Applying a Systems Thinking Approach to Health Care for Women & Children in the Flood Plains of Western Zambia

by

Mwimanenwa Njungu

A thesis
presented to the University of Waterloo
in fulfillment of the
thesis requirement for the degree of
Doctor of Philosophy
in
Public Health Sciences (Water)

Waterloo, Ontario, Canada, 2022

1. Examining Committee Membership

The following served on the Examining Committee for this thesis. The decision of the Examining Committee is by majority vote.

External Examiner	Dr. Nicole Berry Faculty of Health Sciences Simon Fraser University
Supervisor	Dr. Craig Janes School of Public Health Sciences University of Waterloo
Internal Members	Dr. Jennifer Liu Department of Anthropology School of Public Health Sciences University of Waterloo
	Dr. Warren Dodd School of Public Health Sciences University of Waterloo
	Dr Elena Neiterman School of Public Health Sciences University of Waterloo
Internal/External Examiner	Dr. Susan Elliott Department of Geography and Environmental Management University of Waterloo

Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

At least half of the world's population are reportedly unable to obtain essential health services with significant gaps being noted in sub–Saharan Africa and Southern Asia. Access to health services incorporates physical accessibility, acceptability and affordability and is influenced by multiple factors. Environmental factors such as flooding and changing weather patterns due to global climate change, contribute to limited geographical access to health services particularly for rural communities. Like many low- and middle-income countries, Zambia, a predominantly rural country in southern Africa has some poor health indicators such as high infant and under-five mortality rates, demonstrating that some communities are lacking access to essential health services. The aim of this research was to apply a systems' thinking framework to the investigation of contextual factors influencing access to maternal and child health (MCH) services in Zambia's Western Province where there is increasing variability in seasonal floods, with a view to improving mitigation strategies.

The main objectives of this study were:

1) To identify the effects of flooding on access to maternal and child health services in flood prone areas of Western Province, Zambia.
2) To explore the perceptions of environmental change among residents of the Zambezi flood plains in Western Province and how these changes influence health outcomes.
3) To understand the interaction of contextual factors on public health interventions for maternal health from a systems perspective and identify potential leverage points for improvement.

A qualitative study design was used for this research based on interviews, focus group discussions observations and some document reviews. Data collection for this research was undertaken over several field visits between June 2019 and February 2021.

The findings of the research indicate that there were four main effects of flooding on access to care. These were disruption of the health service delivery system, disruption of routes of access and transportation challenges, negative economic effects and negative effects

on water and sanitation. Environmental changes most reported by residents in the flood plains were changes in timing of the different seasons and rainfall patterns and increasing intensity of both droughts and floods with devastating consequences on the livelihoods. Consequently, residents' resort to use of traditional remedies and self-medication to treat illness. Home deliveries are common for remote communities with many complications reportedly being experienced. Contextual factors that are influencing the effectiveness and outcomes of maternal health interventions included political and developmental factors, socio-cultural factors, and environmental factors. The findings illustrate the effects of floods on access to essential health services in the flood plains of Western Province. They also describe the perceptions of residents on environmental changes observed and the resulting health outcomes experienced. The interaction of different systems in influencing access to health services and public health interventions is presented demonstrating that long term solutions require a multipronged strategy involving multiple departments and the participation of local communities.

The study makes several significant contributions. It builds on existing knowledge on the potential of a systems approach to strengthening design of interventions for health system challenges. By applying a systems framework and using some systems tools it makes theoretical and methodological contributions. It also adds to the body of knowledge on the effects of flooding on health systems in LMICs such as Zambia. These findings are significant for the global community to be aware of the wide-reaching effects of ongoing climate change among communities that contribute minimally to such change.

Acknowledgements

I would like to express my sincere gratitude to my supervisor, Dr Craig Janes for giving me the opportunity to fulfill this dream. Thank you for your mentorship and invaluable support throughout this journey.

Special thanks to other committee members, Drs Jennifer Liu, Warren Dodd, Elena Neiterman for your guidance, insights, availability, and encouragement; my internal/external examiner, Dr. Susan Elliott, and external examiner Dr. Nicole Berry for your availability to serve as examiners in spite of having very busy schedules.

Thank you to the School of Public Health Sciences: faculty, staff, and graduate students. You have all been a continuing source of inspiration and encouragement. Thank you to the greater University of Waterloo community for your kindness. It was a joy to belong to this unique community.

Thank you to my colleagues in the Global Health Lab. You became my family in Canada and your friendship and encouragement have been incomparable.

Beyond UW, I am grateful to Vic Neufeld, who "opened the door" for me to meet my supervisor and pursue this PhD journey and Dr Kitty Corbett whose introductory seminar course, among other courses, was instrumental in helping me adapt to my new environment and has continued to be an encouragement. I am also grateful to the Zambian family-away-from-home: the Acheta and Sichilima families in Kitchener-Waterloo, as well as the many friends I made along the way.

I would like to thank the Ministry of Health in Zambia, particularly, the Provincial Health Office in Western Province under the leadership of Drs Francis Liywali and Jacob Sakala, who were my local research partners and whose facilitation enabled my field research. I would also like to thank all the people who contributed to the completion of this research including all research participants, research assistants and colleagues at the University of Barotseland in Mongu, Western Province led by Dr Greg Kwalombota.

Finally, I would like to thank my family: my husband, John, and our daughters Wabwila and Likezo. Thank you for your patience and loving support through this long journey. We endured many trials, but by the grace of our Lord Jesus, we have finally come to the end. My gratitude also to my larger family who have been supportive all the way. I love you all.

I am indebted to the University of Waterloo who funded my doctoral study program through the various teaching and research assistantships, scholarships, and awards, particularly the International Doctoral Student Award and the RBC Water scholarship administered through the Collaborative Water Program of the Water Institute. My research activities were funded through the QES-AS award administered through the Water Institute as well as a scholarship from the Global Health Policy and Innovation Research Centre in the School of Public Health Sciences. I received additional funding also from the Faculty of Health. For all these funds, I am truly grateful.

Dedication

I dedicate this work to my beloved family members who are no longer here on earth and whose presence is deeply missed. My dear parents, my first educators, Dorika Judith Njungu and Aggripa Munumi Njungu, thank you for the million ways you deposited life and value into me, and for the priceless foundation in education. With this milestone, I celebrate and honour your legacy.

My elder sister Edna Mubiana Njungu, you were the trailblazer for all the siblings and second mother to us.

My brother John Chipoba Njungu, you were so much fun to grow up with and dream of what our future would bring, although you now watch it from a higher place.

I also dedicate this work to the One who gave me strength to endure this process, The Almighty God, who alone is Sovereign, King of kings and Lord of lords, who alone is immortal and dwells in unapproachable light! To Him be all glory and praise, amen.

Table of Contents

List of Figures

List of Tables

Chapter 1 Introduction

1.1 Problem Statement

The 2015 resolution of the United Nations General Assembly (UNGA) for sustainable development, directed world attention and efforts to priority challenges that needed joint actions to be addressed effectively. Among these priority areas were the health and well-being of all people, as well as the impacts of climate change, addressed by goals number 3 and 13 respectively (UNGA, 2015). Goal number 3 states "Ensure healthy lives and promote well-being for all at all ages" and sub goal 3.8 states "Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all" (UNGA, 2015). While much is being done to achieve universal health coverage, at least half of the world's population are reportedly unable to obtain essential health services with significant gaps being noted in sub–Saharan Africa (SSA) and Southern Asia (World Health Organization, WHO, & World bank, 2017). The WHO report on the state of health in the African region indicates that access to essential services on the continent is low with most countries in the region being unable to provide the infrastructure, staffing and commodities needed for these services (WHO Regional Office for Africa, 2018). The measure of access used in the report was based on the availability of key inputs such as health workforce, health infrastructure and health products and indicated variability in different member states depending on size, population, and income level, and highlighting substantial challenges in the quest to achieve universal health coverage (WHO Regional Office for Africa, 2018). In addition to access to essential services, quality of services, demand for services and resilience to shocks were also used to measure the performance of health systems in Africa, with access and resilience having the lowest performance scores (WHO Regional Office for Africa, 2018).

Goal number 13 of the UN agenda aims to "take urgent action to combat climate change and its impacts" through strengthening adaptive capacities to climate related hazards, integrating climate change measures in national policy and planning, and increasing

education and awareness on climate change mitigation, adaptation, and early warning (UNGA, 2015). According to the Intergovernmental Panel on Climate Change (IPPC), ongoing climate change is linked to extreme weather events such as temperature extremes, droughts and heavy precipitation leading to floods that are projected to increase to varying degrees in some regions of the world (IPPC, 2018). According to the Lancet commission on Climate and Health, extreme weather events such as flooding were identified as one of the ways climate change is linked to adverse health outcomes (Watts, Adger, Agnolucci, Blackstock, Byass et al, 2015). As climate studies have long projected, heavy precipitation leading to increased river and flash flooding, as well as longer, more intense droughts are occurring in many areas of the world leading to loss of lives and property and other associated public health problems including contamination of potable water leading to disease, crop losses resulting in food shortages and malnutrition and destruction of general infrastructure particularly in line with water supply and sanitation (Watts et al, 2015). Climate change is also linked to changing disease and mortality patterns, effect on human settlements, shelter and migration (Watts et al, 2015). While much study has been conducted on the links between climate change related extreme weather events and health in high income countries, there is limited documentation of such studies in low- and middle-income countries (LMICs) particularly in Africa. For example, a systematic review of injuries and mental health outcomes related to extreme weather events in LMICs conducted by Rataj, Kunzweiler and Garthus-Niegel in 2016 reported that their search yielded no studies from Africa. Like other continents, Africa has not been spared from climate change related extreme weather events. Mozambique in southern Africa and some neighbouring countries have recently experienced the devastating effects of tropical cyclones. In 2019, two cyclones consecutively hit some parts of Mozambique causing severe flooding, damaging infrastructure and agricultural produce leading to loss of lives, property, and livelihoods (Mugabe, Gudo, Inlamea, Kitron, & Ribeiro, 2021). Among the health challenges that resulted in the aftermath of the flooding was the outbreak of cholera which affected 6743 cases after cyclone Idai and 149 cases in two months following cyclone Kenneth (Cambaza, Mongo, Anapakala**,** Nhambire, Singo, & Machava, 2019). These outbreaks demonstrated

how the destruction of essential infrastructure, including water and sanitation infrastructure, by flooding disasters resulted in contamination of water supplies leading to an increase in infectious diseases. There are reports highlighting the need for strengthened resilience of communities and (health) systems in low-income countries like Mozambique to deal with disasters of the magnitude presented by the cyclones of 2019 (Mugabe et al, 2021). Zambia, in southern Africa shares a border with Mozambique and has experienced some flooding in parts of the country resulting from climate related extreme weather events in Mozambique. Schatz (2008) reported on floods in southern African causing massive infrastructural damage affecting the four countries in the path of the Zambezi River that left many homeless and unable to access health services particularly rural areas with obstetric care and access to HIV treatment services most affected and cholera outbreaks in Zambia and Mozambique. Studies on the effects of flooding in the Zambian context and specifically effects of flooding on access to care are limited. However, poor health indicators such as the high infant mortality rate (IMR) of 42 per 1000 live births in 2018 and under -5 mortality rate of 61 per 1000 live births point to ongoing challenges of access to essential health services (Central Statistical Office, CSO, Ministry of health, MOH & and ICF International, ICF, 2019).

The aim of this research was to apply systems thinking to the investigation of contextual factors influencing access to maternal and child health (MCH) services in Western Province where there is increasing variability in seasonal floods, with a view to improving mitigation strategies. The outcome of interest in this research was maternal and child health services which is addressed specifically in Chapter Five, but a foundation of experiences of access to health services in general was necessary and is presented in Chapters Three and Four.

The research question that directed the study was:

How can access and utilization of maternal and child health services in flood prone areas of Western Province be improved using systems thinking?

The specific subquestions were:

1. What are the effects of flooding on access and utilization of MCH services?

2. What are the perceptions and experiences of local communities in the flood plains about environmental change and the resulting health behaviours and outcomes?
3. How are local factors in the context of the flood plains influencing existing public health interventions for maternal health outcomes?
This research contributes to documented knowledge on the effects of flooding on access to and utilization of essential health services as well as knowledge on the application of systems theory to health systems research in low- and middle-income country settings.

1.2 Systems Theory

Systems theory is an interdisciplinary theory that focuses on understanding relationships in complex systems, highlighting the interlinkages with external factors, and seeking ways of improving system performance through developing models and /or projections as well as identifying leverage points that can be used in those relationships to influence change (Leischow, Best, Trochim, Clark, Gallagher et al, 2008; Sim, Parker & Kumanyika, 2010). Systems theory is the logical set of ideas that help us understand how complex systems operate, while systems thinking is an application derived from systems theory. A systems approach is a "paradigm or perspective that considers connections among different components, plans for the implications of their interactions and requires transdisciplinary thinking as well as active engagement of those who have a stake in the outcome to govern the course of change" (Leischow & Milstein, 2006). Four commonly shared elements of systems thinking perspectives and approaches across different fields are (1) attention to managing systems knowledge; (2) an emphasis on transdisciplinary and multidisciplinary networks; (3) development of models and projections using a diversity of analytical methods and (4) systems organizing in order to improve organizational structure and function (Leischow et al, 2008).

1.2.1 Principles of systems theory

One core tenet of systems thinking is attention to the complex nature of systems in their operations and outputs based on the flow of information between the different elements creating feedback loops that are either re-enforcing or balancing (Sim et al, 2010). One manifestation of how such flow of information might influence the behaviour of a health system would be how health care providers respond to changes in financing methods so that they benefit the most, even if that results in other individuals being disadvantaged, an unintended consequence of programs such as results based financing programs. Complex systems exhibit such characteristics as non-linearity and emergent behavior as well as certain leverage points within the system where a small shift can produce a significant change (Sim et al, 2010). Introduction of change or action into the system is likely to lead to reactions or responses from other elements in the wider system and understanding these relationships and the flow of information between them seems to be the basis of modeling and development of projections, one of four basic features across the different fields contributing to systems thinking (Leischow, et al. 2008). The other features are a focus on networks and building relationships, seeking ways of improving systems through organizing and looking at managing new knowledge (Leischow, et al. 2008). As stated, the use of models to represent and demonstrate interlinkages between different elements within and between systems, is a characteristic of systems thinking, a model being a visual representation of our understanding of an object (or process) and the links between its component parts (Trochim, Cabrera, Milstein, Gallagher, & Leischow, 2006; Peters, 2014; Sturmberg, Churilov, & McDonnell, 2013). Models may take different forms including line diagrams, conceptual maps or computer simulated models.

Systems approaches in research emphasize transdisciplinary and multidisciplinary networks. Multidisciplinary research refers to collaborative research efforts involving team members from different academic disciplines therefore drawing on knowledge from different disciplines without necessarily integrating concepts and methods (Lynch, 2006; Choi & Pak, 2006). Transdisciplinary research not only integrates knowledge from different academic disciplines, that is it transcends disciplinary boundaries but also draws from non-scientific

sources such as the community (Lynch, 2006). Interdisciplinary research refers to collaboration between two or more disciplines during which there is continuous interaction between the disciplines and integration of knowledge including concepts and methodologies to produce something new (Lynch, 2006; Choi & Pak, 2006; Galway, Parkes, Allen & Takaro, 2016). Choi and Pak (2006) have referred to multidisciplinarity as additive, interdisciplinarity as a synthesis, and transdisciplinarity as holistic. The current research was designed to incorporate knowledge from biomedical sciences (health workforce), sociology, (social welfare and community development), engineering (transportation), educational institutions as well as indigenous knowledge from community members.

Some of the theories that inform systems theory include Von Bertalanffy's general systems theory which developed from the understanding of biological systems to be open to the environment and regulated by homeostatic principles (a form of feedback mechanism) and more generally that a system is more than just the sum of its component parts (Chughtai & Blanchete, 2017; Best, Moor, Holmes, Clark, Bruce et al, 2003). Cybernetics shed light on understanding feedback mechanisms for regulating biological and other systems; chaos theory from mathematics explains dynamic systems as being highly sensitive to initial conditions such that seemingly small changes to the initial conditions may result in very different outcomes based on fixed rules about changing relationships; catastrophe theory also from mathematics is used to study how small changes in parameters of a non-linear system can lead to sudden and large changes in behaviour of a system (Best et al, 2003).

Other contributing theories include realist evaluation theory, learning organizations theory, complexity theory, path dependency theory and punctuated equilibrium which all inform the methods and tools that are used in research employing systems approaches such as agent based or systems dynamic modeling, scenario planning, causal loop diagrams (CLDs), process mapping and others (Peters, 2014; Agyepong, Aryeetey, Nonvignon, Asenso-Boadi, Dzikunu, et al, 2014). Among the concepts characteristic of systems thinking are complexity which relates to the multiplicity of interactions between agents at multiple levels; nonlinear patterns resulting from flow of information forming multiple feedback loops; emergent behaviour as the whole system responds to regain balance after changes have been

introduced and the idea of modelling (Peters, 2014; Atun & Menabde, 2008). Peters discusses the value of the different types of systems thinking modelling in public health proposing that these are more useful for preparing for anticipated problems rather than focussing on any particular outcome (Peters, 2014). He further proposes the use of some models, such as agent-based models, systems dynamic models and scenario planning, for testing the viability of policy interventions (Peters, 2014**).** By the same token, systems thinking becomes a useful way of illustrating policy resistance which is a situation where interventions fail or create new, unanticipated problems due to a lack of consideration of feedback during development of policies (Sim et al, 2010).

1.2.2 Systems thinking in health systems research

These features of systems theory explain why health systems have been likened to complex systems and the basis for the argument for the increased use of systems approaches in public health. As the World Health Organization (WHO) defines, a health system consists of all organizations, people and actions whose primary intent is to promote, restore or maintain health- its goals are improving health and health equity in ways that are responsive, financially fair, and make the best, or most efficient use of available resources (WHO, 2007). The WHO further describes six building blocks that together constitute a complete system through their multiple relationships and interactions among and between the blocks (De Savigny & Adams, 2009). This back-and-forth interaction allows a health system to be comparable to other systems known to be dynamic and comprising feedback loops that are both reinforcing or balancing and is referred to as a Complex Adaptive System. Health systems form part of the whole government system as well as other social systems to which the main constituents, people, belong. Therefore, they are influenced by changes on other parts of the wider network of systems such as the political and financial systems.

Among the catalysts for the use of systems thinking in health research was the release of the WHO flagship report on systems thinking for health systems strengthening in 2009 which proposed that reforms be based on multi-stakeholder engagements through a ten-step framework (De Savigny & Adams, 2009). Engagement of a diversity of stakeholders in collective brainstorming and development of solutions as described in the framework, would

highlight potential effects (both intended and unintended) of interventions on the wider system and allow modifications to be made prior to implementation (De Savigny & Adams, 2009; Chungtai & Blanchet, 2017). This potential of systems approaches to anticipate undesirable effects of changes introduced into a system through an intervention and the additional possibility for modification prior to implementation has led scholars to argue strongly for the application of systems methods in prevention programs for complex public health problems while also emphasizing the need for capacity building and clearer guidelines for implementation of system-wide interventions (Sim et al, 2010; Carey, Malbon, Carey, Joyce, Crammond, & Carey, 2015; Best et al, 2003).

Systems approaches pay attention to the environment (context) within which the system operates including the political, legal, demographic and economic environments (Atun & Menabde, 2008). The contextual factors proposed by Atun and Menabde were developed into a framework (see Figure 1:1 below) which was used to study the performance of health systems, shown in the inner rectangular box, embedded in the contextual elements in the outer elliptical shape. An adaptation of this framework was used in this research to investigate how the different contextual elements influence access to health services. An adapted framework relating the effects of context on a specific intervention is presented and discussed in Chapter Five of this thesis.

1.2.3 Application of systems thinking in health systems research

Application of systems thinking to solving public health challenges in developing countries has been limited for a variety of reasons, a major one being the traditional reliance of national health systems on donor funding and consequent focus on vertical programmes. Recognizing this, as well as the limited use of multi-disciplinary research teams for collaborative programs in these countries, the 2009 World Health Organization's report on systems thinking for health systems strengthening, called for increased use of a systems approach demonstrating its relevance within the context of the health sector and beyond (De Savigny & Adams, 2009).

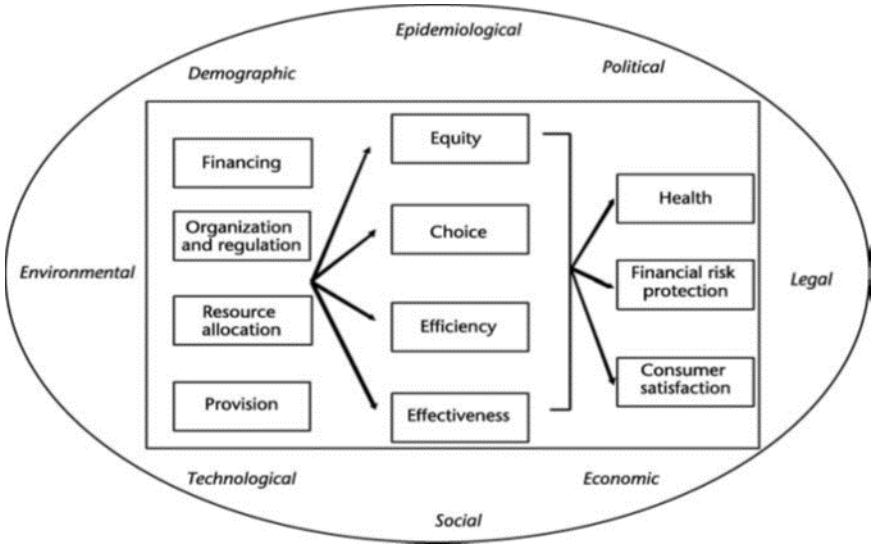

Figure 1:1 A framework for analyzing health systems in context.
Source Atun & Menabde, 2008.

Use of systems perspective in health systems research was advocated by Remme and colleagues in their paper discussing domains of research targeted at improving the health system (Remme, Adam, Becerra-Posada, D'Arcangues, Devlin et al., 2010). They describe health systems research as that which addresses health system and policy questions concerning system problems with repercussions on the whole health system as opposed to being disease specific and argue that a systems perspective is beneficial to this type of research because of its ability to illuminate both positive and negative results of an intervention, facilitating better understanding of the health system challenges and highlight possible remedies (Remme et al, 2010). Additionally, the focus on "multidisciplinarity" that is characteristic of systems thinking would be complementary to health systems research which is itself multidisciplinary in nature (Remme et al, 2010).

Some researchers have demonstrated the application of systems thinking in low- and middle-income country settings for analysing health system challenges such as raised infant mortality rates, low immunization coverage and impacts of task shifting on service delivery (Rwashana, Williams & Neema, 2009; Rwashana, Nakubulwa, Nakakeeto-Kijjambu, & Adam, 2014; Bocoum, Kouanda, Kouyaté, Hounton, & Adam, 2013). Rwashana and

colleagues (2009) used data collected from a combination of methods (surveys, interviews, literature review and brainstorming with stakeholders) to develop CLDs which helped to explain the complex interaction of factors within the Ugandan immunization system and factors external to the system. They also developed other CLDs to explain the complex factors related to neonatal mortality which were then used to identify high leverage points for strategic interventions (Rwashana et al, 2014). In Burkina Faso, researchers used systems methodology to evaluate the implementation of task shifting by engaging a wide range of stakeholders in brainstorming the system wide effects of the program (Bocoum et al, 2013). Such insights are invaluable in the policy making or program design processes. Ribesse and colleagues (2015) used the principles of systems thinking and complexity theories as a methodological lens to guide their research, framing their study subject as a system with multiple stakeholders interacting to bring about reform. They used different systems tools during data collection and analysis including agent-based modelling techniques, "rich pictures" and storytelling (Ribesse et al, 2015).

The features of systems thinking discussed above facilitate visualization of the whole system, uncovering the different interactions between parts which may be useful to understand underlying causes of the different problems under investigation. In addition, potential areas of manipulation for improvement of the systems' performance can be identified and proposed to inform policy reform and program development. In this research, the systems framework was used to guide the data collection process including the selection of study participants, especially the key informants from government departments that were deemed relevant to the study objectives. The framework also provided the analytical lens used in the interpretation and discussion of findings.

1.3 Access to health services

Access to health care has been a focus of attention and concern for the WHO as enshrined in the Alma-Ata declaration of 1978 which called for governments to strive towards universally accessible essential health services for their citizens and defined health as "a state of complete physical, mental and social wellbeing and not just the absence of disease or

infirmity" (WHO, 1978). Access to health services is an important intermediate outcome of health system performance as it directly impacts on how well any system will achieve the main outcome goals of improving health status, meeting customer satisfaction and financial protection. As reported by Evans and colleagues (2013), the WHO refers to access as encompassing three dimensions: -

1)physical accessibility defined as "the availability of good health services within reasonable reach of those who need them and of opening hours, appointment systems and other aspects of service organization and delivery that allow people to obtain the services when they need them",

2) financial affordability which refers to the ability of people to obtain health services without hardship, and

3) acceptability which refers to people's willingness to seek services based on their local preferences.

This is an adaptation of a broader definition of access advanced by Pechansky and others which relates how a health care system meets the needs of clients and incorporates *availability* referring to numbers of providers and services; *accessibility*, referring to proximity of providers to health service users; *accommodation* refers to how easily clients can navigate and use the services being provided; *affordability* refers to the financial cost for using the services; and *acceptability*, which reflects the attitudes of the users of healthcare toward the providers, and vice versa (Ricketts & Goldsmith, 2005). As access to essential health services in many LMICs is inadequate (WHO & World bank, 2017) challenges on both supply and demand sides of the health care system have been investigated. These include insufficient resources, allocation problems and poor quality of services on the supply side and financial costs of seeking health services for low-income communities and local preferences based on culture, level of education and gender (O'Donnel, 2007). Maternal health services are among those whose absence in resource limited settings leads to poor health outcomes for both mothers and children such as raised infant mortality rates (IMR) and maternal mortality ratios (MMR). For example, while the global MMR in 2017 was estimated at 211 (UI 199 to 243) maternal deaths per 100 000 live births representing a

reduction of 38% from the figure in 2000 (WHO, 2019), 86% of those deaths were from SSA and SA, with SSA contributing over 60 % to this figure.

When access to maternal health services has been disturbed, as occurs when floods in rural areas of low- and middle-income countries destroy roads and other infrastructure, there is an increase in maternal mortality (Makanga, Schuurman, von Dadelszen, & Firoz, 2016). Barriers to accessing maternal health services have been discussed in the context of the "three phase delay" model where phase 1 delay refers to delays in making the decision to seek health care; phase 2 refers to the delay in arriving at a health facility once the decision had been made and phase 3 delays refer to delay in receiving adequate care once at the health facility (Thadeus & Maine, 1994). While the model alludes to factors beyond the health sector (phase 1) some authors have found limitations in the framework's utility as far as informing interventions to reduce maternal mortality by not adequately unravelling the different factors involved in delay (Sorensen, Nielsen, Rasch, & Elsass, 2011; Pacagnella, Cecatti, Osis, & Souza, 2012). Pacagnella and colleagues (2012) proposed adding the "near-miss" approach for monitoring maternal morbidity where analysis includes data from survivors of severe pregnancy complications to reveal contributing factors. This research therefore uses a systems approach to study those additional factors linked to the health system that influence decisions related to access and utilization of health services.

1.4 Effects of floods on health

Geographical access to health services is likely to be made worse by extreme weather events such as floods. Such extreme weather events are likely to increase with continuing changes in climate globally.

Climate change with consequent increases in occurrences of extreme weather events, is said to be the main environmental challenge in current times and flooding is among the most common of such events (Rossati, 2017; Patz, Frumkin, Holloway, Vimont& Haines, 2014). Regional differences based on vulnerability and capacity of nations to respond to the challenges arising from weather events such as flooding have been noted **(**Patz & Hatch, 2014; Patz et al, 2014; Nerlander, 2009).

Climate change implies that the process of global warming related to green house gas emissions has and will continue to affect weather patterns resulting in increases in extreme weather events including floods and flood type disasters in different parts of the world (Few & Matthies, 2013). The anticipation is that climate change will lead to intensification of the global water cycle which is the basic process resulting in floods (Few & Matthies, 2013). Mirza (2003) describes floods, droughts, cyclones, heat waves and storms as direct extreme weather events while disease outbreaks and epidemics, malnutrition and harvest failures as secondary events that could be climate driven.

The broader subject of climate change and how it impacts on human life has been widely researched in the literature. Much research has been conducted on the effects of climate change on health in high income countries particularly effects of rising temperatures. In addition, specific disease outcomes related to floods have been studied quite extensively. For example, Ahern and colleagues (2005) in their review of epidemiological evidence of the global health impacts of floods, focused their discussion on disease categories such as vector borne diseases, faecal-oral diseases, injuries and mental health giving some statistical associations between health outcomes (both morbidity and mortality) and flood events (Ahern, Kovats, Wilkinson, Few, & Matthies, 2005). Alderman and colleagues conducted a systematic review on floods and human health looking mainly at disease outcomes of different flood events. Their findings are similar to those of Ahern and colleagues for short term effects additionally include long term effects such as increase in non- communicable diseases in immediate post flood periods, an increase in post-traumatic stress disorder, and an indirect association with malnutrition following flood destruction of agricultural products (Alderman, Turner &Tong, 2012). Rataj and colleagues conducted a systematic review investigating the mental health disorders and injuries arising from extreme weather events in developing countries, finding only studies from South America and Asia (Rataj, Kunzweiler & Garthus-Niegel, 2016).

Floods have been demonstrated to negatively affect health outcomes by increasing incidences of conditions such as diarrheal diseases, injuries and mortality as well as destroying health infrastructure including health facilities which consequently reduces access

to health services (Alderman et al, 2012; Du, FitzGerald, Clark & Hou, 2010; Ahern et al, 2005). Systematic reviews by Ahern and colleagues (2005) as well as Alderman and colleagues (2012) found increased incidences of water borne diarrheal diseases in the immediate post flood periods particularly where access to clean water and proper sanitation facilities was lacking in many low- and middle-income countries. A more recent systematic review of the relationship between different climatic exposures and diarrheal diseases found that both drought and flooding were associated with an increased incidence of diarrhea although this study only included 3 articles on drought and diarrhea from a total of 141 articles on temperature, flooding, heavy rainfall, and drought (Levy, Woster, Goldstein & Carlton, 2016). One of the articles in this review on the association of drought specifically found no correlation between drought and diarrhoea in Africa including Zambia (Levy et al, 2016).

The finding of reduced access to health services during floods is documented by researchers in Mozambique and Namibia in southern Africa. Makanga and colleagues (2017) found seasonal variation in access to maternal care in Mozambique based on travel time. For all modes and combinations of transportation assessed, travel time to care was increased during periods of high precipitation and flooding (Makanga, Schuurman, Sacoor, Boene, Vilanculo, et al, 2017). In the Ohangwena region of Namibia, inaccessibility of HIV treatment services negatively affected the health and livelihoods of people living with HIV (Anthonj, Nkongolo, Schmitz, Hango, & Kistemann, 2015). Few other studies on effects of floods on health services delivery and specifically access to health services in Africa are documented in contrast to high income countries and in Asia where monsoon or tsunami-related events are common and where effects of floods have been extensively investigated. Studies in countries such as Zambia where seasonal flooding is experienced would be beneficial but are currently not well documented although there are reports of previous flood events disrupting maternal and HIV services particularly in rural areas (Schatz, 2008). One study by Moise, Kalipeni and Zulu (2011) analyzed geographical access to HIV sentinel sites and other health facilities. Using geographic information system (GIS) and demographic data they determined that most HIV sentinel clinics were inaccessible to many women (Moise,

Kalipeni and Zulu, 2011). No updated study on this was found. Parts of the country where flooding occurs demonstrate poor health indicators such as higher infant and maternal mortality rates as well as lower immunization coverage rates.

1.5 The Zambian context

Zambia is a landlocked, sub-Saharan country with a land area of 752, 612 square kilometers sharing boundaries with 8 other countries that a part of the Southern African Development Community (SADC) (CSO, MOH, ICF 2014). Falling between latitude 8 and 18 degrees south, and longitude 20 to 35 degrees east, the country has a tropical climate and vegetation with 3 main seasons: a cool dry winter (May- August), hot and dry season (September and October) and a warm wet season (November to April). The highest rainfall is experienced in the northern regions while the southern and eastern regions have the least rainfall measurements which sometimes lead to droughts (CSO, MOH, ICF 2014). The main sources of water are the four main rivers: Zambezi, Kafue, Luangwa and Luapula (CSO, MOH, ICF 2014).

Zambia is predominantly a rural country with ten provinces whose economy is driven by mining, agriculture, construction, transport, and communication (CSO, 2013). Having been historically dependant on the copper mining industry, the country's economy deteriorated in the mid-1970s following declining copper prices which led to increasing levels of poverty for many Zambians in spite of economic recovery measures implemented by successive government regimes (CSO, MOH, ICF 2014). The last living conditions monitoring survey undertaken by the government in 2015 estimated national poverty rates at 54% with a range of 20% in Lusaka province which is the most urban, and 82% in the Western province (CSO, 2016). The estimated population of the country in 2020 based on projections from the last census conducted in 2010 was 17.9 million and a life expectancy at birth of 55.3 years (CSO, 2013). The adult mortality rate in the country is estimated to be 5.11 per 1000 population and the maternal mortality ratio of 252 per 100,000 live births, with the leading causes of death reported in the country's National Health Strategic Plan for years 2017-2021 being malaria, acute respiratory infections, trauma, non-bloody diarrhoea, anaemia, non-infectious digestive conditions, hypertension, TB, cardiovascular conditions,

and severe malnutrition (CSO, MOH & ICF, 2019; MOH, 2017). Table 1 below compares Zambia's population, income level and few health indicators with that of her neighbours demonstrating a relatively favourable position.

Table 1:1 Zambia and neighbouring countries showing populations and some health indicators. (WHO, 2018)

COUNTRY	POPULATION (in 1000s)	INCOME LEVEL	NMR (per 1000)	U5MR (per 1000)	MMR (per 100,000 live births)
Zambia	16,717.3	Lower-MIC	21.4	64	224
Zimbabwe	15,966.8	LIC	23.5	70.7	443
Angola	25,831.0	Lower-MIC	48.7	156.9	447
Mozambique	28,751.4	LIC	27.1	78.5	489
Tanzania	55,155.5	LIC	18.8	48.7	398
DRC	79,722.6	LIC	30.1	98.3	693
Botswana	2,303.8	Upper-MIC	21.9	43.6	129
Malawi	17,749.8	LIC	21.8	64	634
Namibia	2,514.0	Upper-MIC	15.9	45.4	265

The report of the Zambia Demographic and Health Survey of 2018 also indicates that childhood malnutrition measured by stunting was 35% for children under 5 years of age nationally; national immunisation coverage is at 75 % but ranges between 74 and 77% in rural and urban provinces; maternal mortality rate (MMR) for Zambia continues to be high at 252 deaths per 100,000 live births (95% CI of 158 to 347) and the unmet need for family planning services was 20 % nationally and 21% for rural residences the highest reported province being western province at 27% (CSO, MOH & ICF, 2019). The national HIV prevalence is estimated at 13.3% but apparently 15.4% in Western Province, a figure that places it 3rd highest in the country after the two most urban provinces, Lusaka and Copperbelt (CSO, MOH & ICF, 2014). In addition, although 96% of pregnant women attend

ante-natal care services at least once during pregnancy, only 64% of deliveries are attended by skilled birth attendants, a factor that would contribute to peri-natal and maternal mortality rates (MOH, 2018). Related to these indicators are the unfavourable ratios of providers to population. In 2010, the physician and nurse per 1000 population ratio was far below the WHO recommendation of 2 medical doctors and 14 nurses per 1000 population (MOH, 2011). This is illustrated in Table 1:2 below which compares the situation in Zambia to that in neighbouring countries. The indicators noted illustrate the vulnerability of women and children in terms of accessing health services as they are often dependant on other members of the family and society for decision making and access to resources and services. While women have health care needs that are unique to them, they also bear the burden of care for other family members. Environmental factors such as flooding and changing weather patterns due to global climate change, contribute to limited geographical access to health services for communities in some parts of the country.

Table 1:2 Physician to population and nurse/midwives to population ratios 2007-2013 (WHO, 2016)

Country	Physician to population ratio (per 10,000 population)	Nurse & midwives to population (per 10,000 population)
Zambia	1.7	7.8
Zimbabwe	0.8	13.4
Namibia	3.7	27.8
Angola	1.7	16.6
Tanzania	0.3	4.4
Africa	2.7	12.4

1.6 Study setting

The research was conducted in four districts of the Western Province which lie in the flood plains of the Zambezi River (see Figure 1:2). The Zambezi River basin on the western part of the country divides the Western Province from north to south. The province has a population

of 902,074 which forms 7 % of the national population (Central Statistical Office, 2012) and the highest poverty level in the country at 82% while the national level is at 54% (CSO, 2016). The province experiences seasonal flooding during which affected communities must temporarily relocate to higher ground resulting in disruption of health care services for different communities for extended periods of time.

However, limited information is available on the effects of changing climate and extreme weather events and how these in turn have affected access to essential services particularly those that address the leading causes of morbidity, mortality and disability: HIV/AIDS, malaria, respiratory infections, diarrhoeal diseases, peri-natal conditions, adverse outcomes of childbirth and protein energy malnutrition (MOH, 2012).

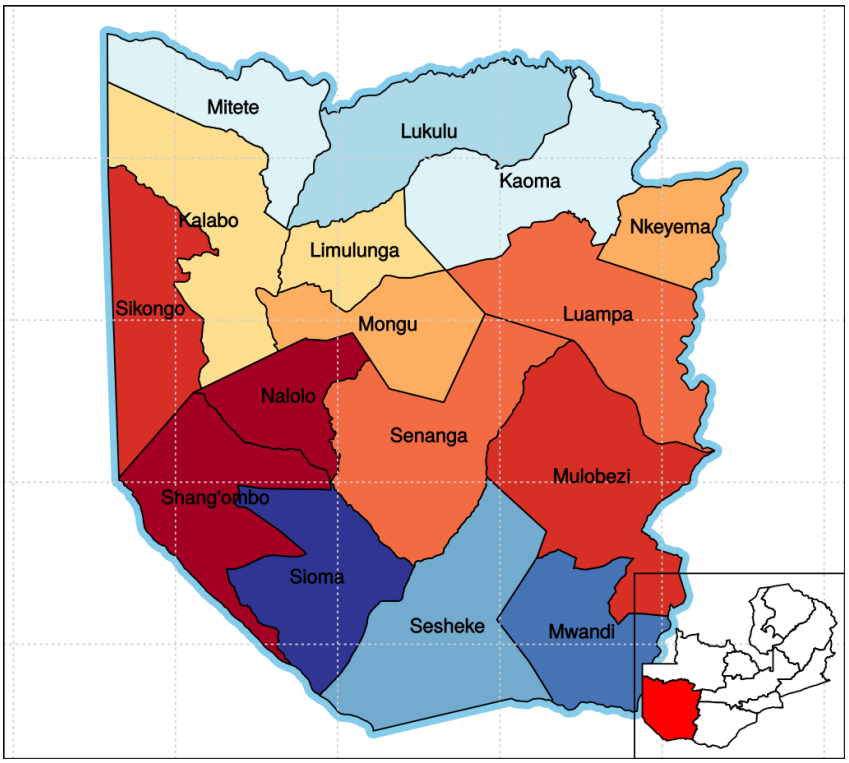

Figure 1:2 MAP OF WESTERN PROVINCE downloaded from https://simple.wikipedia.org/wiki/Western_Province,_Zambia

1.7 Rationale

Interventions known to be effective in reducing morbidity and mortality resulting from these

preventable conditions, as well as improving access to care, are being implemented in the country. However, evidence from studies in implementation of interventions and policies in some countries in Africa, indicates that when such interventions are imported without an understanding of the local context, they may not be as successful as intended. This may partly explain the seeming slow progress in improving health outcomes in the study area. In relation to implementation of nutrition interventions, Tumilowicz and colleagues (2015) argue that knowledge of social and cultural practices of communities targeted for specific programmes helps explain why some interventions succeed or fail by showing how these interventions are perceived and interpreted by local communities. Olivier de Sardan and colleagues (2017) in West Africa conducted studies on the implementation of standard interventions in maternal health such as the partogram, a simple tool developed to be used in resource limited conditions to monitor the progress of labour and make appropriate decisions for action to ensure better maternal outcomes. They found that for varied reasons including work overload, a poor writing culture among midwives and superior value ascribed to experience compared to the use of the form, health workers tended to fill out the partogram after the delivery of the infant has been concluded using some standard information as opposed to the recommendation of filling the partogram during the process of labour (De Sardan et al, 2017). The researchers contend that although the intervention was not working as intended by developers, as their findings revealed, it continues to be promoted as a monitoring tool and used as a legal document as well as an evaluation tool for staff performance (De Sardan et al, 2017).

This is where a systems approach offers a better perspective for investigating public health problems and developing interventions to solve those problems because it posits that the system under study is linked to other systems to making up a greater whole. A systems approach does this by analysing the interlinkages and feedback mechanisms between different system components in their context and anticipating what their response (s) to proposed change might be. This approach has, therefore, been proposed for understanding and solving complex public health problems and will be used to explore relationships that are relevant to public health, particularly access to essential health services (Peters, 2014).

This research was intended to explore the use of systems theory to inform the development or modification of interventions to mitigate the effects of flooding events on access and utilization of health care services for women and children.

STUDY PURPOSE

The purpose of this study was to explore application of systems thinking to mitigating the effects of flooding on access and utilization of health care services for women and children in selected districts of Western Province, Zambia.

The research question that directed the study was:

How can access and utilization of maternal and child health services in flood prone areas of Western Province be improved using systems thinking?

The specific subquestions were:

1. What are the effects of flooding on access and utilization of MCH services?
2. What are the perceptions and experiences of local communities in the flood plains about environmental change and the resulting health behaviours and outcomes?
3. How are local factors in the context of the flood plains influencing existing public health interventions for maternal health outcomes?

1.8 Thesis outline

The thesis is based on three manuscripts that are intended/ have been submitted for journal publications and framed by an introductory, methodology and concluding chapters. Chapter two discusses the theoretical and methodological considerations that guided the research. Chapter three to five are written as stand-alone manuscripts for publication and therefore have some overlapping features. For example, the data collection methods described across the three manuscripts are similar as this was undertaken during the same period. Similarly, some of the findings are overlapping in the different papers while the focus and context of the discussion is different for each paper. Chapter three answers the first research question and is titled: "**Effects of flooding on access to health services for women and children in the flood plains of western Zambia**". It captures the experiences and observations of key

informants representing different stakeholders in health service delivery and utilization in the study areas as well as local communities in the flood plains. It is intended to be submitted to the International Journal of Environmental Research and Public Health. Chapter four addresses the second research question and is titled: "**Perceptions of environmental change and associated health outcomes in the flood plains of western Zambia"** and is intended to be submitted to the Journal of Wellbeing, Space and Society. This paper discusses the perceptions of environmental change in the context of continuing climate change as expressed by local communities in the flood plains of the Zambezi River. It adds to the existing body of knowledge on the experiences of residents in areas deemed to be vulnerable in relation to climate change and highlights the importance of engaging local communities in the development of culturally sensitive environmental programmes addressing mitigation and adaptation to climate change. Chapter five is titled: "**Exploring the interaction of local contextual factors with health system interventions to influence outcomes for maternal health in the flood plains of Western Zambia"**. It is intended for submission to PLOS Global Public Health. Drawing on some of the findings in the preceding papers, this paper attempts to explore the links between the broad range of local factors that may have an influence on outcomes of public health interventions for maternal health, emphasizing the operation of inter-linked systems. In exploring interconnections and collaborations between different parts of the broader system, this paper attempts to answer questions three to five. Chapter six then gives a summary of key findings from the three manuscripts and discusses some of the implications of these findings as well as contribution of the research to literature.

Chapter 2 Methodology

2.1 Introduction

This thesis adopted a systems theoretical framework to guide the data collection and assist in interpretation of results. The aim of the research was to apply a systems thinking framework to the investigation of contextual factors influencing access to maternal and child health (MCH) services in Zambia's Western Province where there is increasing variability in seasonal flooding. In the study, I wanted to understand the perceptions and experiences of the residents in the study area concerning the research questions. I also wanted to relate those experiences to practical ways to possible solutions that could be developed with the involvement of concerned residents.

2.2 Rationale for theoretical framework

Most health or public health studies on the effects of flooding have taken the biomedical approach that looks at disease states resulting from flood events.[1] For example, Ahern and colleagues (2005) reported associations between flood events and categories of diseases such as vector borne diseases, feaco-oral diseases, injuries, and mental disorders. Other reviews have similarly reported effects of extreme weather events on health in relation to disease outcomes (Alderman, Turner &Tong, 2012; Du, FitzGerald, Clark & Hou, 2010; McCann, Moore & Walker, 2011). While this approach provides estimates of magnitude of disease outcomes, it neither provides insight into the experiences of affected residents nor does it elaborate on the contextual factors that maybe prevalent in different circumstances which may contribute to the measured disease outcomes. This question is fundamental to the current thesis.

[1] According to Wade and Halligan (2004) the biomedical model of illness among other things posits that all illness and all symptoms and signs arise from an underlying abnormality within the body (usually in the functioning or structure of specific organs), referred to as a disease and that health is the absence of disease (Wade & Halligan, 2004)

In this regard, I am drawing on a constructivist perspective for this research. This perspective holds that meaning of reality or experience is socially constructed by individuals and researchers holding this view seek to understand the different meanings provided by participants and focus on interactions and the specific contexts in which individuals live and work (Creswell, 2014). Kleinman (2010) refers to the relevance of social constructionism in global health arguing that local context influences the behaviour of its members leading to the elaboration and construction of different priority issues in different parts of the world. Bearing this in mind, I developed a framework that would allow me to explore such contextual elements that influence the health seeking behaviour of residents in the study area. The systems framework chosen for this research allowed me to conduct the study, guiding me in the choice of qualitative methods as well as the interpretation of results.

The systems theoretical framework has some similarity to one of the early models commonly used to study access to health care developed by Andersen and colleagues. The Andersen framework presents a core process that involves predisposing characteristics, enabling resources and need, leading to certain health behaviour and health outcomes that feed back into the core process as indicated in Figure 2:1 below (Aday & Andersen, 1974; Andersen, 1995). This type of feedback mechanism is one of the key elements of systems modeling.

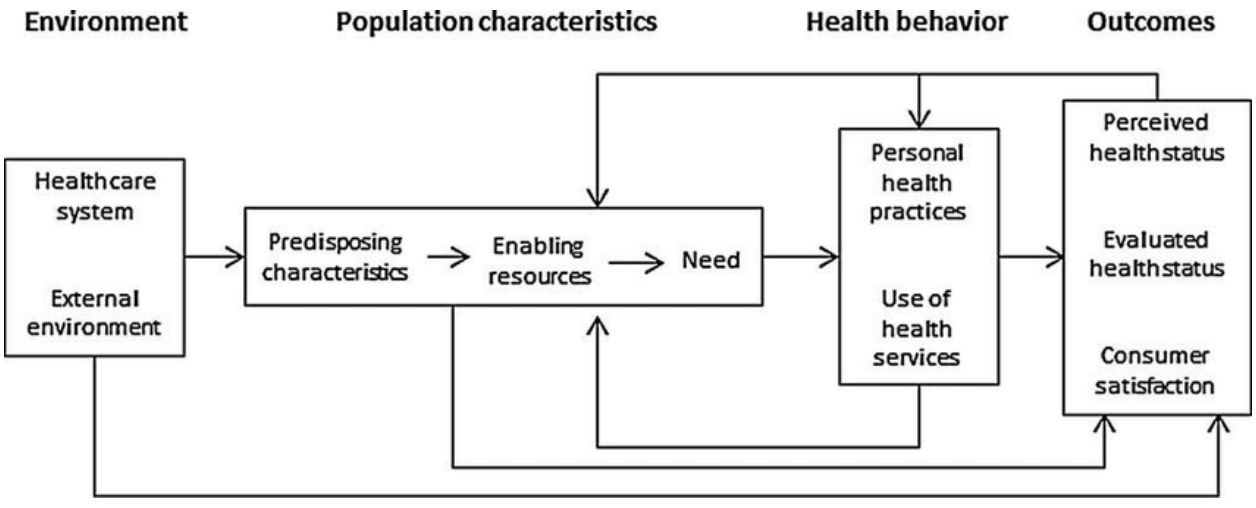

Figure 2:1 Andersen model of access. Source Andersen, 1995.

2.3 Methods

Systems approaches require a diversity of methods and tools to explore complex problems such as those commonly encountered in public health. Systems thinking facilitates having a holistic perspective on society and in this study, this helped me to look beyond the health system to understand how other factors in the external environment within which the health system operates interact to influence health behavior and outcomes in the study area. This also allowed me to account for multiple factors that influence access to care, including environmental factors. In this research, the systems thinking element that pays attention to managing systems knowledge motivated the inclusion of participants who have been working in the affected regions as well as traditional leaders based on the understanding that these groups were custodians of different knowledge sources that were relevant to the purpose of the study. The selection of participants from government sectors other than health and traditional leaders and the search for connections in their operations, additionally drew from the emphasis on trans-and multidisciplinary networks. The modelling element of systems thinking is applied in chapter five with the development of a causal loop diagram using findings from chapter three and four.

2.3.1 Research design

As the aim of this research was to explore and understand the multiple contextual elements interacting to influence access to health services in the study areas and especially to obtain the perceptions and experiences of residents living in the area. A qualitative research design was deemed the more appropriate approach for meeting this aim. Qualitative studies are useful to answer exploratory and explanatory research questions (Sheikh, Gilson, Agyepong, Hanson, Ssengooba et al, 2011; Giacomini, 2001) and well suited to study human interactions and their influence on behavior related to health interventions (Gilson, Hanson, Sheikh, Agyepong, Ssengooba & Bennett, 2011). The chosen design helped me achieve the aim of understanding the study subject from the perspective of residents in the flood plains, as well as study the experiences of study participants. Among the characteristics of qualitative research designs which made this design appropriate for my research is that the study took place in a natural setting, meaning interaction with study participants took place in

the setting where they live and experience the issues under investigation (Creswell, 2014). Qualitative studies also collect data through more than one method, usually a combination of interviews, observations, and documents, and focus on learning the meanings assigned to the subject under study by participants (Creswell, 2014). In this study I used face to face interviews and group interviews as the main sources of data along with some field observations and document reviews.

2.3.2 Study population and sampling

The study population included health managers from the provincial and district health offices, providers, and users of health services living in the four districts Mitete, Kalabo, Mongu and Nalolo. Other identified stakeholders included officers from other government departments such as Community Development and Social Services, Education and Transportation (under the local government) as well as nongovernmental organizations involved with health and community development in the selected districts.

The sample was purposively selected in consultation with the health system administrators (Provincial and District Health Officers). Purposeful sampling selects information-rich cases whose study will illuminate the questions under study, information-rich cases being those from which one can learn a great deal about issues of central importance to the research, thus the term purposeful sampling (Paton, 1990). Two sampling strategies were used for the different categories of participants.

1) *Homogenous group sampling* in which the participants are similar in their background and experience. Homogenous sample is usually chosen when the aim is to describe a particular group in depth (Patton 1990). The similarity of the participants selected for focus groups was in relation to their cultural background and limited health services available to them, as well as their experiences managing environmental and socio-economic challenges.

2) *Criterion sampling* was used for the selection of key informants. The main criteria were being employed in one of the government departments that were previously selected as relevant to the study questions or serving as a traditional local leader or working with a health-related NGO. The selected government departments were the Ministries of Health, Education, Local Government, and Community Development and Social Welfare.

Recruitment of participants was done after obtaining local ethics clearance from both the University of Waterloo and Zambia-based research ethics committees and relevant permissions from the Provincial and District Health Administration. Key informants were visited, given information and recruitment letters with specific appointments being made once they agreed to participate. Participants for focus group discussions were recruited with the help of health facility staff and the local leaders in the study area.

2.3.3 Data collection procedures

Qualitative interviews –the qualitative interview is a particular type of conversation that allows an interviewee to give an account of the issues that matter to them (Green & Thorogood, 2014). These interviews involve few open-ended questions intended to elicit views and opinions from the participants (Creswell, 2014). Semi-structured interviews are those in which the topic of discussion is set by the researcher and presented as guiding questions, but the responses of the interviewee are open to their content prioritization (Green & Thorogood, 2014). These interviews were considered the most suitable primary data collection tool to access knowledge from the key informants identified for this study as they enable flexible, in-depth exploration of the study topic. Most of the key informants were government employed individuals who had limited time available for interviews and included health managers and providers, non-health sector officers from the Ministries of Community Development and Social Welfare, Education, Local Government, non-governmental organizations & community leaders. Key informants in this study were identified and chosen because of their official position which was thought to make them an "expert source of information" concerning the research questions (Marshall, 1996). Key informant interviews were conducted in English and/or the local language (Lozi). Interviews were also conducted with community members who are health service users to capture perspectives that may be missing from the group interviews that were conducted. These were all conducted in Lozi.

Focus group discussions –the focus group discussion (FGD) is a qualitative method of collecting client perspectives in a social setting that allows participants to co-construct a

common view by sharing and contesting their knowledge and experiences (Lehoux, Poland & Daudelin, 2006). Four aspects of the social space provided by the focus group have been reported to influence the group interaction that "produces" the participants' perspectives. These are the associational context which describes the common elements among participants; the status context which describes participants relative social status; conversational context is that element of the conversational dynamics that will allow participants to contribute to or respond to contributions of others; and relational context which describes the prevailing level of mutual trust and understanding between focus group participants (Lehoux et al, 2006).

In this research, associational context related to the common use of the limited public health services available which was the main criteria for inclusion of participants. Meeting the ideal constitution of the focus groups in relation to social status was not easy. For example, all participants had to be above the age of eighteen (18). However, while the ideal would have been to have groups separated by gender, the availability of participants was limited during the data collection period because of the long distances of residents from their dwelling places to the chosen meeting place at the nearest health facility as well as prevailing flood conditions. This caused us to constitute a focus group as soon as we had enough participants willing to participate and had given consent. The resulting groups were therefore mixed in terms of gender, occupation, and social position but were conducted in two separate locations within each study district. To capture perceptions that were potentially hindered due to the mixed-gender nature of the focus groups, additional one on one interviews were held with health service users. The interaction of participants in focus groups is useful in highlighting new insights. In the current research, this interaction uncovered respondents' frustration concerning the lack of development they experienced in their communities. This frustration was revealed after there had been some discussion and interaction amongst participants, suggesting that it might not have been discussed or revealed without the group interaction.

FGDs were conducted in Lozi by trained research assistants who underwent a three-day training in interview techniques and focus group facilitation. Two research assistants

facilitated the focus group discussions which allowed one of them to lead the discussion while the other handled the recording and took notes. All the interviews were recorded after obtaining informed consent from all participants. Table 2:1 below gives details of study participants.

Observations – qualitative observation is when a researcher takes field notes on the behaviour and activities on individuals at the research site (Creswell, 2014) and may or may not participate in the activities. Health service provision activities at the research sites were observed as well as available infrastructure, and transportation modes needed to traverse distances from health service points.

Table 2: 1 List of study participants

	Description	Total number
KEY INFORMANTS	Health managers	2
	Health care workers	9
	Educators (Teachers)	4
	Community Development Officer	1
	Local Government Officers	3
	Non-governmental organization employees	2
	Traditional leaders	4
	Disaster Management & Mitigation unit	1
FOCUS GROUP AND HEALTH SERVICE USERS	Community members (women)	39
	Community members (men)	42
TOTAL		107

2.3.4 Data management and analysis

To enhance reliability, all interviews were recorded, transcribed and translated from Lozi to English. The translated Word documents were then imported into Nvivo 12 software which was used for organization and coding as part of the analytical process. Thematic analysis was used to analyse the data collected. As defined by Braun and Clarke (2006), thematic analysis

is a method for identifying, analysing and reporting patterns (themes) in data, can be used with a variety of theoretical frameworks and comprises six steps:-

1. familiarization with the data (including transcription and re-reading data)
2. generating initial codes (coding interesting features of the data)
3. searching for themes (collating codes into potential themes)
4. reviewing themes (checking if the themes work in relation to the codes and whole data set)
5. defining and naming themes (ongoing analysis to refine themes), and
6. producing the report (selecting extract examples and relating analysis back to research question and literature).

Coding of transcripts was undertaken both deductively (deriving codes from the interview guides) and inductively (deriving codes from the participants responses). Codes were collated into themes that were reviewed and reorganized into the final themes for reporting. Triangulation of data from the different sources (KII, FGDs, Field notes) was used to validate the data findings by cross referencing.

Triangulation refers to a process of verification that increases validity by using multiple viewpoints and methods with four main types of triangulation being described in social sciences research (Yeasmin & Rahman, 2012): **data triangulation** (use of a variety of data sources in the same study); **investigator triangulation** (use of more than one investigator, interviewer, observer, researcher or data analyst in a study); **theory triangulation** (use of multiple theories or hypotheses when examining a situation or phenomenon) and **methodological triangulation** (use of multiple methods to study a situation or phenomenon in order to decrease the deficiencies and biases that come from any single method).
In this study, a combination of data and methodological triangulation was used. During data collection, multiple methods were used to collect data and then during the analysis, the data from the different sources (key informants, community members, field notes, census reports) were analyzed and compared to confirm findings or otherwise. Triangulation serves the purpose of confirming findings through the convergence of different perspectives and

methods, thus increasing validity.

Additional measures undertaken to enhance the validity in this research were providing as detailed descriptions as possible of the study setting, reflecting on my own biases as a researcher based on my background as well as having other researchers review my research and ask questions about the study referred to as peer debriefing (Creswell, 2014). My reflection and positionality are presented below (see section 2:5 below).

2.3.5 Field research

Field visits for this research were conducted over three separate periods. My first visit was in December 2017 when I stayed in the provincial capital of Western Province, Mongu, for a week. This was an introductory visit to meet with the main local partners who would facilitate most of the research activities. These are the health administrators working at the provincial office of the Ministry of Health in Mongu.

The second visit was in June and July 2019 during which visits to the study sites were conducted in order to initiate contact with relevant stakeholders and observe some of the study sites. During this second visit, informal conversations and meetings were conducted with the local gatekeepers, health care administrators at provincial and district level to introduce the research topic and some of the questions I wanted to investigate. I visited seven district health offices in the province to find out what their experiences were in relation to the effects of flooding on the execution of their service provision activities. I was able to travel around in the districts and observe some of the health service activities being conducted in a number of these rural districts such as antenatal clinics and under-five children's clinics as well as observe some of the distances that health care users must travel, most often by walking, to access services. The information obtained during this visit helped me consolidate my research proposal by helping me select the districts that would help me answer the research questions best, i.e., based on how much flooding was experienced and other factors such as the distribution of available health facilities. From this visit, I identified stakeholders who would be rich sources of the information I would need to answer my research questions both from within the health sector and other government departments that, in line with the systems framework guiding the study, seemed linked to health service operations and

outcomes in some way. I was also able to review and refine my data collection tools like the interview guides. This visit gave me an opportunity to experience a little of the transportation challenges that exist in the rural province where this research was conducted as I used the available public transport to move between districts and within the district. Limited public transportation in the form of buses and small vehicles are available for inter-district travel. Within the district, the availability of transport reduces further, and I had to walk from one place to another when visiting different government offices to meet with different stakeholders. As the study findings confirm, walking is the primary mode of travel for residents seeking health care services.

The third visit was conducted over 2 months from December 2020 to early February 2021. This visit had been delayed due to the COVID 19 pandemic that had caused a global shut down that severely affected research work with human subjects beginning in March 2020. The first part of the visit in Zambia was spent sorting out the ethical and administrative approvals that were required before any formal data collection could be undertaken. Once local ethics clearance was obtained, I teamed up with colleagues from the local University of Barotseland in Mongu who are established researchers and lecturers to conduct a three-day training of research assistants (RAs) who facilitated data collection in the four study districts under our supervision. This training was necessary to facilitate data collection in all the study districts in the limited amount of time that was remaining for this phase of the field research. The RAs were undergraduate students in public health at the University of Barotseland who were conversant in the local language, Lozi. The use of local RAs served as one mitigation strategy against the limitation of time available for the research and development of rapport with study participants, since the RAs were also residents who understood the local culture and lifestyle. We then proceeded to conduct the interviews and focus group discussions during February 2021

2.4 Ethical considerations

Ethics approval for the study was obtained from the Office of Research Ethics at University of

Waterloo (ORE#42070) as well as The *Eres Converge* Research Ethics Board in Lusaka, Zambia (Approval number: 2020-Nov-006).

Informed consent: All interviews were preceded by obtaining informed consent from all the participants. Key informants were given the information sheets to read and the consent form to sign prior to the interview. Written consent by signing on a consent form after understanding the information provided and being given an opportunity to clarify any points was obtained. For the FGDs, the information was read to all participants and their consent was obtained prior to the start of the group discussion either by signing the consent form or verbal consent by asking them the consent questions after the information was given and clarified. Their names were then written at the end of the form when they gave their consent. This included consent to audio recording of the interviews and use of anonymous quotations for report writing. Participants were informed of their right to withdraw consent at any time during and after the study period, until results are submitted for publication.

Risks and harms: During the interactions with participants necessary for data collection, there was no exposure to any risks or harms greater than they would experience in their everyday life. However, to anticipatively handle the potential of short term psychological or emotional harm in the recollection of negative experiences or distress due to discussing this topic, participants were informed that they could choose not to answer any question and that they were free to withdraw from the study at any point. Provision was made for participants needing support to speak to trained counselors who are available at the health centre with whom prior referral arrangements had been made.

Transport refunds: Travel expenses were refunded to all participants at the time of the interviews amounting to ZMW 50.00.

Privacy and confidentiality: Participant identities will be kept confidential. No names will be used in any reports resulting from the study. Consent was obtained from participants to use anonymous quotations in written reports. All data collected including the audio recordings will be retained for a minimum of seven years after which it will be destroyed. During this time, it will be stored in a locked cabinet accessible only by myself and my supervisor.

Benefits of the study: Participants were informed that there was no direct benefit from

participating in the study. However, as results from the study are shared with policy makers and program designers to inform their planning processes, it is hoped that the results of this study would contribute to improvements in program design and implementation and ultimately improve access to health care for all community members.

2.5 Positionality

Being a female medical practitioner in Zambia, I have had an interest in child and maternal health issues for a long time. As a medical student I conducted a project on the effects of Sickle Cell Disease on growth and development of children during which I became aware of the continuing need for medical attention that children with the condition required. Some of the children who were being followed up in the specialist children's clinic at the teaching hospital used to travel from rural areas and would spend a lot of money on such hospital trips. This made me question why these services were not available in the areas they were traveling from. In later years, I investigated the management of severe malnutrition in two hospitals in Namibia where I worked at the time. I realized that sometimes the medical outcomes represented by sick children had a lot to do with the environment they were living in including the resources available to their families and the level of education of the mothers. My experience of working with sick children as a medical practitioner in Zambia and Namibia contributed to my interest in the health of the women who are the primary care givers for children and whole families, women who often sacrifice their own health for the sake of their families.

For several years in my medical career, I worked as a clinical care officer in a non-governmental organization (NGO) which partnered with the Ministry of Health in Zambia in the care and treatment of individuals with HIV/AIDS in the northwestern province of the country. As I was involved in supportive supervision and technical support for health care workers in the province, I became aware of remote areas across the Zambezi River that were inaccessible to health care providers during periods of flooding. While efforts were made by providers to proactively provide medication for patients on ART, quality of care for clients was compromised as follow up of clients was irregular and supply of drugs wasn't always

assured. From that experience, I became interested in investigating the experiences of clients living in areas similarly affected by flooding

Having a clinical background as a practitioner, I have largely been exposed to quantitative research methods as employed in most epidemiological studies. Although I was aware of qualitative research, my appreciation of its contribution to understanding why some public health challenges persist increased when I began my doctoral study program at the University of Waterloo. At the beginning of my program, I took courses in qualitative research methods that broadened my understanding and allowed me to see that this might add much value to answering questions such as the ones guiding this research and allow the voices of residents in rural areas to be heard around issues that concern them.

My identity as a Zambian researcher, gave me acceptance and ease in conducting interviews with key informants who were willing to share their experiences with me. For some focus group participants, on the other hand, although I was Zambian, my identity as a university student from a Canadian university made me distinctly an outsider and was considered as one of the many researchers who are just looking for information and not really concerned about them. This influenced how some respondents gave their responses sometimes with reluctance and complaints. Working with local research assistants who knew the local culture and concerns of residents, was helpful to overcome this apprehension as well as the understanding that the study findings would be communicated to relevant authorities and program developers.

Chapter 3 The effects of flooding on access to health services for women and children

3.1 Introduction

Inadequate access to health care is one of the prevailing challenges of health systems in many low- and middle-income countries and especially among rural populations in Sub-Saharan Africa (SSA) and South-East Asia (SEA) being among the regions most affected (World Health Organization, WHO, & World bank, 2017), resulting in poor health outcomes such as high infant and maternal mortality rates. Access to health services is an important intermediate outcome of health system performance as it directly affects how well any system will achieve the main outcome goals of improving health status, responding appropriately to people's needs and financial protection (WHO, 2007). Among the multiple factors that influence access to health services are environmental conditions.

Ongoing climate change is the main environmental challenge in current times and is resulting in increasing occurrences of extreme weather events such as flooding (Rossati, 2017; Patz, Frumkin, Holloway, Vimont & Haines, 2014). Flooding refers to any excessive accumulation of water on land that is normally dry and may occur because of increased precipitation either directly from increased rainfall which the land surface cannot absorb quickly enough or indirectly from the overflow of river contents onto the riverbanks and beyond (Whitfield, 2012). The Intergovernmental Panel on Climate Change (IPPC) reports that ongoing climate related extreme weather events such as droughts, floods, cyclones, and wildfires result in disruptions of food production and water supply, destruction of human settlements as well as negative outcomes for health and wellbeing (Pachauri, Allen, Barros, Broome, Cramer et al., 2014). The impacts of these extreme events reveal significant vulnerability of some human and ecological systems (Pachauri et al, 2014). Vulnerability of nations and the capacity to respond to the challenges arising from such weather events varies across economic regions **(**Patz & Hatch, 2014; Patz et al, 2014; Nerlander, 2009).

Floods are among the most common extreme weather events globally and their effects on health are well studied (Patz & Hatch, 2014). Floods have been shown to negatively affect

health outcomes by increasing incidences of conditions such as diarrheal diseases, injuries and mortality as well as destroying health infrastructure which in turn reduces access to health services (Alderman, Turner &Tong, 2012; Du, FitzGerald, Clark & Hou, 2010). In addition, flooding can reduce access to health facilities by blocking access routes and affecting locally available forms of transport. A systematic review by Alderman and colleagues (2012) found increased incidences of water borne diarrheal diseases in the immediate post-flood periods, particularly where access to clean water and proper sanitation facilities was lacking in many low and middle-income countries. A more recent systematic review of the relationship between different climatic exposures and diarrheal diseases found that both drought and flooding were associated with an increased incidence of diarrhea although this review included only 3 articles on drought and diarrhea from a total of 141 studies that in addition to drought, examined temperature, flooding, and heavy rainfall (Levy, Woster, Goldstein & Carlton, 2016). In one study, drought led to diarrhea by restricting water sources, while a second study suggested livestock stress during drought led to water sources that were previously limited to humans being shared with animals and spreading pathogens that affected humans when heavy rainfall followed the drought period (Levy et al, 2016). The third study in their review found no association between drought and diarrhea in Africa (Levy et al, 2016).

Reduced access to health services during floods was documented by researchers in Mozambique and Namibia in southern Africa. Makanga and colleagues (2017) found seasonal variation in access to maternal care in Mozambique based on travel time. For all modes and combinations of transportation assessed, travel time to care was increased during periods of high precipitation and flooding (Makanga, Schuurman, Sacoor, Boene, Vilanculo, et al, 2017). In the Ohangwena region of Namibia, inaccessibility of HIV treatment services resulting from flood induced infrastructural damage negatively affected the health and livelihoods of people living with HIV (Anthonj, Nkongolo, Schmitz, Hango, & Kistemann, 2015). Few other studies on effects of floods on health services delivery and specifically access to health services in Africa are documented in contrast to high income countries and

Asia where monsoon or tsunami-related events are common and where effects of floods have been extensively investigated.

Studies of the effects of floods in countries such as Zambia where seasonal flooding is experienced are limited although there are reports of previous flood events disrupting maternal and HIV services particularly in rural areas (Schatz, 2008). One study by Moise and colleagues (2011) analyzed geographical access to HIV sentinel sites and other health facilities. Using geographic information system (GIS) and demographic data they determined that most HIV sentinel clinics were inaccessible to many women (Moise, Kalipeni & Zulu, 2011). However, this study did not address the effects of seasonally variable flooding on access to those health facilities. Health indicators in parts of the country where flooding occurs reveal higher infant and maternal mortality rates as well as lower immunization coverage rates. Limited information is available on the effects of changing climate and extreme weather events and how these in turn have affected access to essential services particularly those that address the leading causes of morbidity, mortality and disability: HIV/AIDS, malaria, respiratory infections, diarrhoeal diseases, peri-natal conditions, adverse outcomes of childbirth and protein energy malnutrition (MOH, 2012). The current study is intended in part to address the existing gap in knowledge of the effects of floods on access to health services in Zambia.

3.2 The Zambian context

Zambia is a landlocked, sub-Saharan country with a land area of 752, 612 square kilometers sharing boundaries with 8 other countries (that together form the Southern African Development Community, SADC) (Central Statistical Office, CSO, Ministry of health, MOH & ICF, 2014). The country has a tropical climate and vegetation with 3 main seasons cool dry winter (May- August), hot and dry season (September and October) and a warm wet season from November to April. The main sources of water are the four main rivers: Zambezi, Kafue, Luangwa and Luapula.

The infant mortality rate (IMR)in Zambia was 42 per 1000 live births in 2018 and under -5 mortality rate was 61 per 1000 live births (CSO, MOH & ICF, 2019). The Zambia

Demographic and Health Survey of 2018 (ZDHS) also indicates that childhood stunting was 35% for children under 5 years of age nationally; national immunization coverage was 75 % but ranged between 74% and 77% in rural and urban provinces; maternal mortality rate (MMR) for Zambia continues to be high at 252 deaths per 100,000 live births and the unmet need for family planning services was 20 % nationally and 21% for rural residences, with the highest reported province being Western Province at 27% (CSO, MOH & ICF, 2019). The national HIV prevalence is estimated at 13.3% but is 15.4% in Western Province, a figure that places it 3rd highest in the country after the two most urban provinces, Lusaka and Copperbelt (CSO, MOH & ICF, 2014). In addition, although 96% of pregnant women attend ante-natal care services at least once during pregnancy, only 64% of deliveries are attended by skilled birth attendants, a factor that would contribute to peri-natal and maternal mortality rates (MOH, 2018). Related to these indicators are the unfavourable ratios of providers to population. In 2010, the physician and nurse per 1000 population ratio was far below the WHO recommendation of 2 medical doctors and 14 nurses per 1000 population (MOH, 2011). These indicators are an illustration of the vulnerability of women and children in terms of accessing health services as they are often dependant on other members of the family and society for decision making and access to resources. While women have health care needs that are unique to them, they also bear the burden of care for other family members. Environmental factors such as flooding and changing weather patterns due to global climate change, contribute to limited geographical access to health services for communities in some parts of the country.

Studies of access to care and the effects of flooding in the Zambian context are limited. The aim of this study was to explore the effects of flooding on access to maternal and child health (MCH) services in Western Province where there is increasing variability in seasonal floods, with a view to identifying and improving mitigation strategies.

3.3 Methods

3.3.1 Study design

This qualitative study was conducted as one component of a broader study applying systems thinking to the investigation of factors affecting access to maternal and child health services in the Western Province of Zambia.

3.3.2 Study setting

The Zambezi River basin on the western part of the country divides the Western Province from north to south. In the last census (2010), the province was reported to have a population of 902,074 which forms 7 % of the national population and the highest poverty level in the country at 82% while the national level was at 54% (CSO, 2012, 2016). Many parts of the province experience seasonal flooding during which affected communities must temporarily relocate to higher ground resulting in disruption of health care services for different communities for extended periods of time

Four districts in the Western Province in Zambia (out of 16) were included in the study and they were selected because of their proximity to the Zambezi River floodplain (the Barotse floodplains). These are Mongu, Kalabo, Mitete and Nalolo districts and are seen in the map of Western Province below (see Figure 3:1 below). The health service delivery system in Zambia is organized such that health services by skilled health care workers are offered in ascending order at a health post, health center, level 1, 2 and 3 hospitals. Availability of expertise and resources increase in the same order.

3.3.3 Recruitment procedures

Recruitment of participants was initiated after obtaining ethics clearance from the University of Waterloo, and from ERES Converge, a local REB located in Lusaka. Relevant permissions were also obtained from the provincial and district health administration. Key informants were visited, given information and recruitment letters with specific appointments being made once they agreed to participate. Participants for focus group discussions were recruited with the help of health facility staff and the local leaders in the study area.

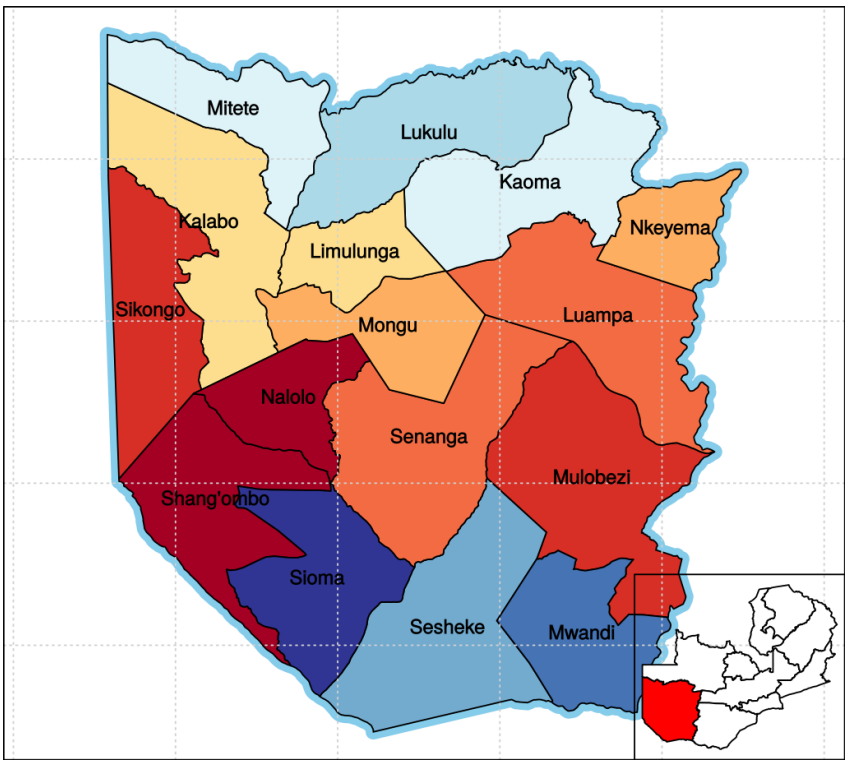

Figure 3:1 MAP OF WESTERN PROVINCE downloaded from https://simple.wikipedia.org/wiki/Western_Province,_Zambia

Key informants included Ministry of Health employed health providers and administrators from the four districts including one maternal and child health (MCH) coordinator from each district and one MCH coordinator from the provincial office; Ministry of Education employees from the four districts; Ministry of Local Government employed officers, Ministry of Community Development and Social Welfare employees and traditional leaders from the four districts. A total of 26 key informants participated in the study.

Participants in focus group discussions were both men and women above 18 years of age living in the study sites and accessing health services in the area. These included farmers, teachers, local businessmen/traders and "ordinary citizens". In each district, 2 mixed focus group discussions were conducted which included a total of 61 participants from the four districts.

In addition, individual interviews were conducted with 5 health service users in each district yielding a total of 20 participants.

3.3.4 Data collection

Key informant interviews were conducted in English and/or the local language (Lozi) while focus group discussions were conducted entirely in Lozi by trained research assistants. The research assistants completed a three-day training in interview techniques and focus group facilitation prior to data collection. All interviews were conducted in person using interview guides and the average duration of the interviews was 30 minutes. Two research assistants facilitated the focus group discussions, which allowed one of them to lead the discussion while the other handled the recording and took notes. Informed consent was obtained prior to all data collection activities.

3.3.5 Data analysis

Interview recordings were transcribed and translated from Lozi to English. The translated word documents were then imported into Nvivo 12 software for coding. Coding of transcripts was undertaken both deductively (deriving codes from the interview guides) and inductively (deriving codes from the participants responses). Codes were collated into themes that were reviewed and reorganized into the final themes for reporting. Triangulation of the findings was obtained by comparing and cross referencing the different data sources (KII, FGDs, field notes).

3.4 Results

3.4.1 Characteristics of participants

A total of 8 focus group discussions (FGDs) were conducted, two from each district, and 26 key informant interviews (KII) were completed. Participants in focus groups were both male and female adults (aged 18years and above) who use the public health services available in the districts while key informants included government officials from both ministry of health

and other government departments and officers from health-related non-governmental organizations operating in the study areas as well as community leaders.

Table 3:1 Characteristics of respondents

	MALE	FEMALE	TOTAL
Key Informants	16	10	26
Focus group participants	30	31	61
Total	46	41	87

Table 3:2 Health facility types in the district and number of skilled health care workers at health centres in the 4 study districts (source: Health Plan WPHO, 2020).

Facility	Kalabo	Mongu	Nalolo	Mitete
Level 2 hospital	0	1	0	0
Level 1 hospital	2 (1 gov't hospital and 1 NGO-run facility)	1	0	0
Rural Health centre	10	13	6	3
Urban health centre	2	7	3	0
Health post	16	13	9	6
Total number of facilities	30	35	18	9

Of the 4 study districts, Mitete is furthest from the provincial capital, Mongu, has no hydro-electricity supply, has the lowest number of facilities and therefore represents the longest distances that have to be covered by people seeking health services. Road development is

poor in most of the province due to sandy soils and seasonal flooding of the Barotse floodplain, resulting in compromised health service delivery.

Table 3:3 Summary themes describing the effects of flooding on health care access.

THEME	DESCRIPTION	EXAMPLE CODES	EXAMPLE DATA
1. Health service delivery system	This theme includes coded data describing how the health system itself is affected by floods ie facilities, programs	Program disruption Nonfunctional facilities Distances to facilities Referral problems Migration	"Okay when there are floods [umh] that means the facilities… some of the facilities they are affected and they will be cut off from… they will be hard to reach, that is making the services provided [uhm] to that place very difficult, okay, they are not easily accessible. So even transporting the patient from those areas which are cut off is not easy for health care providers including the districts." (Mongu)
2. Transportation	This theme includes coded data describing the effects of floods on both modes of transportation and routes to access and deliver services	Transportation modes Routes of access Challenges of transportation	"And you can't use any other means of transport if not a boat. Unfortunately, there are some places you can't use even a boat because the floods they are separated by highlands, so you

			can't use a boat in that case." (Mitete)
3. Economic effects	This includes coded data describing the effects of floods on the livelihoods of communities and resulting economic consequences	Changing rain patterns Crop destruction Food security Access to other services	"You know, floods come with a lot of effects. I don't know if you are also looking at the angle of the economic part of it. Because you find that when people relocate, when floods come, they destroy crops. Then you find that chances that there will be hunger in that year are very high". (Nalolo)
4. Water & sanitation	This includes coded data describing the effects on drinking water supplies and sanitation facilities in affected communities	Contamination of drinking water Lacking sanitation facilities Flooding of latrines	"During flooding we have a challenge in terms of pit latrines…….The pit latrines were all submerged in water …….we are in trouble because even our water wells where we fetch water from, you will find that they are near pit latrines and as a result when its flooded our water is contaminated". (Mongu)

3.4.2 These themes are described more fully below:

1) **Effects on the Health system**

The health service delivery system in Zambia is organized such that health services by skilled health care workers are offered in ascending order at a health post, health center, level 1, 2 and 3 hospitals. Availability of expertise and resources increase in the same order (see Table 3:4). Health posts are typically staffed by a nurse, a community health assistant, and supervise community health workers. Posts may also be staffed by an environmental health worker and a midwife, though this varies from post to post. Health centres are staffed by a clinical officer, nurse, midwife, environmental health worker, and a community health assistant. Posts and centres usually have at least one in-patient and maternity delivery bed, though this varies, and provide basic primary health care. Most can provide basic emergency obstetric care. The district (level 1 hospitals) accepts referrals for more complex or emergency care, including surgery, trauma care, and higher-level comprehensive emergency obstetric care, including C-sections. Level 2 and three hospitals are tertiary care facilities; Western Province has one level 2 hospital in the capital of Mongu (See Table 3:4).

TABLE 3:4 Services available at health facilities (Sources: National Health Strategic Plan, NHSP 2017-2021 & National Community Health Strategy, NCHS 2019-2021)

Facility type	Staffing	Services offered
Health post	Nurse, Community Health Assistant, Community health workers (community-based).	Basic services -diagnosis and treatment of malaria, pneumonia and diarrheal diseases Health promotion and preventive services in the basic health care package. This includes community interventions and immunisations.

Health centre	Clinical officer Nurse Midwife Environmental officers	This includes all the services offered by the health posts. The Rural health centre may receive referral from health posts. Health promotion and disease prevention, limited curative and in-patient services, maternal, newborn and child health services, communicable and non-communicable diseases, environmental, water and sanitation; school health and nutrition & epidemic preparedness programs.
Level 1 Hospital	Doctors Clinical officers Nurses Midwives	Found at district level; support referrals from health centres. Curative-medical, obstetric, surgical, diagnostic & preventive services.
Level 2 Hospital	Consultants & specialists Doctors Clinical officers Nurses Midwives	Found at the Provincial level; support referrals from level 1 hospitals. Internal medicine, surgical, obstetric and gynaecology, paediatric, dental care, psychiatry and intensive care. Training functions
Level 3 Specialized Hospital	Specialists Doctors Nurses	Peadiatric hospitals, cancer hospitals and Psychiatry hospitals

Flooding results in the disruption of service delivery in the study populations by increasing the difficulty of clients meeting their health care providers. Health service users have to find longer routes to avoid the flooded paths and health care workers seeking to follow up clients in the communities also face travel challenges. Outreach and follow up programs are compromised as only water transport is possible in some areas. Some facilities are inaccessible even by water transport such as boats because of the uneven nature of the flooded areas and the presence of tall grass in some places. Since client attendance is reduced during such periods, health indicators such as immunization coverage and antenatal clinic attendance are reported to deteriorate.

> ***"During flooding even for our members of staff to go into outreaches it's really a challenge. Even our coverage goes down during floods, from January to April. Our child health coverage is down as well as for pregnant women. It's difficult for them to come and access the services."*** KII, Nalolo.

As part of their adaptation to floods, some communities migrate to higher land, which may also involve moving away from available services. The numbers of clients attending services are further reduced. The supply of essential drugs and materials required for the functioning of facilities is hindered and the referral system is significantly challenged as there are places where referral patients have to be transported first by non-motorized transport means (canoe and/or oxcart) to a point where they can be met by an ambulance. This ambulance in these cases may require driving for up to four hours before they get to the meeting point. This situation is complicated by the prevailing condition in many remote parts of the country where communication by mobile networks is limited.

> **"*It becomes a bit difficult because the roads are not passable for some health facilities when it's flooded. Sometimes vehicles can't reach they have to meet them somehow. They have to come by ox-cart to some place, then there is a delay for them to get to the health services.*"** KII, Mongu.
>
> "***So, when there is a complication, they have first of all to look for network to communicate to the district that there is a complication. The district has to organize***

fuel, look for the people to go and evacuate that woman. Some of the facilities, like I said are about 200kms away. So you need about 4hours one way and think of the woman who is calling in sometimes in cases of pph (post-partum haemorrhage), so 4 hrs going someone tries there and she fails, then another 4 hrs coming back so it becomes difficult. Sometimes we have even lost women on the way." KII, Mongu.

While health service users expressed challenges accessing care, these were not expressed as an effect of floods but rather as general on-going challenges that are made worse by flooding such as few health care workers and shortage of drugs at the health facilities as well as few available health facilities that are located far from their villages. Distances to the existing health facilities are increased during floods as alternative routes have to be used. For example:

"We have the problem with the distance to the health centre, it's about 6hrs walking to reach the health centre. The problem we have is the health centre. The clinic is very far from our village such that come night or daytime, we can't rush the patient to the health centre due to the distance and the floods. What we see is that drugs are very far away from us, and we have plenty of water.". FGD participant, Mitete.

Health service delivery is also disrupted by floods when they cause damage to the health facilities making them non-functional. This was reported in Nalolo, Mongu and Mitete districts by health service administrators

"We also have for example, one of the facilities in Nalolo district, this facility was submerged in water. So, it was closed for some time during the floods. It was closed for some time meaning now the mothers who needed those services, they had to go to other facilities which were very far from where they were staying and making it difficult even someone to walk, even to start antenatal services." KII, Mongu.

2) **Effects on transportation**

Roads are fundamental to the development of any society. They allow movement from one place to another, allowing for the faster and more efficient transfer of goods and services.

Social and economic development is therefore dependent on the availability of proper road infrastructure and networks. The absence of these in the study districts results in the limited availability of some essential services, including health services, as well as opportunities for socio-economic growth and progress.

The **national transport policy (NTP)** also acknowledges the lack of transportation options that faces residents in rural areas and particularly those who rely on water transportation indicating that:

> ***"Approved public transport operations in rural areas are almost non-existent. For transit, people largely depend on trucks, pick ups and at times non-motorized transport like oxcarts and bicycles. Currently, road infrastructure provides little or no facilities for non-motorized road users. This increases the risk of fatalities in the event of a road traffic crash and inhibits growth."*** NTP page 3.

While the stated vision of the national transport sector is "to have an efficient and integrated transport system in Zambia by 2028" and its rationale includes ensuring optimal development of infrastructure for non-motorized public urban and rural transportation (NTP page 14), the policy acknowledges that inland waterway transport infrastructure is poorly developed, lacking significant investment that has resulted in unsatisfactory service provision. The policy also notes that despite this, there are parts of the country where this is the only mode of transportation. This seems to be the case in some of the study areas included.

For most residents in the study areas, the usual mode of transportation in the dry season is walking. Other modes of transportation used by residents are bicycles and oxcarts. During rainy seasons when the river and the plains flood, movement of individuals is restricted as they can no longer use their normal footpaths. Alternate routes which make the distance to be travelled longer are sometimes available, but the longer distance is a deterrent to movement of individuals unless it is absolutely essential that they do so. This is the case with health seeking behavior as well across all the study districts. Flooding therefore poses a significant challenge to clients seeking health care at the limited number of facilities available in their districts.

"We have the problem during the floods seasons, we use canoes to go to the health facilities, as a result many are ill at home and they stay without visiting the health facilities , more especially pregnant women , on the way the mother may give birth and at times in the canoe if there is no one to help them as a result the mother together with the baby may have serious problems". FGD participant, Mitete.

During flood seasons the mode of transportation that is preferable is water transportation such as boats which are not affordable for most villagers who are small scale farmers and whose livelihoods are most affected by extreme weather events. A few residents in the study areas reportedly own a canoe that they can use during flood seasons, and this is sometimes available to other community members as a private means of transportation with fees attached. Extra financial resources are therefore needed during flood seasons to secure a canoe and/or the paddlers for transportation. This is used when clients need health services and especially pregnant women being transported to health facilities for delivery. Some communities live across major river channels and are constantly faced with a water barrier that requires crossing with a canoe or boat. Respondents from Kalabo and Mitete districts expressed this situation more than other districts, regardless of whether it was flood season or not.

"Let me say that last year up-date the main challenge is transport like now its flooded, we don't have canoes to use when crossing the river. Yes, it's the same even when it's not flooded, that's the main challenge of crossing to the other side. We don't have canoes." FGD participant, Kalabo.

"During floods and drought seasons we don't have transport and we have a lot of children suffering from different diseases because just to go to the health centre we need to cross the river and women give birth on the way." FGD participant, Mitete.

In some of the districts, particularly Mitete which is the most remote of the study districts, flooding so disrupts transportation that multiple modes of transportation maybe required for individuals seeking health services. The terrain of the plain covered by flood

waters in some places is uneven due to presence of tall grass and mounded islands making it impossible to use boats. In such cases, clients may walk some of the distance or be transported by oxcart to a road where an ambulance can safely drive. This is sometimes the case for maternity cases that have to be transported to a higher referral centre where they can access specialized skills such as operative deliveries by trained health care providers. One participant from Mitete expressed it in the following way:

> "***We book an oxcart to take the patient to the health centre during the dry season sometimes we ride bicycles ahead of the oxen to inform the in-charge at the clinic about the development, then the in charge gets a motor bike rushes to meet the patient on the oxcart."*** FGD participant, Mitete.

The transportation challenges in the communities are also related to the use of canoes. Participants reported risks associated with water travel such as drowning especially when there are strong winds, attacks by animals such as crocodiles and hippos that are brought closer to human dwellings by the flood waters covering maize fields. Safety and security concerns were raised by participants regarding night travel. Additionally, it was reported that there were usually multiple demands for the use of the few available canoes in the communities. For example, a family with a canoe may use it for business such as fishing and taking school children to school. When there is a need for a patient to be taken to the health facility, the conflicting demands may result in the health situation not being prioritized particularly if it concerns an individual who is not a member of the household. Such delays likely have a negative effect on health outcomes particularly for pregnant women and little children whose conditions can deteriorate in a short period of time. For participants to whom the river is a permanent obstacle, requests for a bridge to be built to facilitate movement to health facilities is understandable.

> ***"The paddlers go to sleep at night. When we have a bridge built, there will be nothing like the paddlers have gone to sleep. When there is a bridge people will be able to reach the hospital. That's the greatest help we can get to help us reach the hospital in no time in that even cyclists or those using oxcart can easily get to the***

other side when taking a person who is ill. Sometimes even if we are provided with canoes, you will find that the canoes are on the other side of the river and even if you shout for help you will not be heard because the river is wide and flooded and also the ones on other side are scared to come and help you out in fear of being killed because people have been killed at night. In that situation, a sick person then dies, or a pregnant mother can be in danger or dies without reaching the hospital for help. So, a bridge can be of help all year round." FGD participant, Kalabo.

As in most rural areas in the country, road infrastructure in the study areas is poorly developed, as are road networks. Flooding leads to further destruction of the roads that are in a poor state already making them non-functional. Existing bridges over low lying roads are particularly susceptible to such destruction by flooding, as expressed by a key informant from Mongu:

***"Because this is mainly a rural province with poor roads; floods make it very difficult to access health services. Pregnant women have difficulty accessing services. During floods you find that bridges are washed away, and they have to use canoes*.**" KII, Mongu.

3) **Effects on Economic activity**

Respondents in the study included government employed officers, a few employees of non-governmental organizations and community members who are mainly involved in small scale farming activities. The main cash crops that are grown in the study areas are maize, cassava, and rice. The normal annual seasonal floods have been beneficial to these agricultural activities as the plains were enriched by the flood waters that brought nutrient rich silt to the land. After the floods recede, these nutrient rich plains were used to cultivate their cash crops without the use of chemical fertilizers. Seasonal flooding was related to annual rainfall patterns that were predictable and linked to local adaptation measures involving migration of people and their animals to higher ground. However, in recent years, participants noted that there have been changes in the rainfall patterns which have made the rains unpredictable, and

they also noted cycles of extensive dry seasons and heavier than normal rains that have resulted in greater intensity of flooding. This has affected the planting seasons for their crops and consequently the potential harvest. One participant from Mongu expressed it in the following quote:

> ***"The changes we have seen in Bulozi (the plain) as time goes on, will cause us to have challenges in terms of farming. Like in the year 2018 we experience dry lands because we didn't receive normal rains and our fields dried. And so, it is difficult for us to have correct information on farming periods as to when we should plant and when we should harvest. We are confused of the correct farming time because seasons have changed. Last year, 2020, we received the first rain in December, and it was flooded meaning all our fields were submerged, okay, before we could even sell our crops especially us who do gardening, okay, because we haven't benefited from our fields. So, these weather changes have made us not to understand timing in terms of when to start planting".*** FGD participant, Mongu.

Intense droughts have resulted in crop failure leading to economic hardship for the farmers. Excessive rainfall with accompanying floods has also resulted in destruction of agricultural produce that is in the fields at the time of heavy rains. Repeated cycles of intense prolonged drought and heavy rainfall with more extensive flooding have resulted in much hardship and fears of the threat of hunger. Not only do the flood waters destroy the cultivated fields, but participants also complained of animals like hippos and crocodiles coming with flood waters grazing on the fields. Participants from Mongu, Mitete and Nalolo districts reported this destruction of agricultural crops amid changing weather patterns. The loss of livelihood in this way negatively impacts the ability of community members to secure services and resources that are needed when health needs that require travelling to distant health facilities arise. One key informant from Nalolo district described this effect on livelihood in the following way:

> ***"You find that when people relocate, when floods come, they destroy crops. Then you find that chances that there will be hunger in that year are very high. The other thing***

***is that there will be no source of income for the people around for the small farmers and just the normal villagers around there will be less income. So, they will be unable to procure or buy food that they need at the given time for their sustenance and survive.*"** KII, Nalolo.

Participants in the focus group discussions expressed a lot of concern about this as well as the unpredictability of the rainfall and planting seasons they have recently been experiencing.

"During this flood seasons people have serious disaster problems, their fields of maize and cassava are flooded more especially this year 2021." FGD participant, Mitete.

Yet others added that other sources of food were negatively affected by flooding increasing the threat of food insecurity. This is reflected by one participant's comments:

Just an addition, when it's flooded like this, we will have less fish in our rivers. So you will find that our crops get submerged, and we will have less fish as a result we will experience hunger. So, our cost of living becomes higher. FGD participant, Mongu

4) Effects on Water and Sanitation

Most participants in the study districts draw their drinking water from nearby rivers and streams. While acknowledging that nearby villages had protected wells, some participants reported drinking water from unprotected wells as the following quote from a participant in Mitete expresses:

"Another concern is the water we drink, we drink water from open wells and during the flood seasons like this one the water become contaminated consequently we suffer a lot from water bone diseases". FGD participant, Mitete.

Residents also practice open, or water defecation as improved sanitation facilities are not readily available. Some residents have pit latrines which they reported are usually

submerged during flood seasons. The lack of safe drinking water and proper sanitation facilities and the resulting contamination of drinking water during floods from the overflow of flooded latrines was discussed in all focus groups as a major concern, but particularly in Mongu and Mitete districts.

> **"O*n the issue of pit latrines, this village gets flooded and the pit latrines in most cases are also submerged. As a result, the toilet waste floats on water and the fish eats the waste. And again, the children will swim in the same water as a result people get sick, it's a challenge."*** FGD participant, Mongu.

Participants from Mongu referred to a pilot project previously undertaken by the NGO *Village Water* which was meant to assist villagers in building pit latrines and other efforts by the Disaster Management and Mitigation Unit (DMMU) which is an agency falling under the office of the Vice President. Both these efforts were reportedly not sustained. Participants expressed their concern relating to ongoing water contamination which they associated with increased health challenges such as diarrheal diseases during flood seasons and prompting them to call for help with water purification measures such as chlorine supplies

> ***"What we usually do if you feel like going to the toilet, you will just paddle across to help yourself out and when am done the fish will eat the feaces because it is in water. And so the same fish will be caught in my fishing net for relish. You see those things? At the end I found myself eating that same dirty and maybe end up suffering from cholera. This is how diseases spread like this. Especially department of health, they can bring us chlorine to put in water because you would find that we fetch the same water which has been contaminated. We normally drink dirty water. So, if it is possible to be given chlorine to put in that same water. Those with pit latrines also must put chemicals in the pit latrine. So, it's a challenge in that people drink contaminated water and as a result people suffer from different diseases."*** FGD participant, Mongu.

Health providers also pointed to this effect of floods in their discussion as represented by the following quote from Mitete:

"The floods when they come, there are some outbreaks like diarrhoeal diseases because all the toilets they are flooded, by doing so there are mixtures with all these dirt. That is the reason why if you come to see our data, diarrhoeal diseases are a bit higher than any other diseases during this time." KII, Mitete.

3.5 Discussion

Floods result in existing health services being made more inaccessible. Existing health facilities are few and sparsely positioned in the study districts. Floods increase the time it takes to reach these few facilities as normal routes used for walking are flooded and clients must find other ways of reaching the health centres which often means longer distances or use of oxcarts and boats. For service providers carrying out outreach programs, if water levels are high enough, they may be able to use speed boats in some areas. The terrain in other areas is such that speed boats cannot be used. Non-motorized canoes are also not used where the terrain includes much grass and islands of high ground covered by the flood waters. These outreach programs also depend on availability of health care providers so that services at the facility continue. Ongoing challenges in relation to lack of human resources within the health system makes this difficult to be carried out in a consistent way. Human resource challenges reflect weaknesses in the supply of health care providers and practitioners from training institutions which are not available in the rural areas represented in this study. Improving all levels of education including tertiary education where much needed clinical and nursing skills may be obtained by local residents would do much to solve the long-standing human resource shortages as practitioners from other parts of the country are not readily available to take up positions in remote areas. The education system, though external to the health system, provides a vital link and opportunity to strengthening the health system in general by allowing more members of local communities to acquire necessary skills and be available closer to the people requiring their services. This would in turn mitigate the hardship in finding health services experienced by residents made worse by extensive flooding.

Destruction of infrastructure is a well-documented effect of floods which fundamentally disrupts provision of health services in affected communities. Researchers in Namibia reported how floods negatively impact health service delivery through infrastructural damages and reduced numbers of healthcare workers faced with increasing patient numbers with flood related health conditions to be dealt with (Anthonj, et al, 2015). Makanga and colleagues (2017) also described disruption of maternal health services during seasons of high precipitation and flooding in parts of Mozambique that are prone to flooding. In the current study infrastructural damage was reported affecting health facilities and roads that are in poor conditions even prior to onset of rainy season. Road infrastructure is a vital link for development and these rural areas are yet to have significant progress in both. The transport sector is needed by all other government sectors for their activities to be carried on, yet it remains one of the weakest areas which presents an opportunity for investment and development which will improve lives of rural communities on multiple levels.

Infrastructure for sanitation, which in the study districts was mainly in form of pit latrines, were also reported destroyed by flooding, contributing to contamination of drinking water sources which are mainly rivers and streams. In the subregion, the link between flooding, poor water and sanitation facilities and increasing waterborne diseases was demonstrated with the tropical cyclones that affected coastal regions in neighbouring Mozambique in 2019 which were followed with cholera outbreaks. For example, leading up to cyclone Kenneth, Cambaza and colleagues (2019) reported that there was limited supply of clean water and sanitation infrastructure was in poor condition (Cambaza, Mongo, Anapakala, Nhambire, Singo & Machava, 2019) which accordingly were addressed in the response to the outbreak**.** Mugabe and colleagues (2021) also refer to the infrastructural damage to roads and sanitation services caused by cyclones Idai and Kenneth as well as worsening drinking water supplies that were already in limited supply. Learning from the reported experiences, anticipating such events and preparing for them is important. More than preparation, efforts to prevent such waterborne diseases following floods by improving supplies of safe drinking water and improved sanitation facilities that are resistant to flood damage in vulnerable communities are recommended. This calls for collaboration between

different sectors such as environmental sanitation engineers, public health practitioners and water resource managers among others.

Both key informants and focus group discussion participants reported the negative effects of floods on the livelihoods of local communities. Local communities practice subsistence farming with the main crops being maize and cassava. Traditional planting seasons have been altered by changes in weather patterns with early rainfall and flooding causing devastation to crops. The resulting economic loses and food insecurity indirectly affects access to care since resources to facilitate transportation to health services are not available. This is another demonstration of the inter-connected nature of social systems and how changes in one part of the system affect other parts of the wider whole. This effect on livelihoods has been described by others like Anthonj and colleagues in Namibia (2015) as well as Rosen and colleagues (2021) who describe a similar effect of drought in parts of western and southern provinces of Zambia. One systematic review found an indirect association between floods and malnutrition following destruction of agricultural produce during floods (Alderman et al, 2012). Such effects of flooding in repeating cycles keep rural communities dwelling in the flood plains in a vulnerable state as they cannot move away from their tribal land which is their heritage. Therefore, efforts to find lasting solutions for such sub-populations are urgently required and need intersectoral collaboration. Strategies such as innovative irrigation systems on the higher lands where communities migrate to as well as during dry summer months may be helpful.

3.6 Conclusion

The aim of this study was to explore the effects of flooding on access to maternal and child health services in the Western Province of Zambia. The study found that the main effects reported by respondents centred on four themes: effects on health service delivery; effects on transportation; effects on livelihoods and effects on water and sanitation. The findings demonstrate the interlinked nature of the different sectors in which societies are embedded, suggesting strongly that lasting solutions need to address multiple factors affecting the lives of vulnerable communities living in the flood plains. Solutions must address the security of their livelihoods, conditions of living including providing clean water and improved

sanitation as well as building strong roads that will facilitate mobility to essential services such as health care. Increasing the availability of all levels of education for rural communities will help address human resource needs in all government sectors to the benefit of vulnerable populations.

Chapter 4 Perceptions of environmental change and associated health outcomes in the flood plains of western Zambia

4.1 Introduction

4.1.1 Background

More than 2 billion people globally were estimated to have been negatively affected by floods between the years 1998 and 2017, through destruction of property, infrastructure, and loss of lives (Centre for Research on the Epidemiology of Disasters, CRED, & United Nations Office for Disaster Risk Reduction, UNISDR, 2018). During the same period, floods reportedly caused 43% of all natural disasters, much higher than other natural events such as droughts, storms and heat waves and earthquakes (CRED & UNISDR, 2018). Extreme weather events such as flooding are identified as one of the ways climate change is linked to adverse health outcomes (Watts, Adger, Agnolucci, Blackstock, Byass et al, 2015).

Flooding refers to any excessive accumulation of water on land that is normally dry and may occur because of increased precipitation either directly from increased rainfall which the land surface cannot absorb quickly enough or indirectly from the overflow of river contents onto the riverbanks and beyond (Whitfield, 2012). As climate studies have long projected, heavy precipitation leading to increased river and flash flooding, as well as longer, more intense droughts are occurring in many areas of the world leading to loss of lives and property and other associated public health problems including contamination of potable water leading to disease, crop losses resulting in food shortages and malnutrition and destruction of general infrastructure particularly in line with water supply and sanitation (Watts et al, 2015).

Similarly, the Intergovernmental Panel on Climate Change (IPCC) projections indicate that the intensity of extreme weather events such as droughts, flooding, cyclones, wildfires, and heat storms are likely to increase to varying degrees in different regions of the world as global warming continues, with consequent disruptions of food production and water supply, destructions of human settlements as well as negative outcomes for health and wellbeing (IPCC, 2014). These extreme weather events reveal the vulnerability and exposure

of human ecosystems to climate variability which seems linked to a lack of preparedness in some cases (IPCC, 2014). These regional differences in vulnerability and health impacts have been studied by several scholars. For example, flooding is regular in Mozambique's coastal flood plains where much of the country's agriculture takes place. Capacities to cope with excessive flooding and the resultant loss of life and economic productivity in this LMIC are likely more challenged when compared to similar flood events occurring in a country such as the US or Australia (Patz & Hatch, 2014).

More recently, the Lancet reported on the devastation of the country by two massive cyclones in the same season referring to the inadequacy of relief efforts to deal with both (Hope, 2019 & Devi, 2019). Amidst the general devastation, these reports refer to the severe disruption of health services affecting access to essential treatment for long term conditions such as tuberculosis, hypertension and HIV, while also dealing with increased risks of injuries, malaria and actual outbreaks of cholera (Hope, 2019 & Devi, 2019). Another report documented outbreaks of cholera following the worst known cyclone to affect Mozambique highlighting the collaborative response of the government and their partners (Cambaza, Mongo, Anapakala, Nhambire, Singo, & Machava, 2019)**.** However, this report doesn't discuss the effects on the health system and neither report incorporates the perspectives of residents. The effects of such extreme weather events in Mozambique sometimes extend into neighbouring countries including Zambia causing heavy rainfall and flooding in parts of the country. For example, a report in 2008 detailed flooding that affected both Zambia and Mozambique disrupting health services and causing infrastructural damage resulting in cholera outbreaks in both countries (Schatz ,2008). In its third national communication to the IPPC, Zambia reports ongoing climate variability with increasing episodes of droughts dry spells and floods that have had devastating consequences on livelihoods, infrastructure, energy, water resources, agriculture, and health (Government of the Republic of Zambia, GRZ, 2020).

Zambia, a landlocked sub-Saharan country with a land area of 752, 612 square kilometers has a tropical vegetation and climate characterized by three main seasons: - a cool dry winter (May- August), a hot and dry season (September and October), and a warm wet

season from November to April. The highest rainfall is in the northern regions with the southern and eastern regions having the lowest rainfall measurements and sometimes experiencing droughts. The main sources of water are four main river systems: the Zambezi, Kafue, Luangwa and Luapula rivers (Central Statistical Office (CSO) [Zambia], Ministry of Health (MOH) [Zambia], and ICF International, 2014).

4.1.2 Environmental change in the Zambezi flood plain

The Zambezi River basin on the western part of the country divides the Western Province from north to south. The province experiences seasonal flooding during which affected communities must temporarily relocate to higher ground resulting in disruption of health care services for different communities for extended periods of time. However, limited information is available on the effects of changing climate and extreme weather events in such settings, especially from the perspective of local communities.

Few studies were found that have investigated climate change mitigation and adaptation among the Lozi people of Western Province. Banda, Namafe and Chakanika (2015) discussed the role of traditional environmental knowledge of the Lozi people in the flood plains in mitigating climate change. Their study of the most populated Mongu district, indicated that most adults in the study were not aware of the concept of climate change but had experienced such effects as prolonged dry spells that affected their food security and threatened some observations of their cultural identity, particularly the *Kuomboka* ceremony during which the Lozi people led by their King migrate from the wetlands in Lealui to higher ground in Limulunga at the beginning of the flood season (Banda, Namafe & Chakanika, 2015). (The "*Kuomboka*", meaning coming out of water, is a traditional adaptation of the Lozi to the seasonal changes of the water levels in the Zambezi.)

Other sustainable, traditional practices beneficial for the environment reported by the researchers include use of paddled or polled dugout canoes for water transportation as well as the prominent role of local leaders in discouraging indiscriminate chopping of trees (Banda, Namafe & Chakanika, 2015). A lack of awareness of climate change per se was also found in a study of adaptation to climate change among those living on the Barotse floodplain, though respondents reported increasing unpredictability of rainfall and seasonal flooding (Milupi,

Njungu, Moonga, Namafe, Monde & Simooya, 2019). While findings on the negative effects of climate change reported in their study were similar to those earlier reported by Banda and colleagues in 2015, Milupi and colleagues (2019) also reported on the disappearance of specific plant and animal species observed by local residents in the plains. They also detailed traditional ecological knowledge being used to support adaptation to environmental changes experienced such as the planting of drought resistant crops such as early maturing cassava and use of alternate sources of fuel (Milupi et al, 2019). These previous studies have not included health behaviors and health outcomes in their analyses.

The aim of this study is therefore to further explore the perceptions of environmental change and resulting health behaviour and outcomes among communities in the flood plains of western province of Zambia.

4.2 Methods

4.2.1 Study design

This is a qualitative study based on focus group discussions and individual interviews which were conducted as a component part of a broader study that applied systems thinking strategies to the investigation of factors affecting access to maternal and child health services in the western province of Zambia.

4.2.2 Study setting

Residents of the Western Province constitute 7 % of the national population and are reported to have the highest poverty level in the country at 82% while the national level is at 54% (CSO, 2012, 2016).

Four districts in the Western Province in Zambia (out of 16 districts in the province) were included in the study selected because of their proximity to the Zambezi River. These are- Mongu, Kalabo, Mitete and Nalolo districts. Figure 4:1 shows the map of Western Province and the districts in the province while Figure 4:2 shows the areas most prone to flooding.

4.2.3 Recruitment strategies

Recruitment of participants was done after clearances from ethics boards in Canada and Zambia, and relevant permissions from the provincial and district health administration. Participants in focus group discussions were recruited with the help of health facility staff and local leaders in the study area. Participants in the focus groups included both men and women above 18 years of age living in the study sites and accessing health services in the area. These included farmers, teachers, local businessmen/traders and "ordinary citizens". In each district, two mixed focus group discussions were conducted with a total of 61 participants from the four districts.

4.2.4 Data collection

Focus group discussions were conducted in Lozi by trained research assistants. The research assistants had completed a three-day training in interview techniques and focus group facilitation conducted by the author. All the interviews were conducted in person. Two research assistants facilitated the focus group discussions which allowed one of them to lead the discussion while the other handled the recording and took notes. All the discussions were recorded after obtaining informed consent from all participants.

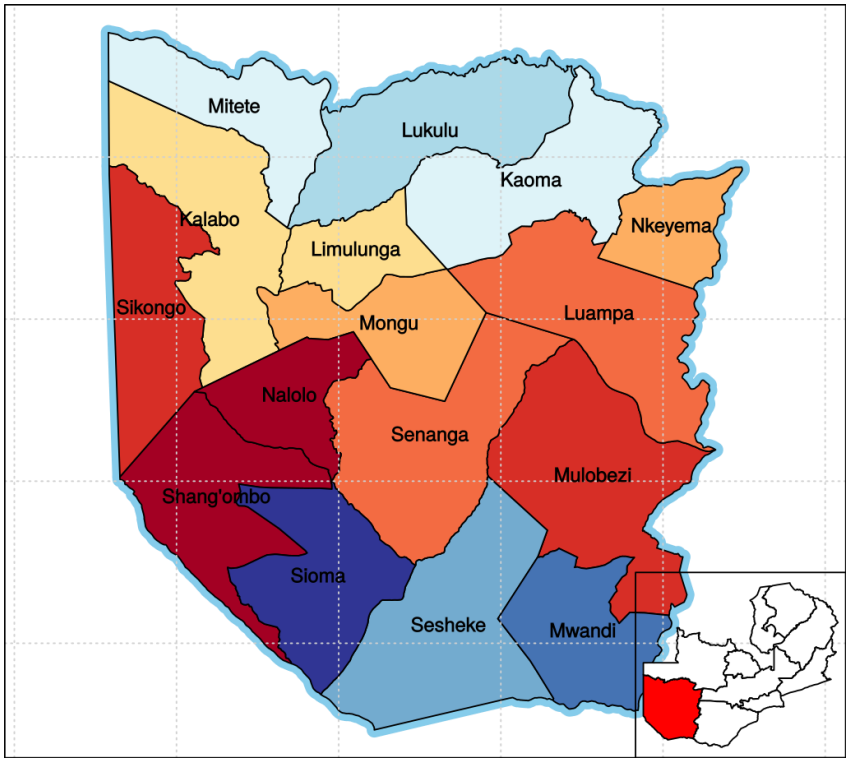

Figure 4:1 MAP OF WESTERN PROVINCE downloaded from https://simple.wikipedia.org/wiki/Western_Province,_Zambia

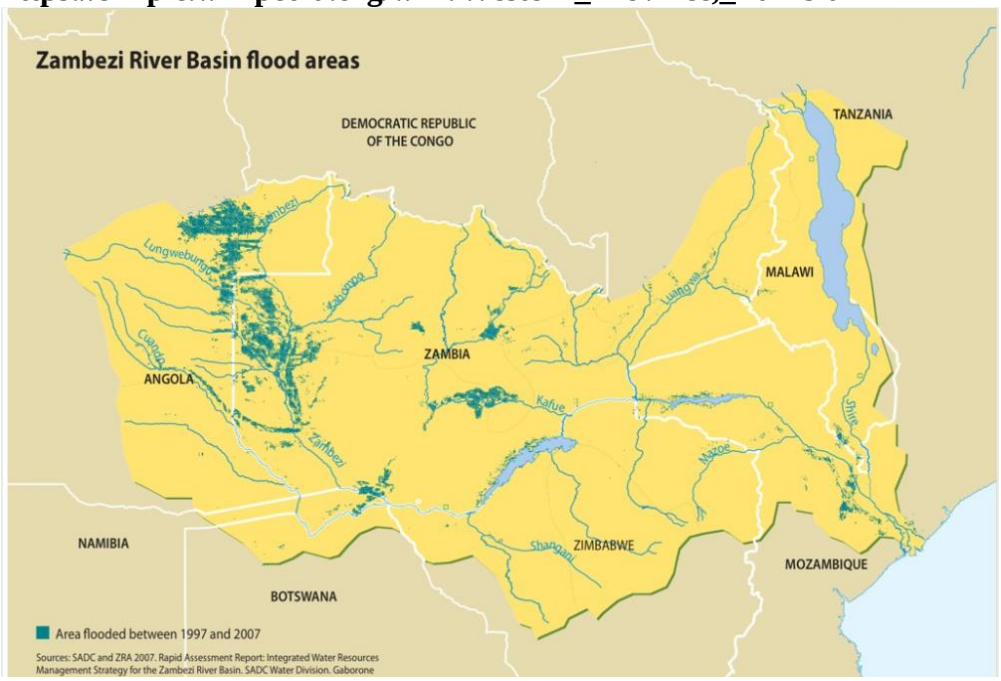

Figure 4:2 Zambezi River Basin flood areas Source Western Power Company Ltd, 2020

4.2.5 Data management and analysis

Interview recordings were transcribed and translated from Lozi to English. The translated MS Word documents were imported into Nvivo 12 software for coding. Coding of transcripts was undertaken both deductively (deriving codes from the interview guides) and inductively (deriving codes from the participants responses). Codes were collated into themes that were reviewed and reorganized into the final themes for reporting. Triangulation of data from the different sources (interviews, field notes and observations) was used to validate the data findings by cross referencing.

4.3 Findings

A total of eight focus group discussions (FGDs) were conducted, two from each district. Participants in the FGDs were both male and female adults (aged 18years and above) who use the public health services available in the districts. The main occupations among participants included farming, teaching, trading. Twenty (20) individual interviews were also conducted with health service users (HSU), 5 from each district.

Of the 4 study districts, Mitete is the poorest, is not linked to the national electric grid, has the fewest number of facilities and is characterized by long travel distances for people seeking health services. Road development is poor in most of the province due to sandy soils and the plain that is flooded for parts of the year resulting in significant barriers to accessing health services.

Table 4:1 Distribution of study participants

	Number of Focus Groups	Number of Health service users	Total
Mongu	16	5	21
Kalabo	16	5	21
Nalolo	13	5	18
Mitete	16	5	21
Total	61	20	81

4.3.1 Perceptions

Respondents' perceptions of environmental changes revolved around seasonal changes, changes in the natural environment, extreme weather events (floods and droughts) and effects on agriculture.

Seasonal changes

Most residents in the study area are farmers and depend on the timely rainfall pattern for successful harvest of their cash crops. Respondents in the study reported that there are changes related to both the timing and intensity of the seasons. From every district, participants indicated that there have been changes observed on the onset and duration of the rainy season as well as that of the dry season. While previously, rains were expected in September, participants reported that sometimes the first rains are only observed in November or December, affecting the planting of maize which is a staple food crop. Sometimes rains are unexpectedly early. This unpredictability of the rainfall pattern has affected crop yields. Respondents also discussed how the rainfall now is observed to be heavier than before leading to flooding. Although seasonal floods are not a new occurrence in the flood plains, the intensity and magnitude of the floods has reportedly increased. Even the dry seasons were reportedly longer and hotter than in previous years.

> ***"Here in Lealui the changes we have seen in the past 10 years is on the pattern of rainfall. The rain pattern has changed in that we do not receive the normal rainfall. In the past, we used to see the first rain in the months of September, and we used to have good maize harvest because we never used to have drought. Of late, the first rains come in November. And so, when the rains start in November this will cause early flooding and the maize field gets flooded. When you plant early [before the rains], the sun will burn the crops and so it will be a waste of resources. Climate change has brought challenges in our plains. And when the rain starts, it comes with such force that it gets flooded within a short period of time. Those are the changes we have seen."*** Mongu FGD participant.

Natural environment

The communities living in the flood plains have long adapted their social, cultural and economic lifestyle to the seasonal changes of the Zambezi River and its tributaries. Based on their local knowledge of water levels in the river, they would know when they would need to migrate to higher ground for the duration of the flood season. This is usually associated with cultural celebrations that have been disrupted in recent years due to low levels of water in the river. In line with this was the reported observation in the focus group discussion that over recent years, the appearance of the river has changed. In previous years, the river was said to be "deeper" and "more attractive" while it was observed to be shallow in recent years. This observation was only reported in Nalolo district though. This change in the appearance of the river was also said to be linked to a reduction in the number of fish available in the river as well as other animal and plant species. This is how one participant explained it:

> ***"What I have noticed over the years is that ten years ago the rivers were deep and very attractive. But this time around the rivers are not deep as before and all the things that were in the rivers have just gone out of existence. So, the rivers are now going down. The way the rivers are filled with water is different. At first the rivers were filled with so much water but now the rivers are becoming shallow. This is also a sign that all the things that used to live in the water are no longer there. The same things which use to live in water use to make the rivers deep. We have also come to realize that there is no longer fish in the rivers. We also used to see some green grass just near the rivers, specifically a certain grass we used to call "muchimbani", but these days it's no longer seen."*** Nalolo FGD participant.

Participants in Mongu district did not share this observation but they reported an observed reduction in the availability of fish, in this case relating it to the increased flooding, which discussants in Nalolo also alluded to. In Kalabo district, participants observed an increase in the level of soil erosion which was related to increased flooding and consequently had a negative effect on crop yields as reflected in the following statement:

"This time around, there has been a lot of floods, a lot of floods that have been causing a lot of soil erosion. Soil erosion, yes, it washes away the nutrients which are important for plants." Kalabo FGD participant.

Extreme weather events

Participants from all districts reported an increase in the occurrence of both severe droughts and flooding. These events appear to alternate in cycles with devastating consequences for flood plains communities. A participant from Mitete district described their experience of having "**spells of droughts and floods of unexpected levels"** in recent years. Participants from Nalolo reported that when the rains come, they are very heavy and then they also experience droughts which are very dry and very hot. There were several references to the 2018/ 2019 planting season during which the drought experienced was severe and devastating for local communities whose livelihoods are dependent on crop production. This was then followed with heavy rains in the next season which flooded the crops before they were harvested illustrating a cycle that has been experienced repeatedly. Mongu participants reported how droughts have negatively affected food availability through crop failure and cause a reduction in the available drinking water supply. Both droughts and flooding are reported to have had negative effects on drinking water. Droughts have often resulted in scarcity of surface water used for domestic purposes while during flooding, destruction of the local sanitation infrastructure leads to much water contamination and was a major point of discussion in both Mongu and Mitete. One of the participants from Mongu expressed their concern as follows:

"This village gets flooded and the pit latrine in most cases are also submerged. The challenge concerning drinking water here in Bulozi [the Barotse flood plain], the water is contaminated as you can see you will not find any toilet in this area, now ask yourself that where do these people go to when they feel like going to the toilet? The water we drink is contaminated." Mongu FGD participant.

Another respondent from Mitete expressed it in this way:

"Another concern is the water we drink: - we drink water from open wells and during the flood seasons like this one the water becomes contaminated. Consequently, we suffer a lot from water-borne diseases." Mitete FGD participant.

The patterns of heavy rains and consequent flooding being experienced has resulted in an increase in the cost of living. This is because the reduction in food due to crop failure and reduction in available fish necessitates additional resources being used to obtain alternative food sources. Additionally, travel for essential services is more expensive during flooding as residents must pay for private water transportation by boat for health and other services. Increased flooding of maize fields is reportedly increasing the presence of predator mammals such as crocodiles and hippos that are dangerous to humans and cause destruction of agricultural produce.

Effects on agriculture

Agriculture is the main economic activity of the residents in the flood plains with maize, cassava and rice being the main food crops being cultivated as well as cattle husbandry. All districts reported the role of the changes in climate that were ongoing in their areas in reducing their agricultural produce and contributing to the threat of famine due to food insecurity.

Planting seasons have been severely disrupted by the rainfall unpredictability. This was a particular concern addressed by participants in the Mongu focus groups but referred to by the other district focus groups as well. For example, in one of the Mitete focus groups, one participant had this to say:

"During these flood seasons people have serious disaster problems, their fields of maize and cassava are flooded, especially this year 2021. People will live in famine this year." Mitete FGD participant.

Farmers find themselves in a dilemma of planting their seeds before the rains come, which presents the risk of losing their crops to the scorching heat from the sun or delaying the planting while they have no assurance of rainfall. Unpredictable heavy rains have sometimes come when crops in the fields are yet to be harvested and the resulting floods lead to crop destruction.

> ***"And so, it is difficult for us to have correct dates on farming periods as to when we should plant and when we should harvest. We are confused about the correct farming time because seasons have changed. Last year- 2020- we received the first rain in December, and it was flooded meaning all our fields were submerged before we could even sell our crops, especially we who do gardening because we haven't benefited from our fields. So, these weather changes have made us not to understand timing in terms of when to start planting. These are the changes that have challenged us***." Mongu FGD participant.

Other farming practices discussed were the need for fertilizers for their crops to grow which is a deviation from the traditional reliance on cow manure. Additionally, the severe droughts appear to have increased the presence of pests which are negatively affecting crops and for which they now need to purchase pesticides. This was related to the observation of increased soil erosion resulting in depletion of plant nutrients. The purchase of fertilizers and pesticides has raised the costs associated with farming and made the farmers more dependent on external assistance mainly from the government for such inputs. This is not always assured and sometimes not given in good time.

> ***"In the past we never used to see our maize fields wither, but today unless you buy pest and crop "medicine" [herb and pesticides] and fertilizer and also some medicine to add to the soil, you see this. In the past we used cow manure to grow our maize but today unless you have money to buy medicine and if you do not have resources, your maize field withers or will be destroyed by pests."*** Mongu FGD participant.

4.3.2 Resulting health behaviour and health outcomes

Of the sites included in the study, Mongu district is the most developed being the provincial capital and the center of most economic activity. Transportation is also more available in Mongu compared to the other districts given better road infrastructure. Mitete district is the most remote of the four study districts, having the lowest level of trade, economic and social development as well as a very poorly developed road network. This district was previously part of the neighbouring Lukulu district which still houses the nearest hospital and other government administrative offices. However, it is completely separated from Lukulu district by the Zambezi River and is reliant on water transportation to access essential services across the river. Nalolo and Kalabo districts are rural districts with poor road networks and flood prone areas. While the rural nature of these areas presents barriers to accessing health services, flooding intensity and duration, as well as the extreme heat experienced during dry seasons, have increased the challenges associated with accessing such services. The health consequences of these environmental factors are as follows:

Alternative treatments- Because of the long distances people must travel to access health care at a public health facility and the frequent shortages of both health care providers and medicines at the health facilities, they may opt to stay home and use alternative methods of dealing with ill health. These include consulting traditional healers, herbalists or elderly family members who are knowledgeable of traditional medications and give advice on what to do. These traditional treatments include use of leaves and roots from specific plants that are boiled and then taken orally as reported by participants in Nalolo and Kalabo. “Sinuke nuke”, a traditional herb, is used as an external treatment in bath water while others rely on drinking a lot of water, or steam inhalation as a form of treatment. An example of this practice is expressed in the statement from a participant in Nalolo district:

"We get help by getting what is known as "sinuke nuke", warm it and then take a bath with the same warm water. And sometimes when you take a bath with hot water at night you will feel much better". Nalolo, FGD participant.

Participants also reported self-treatment by buying over-the-counter drugs like Panadol (acetaminophen) from small grocery stalls in the villages.

Community mobilization – The main complaint across all the districts in relation healthcare access was the lack of transportation available to meet health needs. The main mode of transportation is walking, and some residents use bicycles and canoes during flood seasons. Not all can afford or have access to canoes, so they rely on help from community members who own canoes to assist when there is a need for transportation to health facility or getting help from healers known to community members. In some cases, villagers donate money to cover transportation costs for those who do not have canoes. With regards to requesting help with canoes from neighbours or other community members, some participants discussed the problem of related costs for canoe or paddler charges as well as prescribed medication which must be purchased from private providers. Different experiences amongst participants were reported in relation to ease of being helped by other community members in their time of need, with some participants from one FGD in Nalolo reporting that in cases of ill health, help is given without charge. This comment differed from the other FGDs. Mongu participants raised the issue of advanced preparation for the rainy season and potential flooding which was not mentioned by participants from other districts. This was linked to being able to secure resources and services quicker with resulting better outcomes in an emergency.

Home deliveries for pregnant mothers- Pregnant mothers, like other community members, experience challenges with transportation to health facilities and often resort to having their delivery in their home, relying on the assistance of older women in the family or community who are deemed experienced in attending to child births. In places where there are maternity

waiting shelters[2], some women may not use these due to lack of resources for use at the shelter. More home deliveries reportedly occur during flood seasons, and this was reported in all the districts, although it was discussed more in Mitete district. In some cases, because of increased challenges with appropriate transportation during floods in the most remote areas, multiple modes of transportation are required for communities to reach appropriate health facilities that have the required resources and skilled health providers. This results in deliveries occurring while an expectant mother is in transit to the health facility. In these situations of home deliveries or those in transit, the risk of complications, including serious infections and death for both mother and baby, is increased.

> ***"Pregnant mothers give birth in the villages because we don't have things (resources) to take them to the facilities. During floods and drought seasons we don't have transport and we have a lot of children suffering from different diseases because just to go to the health centre, we need to cross the river and women give birth on the way".*** Mitete FGD participant.

Fatalities in transit to health facilities- As noted above, during flooding seasons, the only mode of transport available for residents is the use of canoes that are not readily available for everyone and has risks associated with it. These include rough winds on the river that can be dangerous and cause fatal accidents for travelers in canoes. Flood waters also raise the risk of attacks from wild animals like crocodiles and hippos which paddlers must look out for before they set out on a trip. As such, risks of drowning are always there, and participants reported such cases. Sometimes the difficulty of obtaining transport when a resident is ill results in deterioration of the condition to the extent that death may occur while the patient is being transported to a health facility. This was reported from all districts and was particularly related to children whose condition can change in a short period of time. One participant from Kalabo had this to say about this:

[2] Maternity waiting homes or shelters are accommodations established near health facilities where skilled care for childbirth, obstetric and newborn complications is provided and are intended to remove the barriers that would otherwise limit access to such care in a timely manner such as distance, geography, transportation, and problems with the referral system (WHO, 2015)

> **"*So, we normally encounter challenges and sometimes pregnant women deliver at home. Sometimes you have a sick child, when there is a sick child in our village you will find that the child will end up dying at home or pregnant women giving birth at home, if they encounter some complication, they end up dying just like that".*** Kalabo HSU.

Vectorborne and waterborne diseases- Participants in all districts observed that there was an increase in infectious diseases associated with flooding. These include vector borne diseases such as malaria. The flooding and associated vegetation growth provide a conducive breeding environment for mosquitoes. Flooding also results in the destruction of existing sanitation infrastructure, mainly pit latrines, leading to contamination of drinking water sources and consequently an increase in diarrheal diseases. Boreholes and scarce, so the main sources of drinking water are from rivers and streams which are used for many other purposes including bathing and defecation. The following is a quote from a participant in Mongu:

> **"Y*ou would find that during floods we face a lot of challenges, and we experience a lot of death because people do not have canoes to take them to the hospital. When its flooded we record a lot of people dying because of water and you will notice that that's the time when we see a lot of mosquitoes. I have noticed that when we have floods, there are a lot of malaria cases recorded. And when you are sick of malaria and would like to go to the hospital, but you are limited by transport. So that's what happens though we have noticed that during floods we record more cases of diseases and death"*.** Mongu HSU.

> ***"In the time of floods let me say that, maybe there is this thing because we have a lot of water and so we experience a lot of diseases like diarrhea in diseases"***. Mongu HSU.

Missed appointments- Because of the challenges associated with transportation across the flooded plains, scheduling appointments for clinic visits may be unsuccessful. This poses

problems for follow up of clients such as for ante natal mothers or clients on long term therapy such as anti-retroviral therapy (ARV) for HIV/AIDS. Flooding presents a barrier for parents to take their children for scheduled clinic days when childhood vaccinations are administered. Health providers who often conduct outreach clinics where they bring such services to the communities may be hindered from doing this by a number of challenges including the reduced number of health care workers available from the sending facility, availability of boats and fuel to traverse the flooded river. The uneven terrain of the flood plains during floods also adds to the difficulty of travel as multiple modes of transportation are needed for the most remote areas. A participant from Nalolo reflected it as follows:

> "***We would also want the clinic to be extended so that we are going to be given things like fridges, because our children do not get vaccinated. And because transport is a challenge it is difficult for us to go to other clinics to get them vaccinated."*** Nalolo FGD participant.

Threat of malnutrition-Across the four districts, one of the main concerns of the respondents was the destruction of food crops via excessive flooding as well as the intense and prolonged droughts that have been experienced in the study districts. As most residents are small-scale subsistence farmers relying on a stable annual rainfall pattern, the increasing unpredictability of the seasons has resulted in crop failure and economic hardships, leaving most residents concerned for looming hunger and consequent malnutrition. Examples of comments given from the districts on this threat are following:

> ***"Our fields of maize and cassava are flooded; people will live in famine this year".*** Mitete FGD participant.
>
> ***"Seasons have changed because even the rains do not start like the way they used to. Drought causes crops to fail to grow as a result there is hunger a lot. And even fish will not be there".*** Mongu FGD participant.
>
> ***"The rain patterns have increased the problem of hunger in our society. Because it rains so much it has brought problems. If the rain was moderate, maybe our harvest would be better".*** Nalolo FGD participant.

"With the coming of floods, it means food security in the house holds will not be guaranteed because their crops are going to waste. So that's one of the negative effects that the floods have, even droughts". Kalabo HSU.

Table 4:2 Table showing perceived changes and some health-related outcomes

PERCEPTION	EFFECT	HEALTH RELATED OUTCOMES
Heavier rains Increased floods	Destruction of crops; movement to health care facilities hindered	Waterborne diseases Famine Home deliveries Use of alternative treatments
Soil erosion	Loss of soil nutrients; crop failure	Food insecurity
Increased frequency of drought	Crop failure; water scarcity	Food insecurity; famine; water borne diseases
Changes in timing of rains and duration of the rainy seasons	Crop failure	Food insecurity
Decline in fish stocks; crops submerged before being harvested	Food availability limited Crop failure	Food insecurity; resulting hunger contributes to school absences leading to cycles of poverty
Nature of river-no longer deep and "attractive", shallower: common species in rivers have disappeared;	Food availability reduced Cultural activity affected	Food insecurity Social -cultural practices that strengthen the community weakened. For example, the *kuomboka*[3]

[3] "Kuomboka" means coming out of the water. It is a traditional ceremony that marks the traditional migration of the Lozi people, led by their king, from the low-lying flood plain to higher ground.

both plants(grass) & animals (fish)		ceremony doesn't take place when water levels are low.
Flooding-pit latrines get submerged/ water contamination (water wells built near pit latrines)	Contamination of water	Waterborne diseases

4.4 Discussion and conclusion

This study explored the perceptions of residents of four districts in Western Province, Zambia. We found that along the Zambezi flood plains, residents have experienced numerous environmental changes affecting their communities. The study also explored how these changes have affected reported adverse health outcomes. The main observations reported involved changes in the predictability of wet and dry seasons, including the onset, duration and intensity of the rainy season; changes in the natural environment, including river characteristics and the disappearance of plant and animal species; the increased frequency of extreme weather events especially floods and droughts; and the negative effects of environmental changes on their agricultural activities, which is the main source of both cash income and nutritional sustenance for the majority of residents. Reported health behaviours resulting from the challenges exacerbated by environmental changes, especially increased flooding, were using local alternative treatments for health problems due to transportation challenges, missing follow-up visits at health facilities, and higher rates of home deliveries for pregnant mothers. Noted health outcomes include death from drowning; death of very ill patients in transit to health facilities; complications of child births conducted at home and in transit to health facilities including maternal and neonatal deaths; increased occurrences of vector borne (particularly malaria) and water borne diseases (infective diarrheal diseases); and the increased threat of malnutrition due to crop failure. Many of the adverse health events arise because residents are discouraged from seeking health services early due to multiple factors such as the long distances that must be travelled, the lack of transportation and poor road infrastructure in the study areas, and reliance on alternative, and slower,

transport options such as oxcarts and canoes during floods. Health system barriers included the limited number of facilities and health care providers available as well as frequent shortages of supplies at the facilities, including periodic stock-outs of essential drugs. These shortages also discourage potential clients from taking risky trips to health facilities, opting instead for alternatives available closer to home.

Investigating the prevailing level of awareness among local communities is important because it highlights the potential gaps that might be addressed through health education programs. But this should be built on local knowledge that has allowed indigenous communities to continue living in the flood plains despite increasing threats to their survival presented by ongoing climate change. Engagement of local communities in the development of environmental programs that are culturally sensitive and inclusive will increase sustainability of such programs, while respecting the cultural identity and heritage of local communities. Awareness is the foundation on which demand for solutions can be built. Awareness is linked to availability of information which might come through education systems, media, telecommunications, and internet connectivity. All these sources of information are absent in some districts like Mitete and parts of Nalolo. This situation is linked to the lack of socio-economic development in the study districts, which in turn is linked to historical and political conditions that have left whole provinces such as the study province in the margins of development. Banda and colleagues working in the Mongu district reported a lack of awareness of climate change which was echoed by Milupi and colleagues (Banda, Namafe & Chakanika, 2015; Milupi et al, 2019). Both research teams however reported effects of environmental changes observed by local communities like those reported in the current study.

In this study, participants bemoaned the loss of livelihoods brought about by both excessive flooding and severe droughts. Rosen and colleagues (2021) reported on the devastating effects of drought on farming communities in some districts in southern and western provinces of Zambia, which led to reduced incomes and food insecurity especially for women. With ongoing climate change, such loss of livelihoods for farming communities will likely continue and innovative solutions for income generation are required to sustain

life as well as culturally relevant adaptation strategies that will be built on the foundation of local ecological knowledge. The work of researchers such as Banda and colleagues (2015) as well as Milupi and colleagues (2019) acknowledges the potential of local environmental knowledge in advising policy development, yet more work is required to use such knowledge through transdisciplinary collaborations where custodians of traditional knowledge may be engaged in developing adaptation programs.

Given the prevailing lack of socio-economic development in the study areas, the health behaviours and outcomes reported in the study are not surprising. Other researchers have reported on the health outcomes similar to those in this study, for example in Mozambique and more globally (Hope, 2019; Devi, 2019; Alderman, Turner &Tong, 2012; Levy, Woster, Goldstein & Carlton, 2016). In relation to health behaviour and outcomes for antenatal mothers, researchers working in Luapula and Northern provinces of Zambia that, like the study province, are predominantly rural, reported that for many reasons, mothers were more likely to attend ante natal clinics only once as opposed to the recommended four times through the gestation period because of long distances to health facilities, prioritization of other household chores and the poor quality of perceived services available at the facilities (Jacobs, Michelo & Moshabela, 2018). It is apparent that the distance between communities and health facilities with adequate skills to handle patient needs must be shortened if residents are to be encouraged to use health services. In the study area, this includes, building more health facilities closer to villages, stocked with essential equipment and with health care staff who possess the appropriate skills. More tertiary institutions of learning will need to be introduced in the province in order to train indigenous communities in skills that are desperately needed in these communities so that they improve the human resource of the health system at district and provincial level by taking up long standing vacancies. Road infrastructure and networks must be significantly improved to allow additional transportation such as motorized vehicles, and communication systems need to be improved by installing telecommunication towers so that timely communication is made between clients and health care providers in case of emergencies and patient referrals. Electricity needs to be introduced in the districts where it is lacking as well as improving the housing, water, and sanitation

infrastructure. Not only will such measures improve health outcomes, but better infrastructure will be more attractive to skilled health care providers who tend to shun working in rural areas because of the limited availability of services and difficult living conditions. In the same way that multiple factors straddling different sectors are interacting to result in suboptimal health outcomes, there can be no meaningful and lasting improvement without development across all social systems in the regions. This strengthens the argument for a systems approach in relation to intervention design noting that more factors influencing outcomes are external to the health system. Efforts to bring inter departmental collaboration starting at local and provincial levels are recommended so that a stronger voice is raised to advocate for the needs of the vulnerable and marginalized poor in rural areas.

Chapter 5 Exploring the interaction of local factors with health system interventions to influence outcomes for maternal health in the flood plains of Western Zambia.

5.1 Challenges of access to health services in LMICs

At least half of the world's population do not have access to essential health services (World Health Organization, WHO, 2017). The communities most affected are those in Southeast Asia and Sub-Saharan Africa where health outcomes as demonstrated by key health indicators tend to be less than optimal.

As an important intermediate outcome of health system performance, access to health services directly impacts how well any system will achieve the main outcome goals of improving health status, meeting customer satisfaction and financial protection (WHO, 2012). It is a key component of the Universal Health Coverage strategy articulated in the Sustainable Development Goals of 2015 (WHO, 2021).

Access to health care includes geographical availability of heath care but may be broadened to include questions of affordability and acceptability. Multiple factors that may influence access include environmental factors such as flooding (O'Donnell, 2007). Rural communities are the most affected as the number and accessibility of both health facilities and health care providers tend to decrease with increasing distance from urban centres. Among the most vulnerable sub populations are women and children.

Health outcomes in regions where access to health services is not assured tend to be poor. For example, under five mortality rates in the African region in 2015 ranged from 13.6 per 1000 live births in Seychelles to 156 per 1000 live births in Angola (WHO, 2018). In the southern parts of the continent, neonatal mortality rates range from 15 per thousand live births in Namibia, an upper mid-income country to 47.8 per thousand live births in Angola, a middle-income country (WHO, 2018). Maternal mortality rates in mainland Africa in 2015 ranged from 129 per 100,000 live births in Botswana to 1,360 per 100,000 live births in Sierra Leone (WHO, 2018).

While Zambia in southern Africa, compared favourably with neighbouring countries, the maternal mortality rate is unacceptably high at 224 per one hundred thousand live births. In neighbouring Mozambique, the rate is even higher at 489 per hundred thousand live births (WHO, 2018). Studies in Mozambique have demonstrated that an increase in maternal mortality in some regions is related to disruption of access to maternal health services during flood events (Makanga, Schuurman, von Dadelszen, & Firoz, 2016; Makanga, Schuurman, Sacoor, Boene, Vilanculo, et al, 2017).

5.2 Maternal Health Interventions

Interventions known to be effective in reducing morbidity and mortality as well as improving access to care, are being implemented in several countries. Some of these have been developed based on the three-delay model where phase 1 delay refers to delays in making the decision to seek health care; phase 2 refers to the delay in arriving at a health facility once the decision had been made and phase 3 delays refer to delay in receiving adequate care once at the health facility (Pacagnella, Cecatti, Osis, & Souza, 2012). Accordingly, different health education programs addressing perceptions and knowledge of danger signs, interventions targeting transportation challenges as well as strategies to strengthen the capacity of health care workers to perform core signal functions for emergency obstetric care (EmOC) as recommended by the WHO have been implemented to differing extents and evaluated (Bailey, Lobis, Maine, & Fortney, 2009). For example, Souza and colleagues reported on findings of a WHO multicountry survey on maternal and newborn health which assessed among other things the coverage of key maternal health interventions (Souza, Gülmezoglu, Vogel, Carroli, Lumbiganon, et al, 2013). The researchers observed from the study that there was a high coverage of essential interventions in the different countries but there were also women with severe maternal outcomes who had not received at least one essential indicated intervention such as magnesium sulfate for the treatment of eclampsia (Souza et al, 2013).

Establishment of waiting shelters for pregnant women who are near their time of delivery is another intervention that has been implemented in LMICs like Zambia. Maternity waiting homes (MWHs) were among the recommendations by the WHO in 2015 as an intervention to increase access to skilled care for populations in remote areas or wherever

access to services is limited (WHO, 2015). These are accommodations established near health facilities where skilled care for childbirth, obstetric and newborn complications is provided and are intended to remove the barriers that would otherwise limit access to such care in a timely manner such as distance, geography, transportation, and problems with the referral system (WHO, 2015). However, researchers such as Pen-Kekana and colleagues reviewed the implementation of MWHs in different LMIC settings and reported barriers including long distances, cost and availability of transportation, lack of knowledge or awareness of the benefits, non-inclusion of culturally acceptable practices, non-acceptability of intervention by other family members, lack of food supply and inappropriate hygiene and sanitation facilities (Penn-Kekana, Pereira, Hussein, Bontogon, Chersich, et al, 2017).

Several researchers have reported on different maternal health interventions in Zambia that have aimed to reduce maternal morbidity and mortality. For example, Ensor and colleagues in 2014 reported largely positive results of a community-based intervention they conducted in 6 rural districts. Their intervention involved community education sessions, training of community volunteers and provision of relevant emergency transportation for use by communities in the study districts, strategies which targeted mainly phase 1 and 2 delays (Ensor, Green, Quigley, Badru, Kaluba, & Kureya, 2014). The study reported significant improvement in deliveries attended by skilled providers, facility-based deliveries as well as knowledge of obstetric complications and danger signs (Ensor et al, 2014). Another significant intervention aimed at reducing maternal mortality in Zambia and Uganda was the saving mothers giving life project funded by the US government in collaboration with several other international partners and included elements addressing all three delays (Kruk, Vail, Austin-Evelyn, Atuyambe, Greeson, et al, 2016). The 5-year initiative is reported to have seen a decline of 41% in maternal mortality based on census data between baseline and the end of the project (Healey, Conlon, Malama, Hobson, Kaharuza, Kekitiinwa, et al, 2019). However, having received significant external investment, concerns of sustainability and scale-up challenges were raised by one independent evaluation of the first year of the project (Kruk et al, 2016). Jacobs and colleagues (2018) evaluated a community-based intervention involving the training and establishment of community groups called safe motherhood action

groups (SMAGs). These are groups of community volunteers trained to promote the benefits of skilled birth attendance. Their evaluation found that engagement of SMAGs was associated with an increase in the coverage of key maternal and neonatal health indicators including access to antenatal care as recommended and having deliveries attended by skilled birth attendant (Jacobs, Michelo, Chola, Oliphant, Halwiindi et al, 2018).

5.3 Rationale for systems framework

Outcomes from interventions such as those described above are influenced by many factors. Evidence from studies of implementation of interventions and policies in some countries in Africa, indicates that when such interventions are imported without an understanding of the local context, they may not be as successful as intended.

Tumilowicz and colleagues (2015) who studied implementation of nutrition interventions, argued that knowledge of social and cultural practices of communities targeted for specific programmes helps explain why some interventions succeed or fail by showing how these interventions are perceived and interpreted by local communities. Olivier de Sardan and colleagues (2017) in West Africa conducted studies of the implementation of standard interventions in maternal health such as the partogram, a simple tool developed to be used in resource limited conditions to monitor the progress of labour and make appropriate decisions for action to ensure better maternal outcomes. They found that for varied reasons including work overload, a poor writing culture among midwives and superior value ascribed to experience compared to the use of the form, health workers tended to fill out the partogram after the delivery of the infant had been concluded using standard information as opposed to the recommendation of filling the partogram during the process of labour (De Sardan, Diarra & Moha, 2017). The researchers argued that although the intervention was not working as intended by developers, as their findings revealed, it continues to be promoted as a monitoring tool and used as a legal document as well as an evaluation tool for staff performance (De Sardan, Diarra & Moha, 2017). Examples such as these point to the usefulness of a systems approach, which offers an alternative perspective for investigating public health problems and developing interventions to solve those problems because it posits that the system under study is linked to other systems that make

up a greater whole. A systems approach analyzes the interlinkages and feedback mechanisms between different system components in their context and anticipates what their response (s) to proposed change might be. This approach has, therefore, been proposed for understanding and solving complex public health problems and will be used to explore interactions between different system elements that are relevant to public health, particularly access to essential health services (Peters, 2014).

Although there are many definitions of what is included in a "health system", or "the health sector", here we employ the WHO definition: a health system consists of all organizations, people and actions whose primary intent is to promote, restore or maintain health- its goals are improving health and health equity in ways that are responsive, financially fair, and make the best, or most efficient use of available resources (WHO, 2007). The WHO also describes 6 building blocks that together constitute a complete system through their multiple relationships and interactions among and between the blocks (De Savigny & Adams, 2009). This back-and-forth interaction allows a health system to be comparable to other systems known to be dynamic and comprising feedback loops that are both reinforcing or balancing and be referred to as a Complex Adaptive System (Trochim, Cabrera, Milstein, Gallagher, & Leischow, 2006). Health systems form part of the whole government system as well as other social systems to which the main constituents, people, belong. Therefore, they are influenced by changes in other parts of the wider network of systems such as the political and financial systems.

In the literature, there are limited applications of systems thinking in health systems research in LMICs. Studies identified range from investigation of immunization systems and neonatal mortality in Uganda, evaluation of task shifting in Bukina Faso, and stakeholder network analysis in Nepal and Somaliland. Researchers in Uganda used a systems tool, the causal loop diagram (CLD) to identify the potential leverage points in both immunization and neonatal care systems that could improve the performance of both parts of the health system (Rwashana, Williams & Neema , 2009; Rwashana, Nakubulwa, Nakakeeto-Kijjambu & Adam, 2014; Bocoum, Kouanda, Kouyaté, Hounton & Adam, 2013). CLDs are visual representations of cause-and-effect relationships between different elements or factors in a

system that have either positive or negative effects on the studied outcome and often involving reinforcing or balancing feedback loops (Rwashana, Williams & Neema, 2009). A good example of this approach can be seen in a study of a task shifting intervention in Burkina Faso. The researchers engaged multiple stakeholders to develop a systems conceptual framework that guided their evaluation of the system wide effects of the intervention (Bocoum et al, 2013).

Systems approaches direct attention to the environment (context) within which the system operates including the political, legal, demographic and economic environments (Atun & Menabde, 2008). The contextual factors proposed by Atun and Menabde were developed into a framework used by multi-disciplinary teams in evaluation studies of communicable disease programs in (some European) health systems (Atun & Menabde, 2008). In the study described here, the framework was adapted to explore the interaction of one maternal health intervention with local contextual factors. It was not intended to be an evaluation of the health system or the intervention, it was an exploration of the application of such a systems framework in understanding the influence of the local context on outcomes of intervention programs (see Figure 5:1A & B).

5.4 Study purpose

The specific purpose of this paper is to explore the impact of interacting local factors on public health interventions aimed at improving access to maternal health services in the four districts of Zambia's Western Province. Western Province is one of the predominantly rural provinces in the country and is split into two parts along its length by the Zambezi River system. The associated flood plain experiences seasonal flooding during the rainy season. With increasing climate variability, alternating seasons of intense droughts and heavy flooding have increased, affecting the ability of local communities to interact with the outside world or access goods and services for extended periods.

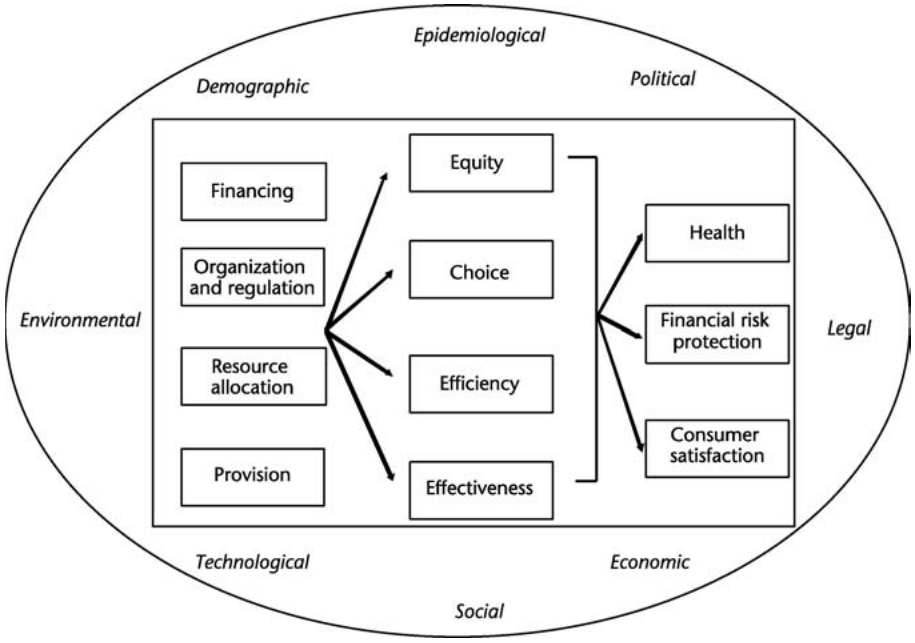

Figure 5:1A A framework for analysing health systems and the context (Source Atun & Menabde, 2008).

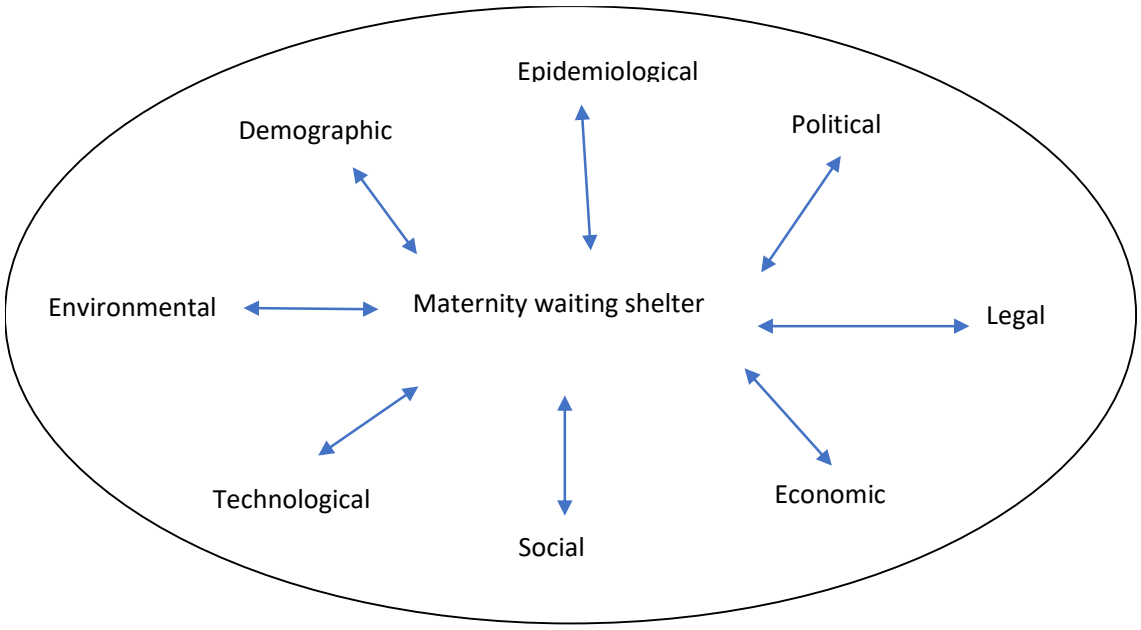

Figure 5:1B Framework adapted to a specific intervention: the maternity waiting shelter

5.5 Methods

5.5.1 Study design

A qualitative study design was used based on key informant interviews and focus group discussions.

5.5.2 Study setting

Four districts in the Western Province in Zambia (out of 16 districts in the province) were included in the study selected because of their proximity to the Zambezi River. These are Mongu, Kalabo, Mitete and Nalolo districts.

The Zambezi River basin (shown in Figure 5:2A below), one of four main river systems in Zambia, divides the Western Province from north to south. The province (shown in Figure 5:2B) has a population of 902,074 which forms 7 % of the national population (CSO, 2012) and the highest poverty level in the country at 82% while the national level is at 54% (CSO, 2016). Eighty eight percent (88%) of the residents live in rural dwellings (CSO, 2016). The province experiences seasonal flooding during which affected communities must temporarily relocate to higher ground resulting in disruption of health care services for different communities for extended periods of time.

5.5.3 Recruitment

Key informants were purposively selected as they were thought to be information rich sources of data. These participants included Ministry of Health employed health providers and administrators from the four districts as well as the provincial office; Ministry of Education employees from the four districts; officers from Ministry of Local Government, Ministry of Community Development and Social Welfare and traditional leaders from the four districts. One maternal and child health (MCH) coordinator from each district was included among the health providers. The total number of key informants interviewed was 26.

Figure 5:2A The Zambezi flood plain in Western Province. Source Western Power Company Ltd, 2020

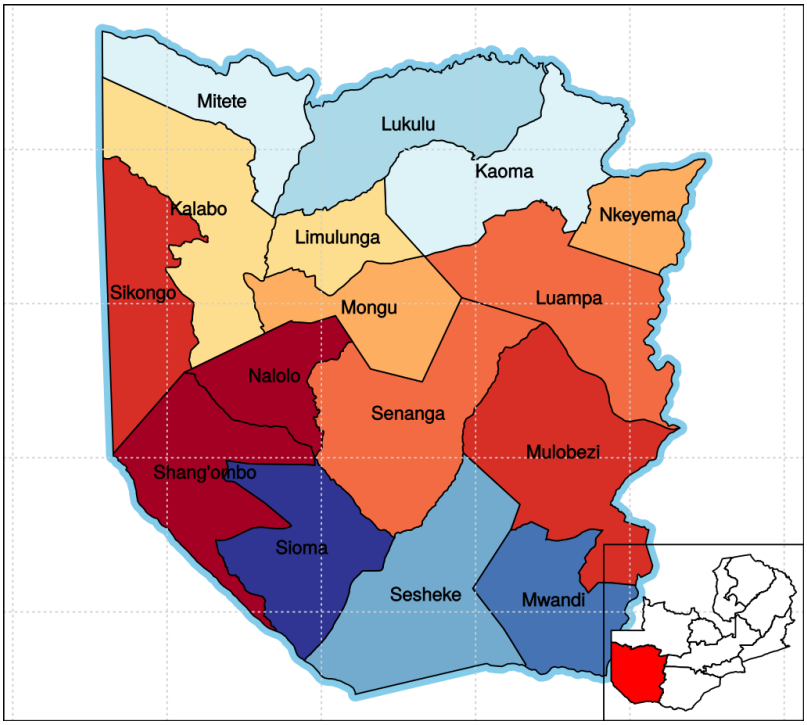

Figure 5:2B MAP OF WESTERN PROVINCE downloaded from https://simple.wikipedia.org/wiki/Western_Province,_Zambia

Participants for focus group discussions were both men and women above 18 years of age living in the study sites and accessing health services in the area. These included farmers, teachers, local businessmen/traders and "ordinary citizens". In each district, 2 focus group discussions were conducted with a total of 61 participants mixed by gender and occupation. In addition, individual interviews were conducted with five health service users in each district, for a total of 20 interviews.

5.5.4 Data collection

Field visits were conducted in 2019 and 2021. During June-July 2019, preliminary discussions with key stakeholders and health administrators in the province were undertaken. Site observations and selection for the study was done, as well as piloting the interview guide in districts not included in the project. Training of research assistants, as well as interviewing participants and focus group discussions (FGDs) was conducted in January and February 2021.

Key informant interviews were conducted in English and/or the local language of Lozi while focus group discussions and health service user interviews were conducted in Lozi by the trained research assistants. The research assistants underwent a three-day training in interview techniques and focus group facilitation. All the interviews were conducted in person using interview guides and the average duration of the interviews was 30 minutes. Two research assistants facilitated the focus group discussions which allowed one of them to lead the discussion while the other handled the recording and took notes. All the interviews were recorded after obtaining informed consent from all participants. Ethics approvals were obtained from the University of Waterloo office of research (Reference number 42070) and the Eres Converge Ethics board in Lusaka Zambia (Approval number: 2020-Nov-006).

5.5.5 Data management and analysis

Interview recordings were transcribed and translated from Lozi to English. The translated Word documents were then imported into Nvivo 12 software for coding. Data analysis followed procedure outlined by Braun and Clarke (2006) beginning with familiarization of the data by repeated reading of the transcripts and listening to the audio recordings of the

interviews. This was followed by generation of initial codes in the transcripts. Coding of transcripts was undertaken both deductively and inductively. Initial codes were derived from the systems theoretical framework focusing on contextual factors. Additional codes were inductively derived from participant responses. Codes were then grouped into categories.

5.6 Findings

5.6.1 General observations

A total of 107 participants were included in the study as indicated in Table 1 below. Key informants (KIIs) were government officers from ministries of health, education, community development and social services and local government, as well as local community leaders and officers from nongovernmental organizations. Two FGDs were conducted in each of the study districts and five individual interviews with health service users (HSU) were conducted in each district.

Table 5:1 Respondent characteristics

	MALE	FEMALE	TOTAL
KII	16	10	26
FGD	30	31	61
HSU	12	8	20
Total	58	49	107

5.6.2 Interventions

The programs being implemented in the study districts to improve access and outcomes in maternal health services discussed by respondents were either facility- or community-based. Facility-based interventions include facility expansions to include a maternity ward for some facilities; building of maternity waiting homes (MWHs) in some areas, and skills development for different levels of providers such as new midwifes being trained and clinicians being equipped with appropriate skills to provide basic and/or comprehensive

emergency obstetric care. Training programs and facility expansion or upgrading were discussed at the provincial level and apply to the whole province. However, the gap to be filled in this way is still significant as complaints of inadequate numbers of facilities and staffing at those facilities were repeated in all districts, contributing to the challenge of long distances between residents dwelling places and health services. Outreach programs include services for antenatal and postnatal care, family planning services, growth monitoring and immunizations for children under the age of five also depend on facility-based staff to conduct these programs or supervise community health workers involved in these activities, although the outreach efforts are conducted at designated primary health care (PHC) and neighborhood health committee (NHC) service points. Supplying extra essential drugs in advance of the flood seasons was discussed by respondents who are health care workers and transportation arrangements from the district health office to cover emergency situations and outreach programs were described in all the districts.

Community based interventions that were described involved mobilization of financial or material resources to assist travel to health facilities for maternal health emergencies and engagement of safe motherhood action groups (SMAGs). For example, some communities collectively contribute money to hire local transportation such as oxcarts or canoes to be used when there is an emergency while others rely on the generosity of fellow villagers and neighbours and still others may be required to pay a fee for the service. Programs of engagement of male community members and traditional leaders were also discussed at the provincial level but not at the other levels (district, facility, or community). With the help of financial partners, community distribution of family planning methods and services by trained volunteers is being conducted in the districts. Table 5:2 below summarizes these interventions and the stakeholders who are involved.

TABLE 5:2 Interventions being implemented in the study districts

	PROGRAM	STAKEHOLDERS	COMMENT
	MATERNITY WAITING HOMES (MWHs)	MOH/FINANCIAL DONORS	Some areas need MWHs to be built.

			Logistics for existing shelters should be increased.
	FACILITY EXPANSIONS	MOH/FINANCIAL DONORS	Dependant on higher level planning and funding
	OUTREACH	MOH/COMMUNITY	Dependant on availability of staff and transport
	PHC/NHC	MOH/COMMUNITY	Needs capacity building-can be strengthened
	SMAGS	MOH/COMMUNITY	Further support to carry out tasks, e.g transportation-bicycles for visitation and patient referral when there is need
	TRANSPORTATION ASSISTANCE PROGRAMS	LOCAL GOVERNMENT; MOH; COMMUNITY	Depend on availability of funding.
	COMMUNITY FAMILY PLANNING DISTRIBUTION	MOH; COMMUNITY; FINANCIAL DONORS	Can be improved with availability of transportation.

5.6.3 Factors influencing intervention outcomes

Local factors discussed by respondents perceived to influence the interaction of communities and health programs being implemented are as follows: -

1. Political/economic-health system and technological factors

Through the efforts of the political administration, health services are being provided in all districts through the establishment of hospitals, health centres and health posts. Of the four study districts, Nalolo and Mitete do not have a hospital, while Kalabo and Mongu districts each have two hospitals. Health care workers in these facilities are employed by the government to undertake all health system activities including outreach programs especially for pregnant women and young children. These outreach activities are conducted with the support and involvement of community health workers and volunteers.

1. a Organization of the Health system

Health service delivery in the districts is organized in ascending order from health posts that are the first point of contact for communities with the health system, health centers and level 1 hospitals. While health posts offer basic diagnostic services by trained community health assistants, there are no skilled health care workers to provide maternal services; these are offered at health centers and hospitals. Health centers have at least one nurse, but larger health centers may have a nurse, clinical officer and an environmental health technician and will refer their complicated cases to the nearest first level (district) hospital. The following tables show the summary of facilities and skilled health care workers in the study districts in 2019 as documented in the provincial strategic plan.

Table 5:3 Number and Type of Health Facilities in the Study Districts (source Western Province Health Plan, 2020).

District	Hospitals	Health centres	Health post	Total # of facilities	Population
Mongu	2	20	13	35	151426
Kalabo	2	12	16	30	98058
Nalolo	0	9	9	18	65308
Mitete	0	3	6	9	32281

Table 5:4 Number of Health Care Workers, by level of Health Facilities, in the Study Districts (source Western Province Health plan, 2020**).**

District	Number of health facilities	Number of trained health care workers (HCW)	Average number of HCWs per health facility	Health facility without trained health care workers.
Mongu	35	232	6	3
Kalabo	30	27	1	2
Nalolo	18	24	1	5
Mitete	9	11	1	1
Province	287	596	2	20

MWHs are one important intervention that has been implemented in the province in some remote areas. This was discussed by key informants at provincial and district levels. Health care workers mentioned their presence in two districts- Kalabo and Mitete while health workers in Mongu and Nalolo did not comment on them. Kalabo differs from Mitete in having 2 level-one hospitals (one run by the Ministry of health and another by a religious organization) and three times the number of health centres as Mitete. The level 1 hospital servicing Mitete district is located in the neighbouring Lukulu district; this presents a geographical barrier of access for communities in Mitete district, which is on the opposite side of the Zambezi River.

Although a waiting home for Mitete district is available at the hospital, one health service user suggested that either there was no shelter available for women at the nearest health facility that he was aware of or that what was available may not be appropriate or acceptable.

> **"The problem of women giving birth at their homes is a big one here because some live very far and then at the hospital, there isn't a proper place to stay so they are afraid of being stranded".** HSU_Mitete

Sentiments by community members in Nalolo district where health care providers did not mention MWHs suggested that the intervention is not available to them.

> **"We were going to be helped if there was any place to stay at the clinic so that when it is the eighth month of the pregnancy you can go to the clinic and wait. When it is time for the pregnancy then people can easily come here to the big hospital"**. Nalolo_FGD

While the reference to MWHs at the facility was discussed specifically by health administrators from two districts and the provincial level, it was also stated that there were challenges associated with the intervention which made it unaffordable for some pregnant women as it was considered an extra cost for their families

> **"So, the woman is supposed to go with the relatives so they can wait for the day to come, at least they deliver while at the facility instead of starting off from home when they know that where they are going is far. That's what is supposed to happen, although there are instances where they say they can't afford to go to those places, so, they will stay just like that. When they feel that the labor has started, they'll start their journey, but mostly you will find that before they reach there, someone would have delivered."** KII_Kalabo

It is the role of the health promotion officers to sensitize and educate women in their communities on the importance of having their deliveries attended by skilled health workers. This is done with the support of safe motherhood action groups (SMAGs) who are groups of volunteers in the villages who are trained to educate and encourage pregnant women to attend ante natal care and to prepare for delivery by moving to the health facility waiting shelters as they approach their expected date of delivery.

The role of collaborating partners in supplementing the efforts of the national government by supplying funding for the construction of MWHs in the province was presented. Reference was made to the work done by UNFPA, World Vison and religious organizations to build such facilities and equip them with bedding and other supplies in different districts. Of the districts included in this study, specific reference was made to Lukulu district which is the referral backstop for Mitete district facilities.

In a discussion at the provincial level, the role of partner organizations also related to provision of food for residents in these waiting homes, a commonly cited reason for women not coming to use a waiting shelter.

> **"Also, things like construction of the mothers' shelters to encourage women to go and wait for the delivery in this nice room, the comfortable bedding and cooking facilities. So, they are encouraged to go and wait for a delivery in this shelter, which is clean, well-constructed and running water and just good ventilation. So, some organizations also they come in once in a while to help us with food for the women who are admitted in the mothers' shelter to make sure that they have adequate food because most times they complain about food to eat when they are in those waiting shelters. So, when they are given a reassurance that food will be provided especially in terms of mealie meal [maize meal], they feel encouraged to go and wait for a delivery in the mothers' shelters."**
> KII_Mongu

While MWHs are an intervention that is helping address the obstacle of long distances to health facilities where skilled attendants are found, other challenges exist, especially financial resources needed to cater for the food, beddings and other needs required to stay in a shelter. This remains a deterrent to the uptake of this intervention despite efforts by community groups such as safe motherhood action groups (SMAGs). Their role in facilitating the use of the MWHs was highlighted during interviews. SMAGs are an extension of maternal services in the communities offering health education for expectant

mothers as well as advocating for the deliveries to be attended by skilled health care workers usually at facility level to prevent complications or attend to them as soon as they are identified. SMAGs incorporate the cadre of women in communities who previously operated as traditional birth attendants. As part of SMAGs now, they identify and follow up pregnant women in their communities encouraging them to make use of available maternal health services, sometimes, facilitating the movement of expectant mothers by escorting them to the MWH, but transportation is a challenge for this additional support.

1.b Developmental factors

This group of factors included political, economic, and technical issues that concerned residents. Community members feel that the government and the elected officials have not paid much attention to the challenges they face in terms of accessing health services by not employing more skilled health workers, not increasing the number of facilities, and not offering remuneration to community volunteers.

Focus group participants expressed dissatisfaction with the political administration, suggesting that they feel neglected by their elected representatives. This, to participants, is what has contributed to the lack of economic and social development in the study regions and is apparent in the absence of basic services such as availability of safe drinking water and proper sanitation. It is also the perceived reason why educational institutions are limited in number, especially tertiary institutions. In some of the remote districts, primary and secondary educational institutions are lacking. This has the ripple effect of limited human resources in service industries such as education and health care. At present, health care workers from other parts of the province and the country are not willing to take up positions in remote districts such as Mitete. This is how one key informant expressed it:

> **"We need more human resources because people do not prefer Mitete because of all the challenges associated with its' remoteness. Especially the young ladies, they fear the waters and the attrition rate is too much here, because of all the challenges. So, we need a lot of support. If the residents can be engaged and trained, maybe they can reduce the attrition rate."** KII_Mitete

Lack of economic and technological development is experienced in these remote areas as lack of basic services such as piped water systems, sanitation facilities, economic institutions such as banks, educational institutions as well as limited health facilities and workers. Availability of electricity is also a challenge as some areas, especially Mitete district, are not connected to the hydroelectric grid. Lack of essential services like electricity works against attraction and retention of human resources in these rural districts. Absence of telecommunication installations in some of the remote areas results in communication challenges which negatively affect the referral system for emergency health care services especially obstetric cases, and this has occasionally led to loss of lives as reflected in the following comments:

> **"So, when there is a complication, they have 1st of all to look for network to communicate to the district that there is a complication. The district must organize fuel, look for the people to go and evacuate that woman. Some of the facilities, like I said are about 200kms away. So, you need about 4 hours to travel one way. Think of the woman who is calling, sometimes in cases of pph (post-partum haemorrhage). So, 4 hours going to where the need is and the health worker tries to deal with the situation there and fails, then another 4 hours coming back, it becomes difficult. Sometimes, we have even lost women on the way."** KII_Mongu

Mitete is most affected with poor communication but some areas of Nalolo are similarly challenged. Reports from these areas indicate that residents can only access mobile networks for communication in specific locations and specific times.

> **"We also have a problem of network. We travel three hours to a place where we can access network and pass through the place where there are hyenas. The same network, for us to access it we have to climb in trees and that is only from 19 to 22hrs."** FGD_Mitete

Most communities earn their living by small scale farming, fishing and trading. Extreme weather events in the area – floods and droughts – have a negative effect on their livelihoods therefore impacting their level of income and ability to purchase goods and services. Transportation to health facilities requires payment in some cases which is a challenge to some community members. While some communities have made local efforts where ongoing contributions are made for such eventualities, this is not universal.

2. Socio-cultural factors

The poverty level in the province is high and participants alluded to limited resources or financial capacity to help them access services being provided by the health facility or health system. Basic social services such as education, clean water, and sanitation, as well as basic health services, are limited in the study districts. While the challenges in health services, water supply and sanitation were discussed in all districts, participants from Mitete, which is the most remote, indicated that they do not have adequate numbers of schools and teachers, as one participant expressed:

> **"About what we need, we have only two teachers from grade 1 to 9, so how can these teachers work? We are asking for more teachers."** FGD_Mitete

Most health services are facility based and require residents to travel long distances, especially for maternity services. Financial challenges along with a traditional culture where older women are called upon to assist in childbirth contribute to decisions for pregnant women to deliver in the villages rather than travel long distances to deliver at a health facility with a skilled health care worker.

> **"Pregnant mothers give birth in the villages because we don't have things to take them to the facilities."** FGD_Mitete

Culturally, the occupants of the flood plains sometimes migrate to higher land. This takes them further away from available health facilities and is another reason for pregnant mothers to make use of the waiting homes service. However, traveling away from the family requires women to have the appropriate support to take care of the family while they are away. They also need an extra supply of food, bedding and self-care materials which is difficult for some,

especially when their livelihoods are destroyed by unfavourable weather conditions which have affected the study district.

Culturally, women are taught and expected to be submissive to their husbands who are the head of the home. Men are therefore being engaged through outreach and health education activities to support their wives towards safe motherhood practices. However, not all men are fully on board and there are those who traditionally will not allow their wives to use the available facilities such as the maternity waiting shelter or the health facility. In the words of one key informant:

> **"We have people that are out in the plains, and they are so… I wouldn't want to use the word primitive. They are so much into tradition. And they say, if you are going to want to access maternal health at the clinic, they are going to give you medicines that are either going to make the child dumb or kill the child. You know what I mean. And then you know how ladies are told to be submissive to their husbands. They end up becoming submissive to that kind of traditional way of thinking. And that eventually affects the access to maternal health."** KII-Mongu

The local health administration has recognized this and are responding through education for men.

> **"We have also held meetings with men as key decision makers. We know our culture, most times, these women will not make their own independent decisions. So we said, behind every pregnancy, there is a man. We should not leave these men behind. Let's move with them from conception of this pregnancy, through delivery, including family planning just to pick support from them".** KII_Mongu

Traditional ways of dealing with health challenges are used by locals as a coping mechanism. Their apparent effectiveness in relieving symptoms encourages their use as a primary treatment for those who live very far from any health facility. Participants from all the districts alluded to the use of traditional medication or consultation of traditional practitioners who are closer to them in the villages. This appears to apply sometimes to

childbirth practices in some remote areas resulting in more home deliveries as stated in the quote above from a focus group participant in Mitete. While general reference was made to older women assisting in matters of health, there was no specific mention of the term "traditional birth attendants" (TBA).

3. **Environmental factors**

These include the geographical terrain and distances between villages and the health facilities with skilled health care providers as well as the lack of a both proper road networks and public transportation system. This makes travel to health services difficult as most health seekers walk to these access points. Oxcarts and bicycles are used for clients who are unable to walk e.g. elderly patients and pregnant women. There are communities whose only accessible health service is situated across a river in which case water transport such as canoes are used to cross the water body. However, when there are floods, low lying areas are covered with flood waters making normal routes inaccessible for pedestrians.

> **"Mitete that other side (meaning western side). We are flooded for six months, so half a year, the district is under floods and all the facilities they are under floods. And when there are floods, all the health services they are compromised because the movement of people is very much reduced. People they do not move like before."** KII_Mitete

When flood water levels are high, transportation by boats is made easier when these are available. The district health office usually has a boat available for use. However, there are areas where the terrain of the flood plains is interrupted by islands and tall grasses making it impossible to traverse by boat. In these cases, ox carts driven by animals that can wade the flood waters and are used to take clients to a point accessible by vehicles/ ambulances. Ordinarily the terrain is sandy and accessible only by using four- wheel drive vehicles.

> **"And you can't use any other means of transport, only a boat. Unfortunately, there are some places you can't use a boat because the floods are separated by highlands. So, you can't use a boat in that case. And in this case for the referral**

system, the referral of emergencies for maternal cases is compromised."

KII_Mitete

Environmental conditions also significantly affect the level of agricultural productivity of the residents in the study districts. Most are subsistence farmers and normally rely on the fertility of the soil in the flood plains to grow food crops such as maize, cassava and rice. Traditionally the locals would time their planting and harvesting seasons according to established rainfall and dry seasons. In recent years, these seasons have become increasingly unpredictable, and the region has also been experiencing cycles of severe droughts and intense flooding. Both types of extreme weather events have negatively affected crop yields, limiting income generation for many. Ability to pay for services such as transportation to health facilities even for pregnant women is severely affected, as is their ability to buy foods and other requirements for them to use should they travel to lodge at the nearest MWH.

"People don't have access to businesses, to food, other items that are needed for their wellbeing. That causes other problems within their families. Climate change is showing much more effect now and the rain season, the rain pattern is also changing so you cannot tell when the rains are coming to an end and the extent of the rains that you are going to receive in a particular year. So, that now increases the density of the problem because when you have so much rain, it means you will have more floods which will last for a long period of time and as a result all those effects we are talking about are also actually extended. You will find that people will be cut off from a main town for a long period of time and access will be difficult even for such things like child health and maternal, maternal health are mostly affected. Except that maybe most of the people in the village they are gotten used to doing things traditionally even without coming to seek for medical attention from the main hospitals which is not safe. So, they are forced to stay there because the floods they have proven difficult for them to, to crossover and access the, the health facility that is available in the town."

KII_Kalabo

5.6.4 Causal loop diagram

The following causal loop diagram (CLD) summarizes initial observations of the causal relationships between different factors interacting with maternity waiting homes in the district (see Figure 5:3). This diagram is proposed as a potential tool that will facilitate future stakeholder engagement and discussion for problem solving.

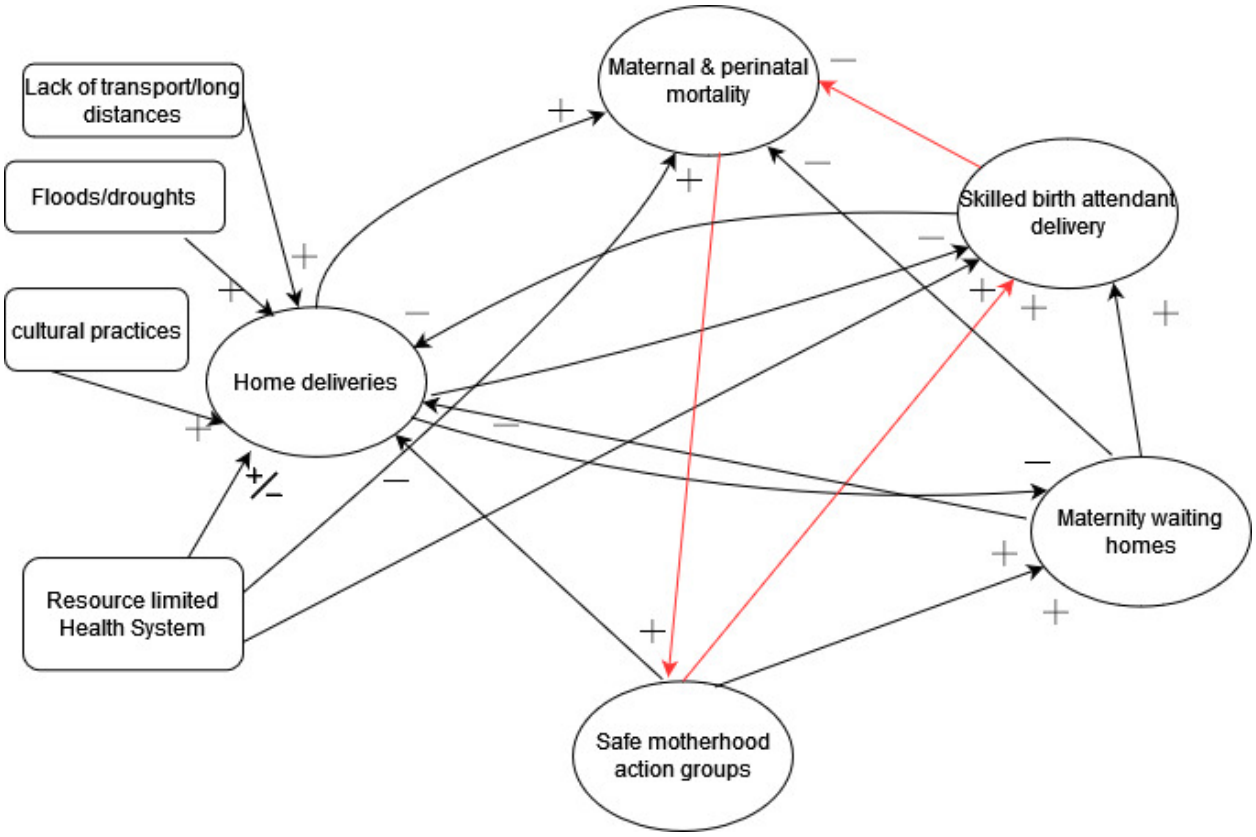

Figure 5:3

Causal loop diagram of factors influencing maternal and perinatal mortality. The causal loop diagram shows how the different factors are interacting with each other by arrows indicating the direction of influence and the + or – sign indicating a reinforcing or balancing effect. The red arrows illustrate a balancing loop in which concern for maternal mortality led to the formation of SMAGs that have been useful in educating communities and increasing the uptake of skilled birth attended deliveries resulting in a decline of maternal mortality.

The CLD above relates factors contributing to maternal and perinatal mortality in communities with limited access to health care and increased numbers of complications associated with childbirths conducted at home. Where these complications have been severe, there have been loss of both mothers and babies. In response to these outcomes, health authorities have implemented programs to encourage pregnant mothers to have their deliveries conducted in health facilities so that they are attended by skilled health care providers who would be able to institute relevant interventions in the case of complications. One solution has been building mothers waiting shelters in the vicinity of some health facilities where mothers from very remote areas can lodge as they approach their expected delivery dates. In addition, residents and community health workers have been organized into safe motherhood action groups (SMAGs) in the villages and have been trained to follow up pregnant women and educate them on the benefits of having their deliveries attended by a skilled health care worker. The diagram is showing the interaction of different factors and the direction of influence is indicated by the direction of the arrows and the positive (+) or negative (-) sign at the arrowhead. For example, home deliveries and associated complications increase maternal mortality while deliveries attended by skilled birth attendants lead to a decrease in maternal mortality. The greater the number of home deliveries, the greater the maternal mortality. However, there are multiple factors influencing the decisions for residents to opt for home deliveries, some of which are indicated in the diagram. The number of links between the different factors in the diagram is not exhaustive as this is meant to generate discussion and joint decision making among stakeholders. One example of a balancing loop indicated in the diagram follows the arrows from maternal mortality to training SMAGs that have been useful in educating communities and increasing the uptake of skilled birth attended deliveries resulting in a decline of maternal mortality. However, without interventions, the poor quality of health service due to limited resources, has a reinforcing effect on maternal mortality.

5.7 Discussion

The findings of the study indicate that there are several public health interventions aimed at improving access to maternal health services that are being implemented in the study districts. These include facility-based interventions such as facility expansion, building of MWHs and skills development programs for health care providers; and community-based interventions such as distribution of family planning services and health education and promotion using volunteers such as SMAGs. The study further found multiple factors influencing outcomes of implemented public health interventions. The main ones were organizational factors (distribution of health resources), economic and developmental factors, socio-cultural factors, and environmental factors including extreme weather events, long distances, and lack of transportation. Some of the interactions of the different factors are indicated in Figure 5:3 above.

These findings are consistent with those from other researchers who have investigated the performance of maternal health interventions in different contexts. In their review of implementation of MWHs in LMICs, Pen-Kekana and colleagues reported barriers such as long distances, cost and availability of transportation, lack of knowledge or awareness of the benefits, non-inclusion of culturally acceptable practices, non-acceptability of intervention by other family members and lack of food supply and inappropriate hygiene and sanitation facilities (Pen-Kekana et al, 2017). Their study also found that involvement of traditional birth attendants (TBAs) who are known and respected in the communities was one of the facilitators of uptake of the intervention, as well as removal of the financial cost of providing their own food and transportation (Pen-Kekana et al, 2017). Another evaluation of a quasi-experimental study involving implementation of an improved model of MWHs in selected rural districts in Southern, Eastern and Luapula provinces of Zambia reported increased uptake of the MWHs with associated increase in facility-based deliveries as well as postnatal care services **(**Scott, Kaiser, Ngoma, McGlasson, Henry et al, 2021). However, the study included only health facilities that were within 2 hours travel time to a referral hospital, which was different with facilities in the present study **(**Scott et al, 2021).

It is noteworthy that TBAs were not specifically mentioned in the interviews. However, reference to the services or assistance of older women in general was made as a health behaviour resulting from traditional practice and the practical reality of health services being located very far from the dwelling places of residents in the remote areas. Some of these birth assistants have been incorporated into the SMAGs and are working to help educate communities on safe motherhood practices including the promotion of having deliveries conducted by skilled birth attendants. Birth assistants have been known to operate in remote areas assisting villagers to conduct deliveries and their role in Lukulu district of western province was described by van den Boogard and colleagues in 2008 who advocated for their incorporation into newer strategies considering their cultural significance and value in remote areas (van den Boogard, Arntzen, Chilwana, Liyungu, Mantingh, & Stekelenburg, 2008). Sialubanje and colleagues also noted the value of TBAs in conducting deliveries in parts of Kalomo district where they were found to be the preferred birth attendants for older women in comparison to younger women who reportedly preferred facility deliveries (Sialubanje, Masser, Hamer & Ruiter, 2014). An evaluation of the SMAGs intervention in rural Zambia found that they had positively influenced the coverage of maternal and neonatal interventions (Jacobs, Michelo, & Moshabela, 2018).

The findings of this study reflect barriers that straddle all three phases of delay contributing to maternal mortality tabulated by Pacagnella and colleagues (2012). This is consistent with the use of the systems framework which emphasizes the interconnectedness of different subsystems (like government departments) to influence the characteristics and behaviour of the greater whole. The need for different government departments to work together to improve the standard of living for rural communities is apparent. Comprehensive solutions will include improvements in housing, supply of water and sanitation facilities, roads, and provision of public transportation for local communities to access essential services, education services by building more schools and providing teachers, improving health services in general by increasing the numbers of skilled health care providers as well as rural health facilities.

Analyzing the interaction of the factors shown in the CLD in Figure 5:3, the effect of interventions appears to be synergistic: groups of factors seem to work together, such as the factors that encourage skilled birth attendance. This is consistent with the works of Ensor and Healey and their teams who reported on complex interventions that incorporated multiple elements targeting different aspects of the access problem (Ensor et al, 2014; Healey et al, 2019). This also strengthens the view that effective solutions to longstanding complex public health challenges such as limited access to maternal health services should be developed with particular attention to the synergism of causal factors that need to be addressed. However, interventions that are internationally funded (like the saving mothers giving life initiative) risk being unsustainable once the external funding is withdrawn, making local innovations necessary to program development.

We also observe that stand alone or "silo"-type interventions may not be enough to bring about meaningful change. Rather, as shown by some comprehensive intervention programs mentioned here, multiple aspects of the complex problem ought to be addressed at the same time. However, as Kruk and colleagues argue, sustainability of externally funded programs is limited (Kruk et al, 2016). Local capacity is required to develop multi-pronged interventions led by multi-disciplinary teams with the full participation of beneficiary communities.

Limitations of the study- Time available for data collection in all the districts was limited. This was especially true for Mitete which is the most remote and distant from the provincial capital, Mongu. The required preliminary steps for project approval, such as ethical clearance from relevant authorities, also limited the time available for data collection. Finally, challenges arose with recruiting for the focus group especially among women as some live very far from health facilities and the flood season had already begun at the time of data collection. Time limitation was further exacerbated by the COVID 19 Pandemic which begun in early 2020 and caused a global shut down that negatively affected academic and research activity, leading to significant delays in ethics clearance processes and travel for field work. Additionally, because of COVID 19 pandemic restrictions, intended workshops with

stakeholders to discuss findings in relation to local priorities and potential steps for interventions were not possible but are planned for a later date.

5.8 Conclusion

The interaction of multiple interdependent sub-systems in the lives of residents in the study areas is demonstrated. While much of this seems to be taken for granted, it must be clear to policy makers that lasting solutions for cross-cutting societal problems including access to essential services require the participation of multiple stakeholders. For areas such as the districts in this study, development across different sectors is required and must be prioritized. Developing the road network for example, will immediately allow better movement of residents, goods and services for improved living, health, and wellbeing. While this responsibility lies outside the jurisdiction of the Ministry of Health, constant communication, and exchange of assessed needs in such rural and remote areas between government departments would be helpful for prioritization and allocation of funding for developmental projects. Meeting the health needs of residents as close to their dwelling places as possible translates in the study area to increasing the numbers of skilled health care workers especially nurses, midwives and clinicians who possess the surgical skills needed for emergency obstetric and neonatal procedures. It also means increasing the numbers of health facilities with capacity to attend to emergency situations

Chapter 6 Discussion and Conclusions

6.1 Introduction

The aim of this research was to apply a systems thinking framework to the investigation of contextual factors influencing access to maternal and child health (MCH) services in Zambia's Western Province where there is increasing variability in seasonal floods, with a view to improving mitigation strategies.

The main objectives of this study were:

1. To identify the effects of flooding on access to maternal and child health services in flood prone areas of Western Province, Zambia.
2. To explore the perceptions of environmental change among residents of the Zambezi flood plains in Western Province and how these changes influence health outcomes.
3. To understand the interaction of contextual factors on public health interventions for maternal health from a systems perspective and identify potential leverage points for improvement.

6.2 Summary of key findings

Chapter 3 responds to the objective of identifying the effects of flooding on access to maternal and child health services in the Western Province of Zambia. The main themes identified in the study were effects on health service delivery, effects on transportation, effects on livelihoods and effects on water and sanitation. Chapter 4 focused on the perceptions of environmental changes observed and experienced by residents in the Zambezi flood plains as well as resulting health behaviour and outcomes. The main observations reported involved changes in seasons, changes in the natural environment including the river and species of organisms, the increased frequency of extreme weather events especially floods and droughts, and the negative effects of the stated environmental changes on their agricultural activities which is the main livelihood, resulting in perpetual economic hardship. Reported health behaviours resulting from the challenges exacerbated by environmental changes were using local alternative treatments for health problems due to transportation challenges, missing follow up visits at health facilities, and preferring to have home

deliveries for pregnant mothers. Noted health outcomes included death from drowning, death of very ill patients in transit to health facilities, complications of child births conducted at home and in transit to health facilities including maternal and neonatal deaths, increased occurrences of vector borne, and water borne diseases, and the increased threat of malnutrition because of food insecurity from crop failure. Chapter 5 then explored the interaction of contextual factors on public health interventions for maternal health from a systems perspective. The findings demonstrated several public health interventions including facility-based interventions like facility expansion, building of MWHs and skills development programs for health care providers, and community-based interventions such as distribution of family planning services, health education and health promotion using volunteers such as SMAGs. Multiple factors influenced outcomes of these interventions including organizational factors (distribution of health resources), economic and developmental factors, socio-cultural factors, and environmental factors like extreme weather events, long distances, and lack of transportation.

6.3 Contributions of this research

6.3.1 Theoretical and methodological contributions

Literature on the application of systems theory and methods to health systems research in low- and middle-income country settings is limited. This research, therefore, contributes to the existing body of knowledge on the utility of systems thinking in health systems research by adapting the theoretical principles of systems theory to the different study elements. The study achieves this by framing the whole of society as a complex system in which the health system is only one part. The different contextual elements that constitute and affect human lives are viewed as sub-systems, parts of the wider system. The involvement of individuals in multiple sub-systems and the resulting interactions of the different parts on each other was explored. The findings then demonstrate this interaction.

For example, one of the biggest challenges experienced by communities in the flood plains was the devastation of livelihoods by both floods and droughts. Not only does this result in food insecurity, but it also compromises health seeking behaviour and affects health

outcomes. It also affects school attendance for children contributing to ongoing cycles of ill health, lack of education and poverty. By demonstrating the interlinkages between the different elements ("systems") of human endeavor, the research illustrates how systems thinking can be useful to explain the value and role of different stakeholders (and the institutions or organizations they represent) in shaping the environment in which their communities live as well as the necessity of interventions that address multiple elements. The thesis also extends knowledge in demonstrating the potential for systems tools to uncover causal links between system elements that can then be useful in identifying leverage points. Chapter three illustrates this in the CLD that was presented to show some of the interactions between contextual factors. Analysis of these interactions will facilitate prioritization of and development of more effective interventions.

The thesis advances the principle and potential of interdisciplinary collaboration between multiple stakeholders, a characteristic of systems thinking. Functional interdisciplinary teams sharing knowledge and other resources will strengthen efforts to build climate resilient health systems in environments that will continue experiencing the effects of climate change like the flood plains in western Zambia.

One of the systems methodological tools useful in health systems research and practice is soft system methodology. This involves the participation of multiple stakeholders sharing their views on a situation of concern and agreeing on feasible actions to address it (De Savigny, Blanchet & Adam, 2017). These joint learning sessions are also opportunities for stakeholders to discuss and highlight ways in which implemented programs have brought about unintended results in different sectors or departments. (De Savigny, Blanchet & Adam, 2017). This research applies this principle in the selection and inclusion of stakeholders external to the health system as participants to share their views and experiences of the health topic. This was an important first step which can be built upon to include interactive sessions where these ideas are further developed as different perspectives and concerns are shared among representatives of different government sectors. The inclusion of traditional leaders as participants in the study was both a demonstration of the value of different sources of knowledge in the wider system as well as a demonstration of the potential of

transdisciplinary collaboration that could be developed for the purpose of joint problem solving.

The use of the CLDs as an analytical tool as illustrated in chapter 5 is another contribution that strengthens stakeholder engagement. This systems tool facilitates the understanding of underlying causes of complex problems while the visual representation also allows identification of potential points of intervention. The CLDs can ideally be jointly developed and refined through the participation of multiple stakeholders using different modalities like workshops. Inter-disciplinary research teams could further develop other types of models as deemed necessary to facilitate understanding the factors contributing to public health and other challenges facing the communities in the study districts.

6.3.2 Substantive contribution

This research makes several substantive contributions. The research responds to the call for increased use of systems thinking in health systems research as articulated in the introductory chapter of the thesis.

The findings of the field research provide evidence that documents the effects of extreme weather events on access to essential health services. This evidence is provided through the responses of research participants who are resident in the flood plains of western province as well as those who have been involved in the provision of health services in parts of the province where seasonal flooding presents one of the persistent challenges in health service delivery to remote communities in the province. The study also contributes evidence on the awareness of local communities on environmental change and impacts of ongoing climate change in the region. Environmental conditions and challenges made worse by climate change have an impact on everyday life experiences, especially the agricultural livelihoods of indigenous communities with spill-over effects in every other sphere of life. The lived reality of residents in the study area in relation to the study questions is presented in the findings demonstrating the link between environmental conditions and the resulting health behaviors undertaken as a coping mechanism. Environmental conditions interact with other local factors such as the socio-economic conditions which are themselves influenced by

prevailing developmental and political conditions to shape the health behaviour patterns of the residents, and influence health outcomes. The daily challenges of accessing health services in remote areas of Zambia, as well as the conflicts of limited resources on both provider and user perspectives, cultural heritage and health behaviour are documented in the findings.

The findings of this research are significant for the global community as they illustrate the wide-reaching effects of ongoing climate change. The communities in the study areas are among the least contributors to anthropogenic climate change and yet they experience the resulting harsh reality daily. Major contributors of greenhouse gas emissions as well as global institutions responsible for mitigation measures ought to hear the voices of those who are most affected by climate change such as the communities represented in this study. It is hoped that such reminders would motivate greater commitment and action to address the prevailing situation.

6.4 Implications for policy and practice

This research has demonstrated the interaction of multiple interdependent sub-systems in the lives of residents in the study areas. While much of this seems to be taken for granted, it is important to realize that lasting solutions for cross-cutting societal problems including access to essential services need the participation of multiple stakeholders. Fundamentally, many of the problems facing residents in Western Province would be addressed by raising the standard of living. The study findings demonstrate the low levels of socio-economic development in the study areas. Poverty and related consequences of inability to acquire goods and services required for a reasonable standard of living were found. In some areas, the availability of educational institutions is so limited that access to even basic education is compromised. Meeting the health needs of residents as close to their dwelling places as possible translates in the study area to increasing the numbers of skilled health care workers especially nurses, midwives and clinical officers particularly medical licentiates who are equipped with the surgical skills necessary for emergency obstetric and neonatal procedures.

It also means increasing the numbers of health facilities with capacity to attend to such emergencies.

While the immediate health challenges are the responsibility of the line ministry, the predisposing conditions are far beyond the boundaries of the ministry as they relate to multiple aspects of life in the area. Some of these relate to basic human rights and are the responsibility of the national government through its different political and administrative structures. A systems perspective elaborates the inter-connectedness of the different factors of concern as identified in this study and provides a useful framework for communicating the different influences on health to stakeholders such as government officials and program planners. This is useful since the different factors are typically the responsibility of different government departments. For example, environmental factors in this study included physical environment (Ministry of Environment and Ministry of Lands and Natural Resources) and transportation (Ministry of Local Government and Ministry of Transport and Communication).

Social issues straddle multiple departments including the Ministry of Education, Ministry of Community Development and Social Services which is responsible for the needs of vulnerable sub-populations, especially women and children. Livelihoods fall under multiple ministries (Agriculture, Community Development and Social Services, Commerce, Trade & Industry). Environmental sanitation is the responsibility of both Ministry of Health and Ministry of Local Government. Using a systems thinking framework facilitates the illustration of the interconnections between the different sectors and potential outcomes of those interactions so that decision makers from the different sectors understand the wider-reaching effects of actions they take. This may also help to underscore the need for multidisciplinary collaboration to bring lasting change that will positively influence the lives of residents in the study districts and province. This would demonstrate how systems approaches can bridge the gap between research and practice. A systems framework helps identify gaps that need to be filled in the wider system to improve performance of the whole.

One example in this study is an apparent missing link between water resource management and other departments that were engaged during the research. This gap presents

an opportunity for meaningful collaboration between existing units in the departments such as rural water development, river authorities, transport, and communication authorities as well as environmental sanitation authorities. This would potentially benefit water purification for human consumption as well as development of the water transport sector which is significantly underdeveloped as demonstrated in the findings of this research. Another significant gap is the availability of transportation and the poorly developed road network and infrastructure in the study areas. Developing the road network would immediately allow better movement of residents, goods and services for improved living, health, and wellbeing. While this responsibility is outside the jurisdiction of the ministry of health, it is certainly a necessary link to more services that may improve living conditions.

6.5 Recommendations

This thesis has presented findings describing the effects of flooding on access to essential maternal and child health services in the flood plains. Among the challenges from the supply side of health services is the limited availability of facilities, human resources to be stationed at those facilities, skills to appropriately manage maternal health conditions and emergencies as soon after they arise as possible and limited financial resources which negatively affects plans for expansion of facilities and utilization of existing services such as maternity waiting homes where clients need to supply their own essentials such as food and toiletries. The role of financial partners who have supported the efforts of the Ministry of Health in the province remains vital although innovations are necessary to ensure solutions that outlast the limited duration of externally funded projects.

Considering the research findings presented in previous chapters, the following recommendations are advanced.

1. Road development and building permanent bridges to facilitate movement of goods, services, and people between districts and out of the province.

2. Improvement of both public and private transportation services like busses and other motor vehicles will be facilitated by better road infrastructure and networks. At present availability of public transportation is very limited.

3. Development of trade and industry, agricultural diversification, marketing of crops. Empowerment programmes need to include diversifying livelihoods to cushion the adverse effects of climate related agricultural failures.

4. For the quickest transfer of patients for emergency medical and surgical treatment investment into an air- ambulance system like the flying doctor service available on Zambia's Copperbelt province. This would overcome the most challenging issues related to transportation in the vast flood plain and is especially urgent for districts like Mitete where there is no district hospital and the whole district lies on the western side of the Zambezi River.

5. Investment into education in the province is essential. Free education has been introduced by the government which is a step in the right direction. More schools (both primary and secondary) and tertiary institutions such as colleges for nursing, clinical officers, and teachers are required in the districts. The province also needs skills required for development projects including construction and agriculture. Increasing the availability of all levels of education for rural communities will help address human resource needs in all government sectors to the benefit of vulnerable populations.

6. Targeted capacity building for residents from these remote areas in clinical/midwifery skills so that the health posts can provide an improved level of skill to attend to obstetric cases and reduce referrals for essential services.

7. Training of more Safe Motherhood Action Groups (SMAGs) and Traditional Birth Attendants (TBAs) and equipping them with transportation means to assist them in following up expectant mothers in their communities and possibly transport their clients when there is a need.

8. Improve housing and living conditions by improving supply of clean water and modern sanitation facilities, as well as introducing electricity where this has been absent.

9. Attract and retain skilled health care workers who can help build capacity within the province and districts. Increased numbers of skilled health workers and health facilities in the remotest parts of the province like Mitete are necessary. Improving living conditions and linking the districts to other parts of the country through better road networks is an important factor in attracting skilled workers who tend to shun working in rural areas because of the limited availability of services associated with an improved lifestyle.

10. Follow up workshops with stakeholders to disseminate findings and engage their participation for brainstorming solutions to their perceived needs. The CLD presented in this paper is one tool that can be used in the workshops to jointly develop or prioritize leverage points for intervention and present the outputs to MOH and other appropriate platforms for consideration in planning and decision making.

11. Efforts to bring inter departmental collaboration starting at local and provincial levels are recommended so that a stronger voice is raised to advocate for the needs of the vulnerable and marginalized poor in rural areas. Just as multiple factors straddling different sectors are interacting to result in suboptimal health outcomes, so there can be no meaningful and lasting improvement without development across all social systems in the regions.

12. Engagement of the traditional leadership of local communities to propose and discuss ways in which their cultural heritage can be leveraged for better health. Cultural events like the traditional Kuomboka Ceremony when the traditional king leads his people in migrating to higher ground at the beginning of the flood season, could be an opportunity to facilitate health service provision through modalities acceptable to the community members. For example, can more services be relocated to the higher residential areas on a temporal basis, depending on availability of resources?

6.6 Limitations

6.6.1 Time available for the study

The limitation in time available for field research was anticipated as part of the doctoral study program. Accordingly, prior liaison with gatekeepers, who are Ministry of Health officials in the provincial and district health offices was made to facilitate data collection with community members. Additionally, the number of districts included in the study was limited to only four.

This limitation turned out to be much worse than anticipated as the COVID-19 pandemic caused a global shutdown as stay-at-home orders and travel restrictions were instituted everywhere, including University of Waterloo in early March 2020, just when I had finished my proposal. Research work that required travel was halted, and the procedures leading to ethics approval at the university almost halted for some time then resumed very slowly. Alternative arrangements for travel to the field had to be made, but the effects of the shut down spilled over into the logistical support that was available for field research.

6.6.2 Funding

A limitation of finances to meet the logistical demands such as transportation and hiring research assistants was anticipated. However, this was made worse by the pandemic related shut down which affected university funded travel and research with human subjects. Thankfully, my supervisor was very supportive and managed to organize financial assistance that was used for the field work. Additionally, local partners at the Ministry of Health and colleagues at the local University of Barotseland were available for collaboration and logistical support like venues for both one-on-one and group interviews as well as training venue for research assistants. The research assistants were also undergraduate students at the University of Barotseland.

6.6.3 Relationship building with study respondents limited

One of the consequences of the limited time available for the research was that building rapport with participants was compromised affecting the quality of information collected. A

key component of qualitative research is undertaking study within the natural environment. In this case some details of their experiences and contextual factors may not be captured as we would be meeting participants for a very limited period, and some would not be comfortable and at liberty to share their experiences. The collaboration with local research assistants who live among the study communities was one way to deal with this as they were familiar with the language and cultural practices of the participants.

6.6.4 Prevailing conditions- flood season and the COVID-19 pandemic

The pandemic not only delayed research travel, but it also meant that more resources were needed to ensure the safety of study participants such as hand sanitizer solution, face masks and hand washing provisions. Covid restrictions also affected my ability to recruit enough numbers of participants to have gender specific FGDs in the study areas or to recruit women who have been pregnant and used the maternity services at the health facility specifically. This was complicated by the remoteness of some of the communities and where there were long distances between villages. In some cases, the research teams settled for conducting focus groups where access was easiest given time limitations.

6.7 Next steps

During the proposal stage for the research reported here, I planned to incorporate another phase of stakeholder engagement that would allow for gathering groups of stakeholders together in workshops. These workshops would have been the opportunity to share initial findings and get their feedback as part of member checking to enhance the validity of the findings. It would also have been the opportunity for shared learning by inviting their contributions to build a fuller picture of the problem of limited access to health services through both concept mapping and developing CLDs. These visualization tools would then be used to facilitate joint brainstorming to prioritize areas of intervention to improve the situation. Due to limited time and resources, this did not take place as originally intended. It therefore is a logical next step along with wider dissemination of results. The three manuscripts that constitute the core of this thesis are in the process of being submitted for

journal publication. A report is being prepared that will be circulated to the National Health Research Authority which authorized the research and opportunities will be sought to share findings in other academic and professional fora.

Another possible step will be to collaborate with colleagues to produce other types of models that may be useful for policy makers.

One aspect of stakeholder engagement that is of interest for further study is network analysis. The findings reported in this thesis suggest that the level of formal interaction between the stakeholders represented by our study participants is very low. As a means of further clarifying the existing gap and encouraging multi-disciplinary collaboration, social network analysis will define existing social networks and try to highlight how they influence each other and ultimately affect the health of individuals.

References

Aday, L. A. & Andersen, R. M. (1974). A framework for the study of access to medical care. *Health Services Research*, 9(3):208- 220.

Agyepong, I. A., Aryeetey, G. C., & Nonvignon, J., et al. (2014). Advancing the application of systems thinking in health: Provider payment and service supply behaviors and incentives in the Ghana national health insurance Scheme–a systems approach. *Health Research Policy and Systems, 12*(1), 35.

Ahern, M., Kovats, R. S., & Wilkinson, P., et al. (2005). Global health impacts of floods: Epidemiologic evidence. *Epidemiologic reviews, 27*(1), 36-46.

Alderman, K., Turner, L. R., & Tong, S. (2012). Floods and human health: A systematic review. *Environment international, 47*, 37-47.

Andersen, R. M. (1995). Revisiting the behavioral model and access to medical care: does it matter? *Journal of Health and Social Behavior* 36:1-10.

Anthonj, C., Nkongolo, O. T., & Schmitz, P., et al. (2015). The impact of flooding on people living with HIV: A case study from the Ohangwena region, Namibia. *Global Health Action, 8*(26441). doi:10.3402/gha.v8.26441

Atun, R., & Menabde, N. (2008). Health systems and systems thinking. *Health systems and the challenge of communicable diseases: experiences from Europe and Latin America. Berkshire (United Kingdom): Open University Press, McGraw Hill Education*, 121-140.

Bailey, P., Lobis, S., Maine, D., & Fortney, J. A. (2009). *Monitoring emergency obstetric care: a handbook*. World Health Organization.

Banda, S., Namafe, C. M. & Chakanika, W. W. (2015). Traditional environmental knowledge among lozi adults in mitigating climate change in the Barotse plains of western Zambia. *International Journal of Humanities Social Sciences and Education (IJHSSE), 2*(9), 222-239.

Best, A., Moor, G., & Holmes, B., et al. (2003). Health promotion dissemination and systems thinking: Towards an integrative model. *American Journal of Health Behavior, 27*(1), S206-S216.

Bocoum, F. Y., Kouanda, S., & Kouyaté, B., et al. (2013). Exploring the effects of task shifting for HIV through a systems thinking lens: The case of Burkina Faso. *BMC Public Health, 13*(1), 997.

Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. DOI: 10.1191/1478088706qp063oa

Cambaza, E., Mongo, E., & Anapakala, E., et al. (2019). Outbreak of cholera due to cyclone kenneth in northern Mozambique. *Int. J. Environ. Res. Public Health, 16*, 2925.

Carey, G., Malbon, E., & Carey, N., Joyce, A., et al. (2015). Systems science and systems thinking for public health: a systematic review of the field. *BMJ open*, *5*(12), e009002.

Central Statistical Office (CSO) [Zambia], Ministry of Health (MOH) [Zambia], and ICF. (2019). *Zambia demographic and health survey 2018: Key Indicators*. Rockville, Maryland, USA: Central Statistical Office, Ministry of Health, and ICF.

Central Statistical Office (CSO) [Zambia], Ministry of Health (MOH) [Zambia], and ICF International. (2014). *Zambia Demographic and Health Survey 2013-14.* Rockville, Maryland, USA: Central Statistical Office, Ministry of Health, and ICF International.

Central Statistical Office (CSO). 2013. *2010 Census of population and housing population and demographic projections 2011–2035***.** Central Statistics Office, Lusaka.

Central Statistical Office, (2012). *2010 census of population and housing analytical report*. Lusaka, Zambia: Central Statistical Office.

Central Statistical Office, (2016). *2015 Living Conditions Monitoring Survey Key Findings.* http://www.zamstats.gov.zm/report/Lcms/LCMS%202015%20Summary%20Report.pdf

Choi, B. C., & Pak, A. W. (2006). Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research and policy: 1. Definitions, objectives, and evidence of effectiveness. *Clin Investig Med*, *29*, 351-64.

Chughtai, S., & Blanchet, K. (2017). Systems thinking in public health: A bibliographic contribution to a meta-narrative review. *Health Policy and Planning*, *32*(4), 585-594. doi:10.1093/heapol/czw159

Creswell, J. W., (2014). Research Design: Qualitative, Quantitative and Mixed Methods Approaches, 4th ed. *Sage*.

De Sardan, J. O., Diarra, A., & Moha, M. (2017). Travelling models and the challenge of pragmatic contexts and practical norms: The case of maternal health. *Health Research Policy and Systems, 15*(1), 60

De Savigny, D., & Adam, T. (2009). *Systems thinking for health systems strengthening*. World Health Organization.

De Savigny, D., Blanchet, K., & Adam, T. (2017). *Applied Systems Thinking for Health Systems Research: A Methodological Handbook*. McGraw-Hill Education (UK).

Devi, S. (2019). *Cyclone Idai: 1 month later, devastation persists. 393*. www.thelancet.com

Du, W., FitzGerald, G. J., & Clark, M., et al. (2010). Health impacts of floods. *Prehospital and Disaster Medicine*, *25*(3), 265-272.

Ensor, T., Green, C., & Quigley, P., et al. (2014). Mobilizing communities to improve maternal health: results of an intervention in rural Zambia. Bull. *World Health Organ*. *92*(1) https://doi.org/10.2471/BLT.13.122721

Evans, D. B., Hsu, J. & Boerma, T. (2013). Universal health coverage and universal access. *Bulletin of the World Health Organization, 91*(8), 546-546A. ISSN 0042-9686. https://doi.org/10.2471/BLT.13.125450

Few, R., & Matthies, F. (2013). Flood hazards and health: Responding to present and future risks. Taylor And Francis, 1-219. Doi:10.4324/9781849771351

Galway, L. P., Parkes, M. W., & Allen, D., et al. (2016). Building interdisciplinary research capacity: a key challenge for ecological approaches in public health. *AIMS public health, 3*(2), 389.

Giacomini, M. K. (2001). The rocky road: qualitative research as evidence. *EBM*, 6.

Gilson, L., Hanson, K., & Sheikh, K., et al. (2011). Building the field of health policy and systems research: Social science matters. *PLoS Medicine, 8*(8), e1001079.

Government of the Republic of Zambia, GRZ. (2020). Zambia, Third National Communication to the United Nations Framework Convention on Climate Change (UNFCCC). Downloaded from https://unfccc.int/sites/default/files/resource/Third%20National%20Communication%20-%20Zambia.pdf

Green, J. & Thorogood, N. (2014). Qualitative methods for health research. *Sage Publications.*

Healey, J., Conlon, C. M., & Malama, K., et al. (2019). Sustainability and Scale of the Saving Mothers, Giving Life Approach in Uganda and Zambia. *Glob Health Sci Pract, 7*, 188-206. https://doi.org/10.9745/GHSP-D-18-00265

Henry, E., Thea, D. & Hamer, D., et al. (2018). The impact of a multi-level maternal health programme on facility delivery and capacity for emergency obstetric care in Zambia. *Global Public Health, 13*(10), 1481-1494, DOI: 10.1080/17441692.2017.1385824

Holmes W and Kennedy E. (2010). Reaching emergency obstetric care: overcoming the 'second delay'. *Burnet Institute.*

Hope, M. (2019). *Cyclones in Mozambique may reveal humanitarian challenges of responding to a new climate reality*. *3*. www.thelancet.com/planetary-health

Jacobs, C., Michelo, C., & Chola, M., et al. (2018). Evaluation of a community-based intervention to improve maternal and neonatal health service coverage in the most rural and remote districts of Zambia. *PloS one, 13*(1), e0190145.

Jacobs, C., Michelo, C., & Moshabela, M. (2018). Implementation of a community-based intervention in the most rural and remote districts of Zambia: a process evaluation of safe motherhood action groups. *Implementation science, 13*(1), 1-10.

Kalipeni, E. & Zulu, L. C. (2011). Analyzing geographical access to HIV sentinel clinics in relation to other health clinics in Zambia. *Journal of Maps, 7*(3), 254-281, DOI: 10.1080/15420353.2011.599756

Kleinman, A. (2010). Four social theories for global health. *The Lancet*, *375*(9725), 1518-1519.

Kruk, M. E., Vail, D., & Austin-Evelyn, K., et al. (2016). Evaluation of a maternal health program in Uganda and Zambia finds mixed results on quality of care and satisfaction. *Health Affairs, 35*(3), 510–519. doi:10.1377/hlthaff.2015.0902

Lehoux, P., Poland, B. & Daudelin,G (2006). Focus group research and ‘‘the patient’s view’’. *Social Science & Medicine,* 63, 2091–2104.

Leischow, S. J., and B. Milstein. 2006. Systems thinking and modeling for public health practice. *American Journal of Public Health,* 96(3), 403-405.

Leischow, S. J., Best, A., & Trochim, et al. (2008). Systems thinking to improve the public's health. *American Journal of Preventive Medicine, 35*(2), S196-S203.

Levy, K., Woster, A. P., & Goldstein, R. S., et al. (2016). Untangling the impacts of climate change on waterborne diseases: A systematic review of relationships between diarrheal diseases and temperature, rainfall, flooding, and drought. *Environmental Science & Technology, 50*(10), 4905-4922.

Lynch, J. (2006). It's not easy being interdisciplinary. *International journal of epidemiology*, *35*(5), 1119-1122.

Makanga, P. T., Schuurman, N., & Sacoor, C., et al. (2017). Seasonal variation in geographical access to maternal health services in regions of southern Mozambique. *International Journal of Health Geographics, 16*(1), 1-016-0074-4. doi:10.1186/s12942-016-0074-4

Makanga, P. T., Schuurman, N., & von Dadelszen, P., Et al. (2016) A scoping review of geographic information systems in maternal health. *International Journal of Gynecology and Obstetrics, 134,* 13–17.

Map of western province. https://simple.wikipedia.org/wiki/Western_Province,_Zambia

Marshall, M. N. (1996). The key informant techniques. *Family Practice,* 13, 92-97

Masson-Delmotte, V., Zhai, P. & Pörtner, H. O. (eds). (2018). *Summary for Policymakers: An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. World Meteorological Organization.

McCann, D. G., Moore, A., & Walker, M. E. A. (2011). The public health implications of water in disasters. *World Medical & Health Policy*, *3*(2), 1-22.

Milupi, I. D, Njungu, et.al. (2019). Climate change impacts, vulnerability, and adaptation options among the lozi speaking people in the Barotse floodplain of Zambia. *International Journal of Humanities Social Sciences and Education (IJHSSE), 6*(9), 149-157. *doi: http://dx. doi.org/10.20431/ 2349-0381.0609017.*

Ministry of Health [Zambia]. (2011). *National human resources for health strategic plan 2011 – 2015*. Lusaka, Zambia.

Ministry of Health [Zambia] (2012). *National Health Strategic Plan 2011-2015*. Lusaka, Zambia

Ministry of Health [Zambia], 2012. *National Health Policy: A nation of healthy and productive people*. Lusaka, Zambia.

Ministry of Health [Zambia] (2017). *Zambia National Health Strategic Plan 2017-2021*. Ministry of Health, Lusaka, Zambia.

Ministry of Health [Zambia]. (2018). *Reproductive, maternal, newborn, child and adolescent health and nutrition communication and advocacy strategy 2018-2021*.Ministry of Health, Lusaka, Zambia.

Ministry of Health [Zambia], 2019. *National Community Health Strategy 2019-2021: Community Health Driving Primary Health Care for Universal Health Coverage***.** Ministry of Health, Lusaka, Zambia.

Ministry of Transport and Communications [Zambia], 2019. *National Transport Policy*: *Towards an efficient and integrated transport system in Zambia by 2028*. Lusaka, Zambia

Ministry of Health [Zambia], Western Province Health Office, (2020). *MTEF HEALTH PLAN 2021-2023.* Ministry of Health, Mongu, Zambia.

Mirza, M. M. Q. (2003). Climate change and extreme weather events: Can developing countries adapt? *Climate Policy*, *3*(3), 233-248.

Moise, I. K., Kalipeni, E. & Zulu, L. C. (2011). Analyzing geographical access to HIV sentinel clinics in relation to other health clinics in Zambia. *Journal of Maps*, 7(3), 254-281, DOI: 10.1080/15420353.2011.599756

Mugabe, V. A., Gudo, E. S., & Inlamea, O. F. (2021). Natural disasters, population displacement and health emergencies: Multiple public health threats in Mozambique. *BMJ Global Health*, *6*(9), e006778.

Nerlander, L. (2009). Climate Change and Health. *The Commission on Climate Change and Development*, *10*, 5-18.

O'Donnell, O. (2007). Access to health care in developing countries: breaking down demand side barriers Cad. *Saúde Pública*, *23(*12), 2820-2834.

Pacagnella, R.C., Cecatti, J.G., & Osis, M.J., et al. (2012). The Role of delays in severe maternal morbidity and mortality: Expanding the conceptual framework. *Reproductive Health Matters: An International Journal on Sexual and Reproductive Health and Rights, 20,* 155-163.

Pachauri, R. K., Allen, M. R., Barros, V. R., Broome, J., Cramer, W., Christ, R., ... & van Ypserle, J. P. (2014). *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* (p. 151). Ipcc.

Patton, M. (1990). Qualitative evaluation and research methods. *Sage Publications*, 169-186.

Patz, J. A. & Hatch, M. J. (2014). Public Health and global climate disruption. *Public Health Reviews, 35*(1).

Patz, J.A., Frumkin, H., & Holloway, T., et al. (2014). Climate change: Challenges and opportunities for global health. *JAMA, 312*(15), 1565-1580. doi:10.1001/jama.2014.13186

Penn-Kekana, L., & Pereira, S., Hussein, J., et al. (2017). Understanding the implementation of maternity waiting homes in low-and middle-income countries: a qualitative thematic synthesis. *BMC pregnancy and childbirth*, *17*(1), 1-12.

Peters, D. H. (2014). The application of systems thinking in health: Why use systems thinking? *Health Research Policy and Systems, 12*(1), 51.

Rataj, E., Kunzweiler, K. & Garthus-Niegel, S. (2016) Extreme weather events in developing countries and related injuries and mental health disorders - a systematic review. *BMC Public Health*.

Remme, J. H. F., Adam, T., & Becerra-Posada, F., et al. 2010). Defining research to improve health systems. *PLoS Med 7*(11), e1001000. doi:10.1371/journal.pmed.1001000

Ribesse, N., Bossyns, P., & Marchal, B., et al. (2015). Methodological approach and tools for systems thinking in health systems research: technical assistants' support of health administration reform in the Democratic Republic of Congo as an application. *Global Health Promotion* 1757-9759, *24*(1), 43– 52, 591684. DOI: 10.1177/1757975915591684

Ricketts, T. C. & Goldsmith, L. J. (2005). Access in health services research: The battle of the frameworks. *Nursing Outlook*; 53, 274-280. doi:10.1016/j.outlook.

Rosen, J. G., Mulenga, D., & Phiri, L., et al. (2021). "Burnt by the scorching sun": climate-induced livelihood transformations, reproductive health, and fertility trajectories in drought-affected communities of Zambia. *BMC Public Health, 21*(1), 1-14.

Rossati, A. (2017). Global warming and its health impact. *The International Journal of Occupational and Environmental Medicine, 8*, 963-7-20.

Rwashana, A. S., Nakubulwa, S., & Nakakeeto-Kijjambu, M., et al. (2014). Advancing the application of systems thinking in health: Understanding the dynamics of neonatal mortality in Uganda. *Health Research Policy and Systems, 12*(1), 36.

Rwashana, A. S., Nakubulwa, S., & Nakakeeto-Kijjambu, M., et al. (2014). Advancing the application of systems thinking in health: Understanding the dynamics of neonatal mortality in Uganda. *Health Research Policy and Systems, 12*(1), 36.

Rwashana, A. S., Williams, D. W., & Neema, S. (2009). System dynamics approach to immunization healthcare issues in developing countries: A case study of Uganda. *Health Informatics Journal, 15*(2), 95-107.

Schatz, J. J. (2008). Floods hamper health-care delivery in southern Africa. *Lancet*, London, England, *371*(9615), 799-800.

Scott, N. A., Kaiser, J. L., & Ngoma T, *et al*. (2021). If we build it, will they come? Results of a quasi-experimental study assessing the impact of maternity waiting homes on facility-based childbirth and maternity care in Zambia. *BMJ Global Health, 6*(12), e006385. doi:10.1136/bmjgh-2021-006385

Sheikh, K., Gilson, L., & Agyepong, I.A., et al. (2011) Building the Field of Health Policy and Systems Research: Framing the Questions. *PLoS Med 8(*8), e1001073. Doi:10.1371/journal.pmed.1001073

Sialubanje, C., Massar, K., & Hamer, D. H. (2014). Understanding the psychosocial and environmental factors and barriers affecting utilization of maternal healthcare services in Kalomo, Zambia: a qualitative study. *Health Education Research, 29* (3), 521–532.

Sim, L. J., Parker, L., & Kumanyika, S. K. (2010). *Bridging the evidence gap in obesity prevention: A framework to inform decision making.* National Academies Press.

Sorensen, B. L., Nielsen, B. B., & Rasch, V., et al. (2011). User and provider perspectives on emergency obstetric care in a Tanzanian rural setting: a qualitative analysis of the three delays model in a field study. *African Journal of Reproductive Health*, *15*(2).

Souza, J. P., Gülmezoglu, A. M., & Vogel, J., et al. (2013). Moving beyond essential interventions for reduction of maternal mortality (the WHO Multi-country Survey on Maternal and Newborn Health): a cross-sectional study. *The Lancet*, *381*(9879), 1747-1755.

Sturmberg, J. P., Churilov, L., & McDonnell, G. (2013). Modelling. In *Handbook of systems and complexity in health*, 81-111.

Thaddeus, S. & Maine, D. (1994). Too far to walk: maternal mortality in context. *Soc Sci Med*. 38(8):1091-110. doi: 10.1016/0277-9536(94)90226-7. PMID: 8042057.

Trochim, W. M., Cabrera, D. A., & Milstein, B., et al. (2006). Practical challenges of systems thinking and modeling in public health. *American Journal of Public Health, 96*(3), 538-546.

Tumilowicz, A., Neufeld, L. M., & Pelto, G. H. (2015). Using ethnography in implementation research to improve nutrition interventions in populations. *Maternal & Child Nutrition, 11*, 55-72.

United Nations General Assembly, UNGA. (2015). *Transforming our world: The 2030 agenda for sustainable development.* https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

van den Boogaard, J., Arntzen, B., & Chilwana, J., et al. (2008). Skilled or traditional birth attendant? Choices of communities in Lukulu District, rural Zambia. *World Health & Population*, *10*(1), 34-43.

Wade, D. T., & Halligan, P. W. (2004). Do biomedical models of illness make for good healthcare systems? *British Medical Journal*,*329*(7479), 1398–1401.

Wallemacq, P., Below, R., & McClean, D. (2018). *Economic losses, poverty & disasters: 1998-2017*. United Nations Office for Disaster Risk Reduction.

Watts, N., Adger, N., & Agnolucci, P. et al (2015). Health and climate change: policy responses to protect public health. *The Lancet Commissions, 386*(10006), 1861-1914. DOI:https://doi.org/10.1016/S0140-6736(15)60854-6

Western Power Company Ltd. (2020). Map of the Zambezi flood plain in western province. https://www.westernpower.org/index.php/ngonye-falls-project/location

Whitfield. (2012). Changing floods in future climates. *Journal of Flood Risk Management, 5*, 336–365. https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1753-318X.2012.01150.x

World Health Organization (1978). Declaration of Alma-Ata, International Conference on Primary Care, Alma-Ata, USSR, 6-12 September 1978. http://www.who.int/publications/almaata_declaration_en.pdf .

World Health Organization, (2007). *Everybody's Business: Strengthening Health Systems to Improve Health Out comes: WHO's Framework for Action*.

World Health Organization, UNFPA, & UNICEF., et al. (2009). *Monitoring emergency obstetric care: A handbook.* http://whqlibdoc.who.int/publications/2009/9789241547734_eng.pdf.

World Health Organization. (2015). *WHO recommendations on health promotion interventions for maternal and newborn health 2015*. World Health Organization.

World Health Organization Regional Office for Africa (2016) *Atlas of African Health Statistics 2016: Health situation analysis of the African Region*.

WHO & WORLD BANK. (2017). Half the world lacks access to essential health services, 100 million still pushed into extreme poverty because of health expenses. *News release*. https://www.who.int/news-room/detail/13-12-2017-world-bank-and-who-half-the-world-lacks-access-to-essential-health-services-100-million-still-pushed-into-extreme-poverty-because-of-health-expenses

World Health Organization. (2018). *Atlas of African health statistics 2018: Universal health coverage and the sustainable development goals in the WHO African region*. Licence: CC BY-NC-SA 3.0 IGO.

World Health Organization Regional Office for Africa. (2018). *The state of health in the WHO African region: an analysis of the status of health, health services and health systems in the context of the sustainable development goals*. Brazzaville.

World Health Organization. (2019). *Trends in maternal mortality 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division.* Licence: CC BY-NC-SA 3.0 IGO.

World Health Organization, WHO, & World bank. (2017). *Half the world lacks access to essential health services, 100 million still pushed into extreme poverty because of health expenses*. News release. https://www.who.int/news-room/detail/13-12-2017-world-bank-

and-who-half-the-world-lacks-access-to-essential-health-services-100-million-still-pushed-into-extreme-poverty-because-of-health-expenses

World Health Organization. (2020). *Floods: overview* downloaded on 2nd July 2022 from https://www.who.int/health-topics/floods#tab=tab_1

World Health Organization. (2021). *Universal health coverage (UHC*)**.** https://www.who.int/news-room/fact-sheets/detail/universal-health-coverage-(uhc).

Yeasmin, S. & Rahman, K. F. (2012). Triangulation' Research Method as the Tool of Social Science Research. *BUP Jour*

Appendix

Interview and Focus Group Discussion Guide

A) Key Informant/ Provider

1. Can you describe what is the role of your organization and what is your role within your organization? [for providers: What is your role in providing health care services for local population?]
2. Are there any other organizations or community partners that you are working with?
3. What effect has extreme weather events like flooding had on access to care?
4. Can you tell me about some of the most important things that your organization/or you do to improve access to health care services (during floods)?

   Probes: What programs /projects are currently being implemented to improve access to health services?

   What has been the result of these interventions for women and children?

   From your experience, what has worked and what has not worked? (in terms of interventions)
5. Can you tell me about some of the challenges you face?
6. Are you aware of local research that has been done on the topic of access to health services during floods? Can you tell me what you know about it?

   Probes: Who did the research? Were any of the results communicated to you? Do you have copies of the reports available?
7. Is there anything else that you would like to add?

B) <u>Community members</u>

1. What changes have you observed in the land or river over the past decade?
2. What are the major health challenges faced by the members of your community?

Probe: Is there any difference in health challenges faced by the local people in the past and currently?

3. Can you talk about what help is available to you when you are unwell?

   Probes: How accessible this help is? Where is it located? How do you go about reaching out for help?

   Probes: How this has changed in the past 10 years or so?

4. What are some of the challenges you face getting health services during flood or dry seasons?

   Probes: for mothers? For their children?

5. What are some of the most important changes that you would like to see to get better access to health care services during floods?

   Probes: how care can be better delivered to you? What can be done differently? What recommendations might you have? What barriers might you expect?

6. What are your hopes for your community? What do you think will make access to health cares services better for your community?
7. Is there anything else that you would like to add?

C) <u>Individuals (health service users)</u>

1. Can you tell me about how you were diagnosed with your condition and for how long you had diagnosis?

Probes: What did you know about your condition before diagnosis? Where did you get this information from?

2. What kind of treatment/medication do you require?
3. How do you obtain that treatment or medication?
4. What happens during flood season and dry season?

   Probe: Have you tried to access health services during those seasons? What barriers did you face?

5. How far away is your health facility from your home?

6. How do you reach the health facility/ health care provider?