

FLOOD OCCURRENCE AND ITS IMPLICATION FOR NAROK COUNTY, KENYA

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DECLARATION AND APPROVAL

Candidate's Declaration

This research project report is my original work and has not been presented for a degree in any other university or any other award

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DEDICATION

I dedicate this project report to all the victims of the floods in Narok Town.

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ACRONYMS AND ABBREVIATIONS

ACTS	African Centre for Technology Studies
CBD	Central Business District
CBO	Community based organisation
CDRMC	County Disaster Risk Management Committee
DRR	Disaster Risk Reduction
ENSDA	Ewaso Ngiro South Development Authority
EPM	Environmental Planning and Management
HFA	Hyogo Framework for Action
ICCA	Institute for Climate Change and Adaptation
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency
KeRRA	Kenya Rural Roads Authority
KFS	Kenya Forest Service
KMT	Kenya Markets Trust
KNHA	Kenyan National Highway Authority
KRC	Kenyan Red Cross
KWS	Kenya Wildlife Service
LH	Lower Highland
LPG	Liquefied petroleum gas
NCG	Narok County Government

NGO	Non-governmental organisations
PDNA	Post Disaster Needs Assessments
PSV	Passenger service vehicles
RVWSB	Rift Valley Water Services Board
SCDRMC	Sub-County Disaster Risk Management Committee
WRMA	Water Resource Management Authority

ABSTRACT

Narok town in Kenya is among the most affected urban areas by the raging seasonal flooding in the recent past resulting to severe ill health, disrupted livelihoods, damage to infrastructure, deaths, injuries, and, and food insecurity. Although assessment has been done on causes, impact and mitigation measures put in place to manage floods in Narok town, there is still evidence of perennial floods and unprecedented impacts of floods. Therefore, this study, assessed the causes, impacts, organisational arrangement, and other aspects of management of floods in Narok town. The following data and information collection tools were used: household survey questionnaire, organisational survey schedule, and observation checklist. The secondary data and information was extracted from the review of literature, and government reports. The data and information collected was analysed using Statistical Package for Social Science and Excel sheet 2013. The results are presented in the form of graphs and tables. The significant underlying causes of floods in Narok town are rainfall and topography. The main native physical impacts caused by flood is soil erosion. The main biological impact caused by flood is loss of vegetation while the main social impact is the loss of life and property, loss of livelihood and displacement of people. The structural flood management measure largely used is the construction of gabions while the main non-structural flood management measure used planting of trees. The measures in place have greatly improved in reducing impacts of floods on socio-economic and biodiversity aspects. There are state and non-state organisations contributing to flood management through policies, legislations, strategies and plans, funding, training and coordination of partnerships. However, lack of clear policy and legislative structures, insufficient funding, equipment and staffing in relevant organisations limit the capacity to effectively mitigate impacts of floods. This study recommends a comprehensive assessment of root causes and impacts of floods; enhance building partnership; and integrated disaster management approach. There is need to study deeper interaction between factors influencing occurrence of floods and impacts of floods the effectiveness of specific structural and non-structural flood mitigation measures on each sector of economy vulnerable to floods. This research report contribute to scientific evidence and it may inform policy support towards sustainable implementation of integrated flood management strategy in Narok town and urban areas elsewhere.

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The 5th Climate Change Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) reveal that the weather and climate events like extreme precipitation and flooding pose risks in urban areas for people, assets, economies, and ecosystems (IPCC, 2014a). IPCC (2014) define flood as an overflowing, large amount of water beyond its normal confines, especially over *what* is normally dry land (IPCC, 2014a). Floods cause damage to property, injuries and even loss of life. Particularly, the populations in urban settings, they experience emergence of diseases, damage to livelihoods and infrastructure deaths, injuries, disruption of service delivery, and food insecurity (IPCC, 2014b). The international Emergency Events Database (EM-DAT), show that the number of flood events and impact reported globally has increased since the 1960s with the devastating flood events in Bangladesh in 1974 and in Venezuela in 1999 (Centre for Research on the Epidemiology of Disasters (CRED), 1988; Jonkman, 2005). The flood events in Bangladesh in 1974 and in Venezuela in 1999 causing an enormous number of reported fatalities of 28,700 and 30,005, which represented 98% and 86% of global flood-related fatalities for those years respectively.

Africa' vulnerability is worsened by its state of economic development and low adaptive capacity (IPCC, 2007). The Post Disaster Needs Assessments (PDNAs) conducted in Dakar, Ouagadougou, and Bangui City in Africa showed that urban floods affect many cities throughout Africa. The urban floods affect many cities throughout Africa are attributed to weak urban governance and the limited infrastructure (World Bank, 2010).

Kenya as a country is facing climate related challenges (Government of Kenya, 2010a). Narok is among parts in Kenya that are prone to floods (Government of Kenya, 2013b). The deforestation and land degradation upstream in Kenya has resulted in excess surface runoff downstream. In addition, several El Nino events have been recorded in the past. The recent strong El Nino events include 1997-98 (Karanja & Mutua, 2000). Floods in Kenya is a perennial problem causing disruption, damage and costing millions of shillings in reconstruction and recovery. Flood affected about one million people and caused economic loss to about 0.8-1.2 billion USD due to public health effect and damage to crops and infrastructure during the 1997/1998 El Nino (Government of Kenya, 2013b). The other floods were recorded in 2002-2008, 2010, 2012, 2013, 2014, and

2015 (Opere, 2013). There is inadequate comprehensive monitoring of regional flooding (Huho *et al.*, 2016).

In Kenya, in the recent past, incidences of urban flooding have been recorded especially in Nairobi City and Narok town. Narok town situated in South west in Kenya and approximately 146 km west of Nairobi City. Narok town is the Headquarters of Narok County (County Government of Narok, 2013). According to the Kenya Demographic and Household Census of 2009, Narok town had a total population of approximately 42,505 persons. Narok town is among the most affected urban areas by the raging seasonal flooding in the recent part. The maximum floods recorded have been examined for the period 1951-1992 with the monthly distribution of highest annual peak discharge happening between in the April, May, August and September in Narok streams (Maloba *et al.*, 2015). In 2013, Narok town experienced flooding (Huho *et al.*, 2016a) and in 2015, it experienced flooding, which resulted to 11 fatalities in 2015, and property loss worth hundreds of millions of shillings and disruption to delivery of services and goods in the Central Business District (Maloba *et al.*, 2015). These floods were attributed to manipulation of the watersheds by humans and the location of Narok town in a valley (drainage basin) and confluence where two major streams (Kakiya and Samburmbur) drain water into Main River called Enkare Narok River. In addition, there is encroachment by illegal and unplanned buildings at the river banks of the two streams and the main river.

1.2 Statement of the Problem

The findings of studies on impacts of floods in Narok town over several decades (IFRC, 2012, 2018; UNISDR, 2012) are validated by the recent Rapid Assessment of Impact of Flood Reports, 2013 and 2015 that Narok town is severely affected by perennial floods normally occurring during the long rains season but attributed to many factors. In 2015, Narok town experienced flooding, which resulted to 11 fatalities, injuries, damage to infrastructure and property worth hundreds of millions of shillings and disruption to delivery of services and goods in the Central Business District. The previous studies on impacts of floods have majorly focused on the whole or other parts of the Narok County with minimal focus on the fast growing Narok town (NDOC, 2013; Odhiambo, Afullo, Eunice, & Maghenda, 2015; UNDP, 2015). In the Narok Town Integrated Floods Management Plan, it is acknowledged that despite Narok still being faced with recurrent flood hazards, the disaster response and management remains largely reactive, with weak coordination mechanism (ENSDA, 2015). The town lack strategy, which is compounded with the

inadequate resources to support capacity to execute core functions of coordination, formulation and implementation of risk reduction policies. Therefore, this study assessed the root causes, impacts, existing flood mitigation measures, organisational arrangement and other potential flood mitigation measures in Narok town to generate key lessons that will inform strategic and sustainable measures that can be integrated into the integrated flood management strategy in Narok town.

1.3 Research Objectives

1. To examine the causes of floods in Narok town
2. To examine the impacts of floods in Narok town
3. To analyse the organisational arrangement for flood management in Narok town
4. To evaluate the various flood management initiatives implemented in Narok Town

1.4 Research Questions

1. What are the underlying causes and impacts of floods in Narok town?
2. What are the impacts of floods in Narok town?
3. How are state and non-state organisations involved in flood management in Narok town?
4. How effective are the existing flood management initiatives implemented in Narok town?

1.5 Significance of the study

In the Narok Town Integrated Floods Management Plan, 2015, the stakeholders acknowledged that the disaster management strategy remains largely reactive, with weak coordination mechanism (ENDA, 2015). This reactive approach means that millions of shillings meant for development are spent on emergency responses and reconstruction impeding development progress. The reactive approach is compounded by the lack of flood management strategy and the inadequate resources, which limit the capacity of Narok County to execute core functions of coordination, formulation and implementation of risk reduction policies. The lack of strategy compounded with the inadequate resources limit the capacity of Narok County to execute core functions of coordination, formulation and implementation of risk reduction policies. Therefore, there is need to understand better the root causes and impact of flooding in Narok. This will generate findings that will be useful in decision making on environmental friendly and resource efficient integrated approaches that will mitigate negative impacts of floods and improve on efficiency in resource utilization for the betterment of human wellbeing. The Narok County Government will benefit from research

findings to inform policies, plans, strategies, programmes and projects on building urban resilience primarily because the management of a city and municipality is vested on the county governments. The other beneficiaries include traders, researchers, academicians, opinion leaders, practitioners, policy makers, development partners and other stakeholders who are involved in making decisions in developing and reviewing of integrated flood management plans and strategies in order to sustain mitigation of adverse impacts of floods in Narok town and other urban areas in the county and the country.

1.6 Conceptual Framework

The conceptual framework developed is informed by the theoretical framework adopted for this study, which is the urban resilience theory advanced by Liao (2012). The urban resilience theory emerged following the occurrence of large-scale flood disasters in many cities in the industrialized world in the twenty-first century.

Achieving urban resilience will require different management practices. The four common functions of management as advanced by McDonald, (2010) include planning, organizing, leading and controlling (Schraeder *et al.*, 2014). Fayol was convinced about the need for formal management education (N. M. Carter, 2011). The concept of management of floods adopted in this study is derived from Fayol(N. M. Carter, 2011; Rodrigues, 2001)and McDonald (Schraeder *et al.*, 2014)

Accordingly, integrated management of floods is the process by which stakeholders predicts the likelihood of floods in the future based on the past and present data and analysis of trends. In addition, the stakeholders need to plan, direct, organize, maintain and coordinate innovatively human resources, organizations and other relevant resources. Urban flood resilience can then be achieved through a scientific, policy guided and evidenced informed decision making process. An integrated floods management strategy integrates: climate information and predictions, socio-economy growth and trends, policies, sector strategies, plans, programmes and legislations at county, national, regional and international level, environment and ecosystem goods and services, built and non-built flood control systems, mutli stakeholder approach, and innovative management and governance practices. The integrated management flood strategy that will be built on the below conceptual framework will inspire creativity, collaboration and innovation among stakeholders.

The stakeholders will be open to debate and think out-of-the-box in managing flood hazards at present and in the future.

The analysis of the above theories and concepts on building resilience of urban areas and management practices and the interaction of the dependent and independent variables guided the development of the conceptual framework (See Figure 1.1). The study try to understand the flood occurrence and implication (dependent variables (DVs)) in Narok town, which are manifested physically, ecologically and socioeconomically. The study also looks at the intervention through organisational arrangement for flood management and flood management initiatives in Narok Town. The independent variables (IVs) examined as causes of floods in Narok town include rainfall, topography, bursting of Narok River and closeness of Narok town to Narok River and soil type. The organisational arrangement for flood management and flood management initiatives are enabling variables towards integrated flood management in Narok.

The study examined the effects of floods in Narok town, which include physical, biological and socia-economic impacts. The physical impacts include soil erosion, siltation and water pollution; biological impacts include loss of vegetation, loss of micro-organisms and habitat destruction; and the social impacts include disease prevalence, education, loss of life and property, loss of livelihood, famine, relief dependency, displacement of people and infrastructure destruction. The study pursued the intervening variables by analysing the organisational arrangement for flood management in Narok town, which include mapping of government and non-governmental organisations contributing to food management; their organisational role in flood management; and their strengths and weaknesses in terms of capacity, strategy implementation, awareness creation, financial, technical and material support, structure, monitoring and evaluation and policy formulation. The study also analysed the structural flood mitigation measures and non-structural flood mitigation measures used to evaluate effectiveness of flood management initiatives in Narok town.

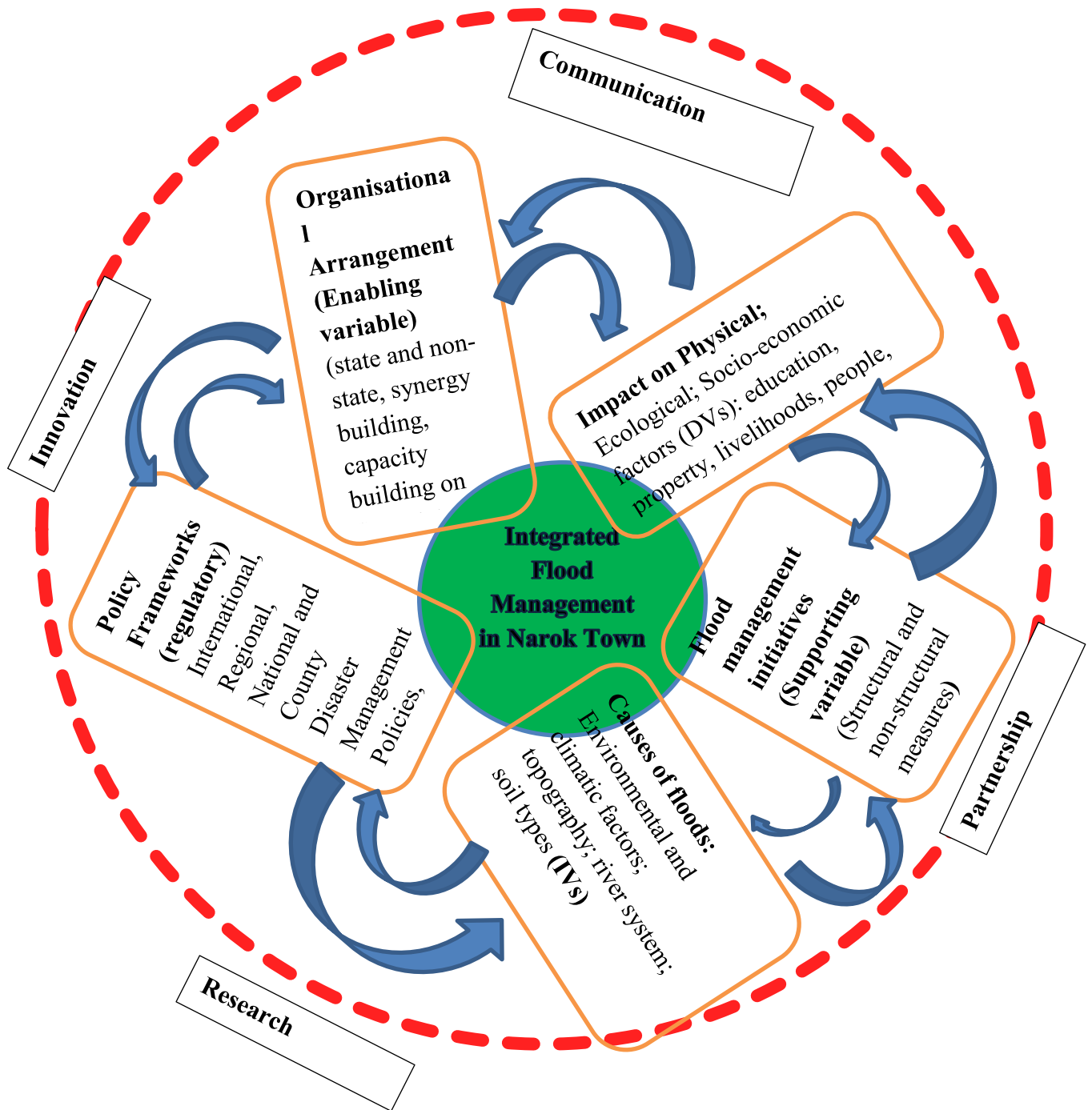


Figure 1: 1 Conceptual Model for Integrated Urban Flood Management Strategy

Source: Adopted from Issues and Challenges of Urban Flood Hazard Management (Dissanayaka & Sangasumana, 2017) with minor changes.

CHAPTER 2 LITERATURE REVIEW

This chapter provides analysis on causes and impact of floods, organisational arrangement, and flood control in urban areas and the policy and regulatory framework on disaster management.

2.1 Causes of Floods

The vulnerability of an urban area to hazards and risks can be attributed to natural and man-made process (Ouma & Tateishi, 2014). Floods are affected by climate system (Bates *et al.*, 2010). In addition, drainage basin conditions, presence of dams and reservoirs and soil character and status and urbanization influence floods (Kundzewicz *et al.*, 2014). The extent of inundation during flooding event can be influenced. Kenya is susceptible to natural disasters such as floods, which are likely to increase as a result of climate change (Government of Kenya (GoK), 2013). The floods in Kenya are caused by several factors, which are either natural or man-made (JICA, 2014). The natural causes include excessive rainfall in the upstream and characteristics of the terrain in downstream i.e. steep gradient, meandering nature, heavy siltation in the river channels and the velocity of the water (JICA, 2014). The man-made causes of flood refer to common human practice of human beings for instance, poor farming practices, deforestation, building homes and towns near rivers and other bodies of water which then contribute to the disastrous consequences of floods (JICA, 2014).

East Africa receive long rains (averagely 2,500mm) between March and May and short rains (averagely 450mm) between October and December every year but over years due to climate variability and change it is becoming unpredictable with extreme rainfall linked to flooding (Owiti, 2012) (Ngaruiya & Muithui, 2016). Flooding has been attributed to excessive rainfall covering the land (JICA, 2014). High rainfall cause torrents to overflow and as a consequence causes severe flooding (Marincioni & Antronico, 2018). In Kenya, that has been attributed to flooding, which have been experienced in various parts of the country when above normal rains is received or when rivers overflows (JICA, 2014)

Heavy rainfall in zones with clay soil formation is more likely to cause flooding (Opere & Ogallo, 2006). Shallow and poorly drained soils are found in a few places in East and South East from Narok town and the surrounding hilly and swampy areas (Wright, 1967). The rangelands, agricultural lands and built-up areas have low soil hydraulic conductivity attributed to compaction

by livestock, farm machinery (tractors) and cemented floor and grounds respectively, hence decreasing infiltration leading to increased flood risk in Narok town during rainy season(Mireille, Mwangi, Mwangi, & Gathenya, 2019).

The geological characteristics of an area are known to influence the drainage patterns, the the nature of soils and land-use pattern(Opere, 2013). Opere (2013) argue that topography influences the gradient of rivers such that in the areas with steep slopes, water flows rapidly into river channels. Topography favours overland flow and small streams(Mandyach, 2015). Kenya's The city of Bogota is Colombia's largest city and populous city has a complex topography making it prone to flood(Dickson, Baker, Hoornweg, & Asmita, 2012). mainly plains and its types of soil with higher water retention increase the likely occurrence of floods(DI, 2019). In a Myanmar study on flood hazard mapping and assessment, among its findings is that most of the areas impacted by floods are those areas lose to rivers, ponds, swamps and fisheries(*Khaing et al.*, 2019). The key key factors that cause floods according to the above literature include soil type, rainfall, topography, bursting of rivers and the closeness of population and buildings to rivers which overflows during heavy rains.

2.2 Impacts of Floods

When floods occur in a geographical location there are good and bad experience as result of off floods(JICA, 2014). These results are known as the impact with the good (positive) impact can be viewed as advantages while the bad (negative) impacts are considered as disadvantages.

Direct tangible damage attributed to flooding includes the physical damage caused to property and contents in both residential and non-residential sectors as well as infrastructure through direct contact with flood waters(Hammond, Chen, Djordjević, Butler, & Mark, 2015).Powerful water flow remove loose soil material, which is most active at the middle part of a slope(Mandyach, 2015)(NASAC, 2015). Hence, floods catalyse soil erosion because there is heavy forest clearance and mechanization of farming at the upstream and along the streams(MoA&I, 2009). Soil erosion and silt deposit in the streams and rivers result in pollution of water and increased turbidity(JICA, 2014; Mainuri & Owino, 2014).

Floods cause water pollution because it washes down the soil and other solid waste from upstream and the affected rivers(Abeygunawardane, Dayawansa, & Pathmarajah, 2011; Gajanayake, Perera,

Kobbekaduwa, & Pathmarajah, 2016). The contribution of floods in increasing water pollution in the rivers is backed by a number of studies. For example, the *Meda Ela* a tributary of Mahaweli River, the main source of drinking water for Kandi city in Sri Lanka is increasingly getting polluted due to multiple sources including flash floods washing downstream grey and black water and solid waste (Abeygunawardane *et al.*, 2011). The eroding factors of floods cause soil erosion, which result to soil and sediment swept downstream polluting the water.

The regeneration of vegetation on land and along the streams and rivers is made difficult (Konana *et al.*, 2017; Renöfält, Merritt, & Nilsson, 2007). Larcher argue that plants growing in regularly flooded riparian areas succumb more quickly to flooding in areas that receive ample precipitation (Larcher, 2003). Therefore, extreme floods reduce riparian plant species richness, a finding of the study on plant composition and richness in free-flowing Vindel River in northern Sweden (Renöfält *et al.*, 2007). The animals inhabiting areas along the streams are affected, which is exacerbated by the loss of vegetation due to the eroding factor of floods (Alho & Silva, 2012; Konana *et al.*, 2017). According to the study on effects of severe floods in Pantanal Wetland in Brazil, changes in the length and severity of floods potentially affect both wild and domestic animals (Alho & Silva, 2012).

Floods have been linked to prevalence of water-borne and insect-borne diseases (Kundzewicz *et al.*, 2014; Opere & Ogallo, 2006; Zevenbergen *et al.*, 2010). The physical health effects caused by floods include injuries, loss of life, diseases linked to flooding, such as waterborne diseases, vector borne diseases and rodent-borne diseases, and mental health effects (Hammond *et al.*, 2015). Several studies have looked at diarrhoeal epidemics induced by flooding in Dhaka, Bangladesh (Hammond *et al.*, 2015).

Floods contribute to poor education level. The study of loss and damage from flooding due to the 2007/2008 rainfall in lower Nyando Basin, Kisumu County, Kenya, established that critical social aspects including education were impacted (Masese, Neyole, & Ombachi, 2016). The impact of floods on school attendance compromised the quality of education, which led to the poor performance by pupils in Nyando District in Kenya (Okuom, Simatwa, Maureen, & Wichenje, 2012).

The impact of flood recorded, 21 deaths, evacuation of 215,207 people, and damage estimated at CAD \$7.9 billion in Canada in 2016 (Morrison *et al.*, 2018). China recorded an estimated annual

damage of US\$51 billion caused by river floods in 2010 (Kundzewicz *et al.*, 2014). The other social impact of floods is loss of life and property. Kenya lost 15 and 84 human lives due to floods across the country and Nyanza/Western region in 2015 and 2012 respectively (Huho *et al.*, 2016b). Floods in Accra have led to casualties, the displacement of thousands of people and costs of more than 1 million US Dollars each year between 2003 and 2012 (Frick-Trzebitzky, Baghel, & Bruns, 2017).

Impacts due to urban floods are significant in terms of economic losses both direct and indirect (Tingsanchali, 2012a). In Malawi, floods triggered not only harvest failures but a sequence of knock-on shocks to local economies and societies leading to famine, which was experienced in 2000/2001 because there were no effective intervention to mitigate the shocks (Devereux, 2007). According to a livelihood zoning exercise undertaken by World Bank in 30 districts in Kenya following the 1997/98 El Nino, most sources of livelihoods in Tana River and Garissa district were negatively affected (Masese *et al.*, 2016). In the case of the 2008 floods in Charleville and Mackay, Australia, communities' experiences particularly consistent disruption of livelihood, assets and property leaving the communities economically vulnerable (Apan *et al.*, 2008).

Largely, many countries in Africa rely in emergency relief to support population affected by floods (AU, 2008). Some countries such as Botswana, Ethiopia, Nigeria and Tanzania have operating funds for relief but most countries finance relief from general sources (such as donor funds and regular government budgets). The victims of floods received emergency relief support during El Nino, where the Kenyan Government, local authorities and Kenya Red Cross distributed basic necessities such as food, shelter and medical care (Nyakundi, Mogere, Mwanzo, & Yitambe, 2010). The Kenya Red Cross (KRC), county and national government contribute to the delivery of emergency and relief to the victims of floods in Kenya. Therefore, there is high dependency on emergency relief. For example, the perennial floods in Nyando District have an annual relief and rehabilitation of not less than Ksh 37 million (Otiende, 2009).

The occurrence of floods contribute to displacement of people due to disruption of education, supplies of clean water, health care, transport, communication, wastewater treatment and electricity (Mireille *et al.*, 2019). Floods also displaced around 100,000 people in the first few months of 2012 in Kenya with the worst affected areas including Nyanza province, parts of Rift Valley and Coast provinces and the Greater Metropolitan area of Nairobi (RMMS, 2013).

In the 2007 summer floods in the UK, of the £4billion damage to the economy, approximately £670million was credited to damages to critical infrastructure (Chatterton, Viviattene, Morris, Penning-RowSELL, & Tapsell, 2010). The floods which occurred in 2007/2008 in Nyando basin impacted in livelihoods and other social aspects including agriculture, health, education, infrastructure, water and sanitation, housing and property and assets of people and livelihoods (Masese *et al.*, 2016).

2.3 Organisational Arrangement and Disaster Risk Management in Urban Areas and Sub-national level

The Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) and the United Nations Framework on Climate Change (UNFCCC) recommends an all-society and all-community policy making process in disaster risk reduction (UNDRR, 2015; UNFCCC, 2015). Institutional and stakeholder interplay (Aligica, 2006) helped in mapping relevant disaster risk organisations, identified their role in flood risk policy and project formulation and implementation, collaboration and cooperation and stakeholder engagement in flood management. Stakeholder refers to persons or groups whose interests and activities strongly affect and are affected by the issues concerned, who have a stake in a change, who control relevant information and resources and whose support is needed in order to implement the change (Aligica, 2006). The modern legal policy frameworks at all levels recognize other key players, which include the private sector, development agencies, civil society, academia and think tanks who largely make input into the policy formulation process. These category of stakeholders collaborate and cooperate in policy related research and actions that enhance mobilization, resource support, generation of evidence, translation of concepts, advocacy among key inputs in formulation process.

In Kenya, the management of floods and other disasters is a cross-cutting issue that requires collaboration action by public and private sector agencies at national, county and community levels (Government of Kenya (GoK), 2013). The Constitution of Kenya (2010) provide that the national and county governments jointly in partnership with the relevant stakeholders manage disaster risks and provide firefighting and rescue services by formulating and implementing relevant policies and projects (Government of Kenya, 2010c). Policy formulation is a process of identifying and addressing possible solutions to policy problems or, to explore various options or

alternatives available for addressing problem (Turnpenny, Jordan, Benson, & Rayner, 2015). Policy design should stress the importance of local knowledge, (Veselý, 2020). Therefore, these definitions guided the mapping of organisations who are contributing to the formulation of policy formulation at the national and the county level. The three arms (executive, parliament & judiciary) of the national government are purely policy formulators(Government of Kenya, 2010c). The national ministries and their agencies and the county governments play double role. They formulate disaster risk policies and implement disaster risk projects and activities.

The Ministry of Interior & Coordination National Government (MI&CNG) is the leading agency in disaster risk policy formulation in Kenya(Government of Kenya, 2014, 2017a). MI&CNG provide overall leadership in disaster risk reduction at national level but get support from the other key ministries including the Ministry of Environment Sector, the Ministry of Planning and the Ministry Treasury, which are the lead ministries and custodians of the climate change, SDGs, and climate and disaster finance respectively. MI&CNG has two agencies which are responsible for coordinating of disaster risk management at the national level and grant support the county governments including Narok County to management county based disaster risks like flood risk. The National Disaster Operations Centre (NDOC) and National Disaster Management Authority (NDMA) domiciled at the MI&CNG) are the lead implementing entities supporting national and county governments in disaster risk management. NDMA mobilise national resources for emergencies on a 24-hour basis since its establishment after the El Nino induced floods in 1998 (Government of Kenya, 2010a). NDOC coordinates emergency operations at the national level and liaise with the county governments for level 1 and level 2 emergency response(Government of Kenya, 2014, 2017a).

At the County Government level, the Governors lead their sectors and departments of the disaster management and firefighting in disaster risk policy formulation and project implementation with contributions from the other sectors, directorates, departments and relevant stakeholders(Government of Kenya, 2010c, 2019; Ministry of Devolution and Planning, 2016). The county governments are mandated to manage cities and other urban areas (Government of Kenya, 2017b). The disasters happening in the urban areas are managed by the county governments with support from the national government and relevant stakeholders including the Kenyan Red Cross (KRC), which is operating nationally. The national and county governments and other local disaster response organizations like the police, military, national youth service,

hospitals, St. John's Ambulance, National Environment Management Authority (NEMA), media among others do respond to floods in rural and urban areas including Narok town through a multi-agency approach coordinated by NODC and NDMA to either undertake rapid vulnerability and impact assessments and develop mitigation strategies (Denise, Ray-Bennett, & Hebden, 2017). There are international organisations who support the local organisations, these include United Nations Humanitarian Assistance Response (UNHCR), Médecins Sans Frontières (MSF), United Kingdom's Oxfam GB and other international humanitarian agencies (Denise *et al.*, 2017; DI, 2019; IFRC, 2018; Niekerk, Coetzee, & NemaKonde, 2020).

The non-state organisations collaborate and cooperate with national and county government in policy and project development and implementation as provided for by the Constitution of Kenya (2010) and the other relevant policies and laws on devolution of functions. The private sector, development agencies, civil society, academia and think tanks, they contribute to the formulation and implementation of the disaster risk policies. They are the non-state actors hence their role is to make input into government led policy and project development processes. They are strongly making input into the policy and project formulation at the national and county level.

The auxiliary agencies (e.g. KRC), private sector, development agencies, and the civil society contribute largely through resource mobilization for humanitarian and other technical support while the civil society and the local community based organizations play more role in advocacy, local community mobilization and relief distribution under the county disaster risk management committee (CDRMC) and the sub-county disaster management committee (SCDRMC) (GoK, 2007; Government of Kenya, 2017a; Narok County Government, 2018a). KRC is also a member of the committees at the county and sub-county level. The academia and think tanks contribute significantly to the translation of the policy provisions using research evidence, resource mobilization and capacity building towards policy formulation and implementation. The local disaster risk committees at the village and ward level are ad-hoc in nature.

Humanitarian agencies dominate response to disaster risks through emergency and recovery followed by the government agencies providing leadership in public policy implementation and private sector supporting investments (Drummond *et al.*, 2014). Research and academic organizations providing research and capacity support came third followed by private sector contributing strongly to rebuilding. The analysis of the literature, however, shows that governance

of disaster risk is still largely emergency in nature and siloed. The national agencies are still coordinating disaster risk management and emergency response at the county level hence specific roles for national and county governments are not clearly defined. There is need to map sectors and categories of organisations and identify their strength and weaknesses at the county level to inform research, private, government and non-governmental organisations agencies and sectors toward integrated and institutionalized disaster risk governance.

2.4 Flood Control in Urban Areas

The urban resilience theory postulates that in urbanized floodplains, the socio-economic trends, climate, infrastructure and riverine processes affect flood hazards and disasters (Liao, 2012). The socio-economic trends, built infrastructure, climate and riverine process operate like evolving ecosystems (Z. Liu et al., 2007). A strategic approach to reduce county's vulnerability to disasters require an infusion of upfront funding and long term planning (Glantz, 2017). The analysis of the past flood control measures in this literature review puts into perspective also the integrated water resource management approach.

The flood-impacted cities have been heavily relying on flood control to mitigate flood hazards, it was criticized for harming riverine ecosystems and increasing long-term flood risks(Burby, Nelson, Parker, & Handmer, 2001). Cities that depend on flood control infrastructure can resist floods only up to a certain magnitude, thereby these cities are ill-prepared for capacity-exceeding extreme floods, which are expected to increase with more intense storms whose exact natures are unpredictable (Alley, 2007). The socio-economic trends, built infrastructure, climate and riverine process operate like evolving ecosystems and are characterized by complex behaviours associated with nonlinearity, emergence, uncertainty, and surprise (J. Liu *et al.*, 2007). A strategic approach to reduce county's vulnerability to disasters require an infusion of upfront funding and long term planning (Glantz, 2017). In Africa, some countries like, in Nigeria, there is emphasis on both structural and non-structural strategies to combating flood hazards(Obeta, 2014). Therefore, this literature review puts into perspective that countries are not integrating the structural and non-structural strategies towards combating flood hazards. However, some countries like Nigeria has strongly integrated the structural and non-structural strategies towards combating flood hazards.

Structural flood management measures have been used over years by many countries. Tingsanchali (2012) describes structural measures to include polders and basins, bypass channels, dredging and widening of stream and channels, levees and embankments, construction of dams or river dikes while the non-structural measures include flood forecasting and warning, flood hazard and risk management, public participation and organisational arrangement (Tingsanchali, 2012b). The flood enlargements and levees have the ‘right of way’ problems hence there is need for floods to be regularly maintained to preserve design standards (Olugunorisa, 2010). Floods hazards challenge river cities around the world, despite many of them being protected by extensive flood-control infrastructure, such as levees, dams and channelization(Liao, 2012; Morrison *et al.*, 2018).

Flood-control infrastructure is not a reliable mitigation approach in the face of climate change uncertainties (Zevenberge and Gersonius 2007).The other structural measures include, construction of water pans, check dams, detention ponds are designed to be placed at intervals between check dams to improve efficiency of holding silt and regulate water flow into check dams; reconstructing and improving the existing bridges and construction of flood control gabions. The construction of water pans, check dams, detention ponds have been placed at intervals between check dams to improve efficiency of holding silt and regulate water flow into check dams in parts of Narok county, which are flood prone (WRMA), 2013; WRMA, 2013).

Douglas in his study on flooding in urban areas in Kenya (Nairobi), Nigeria (Lagos), Mozambique (Maputo) and Ghana (Accra), shows that despite many interventions being taken to mitigate flood impacts, there is a need to move beyond structural, measures at the local-level to develop holistic and innovative practices that bring together multiple, different actors(Douglas *et al.*, 2008b). Douglas finding was further supported by Fraser *et al* (2017) that research, too, needs to shift from focusing on simple procedures and disaster losses to understanding causes, and how to address them(Fraser, Leck, Parnell, & Pelling, 2017). Therefore, there is the urgency to understand the causes of floods and the associated impacts in order to develop appropriate structural flood management strategies at the county level.

There is a growing realization of the importance of the non-structural flood management measures include flood forecasting, early warning, awareness creation among stakeholders to contribute to mitigation of causes of floods (Nastiti, Kim, Jung, & An, 2015). Flood early warning system is one of the is one of the most effective methods of reducing risk to life and property amongst non-

structural flood management strategies(Otiende, 2009).Automatic rain gauges (ARGs) provide a more detailed understanding of the distribution of precipitation for planning, as well as to increase alerting power for flood warning systems(B. Carter & Roy, 2015). However, river management gauges, which were installed in the middle of the Central Asia's rivers but over the last 50 years they have changed natural river flow making it impossible to compute natural river flow using the data from the gauges(Pahl-Wostl, Kabat, & Möltgen, 2007). Therefore, river gauging station need to be integrated with other non-structural measures in order to be effective in data collection and monitoring of river flow at the discharge points at upstream and downstream.

Dissemination of flood warning to the public and professional partners can be through established lines of communication, using for example specially created reports, telephone, two-way radio, radio, television, internet, automated telephone messaging(Zevenbergen *et al.*, 2010). A radio frequency modulation–radio and internet (FM–RANET) transmitter station for vulnerable communities has been installed in the coastal part of Kenya to facilitate communication of flood alerts(Awuor, Orindi, & Andrew, 2009).

The study on the Indian Famine Commission (1880-1901) found out that the funds allocated under recommendation were largely used for structural measures rather than non-structural measures such as capacity building(Marincioni & Antronico, 2018). Mudavanhu in his study on the impact of flood disasters on child education in Muzarabani District, Zimbabwe concluded that both structural and non-structural measures need to be put in place to reduce the vulnerability of schools and children to flood disasters(Komolafe, Herath, & Avtar, 2019). The six European countries (Netherlands, Sweden, Belgium, Poland, England, France), however, are gradually transforming towards fewer structural protection measures and towards a more integrative non-structural strategy in flood risk management (Gralepois *et al.*, 2016).

In order to increase the level of preparedness and protection of the flood-prone areas, additional policies are required to be put in place (Bubeck *et al.*, 2012). A disaster management policy and legislation and clear structure have to be put in place and integrated with the structural and non-structural flood management measures. The German part of Rhine River experienced two consecutive flood events with similar hazards characteristics in 1993 and 1995 and records showed that there was improved preparedness of the population and substantial reduction of damage to the

socio-economic sector during the latter because of the implementation of flood mitigation measures (Bubeck, Botzen, Kreibich, & Aerts, 2012). Therefore, the study will fill this gap in the Narok case by look at the root causes and the impact of floods in order to identify reliable structural and non-structural flood management measures.

In summary, the structural measures to be studied in Narok include, construction of water pans, check dams, detention ponds are designed to be placed at intervals between check dams to improve efficiency of holding silt and regulate water flow into check dams; reconstructing and improving the existing bridges and construction of flood control gabions. The non- structural flood management measures to be studied in Narok include, early warning system comprising of weather information dissemination, release of flood alerts, awareness creation among stakeholders to contribute to mitigation of causes of floods, and stakeholder mobilization to move away from flood zones at onset of heavy rains using social media, public forum and organisational meetings, river gauging station for data collection and monitoring system installed in rivers at the discharge points at upstream and downstream and use of radio among others. Other approaches include conservation measures, which include tree planting campaign and waste collection and management.

The structural and the non- structural flood management measures will also be studied to assess their effectiveness on mitigating flooding and its impact on the socio-economic and biodiversity factors. Some of the socio-economic factors to be include farm productivity, infrastructure, health, business environment, education and settlements.

2.5 Policy, Plan, Strategy and Regulatory Framework on Disaster Management

This section highlight the policies, plans, strategies and regulations on disaster management as they are operationalized at global, regional, national and county level. In addition, it highlight the gaps and limitations of the identified policies, plans, strategies and regulations in addressing causes and impacts of floods, building of synergies and holistic approach towards addressing floods.

2.5.1 Global and Regional Policies, Plans, Strategies and Regulations

The global response through operationalization of the Hyogo Framework for Action 2005-2015 (HFA), the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) and the United Nations Framework on Climate Change (UNFCCC) are designed to countries to address the causes and impacts of disasters including floods, catalyse organisational support through encouraging of

building of synergies in resource mobilization to support up-to-date data and information sharing, capacity building, technology transfer and policy and legislation making.

Kenya is operationalising HFA, SFDRR, ARC and UFCCC through formulation of relevant policies, plans and regulations, which include, the Kenya National Disaster Response Plan (2009).

2.5.2 National Policies, Plans, Strategies and Regulations

The national and county governments in partnership with the relevant stakeholders aim to manage disasters at national and county level (Government of Kenya, 2010c). The national government is mandated to manage disasters at national level as provided for in the Fourth Schedule, Part 1 and Section 24 of the Constitution of Kenya 2010. In addition, the national government under the Fourth Schedule, Part 1 and Section 32 is mandated to provide capacity building (Government of Kenya, 2010b).

Kenya is managing disasters through a multi-sectoral and multi-dimensional approach. The multi approach to disaster management is to mitigate deaths, injuries, damage to properties, disruptions of population, delivery of services and goods, environment and economy. The National Disaster Risk Management Policy (20187), Disaster Risk Finance Strategy (2019) and the other relevant policies, strategies and regulations contribute to operationalization of SDRR and the UNFCCC towards enabling Kenya manage disasters. There are bills, which include, the Disaster Risk Management Policy (2017) and the National Disaster Management Bill (2018). .

However, the lack of finalization of Disaster Risk Management Bill (2016) and the National Disaster Management Bill (2018) make it difficult for the relevant national ministries and departments to coordinate holistic and sustained efforts towards an integrated flood management in the country. The national government will also not make it possible to sufficiently build the capacity of the county governments to manage disasters as provided for in the Constitution, which is evident in the low capacity of the county to manage floods in Narok.

2.5.3 County Policies, Plans, Strategies and Regulations

The county governments are mandated to respond and manage disasters at the county level as provided for in the Fourth Schedule, Part 2, and Section 12 of the Constitution of Kenya 2010. The county governments through their city and town councils in liaison with the national government and relevant stakeholders are mandated to manage disasters at urban areas at county level. Narok

Town Council has the mandate to manage disasters in Narok town as provided for in the Fourth Schedule of the Urban Areas and Cities [Amendment] Bill, 2017. The Narok Town Council facilitated operationalization of HFA. In 2012, Narok Town Council signed up for the implement priorities of the HFA (Melissa & Ebalu, 2012).

The county government of Narok has put in place policy measures to reduce impacts of floods through integration of floods management and conservation measures in the Narok County Environment Management Bill 2017. The other relevant county legislations being formulated to reduce environmental destruction is the Narok County Charcoal Production 2017. The county government has developed an administration, coordination of decentralized services and disaster management department, a disaster management unit and committee to coordinate management of disasters including floods. The county government through its county integrated development plans (CIDPs) has also captured the organisational arrangement, policy recommendations and budgetary allocation to support flood management in the strategic period between 2018 to 2022.

However, Narok Town Council still lacks relevant disaster policy, plan, strategy and regulation to facilitate operationalization of the essentials of SDRR, Paris Agreement, constitutional, Urban Areas and Cities [Amendment] Bill, 2017 and CIDP provisions. The inadequacy in policy, planning, strategy and regulation is evident in lack of building synergies among relevant organisations to address the causes and impacts of floods and implementation of efficient flood management measures in Narok town.

2.6 Summary of gaps in the Literature

The literature review has provided insights in causes, impacts, organisational, strategic and policy support and limitations that still exist rendering urban areas more vulnerable to current and future floods. Some of the gaps identified in addressing the causes and impacts associate with floods is the heavy reliance on flood control to mitigate flood hazards, which has been criticized for harming riverine ecosystems and increasing long-term flood risks. This is evident there is limited integration efforts towards addressing the root cause of floods in urban areas. The natural and man-made processes contributing to urban flooding need to be studied further to generate up to date information on how to best improve on understanding the underlying causes and potential damage beyond what is recorded with the existing tools. Even though there is global and national will through development of different policies, strategies, agreements, protocols and frameworks to

mitigate and manage disasters, the sub-national level is not empowered. This is because, counties are resource poor, lack coordinated actions by the different stakeholders, insufficient policy and legislative support up to community level and limited peer-to-peer learning. Counties also lack strategic planning to leverage multistakeholder support and local actions by the urban poor and the vulnerable local communities towards flood management.

CHAPTER 3 METHODOLOGY

This chapter presents the study area, the research design, the study population, the sample size and sampling procedure. In addition, the chapter presents the research instruments and data collection techniques. Finally, the chapter presents the methods used for data analysis, logistical and ethical considerations.

3.1 Study Area

3.1.1 Administrative Boundary, Location and Extent

The study was carried out in Narok town, Narok County situated in South west in Kenya and approximately 146 km west of Nairobi City, the capital City of Kenya. Narok town is the Headquarters of Narok County located along the Great Rift Valley. The urban area is 305 km sq in the entire Narok county and Narok town is approximately 209.46 km sq (Kenya Roads Board_ArchGIS). Narok town has a good and well maintained road network with most of the roads tarmacked making movement from one place to another easy using motorbikes, passenger service vehicles (PSV), bicycles and big cars like Lorries (County Government of Narok, 2013). In addition to electricity and water connection, Narok town is also connected with telephone and fibre optic and high mobile penetration and network coverage is reliable (County Government of Narok, 2013). Narok town lies between Latitudes 10 00' and 10 05' South and Longitude 35 50' and 35 55' East. (County Government of Narok, 2013).

3.1.2 Physical and Topographic Features

Narok county is home to a number of major rivers, arid and rugged landscapes, and volcanic landforms with areas of prominent geothermal activities. Narok County's topography can broadly be divided into two: the highlands and the lowlands (JICA, 2012). The highlands have altitude ranging from approximately 3,000 metres above sea level while the lowlands range between 900 to 1,400 meters above sea level. The varied topographical scenario sets an ideal situation for possible flooding on low lying areas.

The soils across Narok County are diverse ranging from the loamy soils found on the upper highlands of the county to the sandy soils in the drier areas at the low lands of the county (County Government of Narok, 2013). Narok town is composed of a plateau with lava and volcano ashes.

The soil types in the county are determined by characteristics of the underlying basement rock and range from those developed on mountains to those developed on plains and swamps. Specifically, the main soil types in the study area include: Mollic andosols, luvisols, chromic luvisols, luvic and ando-luvic, phaeozems, chromic vertisols and chromic aerosols. Majority of soils in the county are deep and well drained. Shallow and poorly drained soils are found in a few places in Masai Mara, East and South East from Narok town to Ngurumani escarpment and on the surrounding hilly and swampy areas. Areas with deep and well-drained soils include hilly and mountainous areas of Mau escarpment, Ngorengore, Shatuka, Suswa and Loita hills.

3.1.3 Climatic and Weather conditions

Narok has diverse climatic conditions which are strongly influenced by the altitude and physical features (CIDP, 2013). The county has five agro-climatic zones namely; humid, sub-humid, semi-humid arid and semi-arid (CIDP, 2013). Two-thirds of the county is classified as semi-arid (Narok DEAP 2009- 2013). Narok falls in the semi-humid arid zone. Narok town experience two rainy seasons annually, the long rains occurring from mid-March to June and short rains from September to November (County Government of Narok, 2013). Rainfall range from 2,500mm in wet season to 500mm during the dry season. The county experiences a wide variation of temperatures throughout the year with mean annual temperatures varying from 20°C (January-March) to 10°C (June-September) with an average of 18°C (County Government of Narok, 2013). Temperatures are lowest between July and August, while maximum temperatures are experienced between December and February every year (Japan International Cooperation Agency, 2013).

3.1.4 Water Catchment and River system

The Mau Forest Complex in Narok is one of the five water towers in Kenya. The Maasai Mau Forest is Trust Land hence managed by the Narok County Council (UNEP, 2005). The UNEP' Maasai Mau Status report 2005 indicate that the Maasai Mau forest once covered an area of 43% of the Mau Complex area of 400,000 acres(UNEP, 2005). Over years, the Maasai Mau Forest is one of the most threatened forest block and it has been impacted heavily by encroachment, especially on the western side (UNEP, 2005). Mau Forest Complex in Narok is the source of major rivers like Mara and Ewaso Nyiro with Mara River being the single major river that passes through Maasai Mara Game Reserve ultimately draining into Lake Victoria (UNEP, 2005).

Kakiya and Esampurmpur stream and Narok River drains water across Narok town to Mara River (County Environment Office, 2019). The drainage system for Kakiya stream and Esampurmpur stream drains an area of 31.1Km² and 15.5 Km² respectively (ENDA, 2015). The length of Kakiya stream and Esampurmpur stream is approximately 10km and 7.8Km from the confluence with Narok River to the headwaters respectively. The drainage network comprises of several tributaries in the catchment and connector drains within the town. The total lined section of Kakiya stream and Esampurmpur stream is 444m and 320m within Narok town respectively. The estimated storm drain discharge of Kakiya stream and Esampurmpur stream is 44.2m³/s (45,000 l/s) and 3.97m³/s (4,000 l/s) respectively

3.1.5 Demographic characteristics

Narok town is the largest urban population in Narok county taking 4.5% of the county's population of 850,920 (National Census, 2009). Even though the Maasai and the Kalenjin are the dominant tribes in Narok County, the town is largely cosmopolitan with more persons from the other 40 tribes in Kenya. According to the study on 'Destination Communities' Perceptions of Mixed Migration in Kenya' 2016, Narok town is increasingly becoming cosmopolitan area in which residents do not ascribe to tribe or ethnicity; most immigrants come from the defunct Centrak, Nyanza and Western provinces of Kenya.

Narok town is the largest urban population in Narok county taking 4.5% of the county's population of 850,920 (Commission on Revenue Allocation, 2011). According to the Kenya Demographic and Household Census of 2009, Narok town has a total population of approximately 42,505 persons and it was projected to be approximately 44,506 in 2012. The population of Narok Town as of 2013 is 44,573 and male and females are 22,522 and 22,051 respectively (Kenya National Bureau of Statistics (KNBS) & Society for International Development – East Africa, 2013).

3.1.6 Socio-economic features:

The highland areas of Mau Escarpment, rising to an altitude of 3,100m above sea level provides fertile ground for farming. Production of wheat and barley has made Narok county acquire the tag; the "bread basket" of the country. The flat landscapes are ideal for range livestock keeping and large scale agriculture while the high and steep lands are mainly forest lands supporting cash crop farming like tea and pyrethrum (County Government of Narok, 2013). Narok Town is surrounded by the large farming scale of wheat, barley and maize for commercial purposes. In the peri-urban

area of the town, small plots of crops like maize, beans, onions, tomatoes, variety of vegetables are among crops grown for domestic use. The keeping of livestock is a long held practice maintained by the Maasai in the county but no livestock keeping in the town

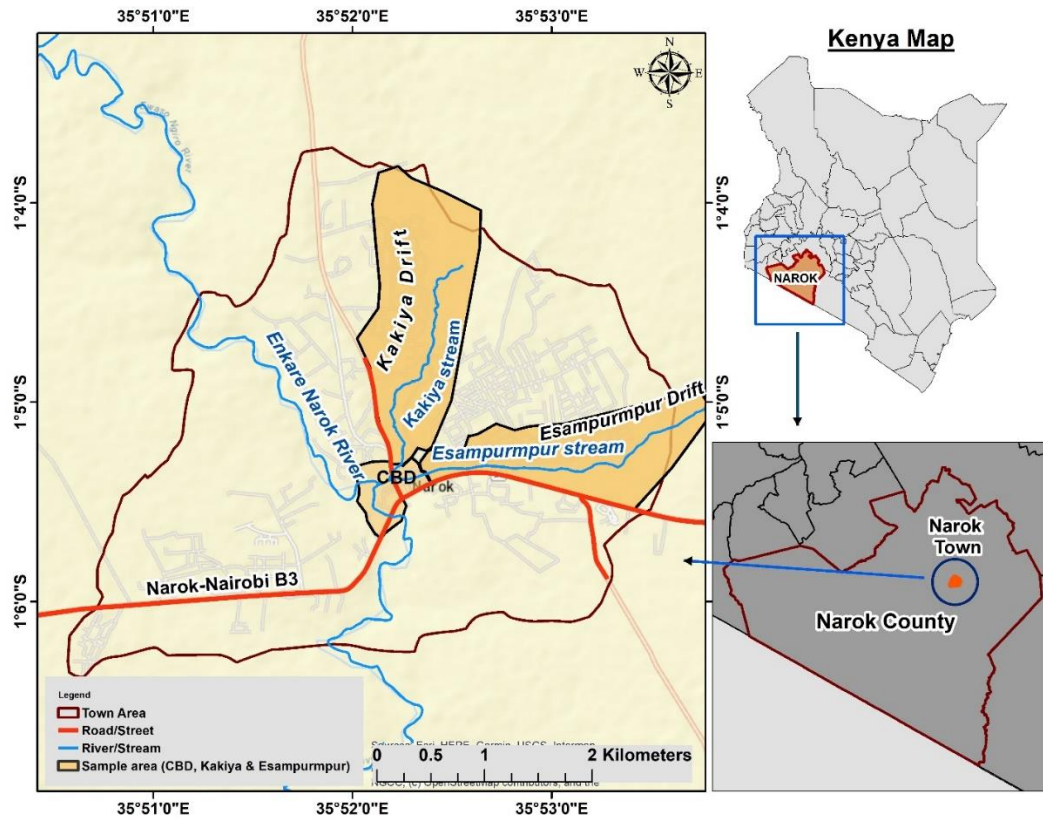


Figure 3: 1 Map of Narok Town, Narok County, Kenya

Source: Kenyatta University’ GIS Lab, 2019

The land use in the county can be classified into the following categories; residential use, industrial zone, educational use, recreation, commercial use, and public utility. The major land use types in the county include livestock, agriculture, forestry, ranching and tourism. Under agriculture, the most prevalent land-use is mixed farming units, with portions of the farm allocated to tree crops, cash crops and vegetables, while fallow land is used to graze livestock. There are three basic categories of land tenure/ownership in the county are free hold, leasehold and group ranch system. Large tracks of land are under group ranch land tenure system but these are rapidly being subdivided and converted into freehold tenure. In towns including Narok town, plot owners have either leasehold title deeds or allotment letters.

Narok town is regarded as one of the 15 towns prioritized for water service development designated in Kenya' Vision 2030 (JICA, 2012). Narok town is connected with running water abstracted from River Enkare Narok which runs through the town from South to North (JICA, 2012). Treated water is distributed to seven (7) service tanks in town through the main distribution pipe and each service tank provides treated water to nearby locations. The town used face shortage of water frequently and people were forced to fetch water in the river and transport using different modes including donkey carts, bicycle, motorcycle, vans, water boozers and hand jerricans carried by shoulder, head or lifted by hands into their homes and businesses.

Narok Town Council owns the general waste disposal site (Quarry Disposal Site) in Olpopongi area of Narok Town. The solid waste in Narok town composed of food and other organic waste, plastics, paper, metal and glass, diapers and mixed wastes (Joseph, 2018). The human waste disposal methods in Narok Town serving 44,574 members of households are: main sewer (1.09%), septic tank (7.46%), cess pool (0.07%), VIP Latrine (5.11%), pit latrine (44.04%), improved sanitation (57.76%), pit latrine uncovered (23.95%), bucket (0.06%), bush (18.22%) and others(0.00%) (Government of Kenya, 2013a)

Narok town is connected with electricity. The sources of energy in Narok Town includes electricity, solar power, liquefied petroleum gas (LPG), paraffin, firewood and charcoal. Narok Town ward has the highest level of charcoal use in Narok County at 69% and 52 percentage points above the county average (KNBS, 2009). Narok Town ward has the highest level of electricity use at 46% in the County that is 40 percentage points above the county coverage.

Narok town is the last major town when travelling by road from Nairobi to Maasai Mara National Park. Narok town stands as a centre of services, business, and finance. The town is very busy and over the years the economy of Narok town has grown exponentially. Much of the Central Business District (CBD) is under commercial activity. This includes the ODM and Muthurwa markets and the commercial areas at Ewuaso Ng'iro, Rrotian and Nkareta 101 centres. Others include the cattle market at Ewuaso Ng'iro and the various hotels, bars and shops in the CBD as well as the other centres. It is also worth noting that the town has a high hawking problem. The strategy under this sector is to concentrate any future commercial activities in the Lemanet area, Majengo and the other smaller centres within the Town (County Government of Narok, 2013)

Narok town does not have a clearly designated Industrial zone(County Government of Narok, 2013). The only Industrial activity of note is the National cereals and produce Board Complex located in Olpopongi along B3 road near the CBD and the slaughterhouses at Lemanet and Ewuaso Ng'iro centres. Most of the other Industrial activity is in the form of Jua Kali enterprises involving carpentry and metal fabrication scattered all over the CBD and the Majengo area. On the other hand, there are Posho Mills which can be found in all the other small centres and the Majengo area near the CBD. Other forms of industrial activities include tailoring, small bakeries and confectionaries, brick making, various types of food processing and quarrying (County Government of Narok, 2013)

Narok town is privileged to host some of the tourists travelling to watch the wildlife and heritage in Narok County hence benefiting the economic sector of the town(County Government of Narok, 2013). This tourism sector is prominent because of the wildlife heritage of the county. Tourism sector is the main economic income in the county, which brings an estimated 10 billion Kenya Shillings annually, as well as wheat farming, which is done both in large and small scale. Maasai Mara Game Reserve is one of the world famous attraction site within the county and it is located 30 miles south of Narok town (County Government of Narok, 2013).

Many quarries exist within the town boundaries since quarrying is active (JICA, 2012). The quarrying of building stones commenced in the old Narok town quarries near the Narok Bible College, which was later closed by the Narok Town Council (Indigenous Concerns Resource Centre, 2009).

Narok town has several public and parochial schools, these includes public primary schools and private schools as well as secondary schools and nursery schools and youth polytechnics(County Government of Narok, 2013). According to the population projections, the existing number of education facilities is not adequate (Government of Kenya, 2010b). The current 100 population structure for Narok town shows that the school going population constitutes over 60% of the population indicating that Narok town has a very high dependency ratio (County Government of Narok, 2013)

Three-star hotels and guesthouses are noticeable throughout Narok town. Some of the major hotels which provide comfortable rooms, catering, conference facilities, and other amenities include Maendeleo Parkview Hotel, Lexington Hotel, and Seasons Hotel. There are tens of small and

medium hotels and restaurants offering varying services like catering, accommodation and meeting rooms for small groups.

Narok Town is hosting Narok Referral Hospital, which is one of the referral health facility in the county. This is the former Narok District Hospital. There are health facilities, dispensaries and private clinics operating in the town. The encroachment on land meant for health organisations is noted to be a major challenge in Narok town.

Most of the CBD is a slum area, with several housing units have shop/restaurant with accommodation(Narok County Government, 2018b). It can be said that Narok Town has only a few organisational housing projects. The only formal housing is in the form of Government houses meant to accommodate senior government officers within the CBD. Many of the other residents of Narok are accommodated in Majengo and its sprawling extended area; in private houses above the commercial buildings within the CBD. Narok Town ward has the highest share of cement floors at 70%, the highest share of corrugated iron sheet roofs at 91%, the lowest share of grass/makuti roof, highest share of brick/stone walls at 54% and the lowest share of mud with wood/cement walls in the County respectively(Government of Kenya, 2010b).

3.2 Research Design

A research design is the conceptual structure within which research is conducted and it constitutes the blueprint for the collection, measurement and analysis of data (Kothari, 2004). The study adopted a descriptive design because it is effective in analysing non-quantified topics and issues as well as less time and resource consuming. The descriptive research methods adopted household survey and organisational survey to gather data that can be analysed for frequencies, averages and patterns. Observation was also used to capture and systematically describe the study area. These research methods enabled me to gather quantitative and qualitative data that can describe the causes, impacts, organisational arrangement and flood management measures and presented in frequency tables. The data collection methods used to collect the primary data and information include, household survey questionnaires, organisational survey schedule, and observation checklists. The secondary data and information was extracted from the review of literature and government reports. The data and information collected was then analysed using Statistical Package for Social Science (SPSS) and ExcelSheet, 2013. The results are presented in the form of charts, graphs and tables.

3.2.1 Purposive sampling

The purposive sampling was used to identify various interest groups. The main goal of purposive sampling was to focus on particular characteristics of the population that were able to answer my research questions. The purposive sampling was used to deliberately target key organisations and informants so as to collate necessary data to compliment data collected from the households. The key organisations targeted were departments at County Government: Agriculture, Environment and Natural Resources, Disaster Management, Urban Planning, and Public Works. The national departments were: County Commissioner' Office, Kenya Forest Service (KFS), Ewaso Nyiro South Development Authority (ENSDA), and National Environment Management Authority (NEMA). The non-state actors were the Kenya Red Cross (KRC) and the Narok CBD business association.

3.2.2 Stratified random sampling

The stratified random sampling was used to identify strata that represent the study area. The study area was divided into six strata representing locations that get affected during flooding in Narok Town Ward. The six strata are the CBD, Total Estate, Parkvilla, Greenland, Kakiya drift, and Esampurmpur drift. Three out of the six strata were then randomly selected to represent the study area: CBD, Kakiya drift and Esampurmpur drift. The CDB encompass Bus Park and Market, Kakiya drift encompass Majengo, River Side and Lenana, Esampurmour drift encompass London and Olopito. All the estates in the selected locations are highly populated and they are located along Kakiya and Esampurmpur stream and CBD is located at the discharging point of Kakiya and Esampurmpur stream to Narok River. The locations selected get affected by floods when they occur. Households were then selected from each of the stratum using simple random sampling to constitute a sample population.

3.3 Target Population

I targeted the entire population of Narok town for study. I then used that to narrow down to households located in locations which are affected by floods in Narok town. The households which are either affected directly or indirectly by floods over years were then sampled for the household interviews. The households targeted are located along the rivers and drainage and flood plains. For example, households living along Kakiya drift and Esampurmpur drifts and streams. These are

households, which have lost property, livelihoods, get evacuated or forcefully moved by the floods or the government if household members are in danger. The household could be composed of an individual living alone more than one but living as a resident or working in Narok but living along the affected areas. The household interview targeted a household representative who accept to be interviewed within the targeted households and areas within the CBD of Narok town, Kakiya drift and Esampurmpur drift.

3.4 Sample Size and Sampling Procedure

The adopted descriptive research methods, observation, household survey interviews and organisational survey guided sampling procedure, sample size and methods for collection of data and information that was analysed for frequencies and qualitative analysis. The number of households in Narok town and hotspot areas affected by floods according to the secondary literature guided household sampling procedure and size. The Card, (2018) define sampling procedure as the chronological selection of a list of elements from the entire study area during a research process to represent the whole population. The population studied consisted of the households, traders, academia, relevant non-governmental organisations (NGOs), community based organisations (CBOs), private sector, relevant national and county government agencies based in Narok town.

3.4.1 Sample size

The method of proportional allocation of the sample size was then used to allocate sample size in proportion to the population distribution.

The sample was determined using the formula recommended by Nassiuma (2000) as follows:

$$n = \frac{NC_v^2}{(C_v^2 + (N-1)e^2)}$$

Where n= sample size

N=population

CV=Coefficient of variation (take 0.5)

e= Tolerance of desired level of confidence, take 0.05% at 95% confidence level

Since Narok Town has 5,700 households as per 2009 national housing and population census, the formula was applied as follows:

$$n = \frac{5700(0.5)^2}{0.5^2 + (5699) \times 0.05^2}$$

Based on the above formula and the variables, the sample size is 98.29 rounded off to 98. Therefore, data was gathered from 98 households (out of the more than 5,700 households). During the administration of household questionnaires, transects were used to identify major features in the study area and took subsequent samples.

Three locations namely, Kakiya drift, Esampurmur drift and CBD of Narok Town were selected to represent the whole Narok Town Ward. The distribution sample sizes for Kakiya, Esampurmpur and CBD are shown in table 3.2.

Table 3:1 Sample Distribution in Selected Locations in Narok Town

No.	Target	Number of Households
1.	Targeted Population in Narok Town	5,700
	Location in Narok Town	Sample Size (households)
2.	Kakiya drift	33
3.	Esampurmpur drift	33
4.	Narok Town CBD	32
	Total	98

3.4.2 Data Collection

The secondary and primary data and information were collected from the secondary and primary sources respectively.

The secondary data and information were collected from the technical reports, articles, maps, plans, strategies, policies and legislations. The secondary data and information were shared by the following organisations: departments at National and County Government: Agriculture, Environment and Natural Resources, Disaster Management and Planning, County Commissioner' Office, Kenya Forest Service (KFS), Ewaso Nyiro South Development Authority (ENSDA), National Environment Management Authority (NEMA). The Kenya Red Cross (KRC) and World Wide Fund (WWF) shared too the secondary data and information. The United Nations agencies database provided information on disaster management and protocols. The data and information on socio-economic status of Narok Town Ward was accessed from the National Census reports and the County Integrated Development Plan (CIDP) downloaded from the website of the Kenya National Bureau of Statistic (KNBS) and Narok County Government respectively.

The rapid flood assessment reports (2015) and draft Narok town flood management strategy (2015) were collected from Ewaso Nyiro South Development Authority (ENSDA) office in Narok. The two document provided detailed information on the causes and impact of flood and mitigation strategies used by people in Narok town. Maps of Narok town and Narok County were collected from the planning office of Narok county government. The data and information on forest cover, past floods and waste related information were collected NEMA, KFS offices and World Wide Fund (WWF). UNEP and UNDP website and database provided information on disaster management and protocols and Mau Forest conservation initiatives and implication on Narok.

Direct observation and using an observation checklist and maps guided me in visiting and observing the flood affected areas in Narok town and the landscape. Observation helped me to familiarise myself with the study area and observe visible impact of flood I got from the secondary materials. Some of the flood related issues I observed were destroyed houses and infrastructure. I also used my observation to check on safe routes to follow as I interacted with the people and the organisations I had mapped for the organisational survey. The primary data were collected using the household questionnaires and organisational survey schedule, which were administered to the sampled households and organisations respectively.

The household survey questionnaire comprised of clearly structured questions relevant to the objectives (Brace, 2018). The household survey questionnaire was in-house survey with a mix of open questions, multiple choices, dichotomous questions and scaling questions. I visited each

household for the interview and each household representative interviewed had pre-set questions to answer. The multiple choices and scaling questions were set to help in developing the frequency and ranking and presented in frequency tables. The open questions helped the interviewee to share more details.

The questionnaire' reliability and validity were ascertained through independent piloting and necessary corrections made to ensure the tool measure all aspects of the variables. The primary data were collected using the household questionnaires, which were administered to the respondents representing households. The questionnaire was written in English and where necessary it was translated into Kiswahili for the respondent to provide appropriate response. English and Kiswahili are spoken in addition to the Maasai language. The questionnaires adopted both open and closed-ended questions to collect data from 98 households. The household questionnaires were distributed in accordance to the household distribution in the three strata, that is 33, 33 and 32 questionnaires were administered along Kakiya and Esampurmpur drift and the CBD respectively.

Observation guide was used to observe flood mitigation approaches and how people interacted with them.

Photography was used to capture data and information, which people in Narok Town permit to be shared by the publics at different levels. Smart phone was used to capture digital photographic data for this study. The data capture include, sections destroyed by floods and flood mitigation structures.

More secondary data needed including up-to-date maps, weather information, ongoing flood mitigation activities and planned activities relevant to the study was collected from the following organisations: Agriculture, Environment and Natural Resources, Disaster Management and Planning, County Commissioner' Office, Kenya Forest Service (KFS), Ewaso Nyiro South Development Authority (ENSDA), National Environment Management Authority (NEMA). The key informants from the non-state actors were from the Kenya Red Cross (KRC) and business association representative. Ten key informants who are representatives from the above organisations were interviewed to provide more information and data maps, weather information, partnerships and ongoing flood mitigation activities and planned activities relevant using organisational survey schedule.

3.4.3 Data Analysis

The data gathered was analysed using both statistical package for social sciences software (SPSS) and excel spreadsheet software. These methods support efficient data handling and analysis. SPSS is designed to support all sort of data and it is integrated with excel spreadsheet software is good for faster generation of frequency tables and infographics. First, the raw data set was sorted and coded. The open-ended questions were analysed manually by grouping responses into similar themes and tallying them. Their frequencies were determined using excel spreadsheet by generating frequency tables. The closed-ended questions were appropriately labelled and entered into the SPSS. The qualitative and quantitative data were presented in discussion and narrative format.

3.4.4 Logistical and Ethical Considerations

The approval to undertake this study was granted by the Graduate School at Kenyatta University and the National Commission for Science and Technology (NACOSTI) of Kenya. I enrolled two research assistants who had better understanding of Narok to support in data collection and linkage with relevant households and organisations. Two research assistants who assisted in the data collection had prior education in environmental planning and management.. The consent was sought from all the respondents before the interviews begin. All references by other scholars and writers were cited and acknowledged.

CHAPTER 4 FINDING AND DISCUSSIONS

4.1 Introduction

This chapter provides the details of the findings and discussions based on the objectives of the study. The chapter presents the causes and impacts of floods in Narok town. Secondly, the chapter presents the organisational arrangement for flood management in Narok town. Thirdly, the chapter presents the various flood management initiatives and approaches implemented in Narok Town. Finally, the chapter presents factors for consideration in an integrated flood management strategy, which include the elevation and socio-economic activities in different locations in Narok town.

4.2 The underlying causes and impacts of floods in Narok town

The household questionnaires were administered to 98 households randomly selected along Kakiya and Esampurpur streams and the Central Business District of Narok Town. The respondents (n-98) provided varying results on the factors causing floods in Narok town. The following causes of flooding in Narok town, were selected by the respondents: soil type, rainfall, topography, bursting of Narok River and the closeness of Narok town to Narok River.

Heavy rainfall in zones with clay soil formation is more likely to cause flooding (Opere & Ogallo, 2006). Majority of soils in the Narok County are deep and well drained. However, shallow and poorly drained soils are found in a few places in East and South East from Narok town and the surrounding hilly and swampy areas (Wright, 1967). The rangelands, agricultural lands and built-up areas in Narok town have low soil hydraulic conductivity attributed to compaction by livestock, farm machinery (tractors) and cemented floor and grounds respectively, hence decreasing infiltration leading to increased flood risk in Narok town during rainy season (Mireille et al., 2019). Narok like many parts of East Africa receive long rains (averagely 2,500mm) between March and May and short rains (averagely 450mm) between October and December every year but over years due to climate variability and change it is becoming unpredictable with extreme rainfall linked to flooding (Owiti, 2012) (Ngaruiya & Muithui, 2016). Historical flooding in Narok town and other parts of the county show that impact was significant in households and areas near the rivers like Ngare Narok River where 3 deaths were recorded in April 29th 2015 and 75 houses, 135 households affected, and 15 deaths recorded in June 1st 2010, 4th January, 2010 and 26th November 2014 respectively (Narok County Government, 2018a). Ngare Narok River drain water through the centre of Narok town and Olopito is located in Esampurpur drift which where sampling of households covered (figure 3).

The respondents further, shared the negative physical, biological and social impacts of flooding in Narok town. The following is the detailed analysis of the responses from the respondents on the factors influencing occurrence of floods and impacts of flooding in Narok town:

4.2.1 Causes of Floods in Narok Town

The respondents rated the following factors causing floods in Narok town either as low, medium or high: rainfall, topography, bursting of Narok River and closeness of Narok town to Narok River and soil type. The factors causing floods in Narok town were treated separately. The respondents rated each factor either as low, medium or high.

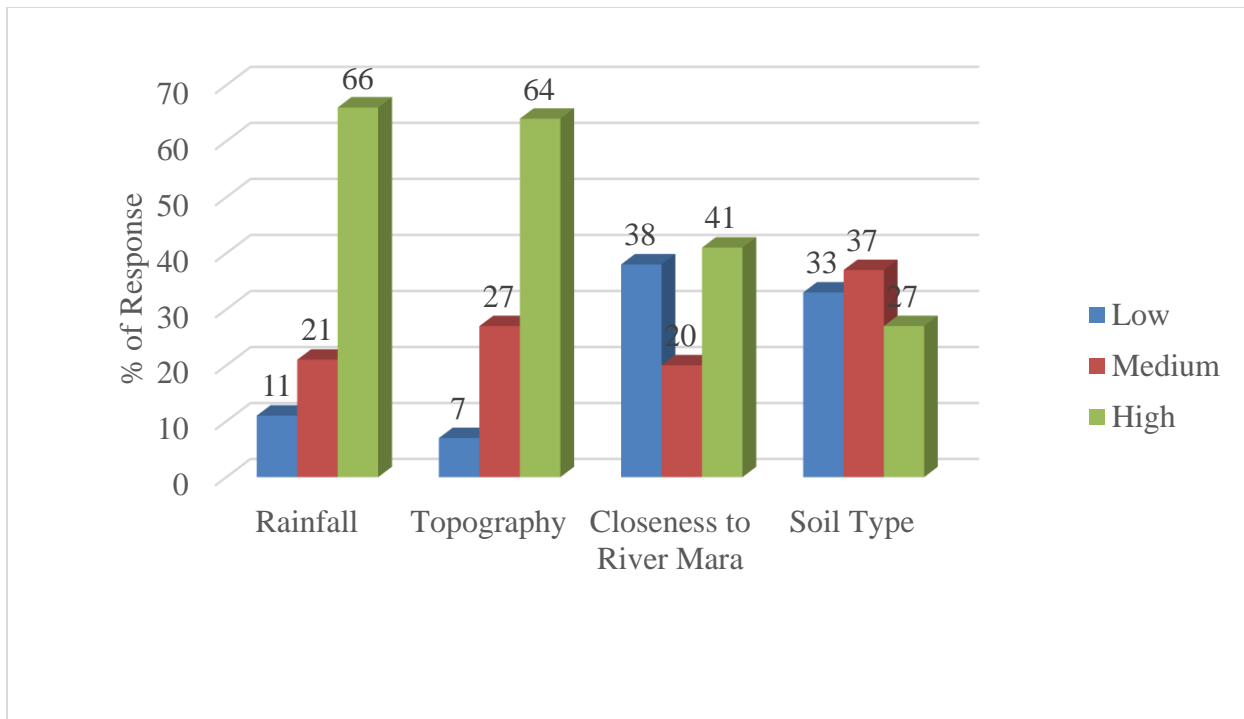


Figure 4:1 Factors causing floods in Narok town

Source: Household Interviews in Narok town, June 2019

Figure 4.1 shows that the rainfall (66%), topography (64%), closeness of Narok town and bursting of Narok River (41%) and soil type (27%) causing floods in Narok town.

The household survey ranks rainfall as the leading cause of floods in Narok town. An interview with the County Environment Office further reveals that this intense precipitation exceeds the

carrying capacity of Kakiya and Esampurmpur stream and Narok River leading to overflow and subsequent flooding, affecting parts of Narok. Latell *et al.*, (2012) confirms that high rainfall over a period of time contribute to river flows in excess of the capacity of the normal channel, resulting to floods. Narok County' CIDP supports these findings as it reports that rainfall during long rains is averagely 2500mm, normally exceeding drainage capacity of the rivers in Narok County(County Government of Narok, 2013).

The topography in Narok town is such that part of its CBD lies within a basin obstructing free flow of water in Kakiya and Esampurmpur stream into Narok River(County Government of Narok, 2013; ENSDA, 2015). This is corroborated with other studies that have shown that low-lying urban and rural areas around rivers and streams are vulnerable to floods. The worst affected areas are low-lying areas (Huho *et al.*, 2016b). Urban floods affect many cities throughout Africa because urban areas like Dakar in Senegal are often located in low-lying river deltas or coastal areas directly exposed to inundation (World Bank, 2010). Narok town is located at the lowest elevation within the catchment where the two natural water ways (Kakiya and Esampurmpur) converge before draining into Narok River (ENSDA, 2015; JICA, 2012). Hence, long rain season in Narok County compounded by the low elevation of Narok town contribute to flash floods affecting Narok town.

Narok River pass through Narok town and it receives water from Kakiya and Esampurmpur stream with both streams passing through the CBD (ENSDA, 2015; JICA, 2012). Flooding is experienced along Kakiya and Esampurmpur stream and Narok River during heavy rainy season when their capacities to accommodate excess water are exceeded leading to overflow into Narok town (ENDA, 2015; ENSDA, 2015). African towns and cities like Accra, Kampala, Nairobi, Lagos, and Maputo city are affected by flooding from major rivers on whose banks have been encroached by buildings (Douglas et al., 2008a). The closeness of Narok town to Kakiya and Esampurmpur stream and Narok River make it vulnerable to floods when water exceeds their carrying capacity (the County Disaster Office 2019) which is confirmed in figure 4.1.

In figure 4.1, households identified soil type has another factor causing floods in Narok town. The County Agriculture Office (2019) highlighted that the poorly drained soil found in places surrounding Narok town has low soil infiltration capacity. Majority of soils in Narok County are deep and well drained but shallow and poorly drained soils are found in a few places in East and South East from Narok town (NEMA, 2009).. In addition to the high rainfall and topography, the

antecedent soil moisture was found to be a contributing factor to the flash flood in Western Cape Province in South Africa (Bangira, Maathuis, Dube, & Gara, 2015). Therefore, guided by the above literature, figure 4.1 confirm that soil type in Narok town, which is poorly drained contributed to floods during long rains season because less water infiltrate into the soil and more water flow downstream.

4.2.2 Impacts of floods in Narok town

The respondents shared the negative physical, biological and social impacts of flooding in Narok town, which I have analysed below.

Physical Impacts of Floods in Narok town

The respondents (n=98) were given chance to choose more than one of the following physical impacts of floods in Narok town: soil erosion, siltation, and water pollution.

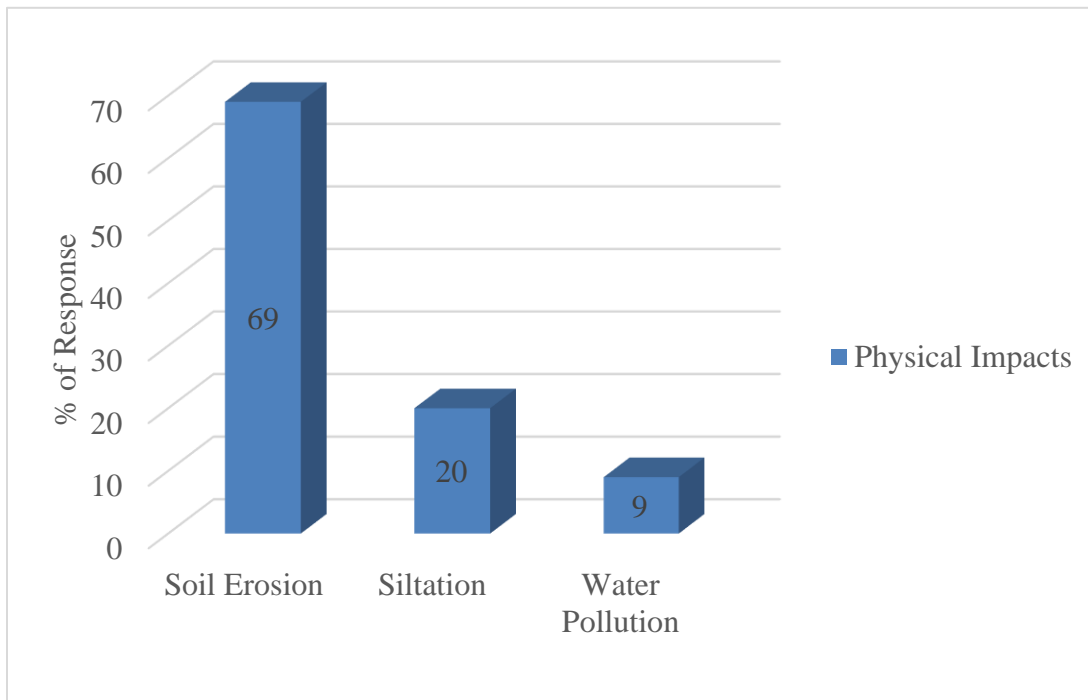


Figure 4: 2 Physical Impacts of Flooding in Narok town

Source: Household Interviews in Narok town, June 2019

The analysed data in the figure 4.2 show the physical impacts of floods in Narok town as follows: soil erosion (69%), siltation (20%) and water pollution (9%). These results show that soil erosion

is the most noticeable physical impact in Narok town followed by siltation (Plate 1:1) and water pollution.

The sheet soil erosion is noticeable in the farm lands in the peri-urban area, streets and at riparian of Kakiya and Esampurmpur stream and drain water to Narok River as shown in plate 1:1. Therefore, removing vegetation leads to a rapid removal of soil cover inadvertently leading to soil erosion (De Oliveira, Duraiappah, & Shepherd, 2003). In addition, powerful water flow remove loose soil material, which is most active at the middle part of a slope(Mandych, 2015). Hence, floods catalyse soil erosion because there is heavy forest clearance and mechanization of farming at the upstream, along the streams and the peri-urban areas of Narok town (ENSDA, 2015). Soil erosion and silt deposit in the streams and Narok River result in pollution of water and increased turbidity (NEMA, 2009). This validate the top ranking of soil erosion among the physical impacts of floods in Narok town as shown in figure 4.2.



Plate 1:1 Kakiya Stream, Narok Town

Source: Field Survey, 2019

Secondly, siltation is a physical impact of floods in Narok town as shown in figure 4.2. Plate 1:1 shows Kakiya stream filling up with silt and soil washed from upstream and eroded riparian of Kakiya stream.. Malasya argue that the variations in up, mid and downstream due to plantation and deforestation expose the soil surface and detaches resulting in the soil erosion and transportation of sediments into the rivers during rainfall in the peninsular Malasya(Anees *et al.*, 2017). This shows that soil erosion and siltation are closely linked physical impacts with soil erosion occurring leading to siltation in the rivers and drainage system in Narok town as shown in figure 4.2

Water pollution in Narok River and Kakiya and Esampurmpur stream is another physical impact caused by floods in Narok town as shown in figure 4.2. The County Water Office, Narok, (2019) also confirmed water pollution is another visible physical impact of flooding in Narok town. The perennial floods increase water pollution because it washes down the soil and other solid waste from upstream and the affected sections of Narok town (ENSDA, 2015; NEMA, 2009). The contribution of floods in increasing water pollution in the rivers is backed by a number of studies. For example, the *Meda Ela* a tributary of Mahaweli River, the main source of drinking water for Kandi city in Sri Lanka is increasingly getting polluted due to multiple sources including flash floods washing downstream grey and black water and solid waste(Abeygunawardane et al., 2011). The eroding factors of floods cause soil erosion, which result to soil and sediment swept downstream polluting the water in Narok River and Kakiya and Esampurmpur stream as shown in figure 4.2.

Biological Impacts of Floods in Narok town

The respondents (n=98) were given chance to choose more than one of the following biological impacts of floods in Narok town: loss of vegetation, loss of animals, and habitat destruction.

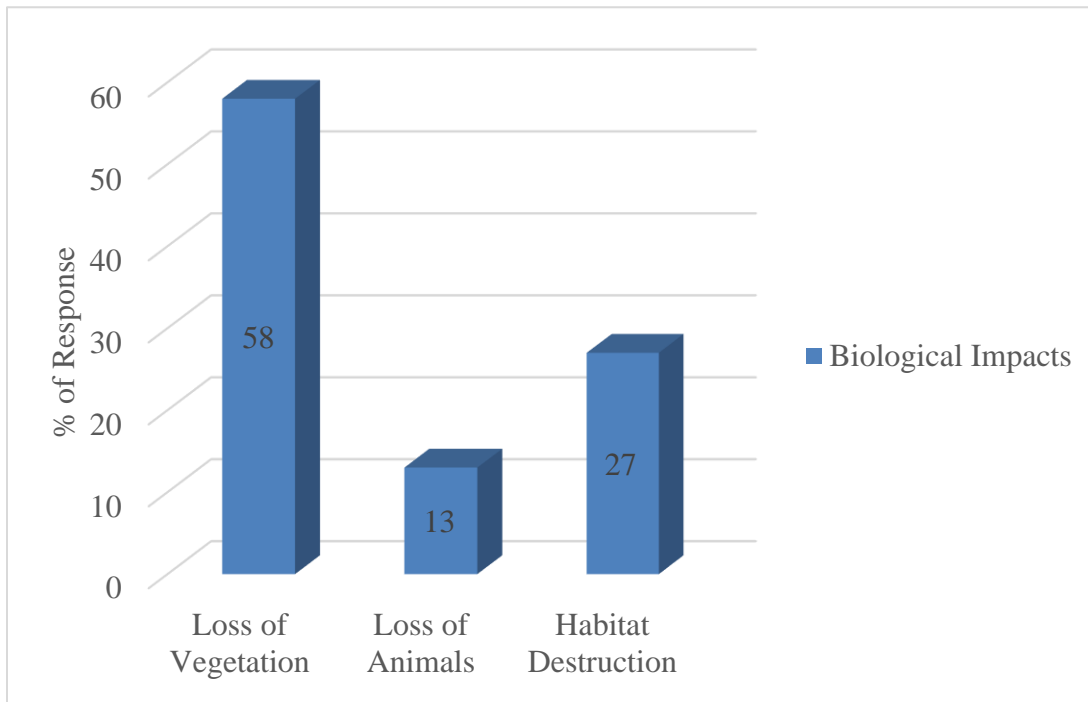


Figure 4: 3 Biological Impacts of Flooding in Narok town

Source: Household Interviews in Narok town, June 2019

The analysed data in the figure 4.3 show the biological impacts of floods in Narok town as follows: loss of vegetation (58%), loss of animals (13%) and habitat destruction (27%). This means that according to the respondents, the loss of vegetation is the most noticeable biological impact followed by the loss of animals and habitat destruction.

According to the household interviews, loss of vegetation along Narok River and Kakiya (plate 1:1) and Esampurmpur stream is noticeable as a result of floods. The regeneration of vegetation on land and along the streams and rivers is made difficult by the flash floods due to eroding factor that uproot small plants and sweep away seeds (Konana *et al.*, 2017). Larcher argue that plants growing in regularly flooded riparian areas succumb more quickly to flooding in areas that receive ample precipitation (Larcher, 2003). Therefore, extreme floods reduce riparian plant species richness, a finding of the study on plant composition and richness in free-flowing Vindel River in northern Sweden (Renöfält *et al.*, 2007). These literature confirm that floods in Narok town have led to loss of vegetation along Narok River and Kakiya (plate 1:1) and Esampurmpur stream as shown in figure 4.3

The animals inhabiting areas along Narok River and the streams are affected, which is exacerbated by the loss of vegetation due to the eroding factor of floods (Konana *et al.*, 2017). According to the study on effects of severe floods in Pantanal Wetland in Brazil, changes in the length and severity of floods potentially affect both wild and domestic animals (Alho & Silva, 2012).. This analysis supports the finding that floods contribute to the destruction of riparian vegetation leading to modification of the animal habitats and disruption or loss of their population as shown in figure 4.3



Plate 1:2 Destruction of vegetation on the riverbank of Kakiya stream

Source: Field Survey, 2019

Social Impacts of Floods in Narok town

The following social impacts of floods in Narok town were rated by the respondents as low, medium and high: loss of life and property, loss of livelihood, displacement of people, and infrastructure destruction, prevalence of diseases, poor education level, famine, and relief dependency. The respondents treated and rated the social impacts separately as low, medium and high. Figure 4.4 show the social impacts of floods in Narok town rated high: prevalence of diseases

(26%), poor education level (28%), loss of life and property (64%), famine (18%), loss of livelihood (54%), relief dependency (15%), displacement of people (51%), and infrastructure destruction (46%).

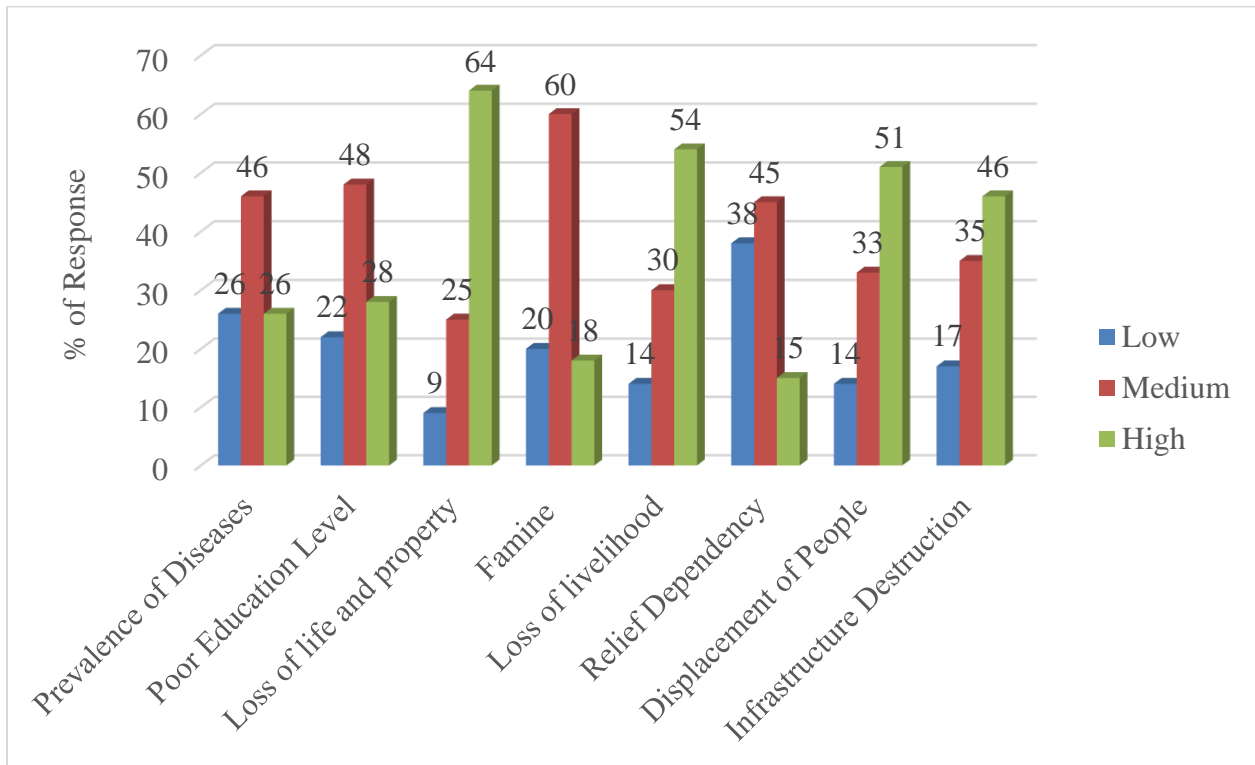


Figure 4: 4 Social Impacts due to Flooding in Narok town

Source: Household Interviews in Narok town, June 2019

The results in figure 4.4 and response from the County Environment Office and ENSDA (2019) confirm that the social impacts of floods in Narok town occurred. The recent case of floods with severe negative social impacts is the flash flood which hit Narok town on 28th April 2015 (ENSDA, 2019). ENSDA estimated that the floods which occurred in April 2015, affected approximately 0.5 Km sq of Narok town with its CBD being the most affected resulting to fatalities, injured, displacement and traumatized people, damage to infrastructure and property, disruption of service delivery within the 7 hours it took to subside (Maloba *et al.*, 2015). Figure 4.4 captures the social impacts as argued by Huho *et al* and Maloba *et al*. The social impacts presented in figure 4.4 are described below in detail.

Prevalence of diseases ranked high among the other social impacts in figure 4.4. The past floods which occurred in Narok town have been linked to prevalence of water-borne and insect-borne diseases (County Disaster Management Office, 2019). The physical health effects sustained during the flood event include injuries, loss of life, diseases linked to flooding, such as waterborne diseases, vector borne diseases and rodent-borne diseases, and mental health effects (Hammond et al., 2015). For example, several studies have looked at diarrhoeal epidemics induced by flooding in Dhaka, Bangladesh (Hammond *et al.*, 2015). These literature supports the analysis in figure 4.4, which shows that floods contribute to prevalence of diseases in Narok town.

Floods contribute to poor education level in Narok town according to figure 4.4. The county disaster management office, floods contribute to disruption of education because education system in the society gets disrupted (ENSDA, 2015). The study of loss and damage from flooding due to the 2007/2008 rainfall in lower Nyando Basin, Kisumu County, Kenya, established that critical social aspects including education were impacted (Masese et al., 2016). The impact of floods on school attendance compromised the quality of education, which led to the poor performance by pupils in Nyando District in Kenya (Okuom et al., 2012). This literature validate the finding in figure 4.4 that in the past floods has contributed to the poor education level in Narok town.

The other social impact of floods capture in figure 4.4 is the loss of life and property. Floods have caused loss of human lives in Narok town (ENSDA, 2015; Narok County Government, 2018a; NEMA, 2009). Kenya lost 15 and 84 human lives due to floods across the country and Nyanza/Western region in 2015 and 2012 respectively (Huho *et al.*, 2016b). Floods in Accra have led to casualties, the displacement of thousands of people and costs of more than 1 million US Dollars each year between 2003 and 2012 (Frick-Trzebitzky et al., 2017). ENSDA estimated that the floods which occurred in April 2015 in Narok town was responsible for eleven (11) confirmed fatalities, eleven (11) injured, and hundreds of displaced persons and traumatized (ENSDA, 2019). This literature confirm that floods have the potential to cause loss of human lives and that figure 4.4 shows loss of life has been experienced in Narok town in the past.

Famine was attributed to floods by the households interviewed as shown in figure 4.4. Potentially, floods destroy food crops in peri-urban area and upstream and disrupt food distribution in Narok town making people vulnerable to food insecurity and famine after long rains (Narok County Government, 2018a). In Malawi, floods triggered not only harvest failures but a sequence of

knock-on shocks to local economies and societies leading to famine, which was experienced in 2000/2001 because there were no effective intervention to mitigate the shocks (Devereux, 2007). This analysis confirm that floods have the potential to contribute to famine as also shown in figure 4.4.

Figure 4.4 show that floods contribute to loss of livelihoods in Narok town. According to a livelihood zoning exercise undertaken by World Bank in 30 districts in Kenya following the 1997/98 El Nino, most sources of livelihoods in Tana River and Garissa district were negatively affected (Masese *et al.*, 2016). In the case of the 2008 floods in Charleville and Mackay, Australia, communities' experiences particularly consistent disruption of livelihood, assets and property leaving the communities economically vulnerable (Apan *et al.*, 2008). The loss of livelihoods in Narok County during flooding season directly contribute to limited purchasing power, food insecurity threatening the population if it persist towards famine (County Agriculture Office, 2019). This literature validate the finding in table 4.4 that floods contribute to loss of livelihood in Narok town.

The emergency relief support is needed by the victims of floods in Narok town as shown in figure 4.4. In the past, there are various agencies led by the Kenya Red Cross (KRC), county and national government who have contributed to delivery of emergency and relief to the victims of floods in Narok town (ENSDA, 2015; IFRC, 2018; Narok County Government, 2018a). The victims of floods in Nyando District received emergency relief support during El Nino, where the Kenyan Government, local authorities and Kenya Red Cross distributed basic necessities such as food, shelter and medical care. (Nyakundi *et al.*, 2010). The perennial floods in Nyando District have an annual relief and rehabilitation of not less than Ksh 37 million (Otiende, 2009). This literature show that there is dependency on relief and emergency support when floods occur in any rural and urban setting. Therefore, it support the finding in figure 4.4 that floods in Narok town induce dependency on relief and emergency support.

The displacement of people during heavy rainy season was attributed to floods in Narok town as shown in figure 4.4. The occurrence of floods contribute to displacement of people due to disruption of education, supplies of clean water, health care, transport, communication, wastewater treatment and electricity (ENSDA, 2015; Mireille *et al.*, 2019). This past assessment undertaken

by the county government and ENSDA support the finding of the household interviews that floods has in the past induced displacement of people in Narok town.

Floods in Narok town has caused destruction of infrastructure as shown in figure 4.4. This finding is supported by the below literature. In the 2007 summer floods in the UK, of the £4billion damage to the economy, approximately £670million was credited to damages to critical infrastructure (Chatterton et al., 2010). ENSDA estimated that the floods which occurred in Narok town in April 2015, contributed to collapse of a building, dozens of small shops were destroyed, water distribution line got damaged, properties worth millions of shillings got destroyed, roads got silted, culverts got clogged and several streets were inundated at the CBD (Maloba *et al.*, 2015). The floods which occurred in 2007/2008 in Nyando basin impacted in livelihoods and other social aspects including agriculture, health, education, infrastructure, water and sanitation, housing and property and assets of people and livelihoods (Masese *et al.*, 2016). This literature show that infrastructure is vulnerable to impact of floods and it validates the finding in figure 4.4 that in the past, floods has caused destruction of infrastructure in Narok town..

4.3 The organisational arrangement in flood management in Narok town

The study sought to know from the households, the stakeholders involved in flood management in Narok town. The findings from the households were integrated with organisational survey. . The organisational survey schedule (n=10) were administered in 10 organisations based in Narok town. The organisational survey also helped in capturing the organisations, their role, mandate, strengths and weaknesses in flood management in Narok town. The data collected from the households, organisations and literature review was analysed in the table 4.1. The identified organisations, agencies, departments, committees and organisations were grouped as either county government, national government, non-governmental organisations, humanitarian organisations, United Nations agencies, academia or private sector.

Table 4:1 Organisational arrangement in management of floods in Narok town

No.	Stakeholder	Role	Strengths	Weaknesses
County Government of Narok				
1.	Disaster Management Unit (DMU)	<ul style="list-style-type: none"> Facilitate preparation of county disaster preparedness and mitigation plan, policy and strategy (County Disaster Management Office, 2019) 	<ul style="list-style-type: none"> Coordinate County Disaster Management Committee and planning to mainstream disaster management in programmes and establish emergency centres in the strategic period, ((County Disaster Management Office, 2019; CIDP, 2018-2023) 	<ul style="list-style-type: none"> All departments and the County Assembly: <ul style="list-style-type: none"> ➤ Lack clear policy and legislative structures for disaster management (County Disaster Office, 2019) ➤ Experience extensive decision making period due to bureaucratic process (County Planning, Disaster Management, Environment Offices, 2019)
2.	Department of Water Services, Energy, Environment and Natural Resources	<ul style="list-style-type: none"> Implement environment, water and forestry policies, projects and programmes at county level (County Environment Office, 2019) 	<ul style="list-style-type: none"> Established County Environment Committee and Drought Management Committee (County Environment Office, 2019) 	
3.	Department of Lands, Housing and	<ul style="list-style-type: none"> Coordinate integrated urban 	<ul style="list-style-type: none"> Fostering establishment of 	

	Physical Planning	planning in urban areas (County Planning Department, 2019)	County physical planning unit & town management committees (CIDP, 2018-2023)	<ul style="list-style-type: none"> ➤ Insufficient funding and staffing (County Disaster Management Unit, 2019) ➤ Inadequate capacity to make requisite laws, plan, strategies and policies (County Disaster Management Unit, 2019) • DMU lacks requisite autonomy, structures, transport, office space and equipment (County Disaster Management Unit, 2019)
4.	Narok Water and Sanitation Company (NARWASCO)	<ul style="list-style-type: none"> • Facilitate installation of water infrastructures and water supply 	<ul style="list-style-type: none"> • Commissioned new water supply project, which make an additional 5,000 cubic meters per day (County Water Office, 2019) 	
5.	Department of Agriculture, Livestock Development and Fisheries	<ul style="list-style-type: none"> • Responsible for crop, fisheries and animal husbandry using Climate Smart Agriculture (CSA) approach 	<ul style="list-style-type: none"> • Facilitate agroforestry and soil conservation (County Agriculture Office, 2019) 	
6.	County Assembly of Narok County	<ul style="list-style-type: none"> • Legislative arm of the county government: facilitate legislation making (County Assembly, 2019) 	<ul style="list-style-type: none"> • Provide representation at Ward level (County Assembly, 2019) 	
National Government' departments and agencies				

7.	Kenya Meteorological Department (KMD)	<ul style="list-style-type: none"> • Monitor, detect and predict weather and climate phenomena; disseminate weather and climate information and early warnings countrywide (KMD, 2019) 	<ul style="list-style-type: none"> • Partners with media community to disseminate weather and climate information regularly (KMD, 2019) 	<ul style="list-style-type: none"> • All departments have inadequate funds, equipment and skilled personnel (Organisational Mapping, 2019) • ENSDA & County Government of Narok' coordination role in flood management in Narok is not clearly defined (ENSDA, 2019)
8.	Ewaso Nyiro South Development Authority (ENSDA)	<ul style="list-style-type: none"> • Implementing flood control and mitigation programme in Narok County with partners (ENSDA, 2019) 	<ul style="list-style-type: none"> • Coordinating a multi-sectoral taskforce on flood management in Narok formed in 2015 (ENSDA, 2019) 	
9.	National Environment and Management Authority (NEMA)	<ul style="list-style-type: none"> • Provide general supervision and co-ordination over environment issues the country (NEMA, 2019) 	<ul style="list-style-type: none"> • Enforce national environmental regulations at all levels (NEMA, 2019) 	
10.	Kenya Forest Service (KFS)	<ul style="list-style-type: none"> • Provide for rational utilization of all forest resources in the country (KFS, 2019) 	<ul style="list-style-type: none"> • Undertakes water conservation through Forest Users Associations at local level (KFS, 2019) 	

11.	Water Resource Management Authority (WARMA)	<ul style="list-style-type: none"> Facilitate water resources management as lead agency in the country (WRMA, 2019) 	<ul style="list-style-type: none"> Undertakes water conservation through Water Users Associations at local level (WRMA, 2019) 	
12.	National Disaster Operation Centre	<ul style="list-style-type: none"> Monitor, co-ordinate, mobilise national resources to respond to disaster incidents in the country (NDOC, 2019) 	<ul style="list-style-type: none"> Has established command structure and coordinate with the National Police Service in ensuring security at scene of disaster (NDOC, 2019) 	
13.	National Police Service (NPS)	<ul style="list-style-type: none"> Provide national security (NDOC, 2019) 	<ul style="list-style-type: none"> Represent NDOC at county level (NDOC, 2019) 	
14.	National Youth Service (NYS)	<ul style="list-style-type: none"> Facilitate the youth to discover and develop their potential in nation building through vocational training and volunteership (County Commissioner Office, 2019) 	<ul style="list-style-type: none"> Equipped to deploy youth volunteers and heavy machinery to support emergency services (County Commissioner Office, 2019) 	
Humanitarian Organisations				

15.	Kenya Red Cross Society (KRC)	<ul style="list-style-type: none"> Support execution of emergency service delivery countrywide (KRC, 2019) 	<ul style="list-style-type: none"> Equipped with ambulances, first aid kit, staff, volunteers and office in Narok town (KRC, 2019) Offer emergency training to volunteers countrywide (KRC, 2019) 	<ul style="list-style-type: none"> Inadequate funds, equipment and skilled personnel (KRC, 2019)
Non-Governmental Organisations (Local, National and International)				
16.	Indigenous Livelihoods Enhancement Partners (ILEPA)	<ul style="list-style-type: none"> Support environmental conservation, climate change and livelihoods improvement (ILEPA, 2019) 	<ul style="list-style-type: none"> Provide technical support in policy, planning and strategic planning (ILEPA, 2019) Supporting advocacy activities (ILEPA, 2019) 	<ul style="list-style-type: none"> Inadequate funds, equipment and skilled personnel in Narok (ILEPA, 2019)
17.	World Vision (WV)		<ul style="list-style-type: none"> Provide funding to selected projects (WV, 2019) 	
18.	Worldwide Fund (WWF)		<ul style="list-style-type: none"> Provide training and technical support in policy, planning and 	

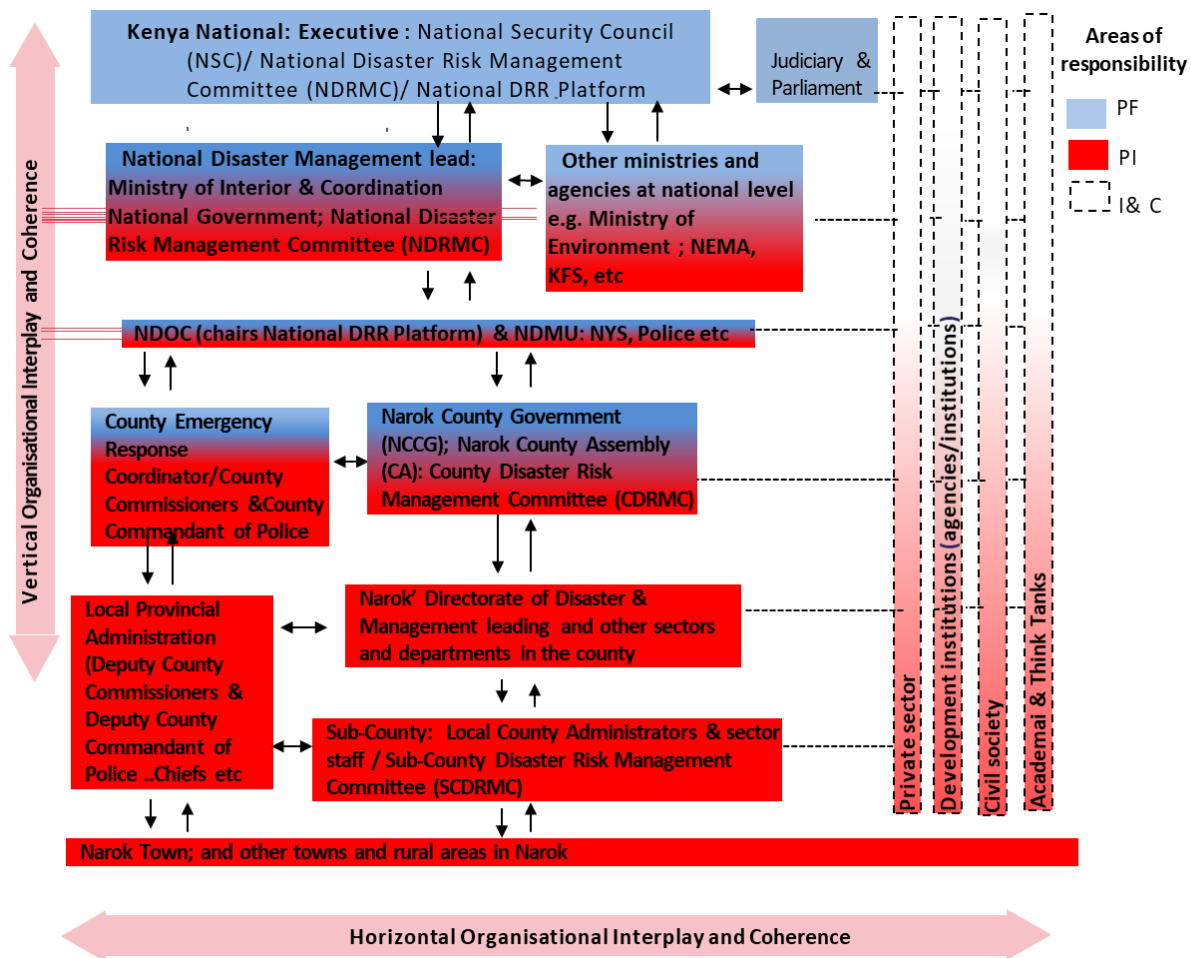
			strategic planning (WWF, 2019)	
United Nation Agencies				
19.	United Nations Environment Programme (UNEP)	<ul style="list-style-type: none"> • UNEP and UNDP Support environmental conservation, climate change and livelihoods improvement 	<ul style="list-style-type: none"> • Provide funding to selected projects (UNDP, 2019) • Provide training and technical support in policy, planning and strategic planning to counties and national governments (UNEP, 2019) 	<ul style="list-style-type: none"> • Inadequate funds, equipment and skilled personnel in Narok
20.	United Nations Development Programme (UNDP)			
Academia				
21.	Maasai Mara University (MMU)	<ul style="list-style-type: none"> • Institution of higher learning supporting research and training 	<ul style="list-style-type: none"> • Undertaking research on environmental issues in Narok town (MMU, 2019) 	<ul style="list-style-type: none"> • Inadequate staff and facilities for research (MMU, 2019)
Private Sector (Business Associations)				
22.	Central Business District Association (CBDA) of Narok Town	<ul style="list-style-type: none"> • Represent interests of traders and businesses (CBDA, 2019) 	<ul style="list-style-type: none"> • Advocacy for business friendly policies and laws and urban design (CBDA, 2019) 	<ul style="list-style-type: none"> • Inadequate staff, membership and facilities (CBDA, 2019)

Sources: Organisational Interviews June, 2019; Literature Review, 2019

The table 4.1 shows organisations contributing to the flood management in Narok town by exercising their respective mandates and roles. The following agencies such as the National County Disaster Risk Management Committee (NDRMC), County Disaster Risk Management Committee (CDRMC) and Sub-County Disaster Risk Management Committee (SCDRMC) have been established under the Kenya national emergency operations plan (2020)(Government of Kenya, 2020). These committees have a multi-agency and multi-sectoral coordinating mandate, and representatives of ministries, departments and agencies (MDAs) at national and county governments, international agencies, non-governmental organisations (NGOs) and private sector operators may be appointed as core members, either to join the Unified Command (UC) committee or assist in the provision of secretariat support staff (Government of Kenya, 2020).

The disaster risk stakeholders consist of responsible municipal authorities, river basin organisations, regional development authorities, academic organisations, private sector, NGOs and concerned citizens and communities(Tingsanchali, 2012b). In Narok, the lead organisations are the governments and their departments with support from other relevant stakeholders. The Ministry of Interior & Coordination National Government (MI&CNG) at national level is the leading ministry in national emergency response and disaster risk management policy formulation and implementation as shown in figure 4.5. I developed figure 4.5 using the interplay and policy coherence framework (Curran, Dougill, Pardoe, & Vincent, 2018) and used it to map and present organisational arrangement in Narok.

MI&CNG liaise with the county governments in county based emergency response and disaster risk management. MI&CNG provide overall leadership at national level but get support from the other key ministries including the Ministry of Environment, the Ministry of Planning and the Ministry Treasury, which are the lead ministries and custodians of the climate change, sustainable development goals (SDGs) planning and climate and disaster finance respectively. The two MI&CNG' agencies, which is the National Disaster Operations Centre (NDOC) and the National Disaster Management Authority (NDMA) are the lead implementing national agencies in emergency response and management respectively. NDOC and NDMA support national and county governments through their representatives at the national, county, sub-county, ward and village level. NDOC and NDMA are multi-agency agencies bring together security and paramilitary agencies (police, military, prisons, KFS, KWS and NYS) and other relevant ministries and agencies and organisations like the Kenya Red Cross (KRC).



PF: Policy Formulation; PI: Policy Implementation; I& C: Input and Collaboration

Figure 4.5. Organisational arrangement for disaster risk management in Narok and link with the national disaster risk management

Source: developed by Charles Tonui (2021)

Narok County Government (NCG) through its disaster management and firefighting unit liaise with NDOC, NDMU and Kenya Red Cross (KRC) in coordinating multi-sector and multi-stakeholder emergency response and disaster risk mitigation and policy formulation through the Narok CDRMC and SCDRMC. The Governor of Narok County Government (NCG) chairs the County Disaster Risk Management Committee (CDRMC). KRC is among the members of the

CDRMC. The county based representatives of the MI&CNG seat in the CDRMC. Narok County Government (NCG) disaster management and firefighting unit liaise with the other Narok county sectors, directorates, and departments in mobilizing relevant stakeholders to make their contributions under the CDRMC and SCDRMC. The Kenya Red Cross (KRC), which is an auxiliary agency co-lead emergency response at national, county to village level.

The private sector, development agencies, civil society, academia and think tanks, they contribute to the implementation of the national and county based disaster risk activities and policy formulation. There is increasing inclusion of the non-state actors in disaster risk management and emergency response. In six European countries (Netherlands, Sweden, Belgium, Poland, England, France) flood risk responsibilities are showing to be increasingly shifting toward actors outside the government like the insurance sector and the citizens (Gralepois *et al.*, 2016). As shown in figure 4.5, the non-state actors largely collaborate and cooperate with the national and county government through CDRMC and SCDRMC at the national, county to local level. However, at the county level they support majorly the implementation unlike at the national level. The auxiliary agencies (e.g. KRC), private sector, development agencies, and the civil society contribute largely through resource mobilization for humanitarian and other technical support while the civil society and the local community based organizations (CBOs) play more role in advocacy, local community mobilization and relief distribution. However, the organisations in table 4.1 are not the only organisations contributing to flood management because there could be other potential stakeholders in Narok town that need to be brought on board as shown by Gralepoise *et al.* (2016).

The international organisations, UN agencies, academia and thinks tanks contribute significantly to the translation of the policy provisions using researched evidence, resource mobilization and capacity building towards policy implementation. However, there is persistent silo approach and limited technical capacity on disaster risk among the county government sectors and county stakeholders, which continue to weaken partnerships and building of synergies towards development of county based flood risk strategy and implementation of flood management strategies and emergency response.

The organisations identified in Narok town have strengths towards flood management in Narok town as shown in table 4.1. For instance, in Dera-Ghazi Khan in Pakistan, the strength of flood management organisations were exhibited in the groupings based on their nature of services where risk-managing organisations deal with structural and non-structural measures, whereas crisis-managing organisations deal with rescue, relief and rehabilitation operations(Ahmed *et al.*, 2014). The strengths of the government organisations is the coordination and facilitation role in preparation of disaster management plans, programmes, policies, legislations and strategies at national and county level. The non-state organisations contribute to flood management through mobilization of funds for selected conservation projects, provide humanitarian, training and technical support in policy and legislation making, programme and strategic planning as shown in table 4.1.

There are weaknesses experienced by the organisations in Narok town as shown in table 4.1. The national and county government' agencies, departments, and committees experience lack of clear policy and legislative structures for disaster management, extensive decision making period due to bureaucratic process, insufficient funding, equipment and staffing. The non-state organisations experience inadequate funds, equipment and skilled personnel. For example, in Nigeria, the weakness of existing organisational frameworks for flood disaster management was attributed to the flooding in 2010 to 2012(Obeta, 2014). This shows that even though organisations have clear mandates, roles and strengths, they experience weaknesses that need to be addressed in order to contribute effectively towards sustained flood management.

4.4 The flood management initiatives implemented in Narok town

This section provide the results that the following flood management initiatives have been implemented in Narok town: planting of trees, construction of gabions, construction of bridges, early warning system, construction of dams, and construction of strong buildings. In addition, it shows the assessment of the flood management initiatives' capacity to reduce the effects of floods on the following socio-economic and biodiversity factors: farm productivity, infrastructure, health, business environment, education and settlements and biodiversity. The following parameters were used by the respondents to assess the effectiveness of the flood management initiatives: none, slightly improved, greatly improved, and declined.

4.4.1 Flood management initiatives in Narok town

The results were generated from the household respondents (n=98) and organisations (n=10) who were randomly selected from in table 4.1. The organisational data was only used to countercheck if there was any different initiative not captured at household interviews but not integrated in the figure 4.6. The organisations did not generate any different initiative. Therefore, the household data was used in identifying the following flood management initiatives implemented in Narok town as shown in figure 4.6: planting of trees (26%), construction of gabions (25%), construction of bridges (9%), early warning system (5%), construction of dams (11%) and construction of strong buildings (1%).

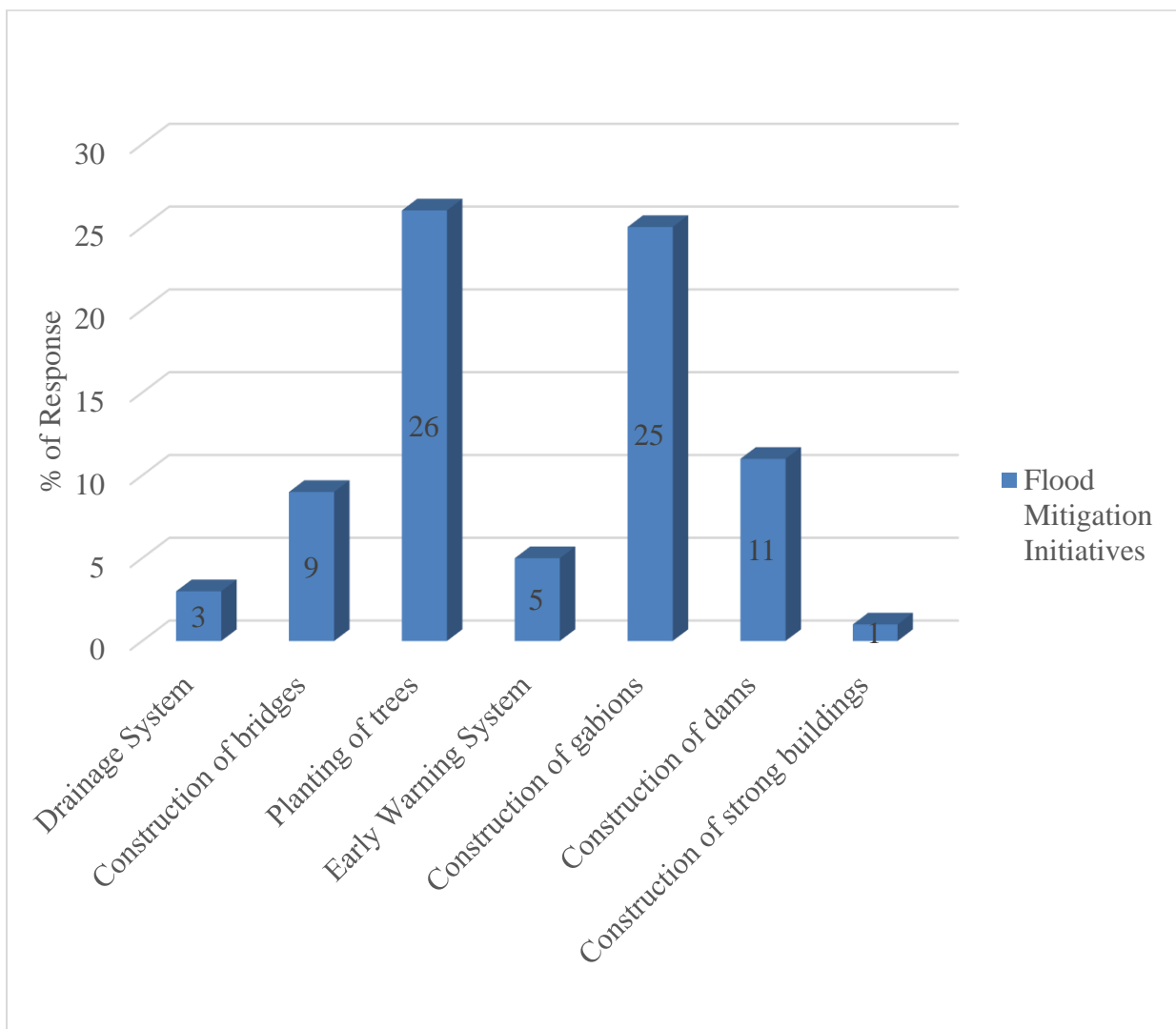


Figure 4: 6 Structural and Non-Structural Flood Mitigation Measures Implemented in Narok town

Source: Household Interviews in Narok town, June 2019

The flood management initiatives captured are categorised as structural and non-structural as shown in table 4.7. The county government has embarked on reconstructing and improving the existing bridges and flood control gabions (Narok County Government, 2018a).

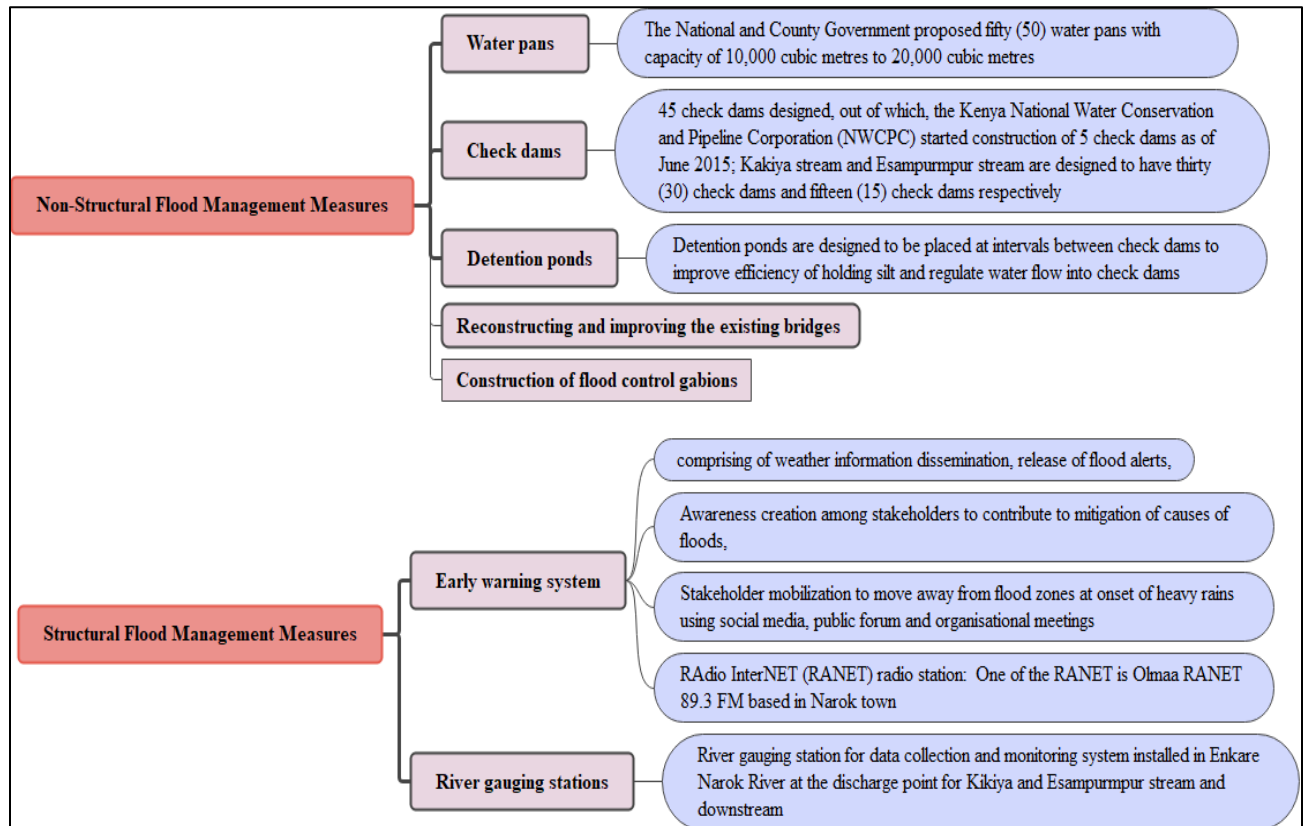


Figure 4: 7 Types and categories of Structural and Non-Structural Flood Management Measures in Narok town

Source: developed by Charles Tonui (2020)

The household interviews highlight structural and non-structural flood management measures in figure 4.6, which are further specified by the organisations in table 4.2. Tingsanchali describes structural measures to include polders and basins, bypass channels, dredging and widening of stream and channels, levees and embankments, construction of dams or river dikes while the non-structural measures include flood forecasting and warning, flood hazard and risk management, public participation and organisational arrangement (Tingsanchali, 2012b).

The floods response in Narok town is that, the structural flood mitigation measures are more in numbers than the non-structural flood management measures as shown in figure 4.6 and table 4.2.

The six European countries (Netherlands, Sweden, Belgium, Poland, England, France), however, are gradually transforming towards fewer structural protection measures and towards a more integrative non-structural strategy in flood risk management (Gralepois *et al.*, 2016). Therefore, there is need for harmonisation of both structural and non-structural flood mitigation measures, in order to achieve sustainable and integrated flood management in Narok town.

4.4.2 Capacity of the flood mitigation measures in Narok town

In the study, the effectiveness of the flood management initiatives in figure 4.6 were assessed by the household respondents (n=98). The respondents were asked to assess the effects of floods on the following socio-economic and biodiversity factors after the implementation of the flood management initiatives in figure 4.6: farm productivity, infrastructure, health, business environment, education and settlements and biodiversity. The following parameters were used in assessing the effectiveness of the flood management initiatives: none, slightly improved, greatly improved, and declined. The results in figure 4.8 shows that flood management initiatives has:

- Greatly improved in reducing the effect of floods on business environment (61%), human settlement (56%) and education (52%).
- Slightly improved in reducing the effect of floods on farm productivity (62%), health (56%), biodiversity (55%), and infrastructure (52%).

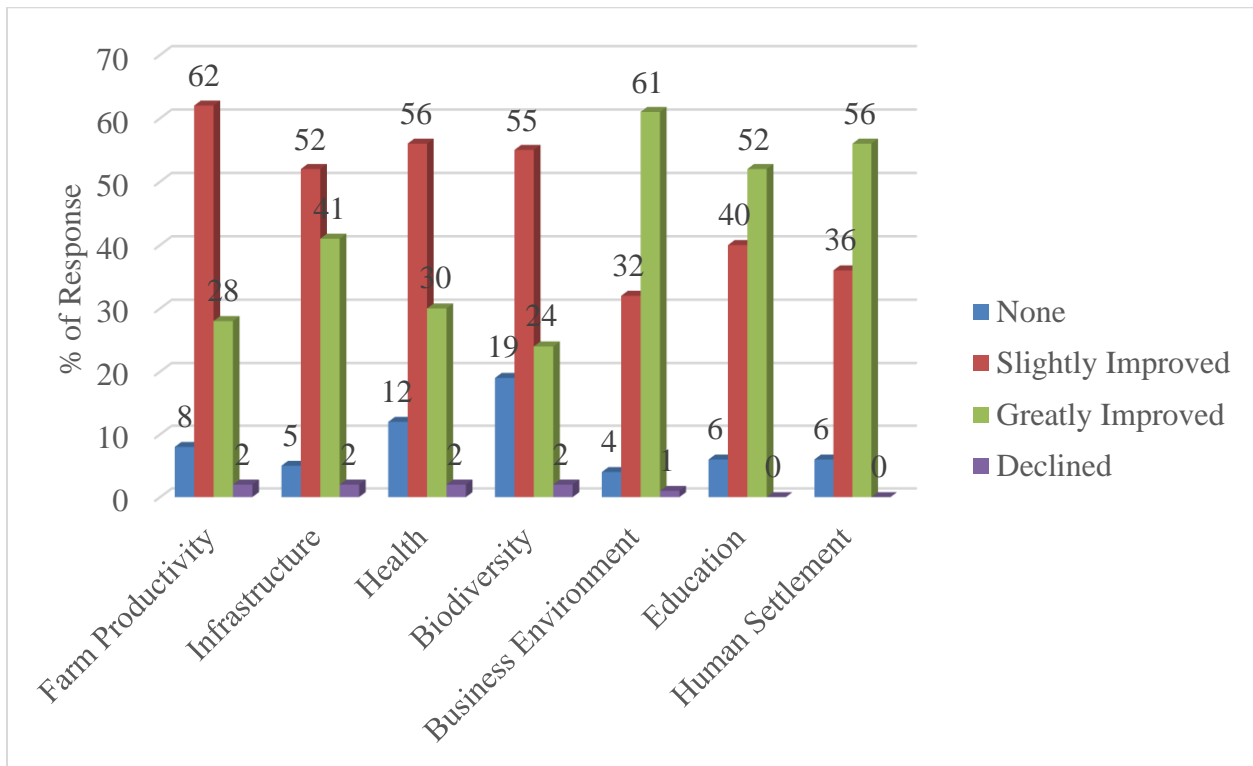


Figure 4:8 Assessment of Flood Management Initiatives on Socio-Economic and Biodiversity Factors

Source: Household Interviews in Narok town, June 2019

According to the household survey as shown in figure 4.6, the structural and non-structural flood management measures presented in table 4.2 and figure 4.8 have improved in reducing the effect of floods on the following socio-economic and biodiversity factors in Narok town: farm productivity, infrastructure, health, business environment, education and settlements and biodiversity. The German part of Rhine River experienced two consecutive flood events with similar hazards characteristics in 1993 and 1995 and records showed that there was improved preparedness of the population and substantial reduction of damage to the socio-economic sector during the latter because of the implementation of flood mitigation measures (Bubeck et al., 2012). However, the structural and non-structural flood management initiatives measures presented in table 4.2 and figure 4.6 have not fully protected the socio-economic sector and biodiversity. Therefore, there is need to improve preparedness of the population and reduction of damage to the socio-economic sector and biodiversity through the implementation of flood mitigation measures in figure 4.6 in an integrated manner.

The reduction of the impacts of floods on farm productivity, infrastructure, health, business environment, education and settlements and biodiversity has been improved due to the implementation of the structural and non-structural flood management measures in table 4.2 (County Disaster Management Unit, 2019). However, there is lack of clear policy and legislative structures for disaster management in Narok town and the county (see table 4.1). This shows that the structural and non-structural flood management measures in table 4.2 have slightly worked in reducing impact of floods in Narok town.

In order to increase the level of preparedness and protection of the flood-prone areas, additional policies are required to be put in place (Bubeck *et al.*, 2012). Therefore, a disaster management policy and legislation and clear structure have to be put in place and integrated with the structural and non-structural flood management measures in table 4.2. Potentially, it will facilitate increasing levels of preparedness and protection of the flood-prone areas in Narok town in the future when compared with the policy proposal by Bubeck *et al.*, (2012).

CHAPTER 5 SUMMARY OF THE FINDINGS, CONCLUSION AND RECOMMENDATIONS

This chapter provide chronologically the summary, conclusion and recommendations generated from the findings and discussion based on the objectives of the study. The chapter presents the summary and conclusion on the: causes and impacts of floods, organisational arrangement for flood management and the flood management initiatives implemented in Narok Town. Finally, the chapter presents recommendations on factors for consideration in developing an integrated flood management strategy for Narok town.

5.1 Summary of the Findings

In line with the first objective on the underlying causes of floods in Narok town, this study findings reveal that rainfall (66%), topography (64%), closeness of Narok town to Narok River and bursting of Narok River (41%) and soil type (27%) influenced the occurrence of floods in Narok town. The rainfall range during long rains is averagely 2,500mm coupled with inadequate, or poorly maintained, local drainage systems contribute to flood occurrence in Narok town. The topography in Narok town places its CBD within a basin hence obstructing free flow of water into Narok River. In addition, the closeness of Narok town to Narok River make it vulnerable to floods when water exceeds its carrying capacity. The shallow and poorly drained soils found in a few places in East and South East from Narok town inhibit efficient infiltration of water and contribute to increased surface runoff to Kakiya and Esampurpur stream and Narok River. The high rainfall during long rainy season coupled with low-lying and closeness of the town to the streams and Narok River and poorly drained soil contribute to floods in Narok town. The interrelationship among these factors is not explicit in Narok town and they need to be studied further to ascertain their synergies towards contributing to floods.

The first objective covered also the impacts of floods in Narok town. The study findings reveal that occurrence of floods caused negative physical, biological and social impacts in Narok town. The physical impacts identified are soil erosion (69%), siltation (20%) and water pollution (9%). The biological impacts of floods identified are loss of vegetation (58%), loss of animals (13%) and habitat destruction (27%). The social impacts identified are prevalence of diseases (26%), poor education level (28%), loss of life and property (64%), famine (18%), loss of livelihood (54%), relief dependency (15%), displacement of people (51%) and infrastructure destruction (46%).

The eroding factors of floods caused soil erosion, which resulted to soil erosion and deposit of sediment downstream contributing to water pollution in Narok River and Kakiya and Esampurmpur stream. Soil erosion was also catalysed by heavy forest clearance and mechanization of farming at the upstream. The floods uprooted small plants and swept away seeds and uprooted plants, therefore, reducing riparian plant species richness, which is noticeable on the riparian of Narok River and Kakiya (plate 1.1) and Esampurmpur stream. This made regeneration of vegetation on riparian difficult altering the habitat of wild animals and pasture for domestic animals. The wild and domestic animals' community structure, population, size and phenology changed since floods change the vegetation and their habitat.

The other impacts contribute to by floods is poor education level because school attendance and teaching were compromised leading to poor performance by pupils in Narok town. Floods destroyed food crops and disrupted food distribution rendering people vulnerable to prolonged food insecurity potentially resulting to famine when rains fail thereafter to support food production. The destruction of crops and farming led to disruption and loss of livelihoods rendering victims of floods to develop relief dependency, which need to be enhanced and sustained annually through contributions from various stakeholders led by the national and county government and the Kenya Red Cross. Lastly, floods damaged infrastructure causing impacts, such as disruption of movement of people, education, supplies of clean water, health care, transport, communication, wastewater treatment and electricity.

The physical, biological and social impacts of floods manifest themselves not only at the affected section of Narok town along Kakiya and Esampurmpur streams and Narok River but also at sections away from flooded sections. The CBD of Narok town is the most affected because it is situated at the point where Kakiya and Esampurmpur stream meet to discharge water into Narok River. Therefore, further study is required to ascertain the actual physical, biological and social impacts of flood at the CBD and other sections not sampled in Narok town in order to inform future review of integrated flood management approach.

In the second objective on assessing the organisational arrangement in flood management in Narok town, this study findings highlight the role, strengths and weakness of the various public, private, non-governmental, academic and humanitarian organisations. The Kenyan Government and the Narok County Government' mandate in flood management in Narok town is to formulate policies,

legislations, strategies, plans, provide funding and coordinate participatory process and decision making on flood risk management. Maasai Mara University is supporting research on flood management in Narok town. The private sector actors like Central Business District Association (CBDA) of Narok Town and the non-governmental organisations working in Narok town provide training and technical support in policy strategic planning, advocacy, and funding to selected flood mitigation projects. The KRC is the main humanitarian organisation with strong ties with the national and county government in response to floods and any other disasters in Narok town.

The weaknesses identified include lack of clear structures for disaster management between the national and county government and non-state actors. There are two flood management committees led by ENSDA & County Government of Narok respectively. The two committees have roles and structures not clearly defined as who should lead flood management in Narok town and at the county level. The lack of clarity in roles is attributed to unspecified role of the levels of governments in the Constitution of Kenya 2010. Lastly, the County Disaster Management Unity (DMU) established lacks requisite autonomy, structures, logistical and administrative support, which include transport, office space and equipment.

The strengths of organisations contributing to the flood management in Narok town include their clear role and mandate, established offices, staff and resources. The strengths can be enhanced if organisations are grouped based on their nature of services as recommended by Ahmend *et al.*, (2014). The organisations in table 4.1 are not the only organisations contributing to flood management because there could be other potential stakeholders in Narok town that need to be brought on board as shown by Grapoise *et al.* (2016) that there are actors outside the government like the insurance sector and the citizens. This is because they can build synergy to eliminate the weaknesses, which include lack clear policy and legislative structures for disaster management, extensive decision making period due to bureaucratic process in governments, inadequate funds, equipment and skilled personnel in floods management.

In the third objective on assessing flood management measures being implemented in Narok town, this study findings highlight both the structural and non-structural flood management measures. . The structural floods management measures are construction of gabions (25%), bridges (9%), dams (11%) and strong buildings (1%). The non-structural flood management measures are early warning system (5%) and planting of trees (26%). The national government had designed fifty

(50) water pans and forty-five (45) check dams. The implementation of construction of 5 check dams started along Kakiya stream in June 2015. The check dams are designed to be integrated with gabions, bridges and detention ponds to reduce silt and regulate water flow from catchment to downstream. The non-structural flood management measures include tree planting campaign, solid waste collection, weather information, flood alerts, river gauging station, use of social media, Olmaa RANET 89.3 FM, public forum and organisational meeting to create flood awareness among stakeholders and citizens to move away from flood prone zones at onset of heavy rains.

The structural and non-structural flood management measures in Narok town were assessed and they have improved in reducing the effect of floods on the socio-economic and biodiversity factors in Narok town. The structural flood mitigation measures are more in numbers than the non-structural flood management measures as shown in figure 4.5 and table 4.2. However, they have greatly improved in reducing the effect of floods on business environment (61%), human settlement (56%) education (52%), farm productivity (28%), health (30%), biodiversity (24%), and infrastructure (41%). However, there is lack of clear policy and legislative structures for disaster management in Narok town. In addition, the structural flood mitigation measure have threshold. The high level of preparedness and protection of the flood-prone areas can be achieved by having additional policies in place (Bubeck *et al.*, 2012). Gradually, transformation towards fewer structural protection measures and towards a more integrative non-structural strategy in flood risk management is needed (Gralepois *et al.*, 2016). Therefore, structural and non-structural flood management measures have to be integrated through policy support to improve efficiency in response to floods in Narok town.

5.2 Conclusion

In conclusion, the main causes of flooding in Narok town is rainfall, topography, closeness of Narok town to Narok River and bursting of Narok River and soil type influence occurrence of floods in Narok town. However, they are not the only main factors because Narok town, its peri-urban and surrounding areas keep changing. The impacts of floods in Narok town manifest themselves in form of physical, biological and socio-economic. Vegetation destruction exposes the soil to eroding force of flood leading to soil erosion, silt and sediment deposits and water pollution downstream. Flood causes damage to infrastructure, disruption of movement of people, education, supplies of clean water, health care, transport, communication, wastewater treatment and electricity. The causes and impacts of floods are linked to each other but interrelationship is not clear.

There are significantly diverse organisations in addition to the national and county government contributing to flood management in Narok town. However, due to lack of clear policy and legislative structures for disaster management between the national and county government and non-state stakeholders, they are disjointed in their response to floods. The disjointed response to floods is compounded by limited skilled staff, funds and equipment among all the government and non-governmental organisations in Narok town. More organisations like the insurance companies need to be integrated to contribute to the recovery of victims of floods and compensation for losses incurred.

The structural flood mitigation measure have threshold as reflected in Narok town. The progress towards mitigating impacts of floods in Narok town depend on gradual transformation towards fewer structural protection measures and towards a more integrative non-structural strategy in flood risk management as advanced by Gralepois *et al.*,(2016). Communication, innovation, governance, and partnership support is essential towards ensuring sustainability in integrated flood management.

5.3 Recommendations

This study recommends a comprehensive assessment of root causes and impacts of floods; enhance building partnership among the relevant lead agencies and the stakeholders to strengthen organisational framework approach; integrated flood management initiatives and integrated disaster management policy, strategy, legislation and plan.

5.3.1 Undertake comprehensive assessment of root causes and impacts of floods in Narok town

A comprehensive assessment of the root causes of floods need to be integrated into the flood management in Narok town. Narok town, it's peri-urban and the surrounding areas up to the catchments have to be factored in the assessment of potential factors that can influence occurrence of floods in Narok town in the future.

The assessment of the interrelationships between and among the factors influencing the occurrence of floods has to be factored. This study found out that various factors are building on each other in catalysing flood occurrence in Narok town. For example, the clearance of catchment and vegetation destruction influence rainfall in the year. The topography influence surface run-off because on the mid slop, water flow and soil erosion are intense.

5.3.2 Enhance partnership among the relevant lead agencies and the stakeholders to strengthen integrated organisational framework approach

The national and county government and non-state organisations are facing key challenges including unclear roles and mandate, poor coordination, insufficient material, human and financial resources. These deficiencies are attributed to lack of clear disaster policy guide at the county.

The county and national government as the leading agencies need to strengthen a multi-agency approach by involving non-governmental agencies, town residents, small medium and large traders, local community members, academia, leaders, private sector and donors. The County government need to bring on board the local communities and other relevant stakeholders as provide for in the Constitution of Kenya (2010).

The County government and ENSDA-led disaster management committees need to merge to bring on board more state and non-state actors. This will also boost the morale and incentivise the non-state actors and the larger population to volunteer and advance their resources towards implementation of short, medium and long term integrated flood mitigation measures.

5.3.3 Adopt integrated flood management initiatives

This study has shown that flood management in Narok town is largely structural. Structural flood management measures have been found in the study to havethreshold. The process of building an urban resilience depending on the flood-control infrastructure can resist floods only up to a certain

magnitude. The six European countries (Netherlands, Sweden, Belgium, Poland, England, France) have demonstrated that they are gradually transforming flood risk management (Gralepois et al., 2016). .Therefore, the flood management strategy need to facilitate harmonisation of both structural and non-structural flood mitigation measures, in order to achieve sustainability in flood risk movement in Narok town.

The early warning system needs to be holistic to ensure both scientific and traditional knowledge and early warning systems are integrated to enable reach and uptake by the population. The local community has historical memory about flooding and response in Narok Town, which is missing in mitigation measures already put in place. The weather and climate information need to be incorporated with the Maasai traditional disaster prediction approaches in preparation for the future flood preparation plan and strategy.

5.3.4 Develop integrated disaster management policy, legislation and plan

The County Government of Narok is leading the development of an integrated flood management plan while ENSDA is leading another taskforce, which developed integrate flood management plan, 2015. The two committees need to harmonise their plans to inform integrated flood management strategy for Narok town. Narok Town does not have an integrated urban development and disaster management plan, policy, legislation and strategy (County Disaster Management Unit, 2019). These are required to be put in place to help the county government to achieve the objectives of devolved government, which included disaster management, disaster preparedness and response.

The county and national government agencies need to provide sufficient policy and legislative support to the non-state actors, including private sector and town residents. This will foster enhanced partnership and build synergy in formulating disaster management policy, plan, and strategy that will facilitate sustain integrated approach towards addressing the causes and impact of flood in Narok town.

5.3.5 Development of an integrate flood management strategy

The integrated county based disaster management taskforce need to facilitate the development of an integrated flood management strategy. The strategy brings on board all relevant sectors to not only contribute needed resources but also integrate the recommendations into their respective sector plans, policies and strategies. An integrated flood management strategy is important because

it will typically provide the County Government of Narok with a sense of direction and outline measurable goals. The strategy will also act as a tool that is useful for guiding day-to-day decisions as well as for evaluating progress and changing approaches when moving forward. The strategy is useful because it provides room for creativity, collaboration and innovation, which encourages openness and embrace out-of-the-box thinking in addressing emergencies, uncertainties, and surprises in the future.

5.4 Areas of Further Studies

This study aimed at identifying factors influencing occurrence of floods, assess impacts of floods and organisational arrangement and flood mitigation measures to inform significantly the development of an integrated flood management strategy. However, the study did not look at the deeper interaction between factors influencing occurrence of floods and impacts of floods the effectiveness of specific structural and non-structural flood mitigation measures on each sector of economy vulnerable to floods. This will be important to be studied to generate finding that will inform sustained urban resilience building in the future

REFERENCE

- Abeygunawardane, A. W. G. N., Dayawansa, N. D. K., & Pathmarajah, S. (2011). Socioeconomic Implications of Water Pollution in an Urban Environment: A Case Study in Meda Ela Catchment, Kandy, Sri Lanka. *Tropical Agricultural Research*, 22(4), 374 – 383. <https://doi.org/10.4038/tar.v22i4.3788>
- Ahmed, B., Wei, S., Fu, Y. G., Shabbir, M., Nabi, G., & Khan, K. U. (2014). Effects of Floods policy in Pakistan and Management Issues : (Case of District Dera-Ghazi Khan). *International Journal of Advanced Research*, 2(10), 967–974.
- Alho, C. J. R., & Silva, J. S. V. (2012). Effects of Severe Floods and Droughts on Wildlife of the Pantanal Wetland (Brazil)—A Review. *Animals*, 2, 591–610. <https://doi.org/10.3390/ani2040591>
- Aligica, P. D. (2006). Institutional and stakeholder mapping: Frameworks for policy analysis and institutional change. *Public Organization Review*, 6(1), 79–90. <https://doi.org/10.1007/s11115-006-6833-0>
- Alley, R. B. (2007). Wally Was Right: Predictive Ability of the North Atlantic “Conveyor Belt” Hypothesis for Abrupt Climate Change. *Annual Review of Earth and Planetary Sciences*, 35(1), 241–272. <https://doi.org/10.1146/annurev.earth.35.081006.131524>
- Anees, M. T., Abdullah, K., Nawawi, M. N. ., Nik Norulaini Nik Ab, R., Abd. Rahni Mt., P., Syakir, M. I., & Omar, M. A. K. (2017). Effect of Upstream on Downstream Due to Spatio-temporal Land Use Land Cover Changes in Kelantan , Peninsular Malaysia. *Nature Environment and Pollution Technology*, 16(January), 29–35.
- Apan, A., Keogh, D., King, D., Thomas, M., Mushtaq, S., & Baddiley, P. (2008). *The 2008 floods in Queensland : A case study of vulnerability , resilience and adaptive capacity*. Gold Coast: National Climate Change Adaptation Research Facility.
- AU. (2008). *Sub-Saharan Africa Reduction in the Disaster Risk Region*. Retrieved from www.unisdr.org/africa
- Awuor, C., Orindi, V., & Andrew, A. (2009). Climate Change and Coastal Cities: The Case of Mombasa, Kenya. In J. Bicknell, D. Dodman, & S. David (Eds.), *Adapting Cities to Climate*

- Change: Understanding and Addressing the Development Challenges* (pp. 209–235). London, UK: Earthscan. https://doi.org/10.1007/978-94-007-1770-1_12
- Bangira, T., Maathuis, B. H. P., Dube, T., & Gara, T. W. (2015). Investigating flash floods potential areas using ASCAT and TRMM satellites in the Western Cape Province, South Africa. *Geocarto International*. <https://doi.org/10.1080/10106049.2014.997302>
- Bates, P. D., Horritt, M. S., & Fewtrell, T. J. (2010). A simple inertial formulation of the shallow water equations for efficient two-dimensional flood inundation modelling. *Journal of Hydrology*, 387(1–2), 33–45. <https://doi.org/10.1016/j.jhydrol.2010.03.027>
- Bubeck, P., Botzen, W. J. W., Kreibich, H., & Aerts, J. C. J. H. (2012). Long-term development and effectiveness of private flood mitigation measures : an analysis for the German part of the river Rhine. *Nat. Hazards Earth Syst. Sci.*, 12, 3507–3518. <https://doi.org/10.5194/nhess-12-3507-2012>
- Burby, R. J., Nelson, A. C., Parker, D., & Handmer, J. (2001). Urban Containment Policy and Exposure to Natural Hazards: Is There a Connection? Downloaded. *Journal of Environmental Planning and Management*, 44(4), 475–490. <https://doi.org/10.1080/09640560125021>
- Carter, B., & Roy, D. (2015). *Water Quality Monitoring System Design*. Retrieved from <https://www.iisd.org/system/files/publications/water-quality-monitoring-system-design.pdf>
- Carter, N. M. (2011). General and Industrial Management. *Academy of Management Review*. <https://doi.org/10.5465/amr.1986.4283873>
- Centre for Research on the Epidemiology of Disasters (CRED). (1988). Emergency Events Database (EM-DAT). Retrieved July 7, 2021, from <https://www.emdat.be/>
- Chatterton, J., Viviattene, C., Morris, J., Penning-Rowsell, E. C., & Tapsell, S. M. (2010). *The costs of the summer 2007 floods in England*. Bristol: Environment Agency. Retrieved from <http://eprints.mdx.ac.uk/4097/>
- Commission on Revenue Allocation. (2011). *Kenya County Fact Sheets*. Nairobi, Kenya.
- County Government of Narok. (2013). *County Integrated Development Plan (CIDP) 2013-2017*.

Narok, Kenya.

- Curran, P., Dougill, A., Pardoe, J., & Vincent, K. (2018). *Policy coherence for sustainable development in sub-Saharan Africa. Grantham Research Institute on Climate Change and the Environment Policy Brief*. Retrieved from [Policy-coherence-for-sustainable-development-in-sub-saharan-africa_](http://www.gri.ac.uk/publications/policy-coherence-for-sustainable-development-in-sub-saharan-africa_)
- De Oliveira, T., Duraiappah, A. K., & Shepherd, G. (2003). *the Global Drylands Imperative - Increasing Capabilities Through an Ecosystem Approach for the Drylands*. Retrieved from http://www.iisd.org/pdf/2003/economics_global_drylands_imp.pdf
- Denise, C., Ray-Bennett, N., & Hebden, S. (2017). *Review of the National Disaster Management Policies and Plans of Kenya and Uganda for Scoping Disaster Risk Reduction for Earth Observation*. Retrieved from http://www.avoidable-deaths.net/wp-content/uploads/2019/05/Review-of-National-Policies_Scoping-DRR-for-EO_Project.pdf
- Devereux, S. (2007). The impact of droughts and floods on food security and policy options to alleviate negative effects. *Agric. Econ.*, (37), 47–58.
- DI. (2019). *Tracking subnational government investments in disaster risk reduction in Kenya*.
- Dickson, E., Baker, J. L., Hoornweg, D., & Asmita, T. (2012). *Urban Risk Assessments: Understanding Disaster and Climate Risk in Cities. Urban Development Series*. <https://doi.org/10.1596/978-0-8213-8962-1>
- Dissanayaka, M. L. S., & Sangasumana, R. P. (2017). Issues and Challenges of Urban Flood Hazard Management in North Colombo Region (A case study of 2016 Flood Affected Kolonnawa Urban Council). *International Journal of Scientific and Research Publications*, 7(October), 310–319. <https://doi.org/10.1542/peds.2006-3300>
- Douglas, I., Alam, K., Maghenda, M., McDonnell, Y., Mclean, L., & Campbell, J. (2008a). Unjust waters : climate change , flooding and the urban poor in Africa. *Environment & Urbanization*, 20(1), 187–205. <https://doi.org/10.1177/0956247808089156>
- Douglas, I., Alam, K., Maghenda, M., McDonnell, Y., Mclean, L., & Campbell, J. (2008b). Unjust waters: Climate change, flooding and the urban poor in Africa. *Environment and*

- Urbanization*, 20(1), 187–205. <https://doi.org/10.1177/0956247808089156>
- Drummond, J., Crawford, N., Fraser, H., Smith, K., Benedek, C., & Gerard, A. (2014). *Humanitarian crises, emergency preparedness and response: the role of business and the private sector Kenya case study Acknowledgements Executive summary*.
- ENDA. (2015). *Narok Town Integrated Floods Management Plan*. Narok, Kenya.
- ENSDA. (2015). *Narok Town Integrated Floods Management Plan*. Narok, Kenya.
- Fraser, A., Leck, H., Parnell, S., & Pelling, M. (2017). Africa's Urban Risk and Resilience. *International Journal of Disaster Risk Reduction*, 26, 1–6. <https://doi.org/10.1016/j.ijdr.2017.09.050>
- Frick-Trzebitzky, F., Baghel, R., & Bruns, A. (2017). Institutional bricolage and the production of vulnerability to floods in an urbanising delta in Accra. *International Journal of Disaster Risk Reduction*, 26(September), 57–68. <https://doi.org/10.1016/j.ijdr.2017.09.030>
- Gajanayake, P., Perera, D., Kobbekaduwa, H., & Pathmarajah, S. (2016). Water Pollution in an Urban Stream, Kandy, Sri Lanka: A Review. In *8th International Perspective on Water Resources and the Environment*.
- Glantz, M. H. (2017). *El Niño Ready Nations and Disaster Risk Reduction (DRR)*. U.S. Retrieved from <http://www.ccb-boulder.org/wp-content/uploads/2017/01/Crop-REVISED-FINAL-Xmas-Master-CrossCutting-QUICK-Qian-12-23A.pdf>
- GoK. The Disaster Risk Management Bill, 2018, 59 Kenya Gazette Supplement § (2007). <https://doi.org/10.4995/muse.2016.6375>
- Government of Kenya. (2010a). *National Climate Change Response Strategy*. Nairobi, Kenya.
- Government of Kenya. (2010b). *The 2009 Kenya Population and Housing Census - Population and Household Distribution by Socio-economic Characteristics (Vol. II)*.
- Government of Kenya. The Constitution of Kenya (2010). <https://doi.org/10.1364/OE.17.019075r186571> [pii]
- Government of Kenya. (2013a). *Kenya Population Situation Analysis*.

<https://doi.org/10.1056/NEJMoa0807865>.An

Government of Kenya. (2013b). *National Climate Change Action Plan 2013 - 2017* (Vol. 28). Nairobi, Kenya. <https://doi.org/10.1017/CBO9781107415324.004>

Government of Kenya. (2014). *National Emergency Response Plan & Standard Operating Procedures (SOPs)*.

Government of Kenya. (2017a). *NATIONAL DISASTER RISK MANAGEMENT POLICY*.

Government of Kenya. The Urban Areas and Cities (Amendment), ACT of Parliament § (2017). Nairobi, Kenya: Parliament of Kenya.

Government of Kenya. Urban Areas and Cities (Amendment) Act, 2019, Pub. L. No. 3, 31 Kenya Gazette Supplement (2019). Kenya. Retrieved from http://www.kenyalaw.org/kl/fileadmin/pdfdownloads/AmendmentActs/2019/UrbanAreasandCities_Amendment_Act_2019.pdf

Government of Kenya. (2020). *Kenya National Emergency Response Plan*.

Government of Kenya (GoK). (2013). *Second Medium Term Plan, 2013 – 2017: Transforming Kenya: Pathway to devolution, socio-economic development, equity and national unity. Second Medium Term Plan, 2013 – 2017* (Vol. 1). <https://doi.org/10.1017/CBO9781107415324.004>

Gralepois, M., Larrue, C., Wiering, M., Crabbé, A., Tapsell, S., Mees, H., ... Malgorzata, S. (2016). Is flood defense changing in nature? Shifts in the flood defense strategy in six European countries. *Ecology and Society*, 21(4), 37. <https://doi.org/https://doi.org/10.5751/ES-08907-210437>

Hammond, M. J., Chen, A. S., Djordjević, S., Butler, D., & Mark, O. (2015). Urban flood impact assessment: A state-of-the-art review. *Urban Water Journal*, 12(1), 14–29. <https://doi.org/10.1080/1573062X.2013.857421>

Huho, J. M., Mashara, J. N., & Musyimi, P. K. (2016a). Profiling Disasters in Kenya and their Causes. *Academic Research International Vol.*, 7(1), 290–305.

- Huho, J. M., Mashara, J. N., & Musyimi, P. K. (2016b). Profiling Disasters in Kenya and Their Causes. *Academic Research International Vol.*, 7(1), 290–305.
- IFRC. (2012). *DREF final report Kenya : Floods*.
- IFRC. (2018). *Emergency Plan of Action Operation Update Kenya : Floods*.
- IPCC. (2007). *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. ([Core Writing Team, R. K. Pachauri, & A. Reisinger, Eds.), IPCC. Geneva, Switzerland.
- IPCC. (2014a). Annex II: Glossary. In K. J. Mach, S. Planton, & C. von Stechow (Eds.), *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 117–130). Geneva, Switzerland. <https://doi.org/10.1017/CBO9781107415324>
- IPCC. (2014b). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. (R. K. Pachauri & L. Meyer, Eds.), IPCC. Geneva, Switzerland. <https://doi.org/10.1017/CBO9781107415324>
- Japan International Cooperation Agency. (2013). The project on the development of the National Water Master Plan 2030, Final Report. The Republic of Kenya, 1, 219.
- JICA. (2012). *Report on the Project for Augmentation of Water Supply System in Narok Town, Kenya*.
- JICA. (2014). *Project on Capacity Development for Effective Flood Management in Flood Prone Area in the Republic of Kenya: Manual for WRMA on Flood Management Education in WRUA and Primary School*.
- Jonkman, S. N. (2005). Global Perspectives on Loss of Human Life Caused by Floods. *Natural Hazards*, 34(2), 151–175. <https://doi.org/https://doi.org/10.1007/s11069-004-8891-3>
- Joseph, S. M. (2018). *Determinants of Solid Waste Management in Urban Centres: Case of Narok Town, Narok County Kenya*. University of Nairobi. Retrieved from

<http://erepository.uonbi.ac.ke/bitstream/handle/11295/104089/mayoz.pdf?sequence=1>

Karanja, F. K., & Mutua, F. M. (2000). *Reducing the Impact of Environmental Emergencies through Early Warning and Preparedness - The Case Of El Niño-Southern Oscillation (ENSO); Impacts of the 1997-98 El Niño Event in Kenya*. Nairobi, Kenya.

Kenya National Bureau of Statistics (KNBS) & Society for International Development – East Africa. (2013). *Exploring Kenya's Inequality: Pulling Apart or Pooling Together?-Narok County*. Nairobi, Kenya.

Khaing, Z. M., Zhang, K., Sawano, H., Shrestha, B. B., Sayama, T., & Nakamura, K. (2019). Flood hazard mapping and assessment in data-scarce Nyaungdon area, Myanmar. *PLoS ONE*, *14*(11). <https://doi.org/10.1371/journal.pone.0224558>

Komolafe, A. A., Herath, S., & Avtar, R. (2019). Establishment of detailed loss functions for the urban flood risk assessment in Chao Phraya River basin, Thailand. *Geomatics, Natural Hazards and Risk*, *10*(1), 633–650. <https://doi.org/10.1080/19475705.2018.1539038>

Konana, C., Gachene, C., Mburu, D., Mureithi, S., Gicheru, P., & Khalif, Z. (2017). Drivers of Gully Erosion: Case Study, Narok County, Kenya. *International Journal of Social Science and Technology*, *2*(3), 53–67. Retrieved from http://www.ijssstr.com/data/frontImages/4_April_17.pdf

Kothari, C. R. (2004). *Research Methodology Methods and Techniques (second revised edition)*. New Age International (P) Ltd. <https://doi.org/10.1017/CBO9781107415324.004>

Kundzewicz, Z. W., Kanae, S., Seneviratne, S. I., Handmer, J., Nicholls, N., Peduzzi, P., ... Sherstyukov, B. (2014). Flood risk and climate change: global and regional perspectives. *Hydrological Sciences Journal*, *59*(1), 1–28. <https://doi.org/10.1080/02626667.2013.857411>

Larcher, W. (2003). *Physiological Plant Ecology* (4th ed.). Berlin, Germany: Springer. <https://doi.org/10.1093/aob/mch084>

Liao, K. H. (2012). A Theory on Urban Resilience to Floods—A Basis for Alternative Planning Practices. *Ecology and Society*, *17*(4). <https://doi.org/10.5751/ES-05231-170448>

Liu, J., Dietz, T., Carpenter, S. R., Alberti, M., Folke, C., Moran, E., ... Taylor, W. W. (2007).

- Complexity of coupled human and natural systems. *Science*, 317(5844), 1513–1516.
<https://doi.org/10.1126/science.1144004>
- Liu, Z., Wang, Y., Gallimore, R., Gasse, F., Johnson, T., deMenocal, P., ... Ong, E. (2007).
 Simulating the transient evolution and abrupt change of Northern Africa atmosphere-ocean-
 terrestrial ecosystem in the Holocene. *Quaternary Science Reviews*, 26(13–14), 1818–1837.
<https://doi.org/10.1016/j.quascirev.2007.03.002>
- Mainuri, Z. G., & Owino, J. O. (2014). Linking landforms and land use to land degradation in
 the Middle River Njoro Watershed 2 Research methodology. *International Soil and Water
 Conservation Research*, 2(2), 1–10. [https://doi.org/10.1016/S2095-6339\(15\)30001-0](https://doi.org/10.1016/S2095-6339(15)30001-0)
- Maloba, E., Tankile, R., Lesita, S., Otunga, T., Adhiambo, G., & Melita, J. (2015). *Rapid Impact
 Assessment Report of the Narok Town Flash Floods of 28 April, 2015 (Final draft) Narok.*
 Narok, Kenya.
- Mandych, A. (2015). Floods and Soil Erosion. *Water Interactions with Energy, Environment,
 Food and Agriculture, II*, 10.
- Marincioni, F., & Antronico, L. (2018). *Natural Hazards and Disaster Risk Reduction Policies.*
 (A. Loredana & F. Marincioni, Eds.). Rende (CS), Italy: Scientific and Cultural
 Association, Università della Calabria.
- Masese, A., Neyole, E., & Ombachi, N. (2016). Loss and Damage from Flooding In Lower
 Nyando Basin , Kisumu County , Kenya. *International Journal of Social Science and
 Humanities Research*, 4(3), 9–22.
- Melissa, P., & Ebalu, O. (2012). *City Resilience in Africa: A Ten Essentials Pilot.* New York.
 Retrieved from http://www.unisdr.org/files/29935_cityresilienceinafricasansdate.pdf
- Ministry of Devolution and Planning. (2016). *Policy on Devolved System of Government.*
 Nairobi, Kenya. Retrieved from [https://www.undp.org/content/dam/kenya/docs/Democratic
 Governance/Final Devolution Policy.pdf](https://www.undp.org/content/dam/kenya/docs/Democratic Governance/Final Devolution Policy.pdf)
- Mireille, N. M., Mwangi, H. M., Mwangi, J. K., & Gathenya, J. M. (2019). Analysis of Land Use
 Change and Its Impact on the Hydrology of Kakia and Esamburmbur of the. *Hydrology*,

6(86), 1–17.

MoA&I. (2009). *Flood Mitigation Strategy (2009)*.

Morrison, A., Westbrook, C. J., & Noble, B. F. (2018). A review of the flood risk management governance and resilience literature. *Journal of Flood Risk Management*, 11(3), 291–304. <https://doi.org/10.1111/jfr3.12315>

Narok County Government. (2018a). *Narok County Flood Early Warning Communication Strategy*.

Narok County Government. (2018b). *Narok county integrated development plan (2018-2022)*.

NASAC. (2015). *Climate Change Adaptation and Resilience in Africa Recommendations to Policymakers*. Retrieved from [http://www.nasaonline.org/attachments/article/253/Climate Change Adaptation and Resilience - Recommendations to Policymakers-WEBi.pdf](http://www.nasaonline.org/attachments/article/253/Climate%20Change%20Adaptation%20and%20Resilience%20-%20Recommendations%20to%20Policymakers-WEBi.pdf)

Nastiti, K. D., Kim, Y., Jung, K., & An, H. (2015). The application of Rainfall-Runoff-Inundation (RRI) model for inundation case in upper Citarum Watershed, West Java-Indonesia. In *Procedia Engineering* (Vol. 125, pp. 166–172). Elsevier Ltd. <https://doi.org/10.1016/j.proeng.2015.11.024>

NDOC. (2013). *Initial Rapid Assessment Report for Flooding in Narok County*.

NEMA. (2009). *Narok District Environment Action Plan 2009-2013*. Retrieved from [https://www.nema.go.ke/images/Docs/Awarness Materials/NEAPS/narok.pdf](https://www.nema.go.ke/images/Docs/Awarness%20Materials/NEAPS/narok.pdf)

Ngaruiya, G. W., & Muithui, L. W. (2016). *Deconstructing a pastoralists ' network to evaluate climate adaptation in the sector : A case study of Narok , Kenya Small Grants Programme*. London. Retrieved from <https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/57391/IDL-57391.pdf>

Niekerk, D. Van, Coetsee, C., & Nemaconde, L. (2020). Implementing the Sendai Framework in Africa : Progress Against the Targets (2015 – 2018). *International Journal of Disaster Risk Science*, 11(2), 179–189. <https://doi.org/10.1007/s13753-020-00266-x>

Nyakundi, H., Mogere, S., Mwanzo, I., & Yitambe, A. (2010). Community perceptions and

- response to flood risks in Nyando District, Western Kenya. *Jàmbá: Journal of Disaster Risk Studies*, 3(1). <https://doi.org/10.4102/jamba.v3i1.35>
- Obeta, M. C. (2014). Institutional Approach to Flood Disaster Management in Nigeria : Need for a Preparedness Plan. *British Journal of Applied Science & Technology*, 4(33), 4575–4590. <https://doi.org/10.9734/BJAST/2014/11844>
- Odhiambo, O., Afullo, A., Eunice, G., & Maghenda, M. (2015). Heavy Metal Concentration and pH Levels in Soils of the Main Dumpsites of Narok Central Sub-countty. *International Journal of Advanced Research*, 3(8), 899–904.
- Okuom, H. A., Simatwa, E. M. W., Maureen, O. A., & Wichenje, K. M. (2012). Assessment of factors that contribute to repetition and dropout of pupils in primary schools in Flood Prone Areas of Nyando District , Kenya : an analytical study. *Educational Research*, 3(2), 190–201.
- Olugunorisa, T. (2010). Strategies for Mitigation of Flood Risk in the Niger Delta, Nigeria. *Journal of Applied Sciences and Environmental Management*, 13. <https://doi.org/10.1038/nrn1076>
- Opere, A. (2013). Floods in Kenya. In *Developments in Earth Surface Processes* (1st ed., Vol. 16, pp. 315–330). Nairobi, Kenya: Elsevier B.V. <https://doi.org/10.1016/B978-0-444-59559-1.00021-9>
- Opere, A., & Ogallo, L. A. (2006). *Natural disasters in Lake Victoria Basin (Kenya): Causes and impacts on environment and livelihoods*. Retrieved from <http://hdl.handle.net/1834/7361>
- Otiende, B. (2009). *The Economic Impacts of Climate Change in Kenya: Riparian Flood Impacts and Cost of Adaptation*. Retrieved from <http://kenya.cceconomics.org/kedo/kenya-riparian-floods-case-study.pdf>
- Ouma, Y. O., & Tateishi, R. (2014). Urban flood vulnerability and risk mapping using integrated multi-parametric AHP and GIS: Methodological overview and case study assessment. *Water (Switzerland)*, 6(6), 1515–1545. <https://doi.org/10.3390/w6061515>

- Owiti, Z. (2012). Spatial distribution of rainfall seasonality over East Africa. *Journal of Geography and Regional Planning*, 5(15), 409–421. <https://doi.org/10.5897/jgrp12.027>
- Pahl-Wostl, C., Kabat, P., & Möltgen, J. (2007). *Adaptive and Integrated Water Management*. (C. Pahl-Wostl, P. Kabat, & J. Möltgen, Eds.), *Adaptive and Integrated Water Management*. New York, USA: Springer-Verlag Berlin Heidelberg. <https://doi.org/10.1007/978-3-540-75941-6>
- Renöfält, B. M., Merritt, D. M., & Nilsson, C. (2007). Connecting variation in vegetation and stream flow : the role of geomorphic context in vegetation response to large floods along boreal rivers. *Journal of Applied Ecology*, 44, 147–157. <https://doi.org/10.1111/j.1365-2664.2006.01223.x>
- RMMS. (2013). *Mixed Migration in Kenya*:
- Rodrigues, C. A. (2001). Fayol’s 14 principles of management then and now: A framework for managing today’s organizations effectively. *Management Decision*. <https://doi.org/10.1108/EUM0000000006527>
- Schraeder, M., Self, D. R., Jordan, M. H., & Portis, R. (2014). The Functions of Management as Mechanisms for Fostering Interpersonal Trust. *Advances in Business Research*, 5, 50–62. Retrieved from <http://journals.sfu.ca/abr%0Ahttp://journals.sfu.ca/abr/index.php/abr/index>
- Tingsanchali, T. (2012a). Urban flood disaster management. In *Procedia Engineering*. <https://doi.org/10.1016/j.proeng.2012.01.1233>
- Tingsanchali, T. (2012b). Urban flood disaster management. *Procedia Engineering*, 32, 25–37. <https://doi.org/10.1016/j.proeng.2012.01.1233>
- Turnpenny, J. R., Jordan, A. J., Benson, D., & Rayner, T. (2015). *The tools of policy formulation: an introduction*.
- UNDP. (2015). *Kenya Natural Disaster Profile*. Nairobi, Kenya. <https://doi.org/10.1007/s00428-015-1895-4>
- UNDRR. (2015). *Sendai Framework for Disaster Risk Reduction 2015 - 2030*.

- UNEP. (2005). *Maasai Mau forest status report 2005*.
- UNFCCC. (2015). *Convention on Climate Change: Climate Agreement of Paris*. Bonn Germany.
Retrieved from <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>
- UNISDR. (2012). *City Resilience in Africa: A Ten Essentials Pilot*.
- Vesely, A. (2020). Policy formulation redesigned: A new understanding of policy design and its implications for instruction. *Teaching Public Administration*, 38(3), 213–232.
<https://doi.org/10.1177/0144739420901729>
- World Bank. (2010). *Report on the status of Disaster Risk Reduction in Sub-Saharan Africa*.
World Bank. Washington, D.C. 20433, U.S.A.
- Wright, J. B. (1967). *Geology of the Geology Narok Area*. Retrieved from <https://s3-eu-west-1.amazonaws.com/samsamwater1/maps/kenya/geology/Geology+of+the+Narok+Area.pdf>
- WRMA. (2013). *Mara Emarti Sub-Catchment Management Plan (SCMP) 2013-2016*.
- WRMA. (2013). *SUB-CATCHMENT MANAGEMENT PLAN (SCMP) 2013-2016*.
- Zevenbergen, C., Cashman, A., Evelpidou, N., Pasche, E., Garvin, S., & Ashley, R. (2010).
Urban Flood Management. New York: Taylor & Francis Group.

APPENDICES

Questionnaires:

Questionnaire for Organisations

Integrated Flood Management in Narok Town, Narok County

Introduction

My name is Charles Tonui, I'm pursuing Master of Environmental Planning and Management from the Department of Environmental Planning and Management at Kenyatta University. In order to fulfill the requirements of this degree programme, I'm carrying out a study to assess the causes and impacts of the perennial floods; mapping of the organisations contributing to the flood management through implementation of various flood management initiatives in Narok town in Narok County. The information you provide will only be used for the purpose of the study and as such, it will be given utmost confidentiality. I kindly seek your indulgence in filling this questionnaire.

The information and data provided will be confidential and is intended for academic purposes only

Name of the Interviewer -----

Date of interview -----

Q1.What is your role and mandate in flood management in Narok?

.....
.....
.....
.....
.....

Q2.What challenges do you face in executing your role and mandate?

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Q3.What initiatives have been put in place to address flood management in Narok?

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Q4.How effective are the above mentioned initiatives?

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Q5. In your opinion how does the local community perceive flood management initiatives?

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Q6.To what extent is the local community involved in flood management initiatives?

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Q7.What challenges do the locals face in implementation of flood management initiatives?

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Q8. Do you have a specific plan for the management of floods in Narok?

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.....
.....

Q9.How have the initiatives adopted in flood management impacted the environment?

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.....
.....
.....

Q10. Whom do you partner with in flood management and why?

.....
.....
.....

THANK YOU FOR YOUR COOPERATION

Questionnaire for Households

Integrated Flood Management in Narok Town, Narok County

Introduction

My name is Charles Tonui, I'm pursuing Master of Environmental Planning and Management from the Department of Environmental Planning and Management at Kenyatta University. In order to fulfill the requirements of this degree programme, I'm carrying out a study to assess the causes and impacts of the perennial floods; mapping of the organisations contributing to the flood management through implementation of various flood management initiatives in Narok town in Narok County. The information you provide will only be used for the purpose of the study and as such, it will be given utmost confidentiality. I kindly seek your indulgence in filling this questionnaire.

Household Questionnaire

The information and data provided will be confidential and is intended for academic purposes only
Please answer these questions to the best of your knowledge.

Name of the Interviewer -----

Date of interview -----

A. Household Information

1. (a) What are your household characteristics? (Please fill in the table below)

Household member/s	Gender	Age	Educational level	Main occupation	Monthly income from the main occupation	Other sources of income	Monthly income from other sources

2. For how long have you been living here?

- (i) 0-5yrs [] (ii) 5-10yrs [] (iii) 10-15yrs [] (iv) 15yrs and above []

B. Impacts of floods in Narok region

3. What are the negative impacts associated with flooding in Narok region?

a) Physical

- (i) Soil erosion [] (ii) siltation [] (iii) water pollution [] (iv) Any other(Specify).....

b) Biological

- (i) Loss of vegetation [] (ii) loss of animals [] (iii) habitat destruction []
 (iv) Any other (Specify)

c) Social

No.	Impact	Low	Medium	High
(i)	Disease prevalence			
(ii)	Poor education levels			
(iii)	Loss of life and property			
(iv)	Famine			
(v)	Loss of livelihood			
(vi)	Relief Dependency			
(vii)	Displacement of people			
(viii)	Infrastructure-transport, education facilities, power supply			

Are there any positive impacts associated with flooding? (i) Yes [] (ii) No []

If yes, please specify

C. Effects of existing flood mitigation measures in Narok region

4. What intervention measures have been put in place to mitigate flooding in Narok?

.....

.....

.....

5. What are the effects of the above existing flood mitigation measures on?

No.	Aspects	None	Slightly improved	Greatly improved	Declined
(i)	Farm productivity				
(ii)	Infrastructure				
(iii)	Health				
(iv)	Biodiversity				
(v)	Business Environment				
(vi)	Education				
(vii)	Settlements				

6. Are the above interventions effective in addressing flooding? (i) Yes [] (ii) No []

If no, what can be done to ensure effectiveness in flood management in Narok?

.....

.....

.....

D. Causes of flood occurrences in Narok region

7. To what extent have the following factors influenced the occurrence of floods in Narok?

No.	Factors	Low	Medium	High
(i)	Soil type			
(ii)	Rainfall			
(iii)	Topography			
(iv)	Adjacency and bursting of River Mara			

E. The role of stakeholders in flood management in Narok region

8. What is the role of stakeholders in flood management in Narok?

No.	Stakeholder	Role	Effectiveness
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THANK YOU FOR YOUR COOPERATION


Work Plan

Project Management Schedule

No.	Activity	Month, 2019			
		February	March	April	May
1.	Acceptance of the Research Proposal				
2.	Contact key informants in the study area & map potential respondents; Training of Enumerators				
3.	Data Collection and Data Entry				
4.	Project Report Writing				
5.	Project Submission				

Research Authorization

i. Authorization for Research from Graduate School, Kenyatta University



KENYATTA UNIVERSITY

GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke P.O. Box 43844, 00100
Website: www.ku.ac.ke NAIROBI, KENYA
Tel. 8710901 Ext. 57530

Our Ref: N50/CTY/PT/25546/2013 DATE: 15th March, 2019

Director General,
National Commission for Science
& Innovation,
P.O. Box 30623-00100,
NAIROBI.

Dear Sir/Madam,

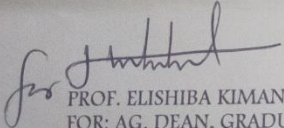
RE: RESEARCH AUTHORIZATION FOR MR. CHARLES TONUI - REG.NO.
N50/CTY/PT/25546/2013.

I write to introduce Mr.Charles Tonui who is a Postgraduate Student of this University. He is registered for MSC. degree programme in the Department of Environmental Planning & Management.

Mr. Tonui intends to conduct research for an MSC. thesis entitled, "Assessing Flood Management in Narok Town, Narok County, Kenya".

Any assistance given will be highly appreciated.

Yours faithfully,


PROF. ELISHIBA KIMANI,
FOR: AG. DEAN, GRADUATE SCHOOL

EO/sw

- ii. Research Authorization from the National Commission for Science, Technology and Innovation (NACOSTI), Kenya



**NATIONAL COMMISSION FOR SCIENCE,
TECHNOLOGY AND INNOVATION**

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When replying please quote

NACOSTI Upper Kabete
Off Waiyake Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref No: **NACOSTI/P/19/66117/29218**

Date: **30th April, 2019**

Charles Kipkurui Tonui
Kenyatta University
P.O. Box 53844-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "*Assessing flood management in Narok Town, Narok County, Kenya*" I am pleased to inform you that you have been authorized to undertake research in **Narok County** for the period ending **30th April, 2020**.

You are advised to report to **the County Commissioner and the County Director of Education, Narok County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit a **copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.


GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Narok County.

The County Director of Education
Narok County.

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

The Grant of Research Licenses is guided by the Science, Technology and Innovation (Research Licensing) Regulations, 2014.

CONDITIONS

1. The License is valid for the proposed research, location and specified period.
2. The License and any rights thereunder are non-transferable.
3. The Licensee shall inform the County Governor before commencement of the research.
4. Excavation, filming and collection of specimens are subject to further necessary clearance from relevant Government Agencies.
5. The License does not give authority to transfer research materials.
6. NACOSTI may monitor and evaluate the licensed research project.
7. The Licensee shall submit one hard copy and upload a soft copy of their final report within one year of completion of the research.
8. NACOSTI reserves the right to modify the conditions of the License including cancellation without prior notice.

National Commission for Science, Technology and Innovation

P.O. Box 30623 - 00100, Nairobi, Kenya

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Email: dg@nacosti.go.ke, registry@nacosti.go.ke

Website: www.nacosti.go.ke



REPUBLIC OF KENYA



**National Commission for Science,
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Serial No.A 24424

CONDITIONS: see back page

iii. Research Authorization from the Ministry of Education, Narok County, Kenya

