land cover from 1990 to 2016 due to subsistence agriculture for livelihood and the dominate occupation is agricultural activities. Majority (86%) of the population in Gakenke District depend on agriculture activities (Karamage et al., 2017).

3.1.5. Vegetation

Vegetation of Rwanda composed of natural forest, bamboo, savannahs and large eucalyptus pinus and coppices plantation and Montane forest. All this vegetation are grouped into four categories; Congo Nile ridge forest, a natural parks and reserves; the savannahs and galley forest; plantation forest and agro-forestry as well as anti-erosion measures species (MINIRENA, 2000).

3.1.6 Social demographics and Economic activities

Gakenke District covers areas of 704.06 km^2, with 338,234 inhabitants and a population density of 480 inhabitants per km^2. Considering the fertility rate of 4.7%, and the population growth rate of 2.8%, the district population growth is on the rise. This phenomenon, if not looked at, will outweigh the strategies of developing the district and may lead to spiral poverty and contribute to disaster occurrence (DDP, 2013). While economic activities in Gakenke District include agriculture by independent farmers, mining and services provision (DDP, 2013).

3.2 Research design

The study involved both qualitative and quantitative analyses; described the dependent variable as landslide risk reduction and independent variables as role of government and community, as well as the evaluation of the relationship between variables in terms of percentages and frequency. It involved also primary as well as secondary data. Primary data were collected from sampled respondents using a household questionnaire; Interviews were also carried out with Disaster Managers in each sectors of Gakenke District. There was also on-site observation in which the researcher made direct observations on the field. A total of 180 household questionnaires were administrated directly to sampled participants in the Gakenke district. Simple random sampling technique was used to get 180 respondents. There were additional 10 participants made up of Disaster Managers in all sectors of the Gakenke District were interviewed. The secondary data were collected using desk reviews of different reports, journals, and online library as well as policy documents related to Landslide management in different countries. The questions for both the household questionnaire survey and interview schedules

focused on the contribution of government to landslide risk reduction and engagement of the community in landslide disaster risk reduction and vulnerability reduction in Gakenke District.

3.2.1 Data source

3.2.2 Primary data

Primary data were derived directly from the people during fieldwork which took place from November 2018 to January 2019 in the Gakenke District. The researcher relied on them because they are the first-hand information of the phenomena being investigated.

By the ministerial instructions No 003/2010 of 09/12/2010, published in Official Gazette of the Republic of Rwanda No special 24/12/2010, regulating the research activities in Rwanda, first, every researcher has to apply for a research permit from the institution in charge of research before he/she starts the research. A preliminary survey was conducted, at the different areas affected by landslide in the Gakenke district, before the main data collection. The aim was to familiarize oneself with the situation on the ground and to fine-tune the research instruments.

3.2.3 Secondary data

According to Grinnell and Williams (1990), secondary data are the data that already exist in boxes of some organization's library or stored in the core of computers. They assert that the good thing with existing data is that we need to neither collect nor survey the population with related problems of the time, but rather consult the existing data and draw insights on them. This study used a great deal of such data to answer research questions and eventually meet the study objectives.

3.2.4 Data collection and instruments

The different methods and instruments that were used to gather the data, these instruments include household questionnaires, interviews, direct observation and literature in different books, related to landslide risk reduction in Rwanda.

Household Questionnaires: A total number of 180 questionnaires were distributed to the population sampled in Gakenke District which is divided into four (4) namely North; South, East, and West to get accurate and well-balanced information of the whole district, data of each region were collected in three weeks which took two months and half to collect all data. Respondents were selected using cluster sampling based on the four regions grouping and then simple random sampling was employed within each cluster to select the participants.

Interview: A semi-structured interview guide was used to allow interviewees express their minds freely in their own words and thoughts on how the landslide management policies, measures, and contributions of the community may help the enhancement of landslide risk reduction. The researcher interviewed ten (10) disaster managers at sector level about the contribution of government in landslide risk and vulnerability reduction. Gakenke District has ten disaster managers at sector level that serve all sectors of Gakenke District.

3.2.5. Sample size determination

The sample size of respondents was determined by using Yamane's formula (Eq. 1). The total numbers of 180 respondents living in the Gakenke District were selected using cluster sampling

and then simple random sampling. Ten Disaster Managers of all sectors of Gakenke District were interviewed.

The sample size of respondents was determined by using Yamane's formula as illustrated below. Thus 95% confidence level and 8% of level of precision was used (Glenn, 2003).

$$\boldsymbol{n} = \frac{\mathrm{N}}{1+\mathrm{N}(\mathrm{e})^2} \qquad \text{(Equation 1)}$$

Where: n is sample size

N: is population size equal to 338,234 populations

e: is marginal error

$$n = \frac{338234}{1 + 338234(0.8)^2}$$

The sample size used for this study equals to 180 respondents

3.2.6. Sampling technique

To ensure the appropriateness of the study, the population was represented by using cluster sampling and a simple random sampling technique was also used to select respondents within two and a half months. A simple random sample is a subset of individuals (a sample) chosen from a larger set (a population). Each is chosen randomly and entirely by chance, such that each has the same probability of being chosen at any stage during the sampling process (Erlandson, 2014). Simple random sampling was applied to people living in the Gakenke District from 2013.

3.2.7. Data processing and analysis

According to Nachmais (1978), data processing and analysis is the link between data collection and analysis. It is the transformation of the findings collected from the field into a system of categories. Data processing, relevant to the research objectives was considered and transformed into meaningful information for interpretation, understanding, and presentation. The collected data were inputted into statistical package for the social sciences (SPSS) software, Versions 23. Gender, educational background, age and occupation, which may influence knowledge of the impact of landslide risk and vulnerability reduction were determined. The data were interpreted and analyzed, with reference to existing disaster management policy in Rwanda.

3.2.8. Limitations of Study

The pursuit of protocol requirements by the Rwandan government and the subsequent delays in field data collection due to late approval of data collection permit affected the timelines of the study. The data collection permit was received one month after request because the district authority sent the request to the national institute of research because the researcher was studying in a university abroad. There was loss of data including photographs which occurred through a robbery attack on the researcher on April 2019. The researcher's computer and phone containing data, pictures and other important documents related to the research work were lost. Time was also spent recovering from an inflicted injury on the researchers' hand.

CHAPTER FOUR: RESULTS

4.0 Introduction

This chapter presents the results obtained from fieldwork based on the set objectives of the study. The chapter begins with the demographic characteristics of the respondents and presents the results on the perspectives of people on landslides.

4.1 Demographic Characteristics of respondents

The characterization of the demographics of respondents was based on the identification of their gender, education level, age, marital status, family size, type of house and occupation (see Table 4.1). As shown in the table, about 54.71% of the respondents were between the ages of 26 and 45. This is an economically active age which constitutes the society and whose views and opinions on the subject are valuable. Gender issues are pertinent when dealing with disaster risk vulnerability because both females and males are affected differently. Also, both sexes contribute to landslides risk reduction and disaster management in general. In this study, the majority of respondents were males, representing 56.47% of the total participants.

The results as illustrated in Table 4.1, further indicate that a majority of the respondents (54.71%) were married while the remaining were divorced, widowed or single. With regard to education, 24.12% had primary school education while the remaining had Secondary School Senior, High School Junior, University or Technical and Vocational Education Training (TVET).With regards to the type of house, 31.18% of respondents had paved houses which are concreted inside with cement and it has water channels around the houses, while others had sun-dried brick 30% of respondents, unpaved with 27.06% of the total respondents, 8.82% had burnt

bricks and 2.94% had wooden houses. An analysis of the occupation of respondents indicates that 48.24% were farmers while others were teachers, traders, cleaners, mechanics, tailors, and local authority employees, and students without jobs. The result further revealed that on family size, 46.47% of respondents had family size varying between 1-4 family members while the remaining had family size varying in the flowing intervals, 5-8, 9-12 per family

Table 4. 1 Profile of respondents

Category	**Description**	**Frequency**	**Percent (%)**
Age	18-25	31	18.24
	26-35	40	23.53
	36- 45	53	31.18
	46-55	22	12.94
	56-65	17	10
	>65	7	4.12
Gender	Male	101	56.47
	Female	79	43.53
Marital Status	Single	36	21.18
	Married	93	54.71
	Widow(er)	32	18.82
	Separated	9	5.29
Education Level	No schooling	32	18.82
	Primary	41	24.12

Category	Description	Frequency	Percent (%)
	High School Seniors	37	21.8
	High School Junior	31	18.24
	University	25	14.71
	TVET	4	2.35
Type of house	Paved	53	31.18
	Unpaved	46	27.06
	Wooden	5	2.94
	Sun-dried brick	51	30
	Burnt brick	15	8.8
Occupation	Farming	82	48.24
	Mechanic	3	1.76
	Cleaner	3	1.76
	Trading	24	14.12
	Teaching	21	12.35
	Mining	16	9.41
	Tailoring	5	2.9
	Local authority	11	6.47
	Student	5	2.94
Family size	1-4	79	46.47
	5-8	68	40
	9-12	23	13.53

4.2 Perspectives of people on landslides

This section focuses on the basic knowledge of people on landslides in general, including causes of the landslide, early warning signs and measures taken to reduce landslide risk and vulnerability. It also presents the community's contributions to landslide risk reduction, and preparedness as well as measures taken to reduce landslide risk and vulnerability reduction.

4.2.1 Type of early warning signals on landslides in Gakenke District

The results show that respondents had differing opinions on the types of early warning signals that indicate when landslides might occur. As illustrated in table 4.2, 54.71% thought the onset of torrential rainfall was the main early warning signal, whilst others saw the development of cracks (17.65%), movement of retaining walls (13.53%) and rockfalls (14.12%) as the potential signs that herald the occurrence of landslides in Gakenke District.

Table 4. 2 Type of signals received before landslides occur

Type of signals received before landslide	Frequency	Percent (%)
Torrential rainfall	93	54.71
Slowly developing of cracks	30	17.65
Retaining walls move	23	13.53
Continuing fall of rock	24	14.12

With regards to measures taken to reduce landslide risk after the landslide signals were seen, community members may communicate with the relevant disaster management authorities or take other measures. Table 4.3, shows that 46.11%of respondents inform the local leaders about the landslide's signal they saw. While 29.44% communicate to their nearby community, 14.44% temporarily relocate to safer areas to escape the effects of incoming landslides and 10% use social media to notify others about the incoming landslide.

Table 4. 3 Measures taken to reduce landslide risk after seeing landslide signals

Measures taken for landslide risk reduction after receiving landslide signs	**Frequency**	**Percent (%)**
Communicate with authorities	83	46.11
Relocate in those areas	26	14.44
Communicate among community	53	29.44
Social media FM radio	18	10

The results further show that there are several causes of vulnerability to landslides in Gakenke District from the point of view of respondents. These range from poverty, quarrying activities, and building on hilly areas, as shown in Figure 4.1, Poverty and lack of awareness respectively received the majority of responses, 34.44% and 33.89%, respectively, whereas, siting of houses on hilly areas, deforestation, quarrying activities, and inappropriate building codes were also mentioned by respondents with varying percentages (Figure 4.1).

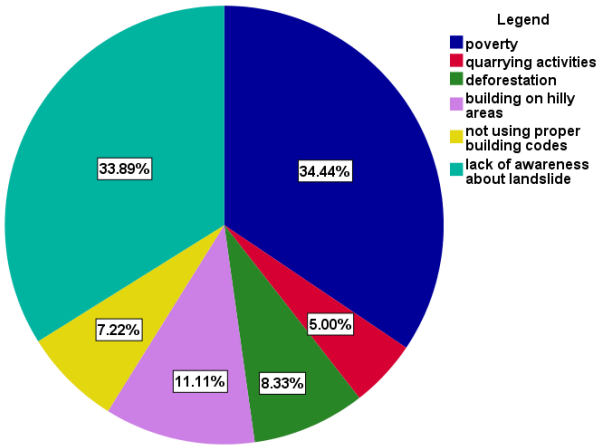

Figure 4. 1 Main causes of vulnerability to landslide in Gakenke District

According to the respondents, within their life time, most of them have been affected by landslides in one way or the other. The results of the survey showed as many as 95.59% of such respondents while a further 94.71% of the respondents were aware of landslide-prone areas in Gakenke District as shown in appendix three.

Table 4.4, is a frequency table which shows the ranking by respondents of the main causes of landslides in Gakenke District based on their own perspective. From the ranking 73.9% of the total respondents attributed the main cause to prolonged rainfall, 53.9% to deforestation, 50.5% to poor agricultural practices, while others, with varying percentage responses attributed causes such as erosion, construction activities, mining activities, poor irrigation, gravitational force, earthquake and waste disposal.

Table 4. 4 Ranking of the main causes of landslides in Gakenke District, Rwanda

RANK	Causes of landslides	Frequency	Percent (%)
1	Prolonged Rainfall	133	73.9
2	Deforestation	97	53.9
3	Poor Agriculture	91	50.5
4	Erosion	77	42.8
5	Construction activities	69	38.3
6	Mining Activities	50	27.7
7	Poor Irrigation	45	25
8	Gravitation force	36	20
9	Earthquake	24	13.3
10	Waste Disposal	21	11.7

The results of the analysis further showed that the effects of landslides in Gakenke District can be very devastating. These effects ranged from loss of crops to loss of human lives in extreme cases. The ranking of the effects revealed that while 146 out of the total number of respondents representing 81.1% thought that loss of crops was the most severe effect of landslide in the district, 109 respondents, accounting for 60.5% believed that destruction of houses was the most severe. Next in the order of ranking was damage to infrastructure(55.5%), followed by loss of human lives, loss of soil fertility, loss of land cover, disturbance of ecosystem, water pollution and finally, flooding, which was ranked by only 21 out of the total number of respondents (180) (table 4.5).

Table 4. 5 Ranking of the effects of landslides according to responses by the respondents' population

Rank	Effects of landslide	Frequency	Percent (%)
1	Loss of crops	146	81.1
2	Destruction of house	109	60.5
3	Damage of infrastructure	100	55.5
4	Loss of life	86	47.8
5	Loss of soil fertility	72	40
6	Loss of land cover	51	28.3
7	Disturbance of the ecosystem	43	23.8
8	Water pollution	36	20
9	Cause flooding	21	11.7

4.3 Knowledge of people about landslide-prone areas

The study investigated the knowledge of people about landslide-prone areas and revealed that 94.71% of respondents were aware of areas classified as landslide-prone areas in the Gakenke District, while only 5.29% seemed not to be aware of these areas. In spite of the high level of awareness, the results revealed that as many as 31.29% of total respondents were still living in landslide-prone areas at the time of field work. With regard to the communication channels that the government uses for informing the community about in-coming landslide events, (53.11%) of respondents received information about landslides through the radio while the remaining received the information through local leaders, social media and television (Table 4.6).

Table 4. 6 Communication channels government use for giving update information to the people for in-coming disasters

Communication government use to inform people about in-coming landslide	Frequency	Percent (%)
Radio	94	53.11
Television	4	2.23
Through district authorities	64	36.16
Social media	15	8.47

From the table 4.7, above we see that the level of education has a significant association with what the respondents do in the event of the landslide signals. The p-value of the test is 0.025 which is less than 0.05 which makes the association between the two variables significant.

From the table, we have 83respondents (46.1%) of the 180respondents who communicate with authorities when they notice the signals of landslides in the area. Out of the 83respondents, we have 9respondents with no schooling experience, 16 respondents with primary education, and 21 respondents with Junior high school. 16 respondents with Senior high school, 21 respondents with University education and we had no respondent with Technical and Vocational Education and Training (TVET) who will communicate with authorities when they experience signals of landslides in their area.

We also had 53 respondents (29.4%) of the 180respondents who will communicate among community when they receive indication or signal of landslides in the area. Out of the 53respondents, 13 respondents have no schooling background, 17 respondents have primary education background, 5respondents have Junior high school background, 4 respondents have

Senior high school background, 13 respondents have University background and 1respondent has TVET background.

We also had 26 respondents (14.4%) of the 180respondents who will relocate in those areas when they receive indication or signal of landslides in the area. Out of this 26respondents, 5respondents have no schooling background, 5respondents have primary education background, 5respondents have Junior high school background, 7 respondents have Senior high school background, 3respondents have University background and 1respondent have TVET background.

We also had 18 respondents (10%) of the 180respondents who will communicate with Social media especially Fm radio when they receive indication or signal of landslides in the area. Out of the 18respondents, 3respondents have no schooling background, 6respondents have primary education background, 2respondents have Junior high school background, 2respondents have Senior high school background, 3respondents have University background and 2respondents have TVET background.

Table 4. 7 Level of education and reaction of people after getting landslide signals

Level of education	**Reaction of people after getting landslide signals**						
No schooling	Communicate with authorities	Relocate in those areas	Communicate among community	Social media & Fm radio	Total	Df	Sig
No. of responses	9	5	13	3	30	15	0.025
Ratio of responses	30.0%	16.7%	43.3%	10.0%	100%		
Primary education							
No. of responses	16	5	17	6	44		
Ratio of responses	36.4%	11.4%	38.6%	13.6%	100%		
Junior high school							
No. of responses	21	5	5	2	33		
Ratio of responses	63.6%	15.2%	15.2%	6.1%	100%		
Senior high school							
No. of response	16	7	4	2	29		
Ratio of responses	55.2%	24.1%	13.8%	6.9%	100%		
University							
No. of responses	21	3	13	3	40		
Ratio of responses	52.5%	7.5%	32.5%	7.5%	100%		
TVET							
No. of responses	0	1	1	2	4		
Ratio of responses	0%	25.0%	25.0%	50.0%	100%		

Several reasons were cited as to the reason why the people continue to settle in landslide-prone areas in Gakenke District despite the dangers. Table 4.8, shows in percentage terms the main reasons to be poverty (82.35%) cultural beliefs or attachment and ignorance (5.04%).

Table 4. 8 The reasons people continue to settle in landslide-prone areas

The reasons people continue to settle in landslide-prone areas	**Frequency**	**Percent**
Lack of capital	148	82.35
Ignorance	9	5
Culture believe	23	12.61

4.4 Government and community preparedness to landslide disaster events

Landslide disaster preparedness both on the part of government and local community members is very important in disaster risk reduction in the event of landslide. In the Gakenke District the role of the government with regards to landslide disaster preparedness include improvement in agricultural production methods that minimizes landslides risks, formulation and implementation of policies such as relocating people from landslide prone areas to safer zones. The government is also responsible for decentralization of disaster management plan at sector level, establishment of grouped settlement plan and the establishment of master plan for each district to increase forest cover to 30% of the total area of the country by focusing on landslide prone areas in order to reduce risk.

Based on the findings, communities also play several roles in landslide disaster reduction. Analysis of the community responses revealed that, community's preparedness mainly relates to strategies they adopt to reduce the risk of disaster. These strategies include, rainwater harvesting to prevent excessive run-off in the event of torrential rains, desilting of major drains to facilitate water flows during rains, voluntary relocation to safer areas and adoption of sustainable agricultural policies (Table 4.9).

Table 4. 9 Community responsibilities in landslide risk reduction at the household level

Community responsibilities in landslide risk reduction	**Frequency**	**Percent (%)**
Roof water harvesting	35	19.44
Clear public water channels	52	28.89
Relocate in landslide prone areas	60	33.33
Improve agriculture method	33	18.33

A further probe into the improved agricultural methods adopted by community members to reduce landslide risk disaster pointed to a number of conservation methods. The results showed that 48.33% of respondents used lateral terraces as one of the improved agriculture method while 34.44% adopt agro-forest methods, where they combine crops and trees to increase soil stability. Others also employ crop rotation (6.67%), land use consolidation (6.11%) and improved irrigation as agricultural methods (4.44%) illustrated in table 4.10 below

Table 4. 10 Improved agriculture methods that contribute to landslide risk reduction

Improved agriculture methods that contribute to landslide risk reduction	Frequency	Percent (%)
Lateral terraces	87	48.33
Improved irrigation	8	4.44
Agro-forest system	62	34.44
Crop rotation	12	6.67
Land use and construction	11	6.11

From the findings, community members provide other support services to reduce landslide disaster risk reduction in the district. These include helping in rescue operations, providing temporary shelter to victims, helping the injured to receive health care and contributing cash for the up-keep of victims. As illustrated in table 4.11, below the most provided service by the communities was helping in rescue operations during disaster and providing temporary accommodation for victims.

Table 4. 11 Contributions of the community for reducing landslides risk during the landslide

Contribution of community in landslide risk reduction during disaster phase	Frequency	Percent (%)
Provide temporary shelter to victims	47	26.11
Help the injured to hospitals	40	22.22
Help in rescue exercise	60	33.33
Contribute in cash or kind for the upkeep of victims	33	18.33

4.5 Risk management plans and responses of local government and community to landslides

This section presents results on respondents ranking of landslide risk management plan. As illustrated in Table 4.12, the respondent ranked their perceptions on risk management interventions using the scale: highly agree, agree, and disagree.

The interventions ranked include research on landslides, relocation from landslide-prone areas, increased awareness of people, warning systems on landslides, law enforcement, proper land-use, establishment of a master plan of the district, proper waste disposal, and proper farming methods. The results indicated, among others that, 96.7% of respondents agreed on proper land use,76.7% respondents highly agreed to increase of awareness of people on landslide, 65% of respondents agreed on law enforcement at moderate level and 65.6% agreed on proper waste disposal and good management plans for landslide risk management (Table 4.12).

Table 4.12 Local communities Perception on Management intervention for landslide risk reduction

Type of Landslide management intervention	High agree		Agree		Disagree		Total	
	%	F	%	F	%	F	F	%
Research on landslide	18.3	33	47.2	85	34.4	62	180	100
Relocation from landslide-prone areas	70	126	30	54	0	0	180	100
Increase awareness of people	76.7	138	23.3	42	0	0	180	100
Warning system on landslide	32.2	58	45.6	82	22.2	40	180	100
Law enforcement	18.3	33	65	117	16.7	30	180	100
Proper land use	60.6	109	36.1	65	3.3	6	180	100
Establishment of a master plan of the District	22.2	40	57.8	104	20	36	180	100
Proper waste disposal	33.9	61	31.7	57	34.4	62	180	100
Proper farming methods	81.1	146	17.8	32	1.1	2	180	100

The findings further revealed that in Gakenke District, 53.33% of respondent's chose relocation of communities from landslide prone-areas as their preferred measure to reducing landslide risk. About 30% and 26.11% however, chose rainwater harvesting and improving housing condition respectively as their preferred landslide risk reducing measures. Table 4.13, illustrates the

perception of respondents on measures that could be taken to reduce landslide vulnerability in Gakenke District.

Table 4. 13 Measures taken to reduce landslide vulnerability

Measures taken to reduce landslide vulnerability	Frequency	Percent (%)
Improved housing condition	37	20.56
Relocate community who are vulnerable to landslide	96	53.33
Rain water harvesting	47	26.11

With regard to the role of government in landslide risk reduction, as perceived by the respondents, the results indicate that government help people living in landslide-prone areas to relocate to safer areas as a way of reducing the number of people living in landslide prone areas. The respondents also recognized the coordination of rescue teams as part of government response, and also government's contribution in raising awareness of people about landslide risk reduction as well as the establishment of laws and policies as the responsibility of the government (Table 4.14).

Table 4. 14 Role of government in landslide risk reduction

Role of government in landslide risk reduction	Frequency	Percent (%)
Coordination of rescue team and stakeholders	49	27.22
Help to relocate people living in landslide prone areas	63	35
Establish law and policies	20	11.11
Raise awareness of people	48	26.67

The Government of Rwanda has formulated several landslides policies to reduce risk associated with landslide as shown in table 4.15 below. Rwandan government established different disaster risk reduction policies, as illustrated in the table 4.15, showed that government established nation forest policy, the purpose is to plant trees on 30 percent of the total surface of the country by focusing on the areas identified as disaster prone-areas, it also noted that government set policy on agriculture for improvement of agriculture sector and agriculture that contribute in disaster risk reduction, to implement this policy government create lateral terraces and introduce land use consolidation system that contribute in landslide risk reduction.

Table 4. 15 Rwandan government's policies on landslide risk reduction

Name of Policy	Institution/Agency responsible	Year of coming into force	Key highlight of the policy
Rwanda's national forest policy	MINIRENA	2011	Increasing forest cover to 30 percent of the total area of country specifically in landslide risk zones
Nation human settlement policy	Rwanda Housing Authority	July 2004	Grouped settlement
National disaster management policy	MIDIMAR	2013	Decentralization of disaster management at sector level
Rationale for national agriculture policy	MINAGRI	2004	Improving agriculture methods

Results from the survey indicated that 26.59% of the total respondents were aware of government participating in relocating operation of people from landslide-prone areas through building of houses and providing iron sheets to the relocated families. About 31.79% were aware of government policy on increasing forest cover to 30 percent of the total area of the country specifically in landslide risk zones while the remaining respondents were aware of policies on grouped settlement, decentralization of disaster management at sector level and improving agriculture methods in Gakenke District as illustrated in Table 4.16 below.

Table 4. 16 Policies for landslide risk reduction in Rwanda

Policies for landslide risk reduction in Rwanda	Frequency	Percent (%)
Establish master plan of each district	7	4
Add disaster management plan at sector level	5	2.9
Increase awareness meetings to landslide	14	7.51
To increase forest cover to 30% of total area	57	31.79
Plan for group settlement	39	21.39
Improve agriculture method	10	5.78
Relocate people in high risk zone	48	26.59

4.6 Collaboration between the community and local government on disaster risk reduction

Landslide risk reduction requires effort and collaboration of government, community and individuals, to achieve both short term and long-term landslide risk reduction management goals.

4.6.1 Engagement with Local Government Officials

According to the findings of the survey, 97.06% of respondents confirmed that local government officials engage community leaders through concerning landslide risk reduction, while 2.94% were not aware of such meetings. The results further showed respondents participation in different landslide risk reduction meetings. About 50% of respondents meet to engage in

community work known as *Umuganda* while 32.12% of the respondents meet during community meetings. Other meetings such as disaster management training and army week are also patronized by the local community members (Figure 4.2).

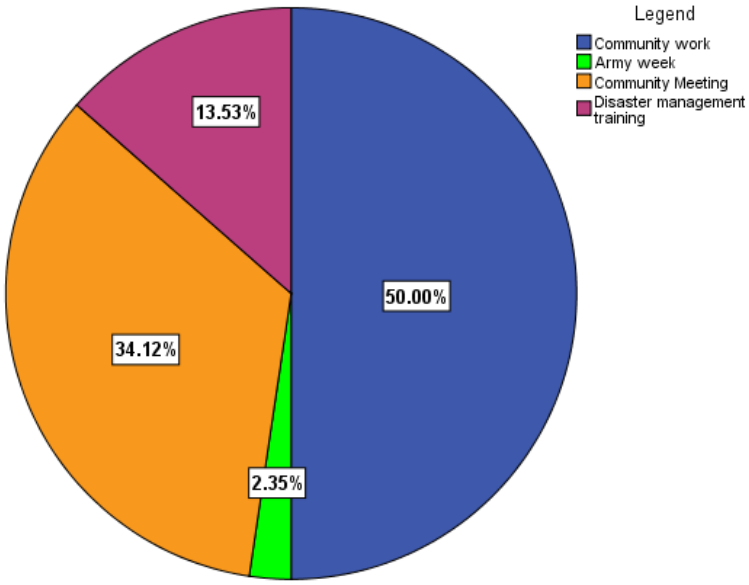

Figure 4.2 Different meetings between local leaders and community meet for disaster management

On the frequency of landslide risk reduction meeting between local authority officials and the community, the result from the survey revealed that 49.14% of the total participants have meetings with the local leader about once per week during community meetings, whereas other meetings were held either once in two weeks, once per month or once per semester. Table 4.17, illustrates various meeting periods. Further statistical analysis of the results based on the relationships among different variables was done to ascertain the strength or statistical significance of such relationships

Table 4. 17 Frequency of meeting between local government and community for disaster management

Frequency of meeting between local government and community for disaster management	Frequency	Percent (%)
Once per week	88	49.14
Once in two weeks	10	5.71
Once per month	56	30.86
Once per semester	26	14.29

From the Table 4.18, below we see that the participation in meetings of landslide risk reduction have a significant association with gender. The p-value of the test is 0.042 which is less than 0.05 which makes the association between the two variables significant. From the table, 79 respondents were females corresponding to 43.5% of the total respondents, 49respondents participated in landslide risk reduction meetings once in a month, 21 respondents attended weekly meetings and 11 respondents participated in landslide meeting once in semester. While 101 respondents (56.5%) were males. 43 respondents participated in monthly meetings, 31 respondents attended the meeting once in a week.

Table 4. 18 Relationship between gender and participation in the meetings of landslide risk reduction

Gender	**Participation in meetings of landslide risk reduction**						
	Once in a week	Once in two weeks	Once in a month	Once in semester	Total	Df	Sig.
Female						7	.042
No. of responses	21	8	49	11	79		
Ratio of responses	6.7%	2.8%	11.1%	3.9%	43.5%		
Male							
No. of responses	31	16	43	11	101		
Ratio of responses	23.3%	8.3%	33.9%	10%	56.5%		

CHAPTER FIVE: DISCUSSION

5.0 Introduction

This chapter focuses on the discussion of the results of the study, which was to investigate the role of government and community in landslide risk and vulnerability reduction in Gakenke District, Rwanda. It gives a detailed interpretation of the results by relating the observed phenomena to the literature and where necessary, making inferences that would lead to the drawing of logical conclusions.

5.1 Socio-demographic characteristics of the respondents

Gender is a crucial aspect to consider in disaster management as it reflects the positions of women in the community. Seeking the views of both females and males on the landslide risk reduction was therefore important. It will therefore make it easy to reduce the impacts of landslide and engage them in landslide risk reduction. In some countries women do not have same rights as men; in Rwanda also some culture and custom limit women to participate in some activities such as disaster risk reduction. Although women and men are part of the society, it does not mean they have the same rights, education and options to manage, neither in normal times nor when landslides take place. There is a gender disparity in the society therefore it is necessary to include women's and men's voices and expertise in landslide risk reduction activities (Stikova, 2016). There is evidence to show that women and men are not equally affected when the landslides and other disasters strike in the community. According to (Alston et al., 2019) disasters reduce women's life expectancy than men. it also noted that girls, boys and women are affected fourteen times more than men during a disaster, and that even as displaced disaster victims women are more likely to suffer further abuse in the form of domestic and sexual

violence in the camps. To avoid related impacts caused by disasters, female should be included in disaster management systems.

With regard to education, it is noted that people have high level of education also have high level coping capacity on disaster risk. The study revealed that high numbers of people living in landslide risk areas are people with low level of education. This includes people who have primary school, junior high school and no schooling. Interviewed people confirmed that educated people live in safe areas and have strong adaptive capacities compared to the people with low education level. The adaptive, mitigation and coping capacity of educated people is high compared to no educated due to high level of understanding (Raya & Lutz, 2014). From the responses, more than half of the respondents had at least High School education with additional other attaining Primary School education, University, TVET, and no schooling (table 4.1). This means the community members are largely literates and are capable and adaptive in their response to prepare and recover from landslides and other disasters but education level of people is not sufficient in landslide risk reduction, based on the views of interviewed people it is realized that education is one of key tools that contribute in disaster risk reduction but disaster risk reduction is complex. It requires different skills, tools, budget, laws, policies and its implementation. Also to have educated communities help government to raise awareness of people because, they have high level of understanding that contribute more in landslide risk reduction. The type of house is another factor that determines resilience of communities to landslide and other disasters. From the findings, most of the houses were either unpaved houses or sun-dried bricked houses which give an indication that some are vulnerable to disasters. Types of house determine the coping capacity of the people living in the house, modern houses resist to landslide because of the materials that built the house, mitigation measures have been taken to

protect them including rain water harvest, creation of water channels all these mitigation measures are for landslide and other disaster risk reduction. Most of the houses in Gakenke District are not built in modern system, but few of them have adapted some mitigation measures including creation of water canals, rain water harvesting, planting trees around and creation of lateral terraces. In 2008 government set regulations to renovate houses built in tradition way and old houses. Most houses were built in tradition ways and were easily affected by the disasters noted by disaster managers. Construction materials determine strength and resistance of the house on landslide and other disasters (Gautam et al., 2016). It is noted that in Nepal, the types of housing, oldness of houses and its location determine resilience of houses to disasters.

5.2 Perspective of the community about landslides risk reduction in Gakenke District

It is evident that the government and community work together to reduce the landslides risk and vulnerability. However, the awareness of citizens regarding landslide management should be enhanced. From the findings, majority of respondents pointed to torrential rainfall as a warning signal received before landslide occurs while the remaining felt that slow development of cracks was the main indicator of a looming landslide disaster, Gakenke District received annual rainfall vary from 1100mm to 1500mm. According to views of disaster managers in Gakenke District confirmed that combination of torrential rainfall and development of cracks on the houses and on land are the main indicators of landslide. As noted by the study conducted by Ministry of Disaster Management and Refugee Affair (MIDIMAR), frequent rainfall in some regions of Rwanda is the looming sign of landslides especially in the mountainous regions of Northern and Western parts of Rwanda where Gakenke District is located (MIDIMAR, 2018b). Based on the

views of disaster managers, in 2016 Gakenke District was faced with a high number of landslides compared with ten years ago. Combination of torrential rainfall and development of cracks on the houses and roads are the main looming signals of landslide in Gakenke District. In 2016 landslide caused by heavy rainfall killed16 people and 32 houses damaged and hundreds of hectares of crop land affected. Contrary, in some parts of Gakenke District, landslide accelerated by the type of soil, poor agricultural activities and mining, disaster managers added.

A study conducted by JICA revealed that most of the landslides which occurred in Sri Lanka were caused by heavy rainfall (JICA, 2008). The USGS, (2013) listed heavy rainfall as the major warning sign for landslides. In the Caribbean, the first indicator of landslides is torrential rainfall. In reference to a study conducted by Anderson, it was revealed that more than 65% of landslides which occurred in the Caribbean region were caused by heavy rainfall (Anderson et al., 2011). On the contrary, the main signal of the landslides in Indonesia are earthquakes as confirmed with the report of Jakarta post (Jakarta, 2017). Also, it is cited that landslides are caused by a combination of volcanoes, heavy rainfall and frequent cyclone activity in St Lucia (Worldbank, 2012). The high rainfall experienced in Gakenke District ranges between 1100 mm and 1500mm per year according to Dibanga et al., (2016), which makes the district very prone to landslide disaster.

This study revealed the factors associated with the vulnerabilities people can have with regards to landslides. Based on the findings many of participants mentioned poverty as a push factor in their vulnerability to landslides; inadequate knowledge is the second factor that pushes people to live in landslide prone-areas in Gakenke District. Due to their low income, the communities in Gakenke District are compelled to build weak houses in unsafe landslide-prone areas. According to the views of disaster managers who were interviewed, it was said that "poverty and lack of

awareness were the main push factors affecting the vulnerable people in the Gakenke District". More people in Gakenke District belong in first and second division of economic class that they don't have capacity to relocate themselves from landslide risk zones, but government contribute in relocating of people who belong in first division of economic class *(Ubudehe)* by providing plots and Iron sheets for them and their neighbors contribute in houses construction activities through community work known as (*Umuganda)* disaster managers added. This implies that the poor people are more vulnerable to landslide than rich people as corroborated by Malcolmg et al., (2013). Poverty is one of the push factors that lead people to be vulnerable to landslides. Poor people do not have enough resources to buy land and build strong houses in safer places because the prices of plots of land in safer areas are more expensive. For that reason, poor people cannot afford the price of settling in safer areas (Vlaeminck et al., 2015). Also, the findings as supported by Anderson (2011) suggest that the economic status of the country, community, and individuals greatly influence their level of vulnerability due to the lower level of mitigation, coping capacity and recovery to the landslide disaster.

With reference to the findings of this study, it is noted that lack of awareness about landslides is a push factor to landslide vulnerability. Regarding to the views of interviewed people, it is said that "awareness of people is the key point in landslide risk reduction because to be aware of landslide risk reduction is more essential than to have resources". Awareness is a foundation in each disaster management phase to achieve sustainable landslide risk reduction, they added. Awareness is a practical tool for disaster risk reduction and in community-based disaster risk management (Parkash, 2016; Manita, 2014). Public awareness as an element of disaster risk reduction was first highlighted in the Yokohama Strategy and Plan of Action in 1994. Since then, the United Nations International Strategy for Disaster Risk Reduction (ISDR) set aside

awareness as one of its four key objectives in the Hyogo Framework for Action for 2015-2030 for disaster risk reduction (UNISDR, 2017). Public awareness aims to familiarize vulnerable communities with their risks and inform them of the various actions that could be taken to minimize these risks (ISDR, 2010). From the study, greater numbers of respondents were aware of areas classified as landslide-prone areas in the Gakenke District. However, the high level of awareness did not stop them from settling in the landslide-prone areas, as the results revealed more respondents were still living in these areas during the time of fieldwork. This is not in consonance with what the literature says, thus, given an indication that other factors apart from community awareness were equally important. This current study revealed that the main reason people still live in landslide high-risk zones in Gakenke District in spite of the high level of awareness is poverty. From the results, majority of respondents attributed their continuous settlements in the landslide-prone areas to poverty, while others cited cultural belief and ignorance as reasons for settling in landslide risk zones. This also confirmed what disaster managers interviewed in the study stated that "majority of people living in high-risk zones are poor they cannot afford easily the price of plots in safer areas" they belong in first economic class which means they are poor families. According to Manita, (2014), most people who are vulnerable to landslides in Nepal were the poor. Such people cannot afford to purchase plots of land in safer areas in Nepal and their mitigation measures are low compared to the rich people. A similar situation is occurring in Bangladesh with the majority of people living in landslide risk zones being of low socio-economic status and therefore cannot afford the price of land in safer area (Shesh& Zubair, 2012).

With regard to the different channels that are used to inform the community about looming of landslide and other disasters, majority of respondents received information through radio while

the remaining participants got information from local leaders, social media and television. Many people received information about coming disaster through radio because majority families use radio receiver to get information that is the reason government frequently use radio to inform people about coming disasters. Radio is an easy and quick way for spreading information in the community. According to NISR, (2018), it is noted that over 92% of Rwandan families have access to the radio for that reason radio is a good channel to inform communities about coming disasters. However local leaders also inform people about coming disaster in the community meetings that take place once in a week and other meetings especially in rainy seasons. Disaster manager confirmed that "people get information from radio because more families have radios", and they provide useful information and technical knowledge to the community through meetings. Also noted that this is disaster week where we focus on disaster management strategic plan and building houses of people affected by disasters. But in case of emergency local leaders can prepare special meetings to inform community about in-coming disasters. In Japan, community radio is the first source of information to alert people about landslides as well as actions to take (IEDM, 2012). In Azerbaijan, television and national radio are used in spreading disaster information to the community before a disaster takes place. It is also used to inform rescue teams about the location of the community affected (Salavatian et al., 2015).

5.3 Responsibility of community and local government to reduce landslide impacts

Community plays an important role in disaster management because they are more directly affected and bear the most burdens when disasters occur. They are also the ones who will be using their resources to cope with the impacts of the disaster before obtaining external assistance from the government, stakeholders, and NGOs (Sodnom, 2012). With regards to the findings of

the study, it is noted that communities are responsible for relocating from landslide prone-areas to safe areas because they are the first affected with landslide, this can be done by families or helped by community. Respondents said that at the household level relocation from landslide-prone areas to safer areas is their responsibility because when landslides hit affect them and their valuable properties. This finding supports the claim by disaster managers during interviews when they purported that "it is the responsibility of people to relocate from landslide-prone areas to safer areas in times of disaster; but contribution of government comes as second option. Even if the government contributes in resettlement of people living in landslide risk zones, people can contribute more in the actions, Disaster managers added. From the study, community contributes in implementation of policies, measures and plans that government wants to put in action for disaster risk reduction at sector and district level. This helps government to use small budget to provide adequate solution on the disasters. As shown by the finding of the study, the contribution of community and government must work together for achieving community resilience to landslide and other disasters. Community has responsibility at household level, cell level and at sector level to mitigate the impacts of landslide, all these activities contribute in implementation of policies and regulations have been set by the government for landslide risk reduction at national level. In Badegaun, the vulnerable community moved to a safer place in 2010 when the landslide hit their community. They lived in a temporary shelter until the effects of landslide got minimized (VUSSC, 2007). In Thakani, a primary school located at the foothill of the mountain was a place the community members were asked to relocate due to the threat of landslides (Mcadoo et al., 2018). In Indonesia, citizens engaged in landslide risk reduction exercises by applying the sketching method to reduce the slope angle of remaining land after building their

houses. This sketch system leads to an increase of shear strength and an increase of slope stability (Mertens et al.,2018).

Governments equally play a central role in landslide risk reduction and other disasters risk reduction through establishment of policies, regulations and raising awareness of people about building community resilience to landslide and other disasters. The study revealed, that government helps people living in landslide-prone areas to relocate by providing plots and Iron sheets for people who want to relocate and people affected by landslide. This supported with disaster managers interviewed. It is indicated that the government helps people to relocate from high-risk zone to safer areas through the different programs which have been set by the government including community work known as (*Umuganda*), community work that take place on last Saturday of the month in whole country and once in a week at cell level, this community work is a good time the government use to enhance community awareness and doing activities related to landslide risk reduction like building the houses of poor people that are vulnerable to landslide, people affected by the disaster and enhance awareness of people about disaster management. From the study findings, also government provides iron sheets to the poor people who want to relocate to safe areas. In the Sri Lankan community of Sindhukol, those living in landslide-prone areas are normally temporarily relocated from their areas by the government as a mitigation measure of landslides, government provide plots and helped them to build the houses to the families relocated (Manita, 2014).The Sri Lankan government had directly participated in relocation activities and raising awareness of community living in the Aranayaka landslide-prone area. Also, the government was involved in a camping process by providing temporary shelter to affected people. Later, the government provided agriculture land for affected people (Pinnawala,

2019). In a similar manner, the government of Nepal saved the Badegaun community by deciding to relocate the community from a landslide-prone area to a safer area (Manita, 2014).

The Pakistani stakeholders adopted a new model of landslide risk reduction through Combined Hydrology and Slope Stability Model (CHASM) which combined hydrology (water flow), surface cover (land use) and slope stability (retaining wall). This method was adopted following many failures experienced with retaining walls that were built by the community as landslide mitigation measures. Due to poor construction code, and CHASM helped by controlling water flow and determining the strength of retaining walls that have the capacity to stabilize vulnerable areas. This model has been successful in Pakistan (Anderson et al., 2011). In India, government contributed to the sketching slope along the roadside to reduce shear stress along the slope and build retaining walls that supports the toes of the mountains (Parkash, 2012). In the Bududa District of Uganda where there were frequent landslides caused by heavy rainfall; the government decided to relocate the affected community to Kiryandongo and buffer the high-risk zone (Ekotu, 2012).

5.4 Risk management plans, vulnerability reduction and responses of local government and communities to landslides

The Government of Rwanda has put in place different disaster risk management interventions to reduce the impacts of landslides. Findings of the study revealed that majority of respondents agreed that land use consolidation was a good management intervention for landslide risk reduction, land use consolidation is a policy government introduced for landslide risk reduction and improvement of agriculture, to implement this policy the government is doing different activities like creation of lateral terraces, planting trees in high risk zones, and creation of water

channels which contribute in landslide risk reduction. As noted by disaster managers, awareness of people should shift from traditional agriculture to land-use consolidation system. This will lead to improving agriculture productivity and disaster risk reduction through utilization of bench terraces and agro-forestry that would ultimately contribute to landslide risk reduction. In Gakenke District, government and their partners started to build lateral terraces that will reduce slopes of some mountains that will reduce occurrence of landslide disaster managers said. The study further indicated that government established national human settlement policy that has a purpose to set out a settlement plan in the village and the cities of the country. Settlement policies focus on establishment of settlement master plan including grouped settlement and identify risk zones of different disasters. And people living in landslide risk zones are helped to relocate to safe areas. As noted by interviewed in the study, local government and community contribute in vulnerability reduction and risk management plans through decentralization of disaster management at sector level, this helps in down up decision making by considering views of the people and in implementation of community based in disaster management by focusing on the need of citizens. In other studies, several of such examples exist. the Government of Saint Lucia, for instance, took measures for the prevention of landslides through improvement of agriculture by rebuilding and creating terraces and sketch slope and controlling drainage by using underground pipes (Government of Saint Lucia, 2008). Preventing settlement in landslide-prone areas, establishing a proper settlement, and establishment of building codes are all good policies that have been used in Singapore to reduce landslide risk in additional building retaining walls that stabilize slope (See et al., 2008).

For the government of Rwanda to achieve the long-term goal of disaster risk reduction, it has marked out all areas which are prone to different disasters through the book called "the National

Risk Atlas of Rwanda". Following that study, the government established a master plan for all parts of the country and established each part with the appropriate activities according to the target of a country and its geological characteristics. This was the first step for disaster risk reduction (Republic of Rwanda, 2015). Based on the master plan of each district, it is prohibited to build new houses in areas identified as prone to disasters. Based on interviewed people, they said that before staring building activities and other big project you have to request permit for checking if the activities you want to start fit within the master plan of the region and will not cause or expose community to landslide or other disasters, disaster managers Added. The policy of increasing forest cover by 30 percent of the total areas of the country by 2030 is another management intervention for landslide risk reduction. This action taken by government of Rwanda was confirmed by respondents who admitted that this management intervention will contribute more to landslide risk reduction and other hazardous events. Increase of land cover area by focusing in areas identified as disaster prone-areas, also increase resistance of soil to landslide.

5.5 Collaboration among local government and community in landslide risk reduction

The collaboration of community and government is paramount in disaster risk reduction especially in developing countries where the government budgetary allocation for emergency situations is normally scanty. From the results of the study, majority of the respondents confirmed that they have had a meeting with local leaders about landslides risk reduction. Community and local leaders collaborate in community meeting place once a week at cell level and once in a month on last Saturday of every month in community work. In the community work people participate in disaster risk reduction including planting trees in areas identified as

disaster risk zones, building houses of poor people who want to relocate from disaster prone areas and contribute in building houses of people affected by disasters. This policy has been taken from tradition culture the people used to help each other to cope with the disasters in their families.

From the study, the respondents claimed that they had regular meetings with local government officials, the regular meeting takes place once in a week, and the local government informs people about new policies and programmes. Regarding on the views of disaster managers interviewed this regular meetings take place once a week every Tuesday afternoon. “It is a good time to inform people about strategic plans for landslide risk reduction and sharing skills about building community resilient to disasters”, Disaster managers added. The study further indicated that people participate in disaster management training facilitated by MIDIMAR, while others took part in “army week” as part of their meeting with local government officials regarding landslide risk reduction. From the interviews, in August 2018 people, soldiers and local leaders contributed building the house of people affected by disasters and planted trees in areas classified as prone to disaster in Gakenke District.

The study findings indicated that females participate in the disaster risk reduction meetings, contrary contribution of women in disaster risk reduction activities are low as revealed by disaster managers interviewed. These arrangements indicate that in Rwanda women participate more in the meetings rather than practical activities in disaster risk reduction. Based on the law of government that promotes gender equality, this engages the women in disaster risk reduction activities. Contrary in some countries women are limited by the cultural beliefs that lead in reduction of women participation in disaster risk reduction. Collaboration of government and

community is very important in landslide risk reduction. In 2012 for example, there was the celebration of International day for Disasters Risk Reduction at MIDIMAR where stakeholders carried out community service in Kigabiro sector and helped in the building houses for people affected by disasters (MIDIMAR, 2012).

Rwanda also has a disaster risk reduction week where the government uses that week to educate and raise awareness about landslide risk reduction. Government builds houses for people who have relocated from landslides and other disasters prone areas and planted trees on mountain slopes, government also provide plots for the poor people that want to relocate from disaster prone areas and give them Iron sheets for their houses (MIDIMAR, 2018a). based on the views of disaster managers interviewed it was said that communities help the government in rescue activities, relocation activities by building houses for the affected people through community activities known as *Umuganda*. In Singapore, local government cooperates with the community during the process of gathering information that will be used for establishing a master plan for disasters in different areas in Singapore, this information is helpful for disaster management (See-Sew et al., 2008). In Myanmar, the community collaborates with the local government in landslide risk reduction through trees plantation in Ayeyarwaddy Delta. This has helped this community to cope with the impacts of landslides (NNDC, 2017).

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6.0. Introduction

This chapter forms the concluding part of the study. It begins with the summary of findings by presenting the highlights of the entire study. This is followed by the conclusion which focuses on the major highlights drawn from the study and ends with the recommendations.

6.1. Summary

The frequency and severity of landslides have increased in recent times globally with serious implications of human lives and property as well as national economies. This has increased emergency management burden on governments and policy makers, who have now recognized the need to adopt proactive strategies for landslides risk reduction. In many disaster response initiatives, community-based disaster management approach is adopted as quick solution to emergency response. Against this background, the study aimed at investigating the role of government and community in landslide risk and vulnerability reduction in Gakenke District in Rwanda. The study was guided by the following four objectives, to investigate community knowledge on pre-disposing factors to landslides in Gakenke District; to find out government and community preparedness to landslide disaster events; to assess responses of government and communities to landslides risk and vulnerability reduction and to find out the level of collaboration among local government and community in landslide risk reduction.

The study was undertaken in Gakenke Districts, Rwanda, quantitative and qualitative methods were used to gather the data from respondents. Questionnaires and an interview guide were also used as data collection instruments. The simple random and cluster sampling were used to select

180 respondents as sampling techniques. Graphs, tables and charts were used in data presentation while chi-square test was also conducted to test relationships between different variables.

The results of the study were presented under five sections based on the objectives of the study. In the determination of the knowledge of community living in Gakenke District regarding the warning signs of landslides, 54.71% of respondents pointed to torrential rainfall, while othersreferred todevelopment of cracks (17.65%), movement of retaining walls (13.53%) and rockfalls (14.12%) as the potential signs that herald the occurrence of landslides. With regard to the reasons for vulnerability to landslides, the results pointed to poverty (3.4.4%) and luck of awareness (33.9%) as main cause, while others pointed sitting of building on sloppy areas, deforestation, quarrying activities and inappropriate building codes as causes. The results further showed that though 94.71% of respondents were aware of areas classified as landslide-prone areas, as much as 31.29% of respondents still settled in these areas.

In determining the community and local government preparedness to landslide hazards, the study revealed that the communities adopt various strategies related to landslide risk reduction including rainwater harvesting to prevent excessive run-off in the event of torrential rains, desilting of major drains to facilitate water flows during rains, voluntary relocation to safer areas and adoption of sustainable agricultural policies. The results further indicated that the community members provide other support services to reduce landslide hazard risk reduction in the district. These include helping in rescue operations, providing temporary shelter to victims, assisting the injured victims to receive health care and contributing cash for the up-keep of victims.

With regarding to risk management interventions and responses of local government and community to landslides, 81.15% of respondents highly agreed to the adoption of proper land use techniques, 76.7% highly agreed to increased awareness of people about landslide, while, 65% of respondents agreed to law enforcement, while34.4% of respondents disagreed that proper waste disposal was an option as landslide management intervention.

The results further indicated the measures taken to reduce landslide vulnerability in Gakenke District to include relocation of community from landslide prone-areas, rainwater harvesting and improving housing condition.

Collaboration of government and community is the key point in landslide risk reduction. According to the results, 97.06% confirmed that they collaborate with local leaders in different meetings regarding landslide risk reduction, 50% of respondents said that they meet with local leaders in community services (*Umuganda*) while the remaining participated in community meetings and disaster management training programmes organized by MIDIMAR.

6.2. Conclusion

On the basis of the findings, the study drew several conclusions on the role of government and community in disaster risk and vulnerability reduction in Gakenke District.

On community knowledge on pre-disposing factors to landslides in Gakenke District, the study concludes that communities have basic knowledge about landslide risk reduction such as causes, effects and the warning signals of landslide and the measures taken to reduce the landslide risk, however, poverty, lack of awareness and cultural belief are the main causes of vulnerability to landslides in Gakenke District.

With regards to the community and local government preparedness to landslide disaster, the study concludes that community adopts various strategies related to landslide risk reduction such as rainwater harvesting, relocation from landslide-prone areas and improved agricultural methods. Additionally, the government contributes through relocating people from landslide prone-areas, coordinating rescue teams and raising awareness of people about landslide risk reduction.

Regarding assessment of risk management interventions, vulnerability reduction and responses of local government and communities to landslide, the study concluded that the Government has put in place different measures and management interventions in order to reduce landslides risk, including, the zoning of areas prone to landslides, relocating people living in landslide risk zones, establishing settlement plan and building codes that explain building standard and reducing the number of settlement in landslide risk zones.

On the level of collaboration among local government and community in landslide risk reduction, the study concluded that the community and local government officials collaborate extensively in different meetings such as disaster management training and community meetings to get information on how to prepare and tackle for in-coming disasters. This collaboration has helped in reducing landslide disaster impacts in Gakenke District.

6.3. Recommendation

Based on findings, the researcher recommends that:

- The government and stakeholders should be more actively engaged in raising awareness and educating the community living in landslide disaster risk zones through formation of disaster management clubs in the community and at schools.

- Communities living in landslide-prone areas should be educated about vulnerability reduction strategies, landslide mitigation measures and landslide preparedness strategies and plans.
- Also, the government should alert communities, especially those living in landslide prone areas prior to landslide occurrence to minimize landslide risks.
- It is also recommended that to enhance community preparedness, government should keep focus on the vulnerability reduction measures for those who are not yet relocated in order to save them before resettlement process starts, this is because to relocate all people living in landslide risk areas will take many years and big budget.
- The study finally recommends that the government should introduce strict building code to discourage the construction of houses in landslide-prone areas and make follow up on its implementation. Moreover, the government should put in place strategies that would encourage people to engage in landslides management and focus on community based approach towards reducing risk associated with landslides. To achieve this, the government should provide adequate resources, skills, and responsibility to the community for coping, mitigating, preparedness and recovery to landslides and other disasters.
- This study was carried out in Gakenke District in Rwanda. The researcher therefore recommends that similar studies be replicated in other Districts of Rwanda to fill in possible gaps in order to enhance a holistic national approach for tackling the problem.
- The government should adopt successful policies, programs and management interventions from other countries for implementation in landslide-prone areas.

- The Government and community should create and clean water channels, build retaining walls and improve housing condition for people living in high risk zones.

Lastly, the government should introduce disaster management into the academic curriculum in order to equip students with sustainable ways of mitigating and managing risk associated with landslides and other disasters.

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APPENDICES

APPENDIX ONE QUESTIONNAIRE

Questionnaire

UNIVERSITY OF GHANA

COLLEGE OF BASIC AND APPLIED SCIENCES

INSTITUTE FOR ENVIRONMENT AND SANITATION STUDIES

Questionnaires for households

This research is being conducted by **Jean Felix NIZEYIMANA**, a student of the Institute for Environment and Sanitation Studies, University of Ghana, Legon, on the topic: "Role of government and community in landslide risk and vulnerability reduction: Case study of Gakenke District, Rwanda". The information collected will be used for the partial fulfillment of a Master of Philosophy degree in Environmental Science at University of Ghana.

Your full support and willingness to respond to the questions are very essential for the success of the study. The anonymity of your responses is assured and all the necessary ethical protocols will be observed.

Section A: respondent's profile

1. **Respondent Name**:……(Optional).

2. Tel optional :…… (optional).

3. Gender:i. Female ☐ ii. Male ☐

4. Respondent age:

i.Between 18 to 25 years ☐ iv. Between 26 to 35 years ☐

ii.Between 36 to 45 years ☐ v. Between 46 to 55 years ☐

iii.Between 56 to 65 years ☐ vi. Above 65 years ☐

5. Marital status: i.Single ☐ ii.Married ☐

iii.Widow(er) ☐ IV**.** Separated ☐

6. **Level of education:**

i. No schooling; ☐ iv. High school junior, ☐

ii. Primary Education ☐ v. University ☐

iii.High school senior ☐ vi.TVET ☐

7. Respondent's family size

i. 1- 4 Persons ☐ iii.7-9 Persons ☐

ii. 5-7 Persons ☐ iv.>9 Persons ☐

8. Type of house of respondent

I. Paved ☐

ii. Unpaved ☐

iii. Wooden house ☐

iv. Clay/mud house ☐

v. Brick house ☐

9. Occupation

Source of income	**First job**	**Second job**
Farming		
Trading		
Teaching		
Mining		
Others (specify)		

Section B investigating community knowledge on pre-disposing factors to landslides

10. Do you receive any signals of landslide?

Yes ☐ No ☐

11. If yes what are those signals?

i. Torrential rainfall ☐

ii. Slowly developing of cracks ☐

iii. Retaining walls move ☐

iv. Continuing fall of rock ☐

v. Others (specify). ☐

12. Do the signal alert you of a looming disaster?

i. YES ☐ ii. NO ☐

13. What do you do in the event of those signals?

i. Communicate with authorities ☐

ii. Relocate in those areas ☐

iii. Communicate among community ☐

iv. Social media FM radio ☐

iv. Others (specify)._____.

14. What makes a person vulnerable to landslides in Gakenke District?

i. Poverty ☐

ii. Quarrying activities ☐

iii. Deforestation ☐

Iv. Building on hilly areas ☐

v. Not using proper building codes ☐

vi. Lack of awareness about landslide ☐

15. How do you reduce vulnerability to landslide?

i. Building retaining walls ☐

ii. Build water channels ☐

iii. Improve houses conditions ☐

iv. Other (specify)_____.

16. Rank the main cause of landslide in Gakenke?

i. Prolong Rainfall 1

ii. Deforestation 2

iii. Poor agriculture method 3

iv. Mining activities 4

v. Construction activities 5

vi. Erosion 6

vii. Poor irrigation 7

viii. Earthquake 8

ix. Gravitational force 9

x. Waste disposal 10

17. Have you been caught up in a landslides event before?

i.Yes ☐ ii. No ☐

18. If yes, in which year?

i. …… iii. ……....

ii. …… iv. …….

19.Rank by order of importance the major effects of landside in Gakenke District?

i. Loss of life 1

ii. Loss of crop 2

iii. Loss of land covers 3

iv. Destruction of houses 4

v. Loss of fertility soil 5

vi. Water pollution 6

vii Damage of infrastructure 7

viii Cause flooding 8

ix. Disturbance of ecosystem 9

20. What are community responsibilities in landslide risk reduction in pre disaster phase?

i. Roof water harvesting ☐ iii. Relocate in landslide prone areas ☐

ii. Clear public water channels ☐ vi. Improve agriculture method ☐

21. What are community role in landslide risk reduction during disaster phase?

i. Provide temporary shelter to victims' ☐ iii. Help in rescue exercise

ii. Help the injured to hospitals ☐

iv. Contribute in cash or kind for the upkeep of victims ☐

v. Other (specify)_____.

22. What is role of government to landslide risk reduction?

i. Coordination of rescue team and stakeholders ☐ iii. Establish law and policies ☐

ii. Help in relocate people living in landslide prone area ☐ vi. Raise awareness of people ☐

23. What are the roles of people to landslide risk reduction at household level?

i. Rain water harvesting ☐ iv. Relocate to landslide prone areas ☐

ii. Improving agriculture method ☐ v. Afforestation ☐

iii. Waste water management ☐

24. What improved agriculture methods do you use to reduce landslide risk?

i. Lateral terraces ☐ vi. Crop rotation ☐

ii. Improved irrigation ☐ v. Land use consolidation ☐

iii. Agro-forest system ☐

25Are you aware of any government laws and regulations to reduce landslide risk in the Gakenke area?

Yes ☐ No ☐

26. If yes, name some of those that you know

1……

2…….

3…….

Section C Government and community preparedness to landslide disaster events

27. Are there government preparedness plans for landslide risk reduction?

i. Yes ☐ ii. No ☐

28. If yes, what are these government preparedness policies for landslide risk reduction?

i. Relocate people in high risk zone ☐ v. Increase awareness meeting to landslide ☐

ii. Improve agriculture method ☐ vi. Add disaster management plan at sector level ☐

iii. Plan for group settlement ☐ vii. Establishing master plan of each District ☐

iv. To increase forest cover to 30% of total area of country ☐

29. What are emergency response organization participate landslide risk reduction?

i. MIDIMAR ☐ iii. Police ☐ v. Red Cross ☐

ii. MINIRENA ☐ iv. REMA ☐ vi. NGOs ☐

30. Does government communicate to community about coming landslide?

i. Yes ☐ ii. No ☐

31. If yes, what communication channels are using?

i. Radio ☐ ii. Television ☐

iii. Through District authorities ☐ iv. Social media ☐

32. Do you know areas that are classified as landslide prone area?

i.Yes ☐ ii.No ☐

33. If yes, do you settle in areas classified as landslide prone area?

i.Yes ☐ ii. No ☐

34. If yes, why don't you relocate to safer areas?

i.Lack of capital ☐ ii. Ignorance ☐ iii.Culture believes ☐

iv. Others (specify)

Section D Risk management plans and responses of local government and communities to landslides

35. What are measures taken to reduce vulnerability in Gakenke District?

i. Improve housing condition ☐ iii. Rain water harvesting ☐

ii. Relocate community who are vulnerable to landslide ☐

36. What are policies addressing for landslide risk reduction?

i.Relocate people living in landslide prone areas ☐ iv. Establishing warning system ☐

ii. Increase awareness of people about landslide ☐ v.improving settlement conditions ☐

iii. Improving agriculture methods ☐ vi. Afforestation policies ☐

37. What are the community management plans for landslide risk reduction?

Actions taken to mitigate landslide	High agree	Agree	disagree
Research on landslide			
Relocate on landslide prone areas			
Increase awareness of people			
Warning system on landslide			
Law enforcement			
Proper land use			
Establish master plan of District			
Proper waste disposal			
Proper farming			

Section E Collaboration among local government and community to landslide risk reduction

38. Are there collaboration between local government and people to landslide risk reduction?

i. Yes ☐ ii. No ☐

39. if yes, how many times do you meet with local government?

i. Once per week ☐

ii.Once in two weeks ☐

iii.Once per month ☐

vi. Once per semester ☐

v. Other (specify)_____

40. When do you collaborate with local government for landslide risk reduction?

i. Community work ☐ ii. Army week ☐ iii. Police week ☐

iv. Meeting ☐ v. Disaster management training ☐

THANK YOU FOR YOUR PARTICIPATION

Appendix Two shows historical landslide from 1988 to 2013 in rwanda

Year	District	Death	Affected people	Damage
1988	Ruhengeri	0	15	3 houses damaged
2006	Kigali	24	2000	-
2010	Kigali	21	5937	-
2011	Nyabihu	17	2 people injured	3 houses damaged
2011	Burera	7	1	-
2011	Rutsiro	1	0	14 houses damaged
2012	Ngororero	2	0	19 houses damaged and 54ha croplands affected
2012	Nyabihu	5	0	147 houses damaged and 305ha croplands affected
2012	Gasabo	2	0	6 houses damaged
2012	Nyamagabe	0	0	2 houses destroyed
2012	Rulindo	0	0	1house and 40ha cropland affected
2012	Nyamasheke	3	0	1 house affected
2012	Nyarugenge	0	0	1 house damaged
2012	Burera	2	1	-
2013	Gasabo	2	3	47 houses damaged
2013	Nyarugenge	4	4	87 houses damaged
2013	Kicukiro	0	0	22 houses destroyed
2013	Rutsiro	3	1	18 houses damaged
2013	Rulindo	12	7	79 houses and 257ha cropland affected
2013	Gakenke	2	6	41houses affected
2013	Gicumbi	3	0	52 houses damaged
2013	Nyamagabe	0	0	8 houses damaged
2013	Burera	2	0	19 house damaged
2013	Ngororero	0	0	4 houses damaged
2013	Rubavu	2	3	0
2013	Karongi	5	0	2 houses damaged

Appendix three: Mining activities associated with the effects of landslides

CAUSE	EFFECT	P-VALUE	ASSOCIATION
Mining activities	Loss of life	0.019	Significant
Mining activities	Loss of crop	0.008	Significant
Mining activities	Loss of land cover	0.034	Significant
Mining activities	Destruction of houses	0.184	Not significant
Mining activities	Loss of fertility	0.000	Significant
Mining activities	Water Pollution	0.003	Significant
Mining activities	Damage of infrastructure	0.000	Significant
Mining activities	Cause flooding	0.002	Significant
Mining activities	Disturbance of the ecosystem	0.088	Not significant

Appendix four: Construction activities associated with the effects of landslides

CAUSE	EFFECT	P-VALUE	ASSOCIATION
Construction activities	Loss of life	0.190	Not significant
Construction activities	Loss of crop	0.625	Not significant
Construction activities	Loss of land cover	0.000	Significant
Construction activities	Destruction of houses	0.007	Significant
Construction activities	Loss of fertility	0.297	Not significant
Construction activities	Water Pollution	0.051	Not significant
Construction activities	Damage of infrastructure	0.000	Significant
Construction activities	Cause flooding	0.172	Not significant
Construction activities	Disturbance of the ecosystem	0.414	Not significant

Appendix five: Poor irrigation association with the effects of landslides

CAUSE	EFFECT	DF	P-VALUE	ASSOCIATION
Poor irrigation	Loss of life	64	0.197	Not significant
Poor irrigation	Loss of crop	40	0.282	Not significant
Poor irrigation	Loss of land cover	64	0.000	Significant
Poor irrigation	Destruction of houses	48	0.000	Significant
Poor irrigation	Loss of fertility	64	0.088	Not significant
Poor irrigation	Water Pollution	64	0.047	Significant
Poor irrigation	Damage of infrastructure	64	0.000	Significant
Poor irrigation	Cause flooding	64	0.380	Not significant
Poor irrigation	Disturbance of the ecosystem	40	0.905	Not significant

Appendix six: Gravitational force associated with the effects of landslides

CAUSE	EFFECT	P-VALUE	ASSOCIATION
Gravitational force	Loss of life	0.001	Significant
Gravitational force	Loss of crop	0.914	Not significant
Gravitational force	Loss of land cover	0.568	Not significant
Gravitational force	Destruction of houses	0.009	Significant
Gravitational force	Loss of fertility	0.024	Significant
Gravitational force	Water Pollution	0.000	Significant
Gravitational force	Damage of infrastructure	0.000	Significant
Gravitational force	Cause flooding	0.011	Significant
Gravitational force	Disturbance of the ecosystem	0.000	Significant