Climate Adaptation in the WASH Sector of East Africa's Lake Victoria Basin

by

Hannah Marcus

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Abstract

Climate change is having increasing impacts on water, sanitation, and hygiene (WASH) worldwide, rendering health-friendly behaviours less achievable in low-resource settings, disrupting WASH service provision, and reversing global progress on improving WASH infrastructure and controlling waterborne diseases. Much of these impacts are mediated through climate-driven changes in rainfall, which lead to both intensified and lengthier droughts, alongside heavier bouts of rain, and more frequent storms and extreme weather events. The impacts of both extreme and minimal rainfall on water quality and access and on sanitation and hygiene maintenance are myriad and have gained increased attention owing to a growing body of literature presenting important social, health, and environmental consequences. In recent years, a rising number of actors have pointed to the need for climate adaptation to be mainstreamed into the WASH sector, to ensure that WASH services, technologies, practices, and infrastructures are maximally resilient to the impending impacts of climate-driven rainfall changes. In the Lake Victoria Basin (LVB), which encompasses parts of Kenya, Uganda, Tanzania, Rwanda, and Burundi, both WASH and, more recently, climate change have been placed relatively high on the agenda of development bodies. A history of WASH progress in this region has notably reduced waterborne disease incidence, but ongoing threats still produce significant morbidity and mortality burdens. Meanwhile, the region is highly vulnerable to climate change due to a combination of geographic, hydrological, and socioeconomic factors. Not surprisingly, East African governments have had to devote increased attention to climate adaptation goal-setting, as the impacts of climate change on the region become more pressing and the United Nations Framework Convention on Climate Change pushes for regular submission of National Adaptation Plans and National Adaptation Programmes of Action. Given the importance of both climate adaptation and WASH in the LVB context, and the growing impetus for climate-WASH integration, this study sought to assess the progress thus far achieved in integrating WASH and climate adaptation agendas in the LVB, and outstanding barriers to progress. A secondary objective was to better understand how lakeside communities are adapting their

own WASH behaviours and practices in response to the new threats posed by climate change-driven changes in rainfall, so that any positive adaptations could be documented, and associated innovations later tapped in regional climate adaptation planning efforts. Through a collaboration with a community-based organization in Western Kenya named Kar Geno- Center for Hope, a quantitative WASH practice survey was conducted, followed by 17 qualitative interviews and 17 focus groups with community members residing in the lakeside village of Mabinju, located in Siaya County. Collaborations were additionally forged with a network of organizations working on WASH and/or climate adaptation in the wider LVB region, from which knowledgeable stakeholders were interviewed. Interviews and focus groups, which were conducted in Luo but translated into English, were recorded and transcribed, and a qualitative thematic content analysis was conducted on all transcripts. This involved inductive coding using Dedoose qualitative data analysis software and a grounded theory analysis framework. The results of the study affirmed the cross-cutting impacts that climate change is having on WASH in the region, at both community and governance levels, and illuminated how it has interacted with other environmental threats to accelerate longstanding trends of environmental degradation and socioeconomic vulnerability. The responses of community members in Mabinju to these impacts were found to be wide in scope, and included both positive and maladaptive behaviour changes. On an institutional level, sectoral siloes and a lack of interdisciplinary collaboration, among other factors related to funding and international priorities, were found to restrain full climate-WASH integration in the region, despite evidence of early progress. Attention paid to sanitation was also found to be notably lacking, paralleling a global trend of disproportionate focus on water within the broader climate adaptation agenda. These findings hold implications for regional climate adaptation planning efforts, and offer global lessons on how governance structures can be made more conducive to climate-WASH integration and on how community knowledge, insights, and innovation potential can be better tapped in the development of novel climate resiliency promoting measures in the WASH sector.

Preface

Ethics approval for this study was sought and received from the University of Alberta Research Ethics Board (REB-1) and the Maseno University Ethics Review Committee. Chapters 4, 5, and 6 have been written with the intention of later submission to specific journals for publication. The journal names and submission categories are indicated at each chapter's start. However, at the time of submitting this thesis, no material has yet been submitted for publication.

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Acronyms

Centers for Disease Control and Prevention (CDC)

Civil Society Organization (CSOs)

Community Health Volunteer (CHV)

Intergovernmental Panel on Climate Change (IPCC)

Joint Monitoring Programme (JMP)

Lake Victoria Basin (LVB)

National Adaptation Plan (NAP)

National Adaptation Programmes of Action (NAPA)

United Nations (UN)

United Nations Children's Fund (UNICEF)

Water, Sanitation, and Hygiene (WASH)

World Health Organization (WHO)

Ch. 1: Background and Context

1.1 Climate Change and Global Water, Sanitation, and Hygiene

As a major disruptor to the hydrological cycle, the climate change crisis is inextricably linked to water. Not only is climate change altering the variability and predictability of precipitation patterns, but it is also inducing extremes of flooding, drought, and severe weather, all of which can wreak havoc on global water supplies and sanitation infrastructures (1). Indeed, with an ever-growing body of evidence, the multifold impacts of climate change on global water, sanitation, and hygiene (WASH) are now widely recognized, and are a source of increased global attention and concern. Multiple actors have sounded alarm bells in the wake of this crisis, with the United Nations (UN) warning in its most recent 2021 World Water Development Report that the world is projected to face a global water deficit of 40% by 2030 (2). This comes amidst an already concerning global water and sanitation picture, whereby 2 billion people live in water-stressed areas and 3.4 billion people (45% of the global population) still lack access to safely managed sanitation facilities (2). While other factors undoubtedly contribute towards these trends, climate change is a widely acknowledged major contributor.

The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) assessed hydrological impacts due to climate change and found them to be highly variable (3). Of note, IPCC models suggested that global warming of 2°C above pre-industrial levels will result in a 20% decline in water availability for irrigation in some snowmelt dependent river basins (3). Simultaneously, under a 2°C warming scenario, global glacier mass loss of 18 ± 13% is projected to diminish water availability for agriculture, hydropower, and human settlements in the mid- to long-term (3). The causal pathways underlying these projections are multifaceted and elucidated by a growing body of evidence on climate change impacts on the WASH sector. Given the breadth of climate-WASH interactions and outcomes, Table 1 has been used to synthesize and summarize the literature concerning potential WASH consequences of various climate hazards. Still, it is worth noting that this is by no means an exhaustive list of possible implications.

Table 1: Summary of Climate Change Impacts on WASH

Climate Effect	Hazard	Potential Impacts on Water, Sanitation, and Hygiene
Decrease in precipitation	Drought	- Water insecurity due to reduction in raw water supplies, reduced river flow, drying up of aquifers and streams (4,5,6) - Reduced drinking water quality due to less dilution, increased concentration of pollutants, and reliance on unsafe water sources in the absence of safer alternatives such as rainfall (4,7)
		- Reduced functionality of water-based toilets (8-10)

		- Reduced dilution of wastewater, blockage of sewerage pipes due to excess fecal deposition (8-10) - Lack of water for personal hygiene and handwashing (11)
Increase in precipitation	Heavy rainfall	- Pollution of surface water bodies due to increased surface runoff (4,12) - Elevation of groundwater table causing contamination by fecal matter (13,14) - Pooling of water enabling increased vector breeding (15) - Inundation of wells (16)
		- Collapse, submergence, or overflow of pit latrines (4,8,9) - Damage to septic tanks, causing leakage (8,9) - Complicated pit emptying and fecal sludge management (17) - Back-flooding of raw sewerage and damage to/leakage of sewerage pipes into surrounding environment (8-10)
		- Lack of clean water for washing hands, dishes, and personal items, leading to easier microbial spread (4,18)
Severe weather (e.g., storms, hurricanes, cyclones, typhoons, flash floods)	Flooding	- Same impacts as heavy rainfall (though intensified) in addition to increased landslides around water sources, sedimentation and turbidity, and damage to water infrastructure including handpumps and pipes (4,19)
		- Same impacts as heavy rainfall (though intensified) in addition to inability to reconstruct pit latrines until flood waters reside and disruption of fecal sludge management chains when roads become impassable (4,8,9)
		- Same impacts as heavy rainfall (though intensified) in addition to damage to taps and direct microbial spread through flood waters (4,20)
Increase in temperatures	Heatwaves, permafrost loss, glacial retreat	- More favorable conditions for toxin buildup and vector breeding in surface water bodies (21-23) - Seasonality of river flows leading to reduction in water availability in the summer (24,25) - Melting and release of permafrost contaminants into groundwater aquifers (26)
Sea-level rise	Flooding, coastal erosion, saltwater intrusion	- In addition to flooding impacts, salinization of drinking water supplies and loss of water purification properties of decimated coastal vegetative buffer zones (27-30)
		- Inundation of wastewater treatment plants located in low-lying coastal areas (8-10)

Considering the manifold ways in which climate change can compromise access to clean water, safe sanitation, and hygiene resources, it is not surprising that it is expected to have a great impact on water-related diseases as well. In a systematic review examining the relationship between meteorological conditions and water-related diseases in Western Asia, a positive association between temperature and water-related diseases was found in most studies (31). Numerous case studies from Africa and Asia have also shown significant effects of flooding on risks of infectious disease spread through water systems, and rates of intestinal parasitic infections among school-aged children (32).

Akanda et al. (2011) found that climate change was likely to result in increases in cholera outbreaks in the Bengal Delta, as greater inundation of land by brackish water would allow *vibrios* to survive long enough to

be washed into freshwater supplies during heavy rainfall (33). Cholera outbreaks have also been linked to drought conditions in inland Africa (34). Given its destructive effects, the World Health Organization (WHO) estimated in 2014 that climate change would cause an additional 48,000 diarrheal deaths by 2030 (35). Mounting evidence coupled with such warnings have created a new impetus for climate-resilient WASH sector development, which is the focus of this study, albeit within the geographically specific context of East Africa's Lake Victoria Basin (LVB).

1.2 The Lake Victoria Basin and Recent Patterns of Disruption

The Lake Victoria Basin (LVB) is significant in large part due to the breadth of ecosystem services provided by Lake Victoria itself, which has a surface area of 68,800 km^2, making it the largest freshwater lake in Africa and the second largest in the world, by area (36). As a transboundary lake shared by three countries (Tanzania- 51%, Uganda- 43%, and Kenya- 6%), Lake Victoria's catchment is approximately 194,000 km^2 and spreads over the five LVB countries of Rwanda, Burundi, Kenya, Tanzania, and Uganda (36). Lake Victoria's watershed is home to approximately 45 million people with a population density of 300 persons per square kilometer, possibly the highest in Africa and still growing at 3.5% per year (36). Given its size, freshwater ecology, and geographic connectivity, Lake Victoria serves as a critical food, water, and livelihood source for the 45 million LVB residents, while feeding the equally critical Nile River whose basin is located just downstream (37). Fishing in Lake Victoria currently supports the livelihoods of 3 million people, and abstraction of drinking water from the lake has allowed major cities like Kampala, Kisumu, and Mwanza to undergo rapid development and industrialization (36).

As in many settings, however, this development and industrialization has come at a cost to the environment and surrounding ecosystem. High population densities have exerted pressure on the natural resources of the LVB, and agricultural settlements have become more concentrated along the lakeshores, leading to loss of vegetation coverage, increasing soil erosion, declining soil fertility, and agrochemical pollution of the lake (36,37). An estimated 60% of the LVB now suffers from degradation, which has the immediate impact of increasing sediment and nutrient loading of Lake Victoria through aerial deposition, river deposition, and surface runoff (36). Untreated municipal and industrial wastewater have also contributed towards the eutrophication of the lake, resulting in lake-wide algal blooms and an explosion of water hyacinth (37). Of concern is also the fact that the dominant blue-green algae variety has been shown to be potentially toxic (38). Taken together, these factors have substantially reduced lake water quality, driven up costs of water treatment, and complicated the navigation of the lake by millions of fishermen whose livelihoods depend upon it (36). Notably, this has compounded the fishing-related impacts of ongoing biodiversity loss within the lake

itself. This was initially spurred by the introduction of the Nile Perch and Nile tilapia in the 1950s, leading to the extinction of up to 200 native species, and is now being accelerated by significant algae-driven oxygen depletion (36,37). The growth of water hyacinth is also particularly concerning from a public health standpoint, as floating masses have been shown to form habitats suitable for both mosquitoes and bilharzia snails (37,39). This has been linked with increased incidences of malaria and schistosomiasis in the region (37,39).

LVB communities are not unaware of these effects. Indeed, their occurrence has been a cause of major concern and a know disruptor to the health, well-being, and livelihoods of those reliant upon the biophysical resources of the LVB. Studies have shown that riparian communities have a deep understanding of the workings of various ecosystems in the basin, and recognize the anthropogenic drivers of ecosystem disruption (40). This is further supported by additional research on community perceptions of the causes of LVB water degradation, which was found to be attributed primarily to poor governance, high population, deforestation, and disruptive farming methods (41). With climate change added to the picture, solutions to environmental disruption in the LVB undoubtedly require increasingly comprehensive and integrated approaches to watershed management.

1.3 Climate Adaptation, Vulnerability, Risk, and Resiliency: Defining Key Concepts

The lexicon on climate adaptation, vulnerability, and resiliency has become increasingly nuanced as the academic discipline itself has evolved. This creates a new need for sensitivity and caution in the use of language when discussing such matters. In respecting this need and keeping pace with the evolution of related terminology, Table 2 offers definitions (as used in this report, where applicable) of various terms related to climate adaptation, risk, and resiliency. Note that some have been taken directly from single sources, while others are derived from a synthesis of sources which similarly define them.

Table 2: A Glossary of Definitions Relating to Climate Adaptation, Vulnerability, Risk, and Resiliency

Category	Term ***When used in relation to climate change	Definition
ADAPTATION	Adaptation (General)	Long-term adjustments aimed at overcoming the destructive impacts of climate change, including measures that reduce negative consequences or exploit new opportunities (42,43).
	Community-Based Adaptation	A more participatory, bottom-up approach to adaptation that engages communities directly in the planning, design, and implementation of adaptation measures (44,45).

	Ecosystem-Based Adaptation or Nature-Based Solutions for Climate Adaptation		A strategic approach that integrates biodiversity and ecosystem services to help humans respond to the adverse effects of climate change and is routinely accompanied by developmental and environmental co-benefits (46,47).
	Coping (General)		Short-term actions to ward off immediate risk, rather than to adjust to continuous or permanent threats or changes (48).
	Maladaptation		Measures which have the unintended effect of increasing long-term exposure and sensitivity to climate change impacts, even if immediate, short-term relief is achieved (49).
	Erosive Coping		A specific type of maladaptation seen in the context of flooding whereby actions undertaken by households to return to normal life after flood events have long-term negative effects on the household economy and livelihood sustainability (50).
	Adaptation Limit		A threshold beyond which risks and losses become so great that no practical adaptation options remain available to moderate them (42,51).
VULNERABILITY	Vulnerability (General)		The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a climate hazard, resulting from the interaction of exposure, sensitivity, and adaptive capacity (52,53).
	Sub-domains (i.e interacting determinants) of vulnerability	Exposure	People, property, systems, or other elements in places or settings that could be adversely affected by climate hazards and that are thereby subject to potential losses (52,53).
		Sensitivity	Intrinsic characteristics or conditions that make individuals, societies, or systems more likely to be affected by given climate exposures (53,54).
		Adaptive Capacity	The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of new opportunities, or to respond to consequences (53,54).
RISK	Risk (General)		The impact potential of any given climate threat, resulting from the interaction of hazard, vulnerability, and exposure, and moderated by the capacity to respond (52,54).

	Sub-domains (i.e., interacting determinants) of risk	Hazard	Something (climate-related) that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (52).
		Exposure	See definition above.
		Vulnerability	See definition above.
		Capacity	The ability to prepare, respond, and recover from the impacts of a climate hazard through use of infrastructure and physical means, institutions, societal coping abilities, and human knowledge, skills, and collective attributes (52).
RESILIENCY	Climate Resilience (General)		The ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate (55).
	Social-Ecological Resilience		The capacity to adapt or transform in the face of change in social-ecological systems, particularly unexpected change, in ways that continue to support human well-being (56).
	Water Systems Resilience		The ability of natural and man-made water systems to return to equilibrium after disruption as a function of both the flexibility inherent in their technical design and their social-ecological resilience (57).
	Health Systems Resilience		The ability of health systems to prepare for, manage, and learn from shocks, enabling continued delivery of the same quantity and quality of services without major disruption (58,59).

1.4 Climate Change and Climate Vulnerability in the Lake Victoria Basin

Recent years have seen a growing focus on climate change in the LVB, spurring more research and documentation on climate trends in the region. Indeed, the importance of climate change in the LVB cannot be overlooked, given present-day and historically entrenched environmental, social, and economic vulnerabilities.

The biggest environmental driver of the LVB's vulnerability to climate change is arguably the dominance of both rainfall over the lake—responsible for 80% of total recharge—and temperature-dependent rates of evaporation in determining lake water balance, with river inflow and outflow making only minor contributions (37,60). The result is that changes in both temperature and rainfall—the two weather variables impacted most greatly by climate change—can have drastic impacts on the lake's hydrological

cycle. As Lake Victoria's waters feed the Nile River (alongside other contributory water bodies) and are heavily relied upon for lakeside irrigation, changes in the lake water balance can have far reaching consequences for surrounding communities and downstream countries dependent on Nile waters, such as Ethiopia, Sudan, and Egypt (61). Such impacts relate not only to freshwater access for drinking and irrigation in a region already characterized by an arid and semi-arid environment, but also to hydropower generation in the upstream countries, which is heavily dependent on Nile flow rates (61).

The typical precipitation pattern in the LVB is characterized by a bimodal seasonal distribution with peaks occurring during March-May (long rains) and October-December (short rains) (61). This pattern is determined by the passage of the inter-tropical convergence zone of the northeast and southeast monsoons (62). The El-Niño Southern Oscillation, however, which has been shown to intensify with rising sea surface temperatures, also has a significant impact on rainfall in the LVB, with above-normal rainfall conditions typically seen during El-Niño events (63). Still, the net rainfall trend in the LVB since the 1990s has been one of declining precipitation during the East African Long Rains—which provides the majority of annual rainfall, leading to drier conditions and increased drought frequency (64). However, this decline has been shown to result not from reductions in the intensity or mean daily rainfall during this period, but rather from a delayed onset and early cessation of the long rains, producing a shorter, more intense rainfall season. This phenomenon has been linked to climate change-driven increases in sea surface temperatures to the north during boreal summer and to the south during austral summer, which leads to an increased pressure gradient and faster movement of the rainband over Eastern Africa during the boreal spring (64).

Still, it has been shown that net annual rainfall over the lake is increasing (60), and the IPCC has projected an increase in total annual precipitation by just under 10% for the RCP4.5 scenario and just under 20% for the RCP8.5 scenario over the 21st century, with up to 40% increases in extreme daily intensities (65). This may exacerbate ongoing patterns of rising lake levels. To reconcile the declining trend of the East African Long Rains and the IPCC projected wetter conditions, the East Africa Climate Change Paradox' has been conceived (62). In summary, this paradox suggests that rainy and dry seasons will respectively become wetter and drier in the future, under projected climate scenarios (66). Meanwhile, climate change may continue increasing surface temperatures of the lake itself—a phenomenon observed since the 1960s—which would have considerable impacts on its ecology and the livelihoods derived from it (67).

The impacts of climate change in the LVB are now readily observable. Indeed, lakeside communities in and around Mwanza, Kisumu, and Jinja have all seen severe incidences of flooding in recent years. In Western Kenya, one of the hardest-hit regions during the March-May 2020 heavy rains, at least 40,000 people

were rendered homeless after the Nzoia river burst its bank (68). A study by the Stockholm Environment Institute estimated that, by 2050, more than 300,000 Kenyans could be flooded each year under a high-emissions scenario (69). Similarly, dry periods have occurred regularly in the region, with 93% of respondents in a study conducted on the Lake Victoria region of Tanzania reporting a significant decline in rainfall frequencies (70). Households consulted in Western Kenya also revealed that drought incidences had increased, with drying of rivers that were once perennial singled out as one of the major indicators (71). With the added sociocultural and economic drivers of climate vulnerability in the LVB, including but not limited to "cultural attachment" of the lake basin dwellers to the land and consequent unwillingness to move to safer places, poverty and lack of income alternatives, and smallholder dependence on biophysical assets, the intensifying climate crisis will cause undue destruction if sufficient adaptation measures are not put in place (72,38).

1.5 WASH and Climate Adaptation Progress in the Lake Victoria Basin from Past to Present

WASH in Sub-Saharan Africa has received critical attention since the acceleration of global efforts to reduce waterborne disease morbidity and mortality in the 1930s (73). To date, notable progress has been achieved in the WASH sector, which has been made evident through intensive monitoring and evaluation efforts, first by the League of Nations Health Organization, subsequently by the WHO, and now jointly by WHO and The United Nations Children's Fund (UNICEF) through their Joint Monitoring Programme (JMP) (73). Generally speaking, East Africa, including the LVB, is no exception to this overall trend of positive progress, despite outstanding challenges and regional disparities. The designation of WASH as an isolated development priority backed by sector-specific financing, alongside the increased uptake and use of Water Safety Plans following the 2004 release of new WHO Guidelines for Drinking Water Quality, have undoubtedly contributed towards observed reductions in waterborne disease spread in the LVB (73,74). Likewise, the rapid diffusion of Community-Led Total Sanitation Campaigns (75), advancement of wastewater treatment and faecal sludge management technologies (76,77) and enlistment of community health workers for WASH promotion and behaviour change communication have all had positive influences (78). Disease surveillance centers and waterborne disease monitoring initiatives supported by the Centers for Disease Control and Prevention (CDC) have played an important role in outbreak control (79), as have specific initiatives such as the International Emerging Infections Program based in Kisumu (38), the Kenya Ministry of Health National Cholera Task Force (38), and Uganda's National Integrated Comprehensive Cholera Prevention and Control Plan (80). Extreme weather events in the LVB nations, however, are still responsible for regular outbreaks of malaria, cholera, typhoid, dysentery, and other intestinal parasites, and faecal contamination of water still contributes towards high rates of schistosomiasis, which has been

reported as the main water-contact disease in the Lake Victoria region (38,81). Table 3 provides a summary of changes (where documented) in access to basic water, sanitation, and hygiene between 2000 and 2017 for each of the main LVB countries of focus in this study (Kenya, Uganda, and Tanzania), taken from the most recent (2019) JMP/WHO/UNICEF progress report (82).

Table 3: Changes in Access to Basic Water, Sanitation, and Hygiene in LVB Nations (2000-2017)

Kenya		Uganda		Tanzania	
Percent of Population with Access to At Least Basic Water Supplies					
2000	2017	2000	2017	2000	2017
47%	59%	27%	49%	27%	57%
Percent of Population with Access to At Least Basic Sanitation					
2000	2017	2000	2017	2000	2017
34%	29%	17%	18%	4%	30%
Percent of Population with Access to At Least Basic Hygiene					
2000	2017	2000	2017	2000	2017
----	25%	----	21%	----	48%

******BASIC WATER SUPPLY:*** *Drinking water from an improved source, provided collection time is not more than 30 minutes for a roundtrip including queuing*
******BASIC SANITATION:*** *Use of improved facilities which are not shared with other households*
******BASIC HYGIENE:*** *Availability of a handwashing facility on premises with soap and water*

While WASH has been a longstanding focus for development efforts in the LVB, climate adaptation has been a more recent addition to the development agenda. Following the 2001 launch of the National Adaptation Programmes of Action (NAPA) initiative which called upon least developed countries to identify priority activities that respond to their urgent and immediate climate adaptation needs, all LVB nations, with the exception of Kenya, which does not fall under the least developed country category, developed and submitted NAPAs with the support of the UN Development Programme (83). Recognizing that 90% of all natural disasters in the world are caused by weather patterns over which climate change has great influence, the Kenyan government developed a National Climate Change Response Strategy in 2010, which included a component, albeit a limited one, on climate adaptation (84). Yet given the more short-term NAPA focus, a decade later, the new national adaptation plan (NAP) process was developed under the 2011 Cancun Adaptation Framework, to facilitate planning for medium- and long-term adaptation needs (85). To date, of the five LVB nations, only Kenya has submitted a finalized NAP (85). Uganda, Tanzania, Rwanda, and Burundi have thus far made progress in developing theirs, but have not submitted finalized copies, making their 2006/7 NAPAs still the most recent policy documents to guide national adaptation planning (85). Despite their outdatedness, however, it is worth noting that like Kenya's more recent NAP, the NAPAs of both Uganda and Tanzania feature exclusive reference to, and endorsement of, community-based adaptation approaches, among other measures (86-88). This is fitting with the growing preference for

participatory frameworks as opposed to top-down development approaches, and has likely been catalyzed by the rising prominence of community-based organizations in East Africa's development sphere.

Besides the NAPAs, climate change adaptation is otherwise driven by regional disaster preparedness and management frameworks, such as the East African Community Disaster Risk Reduction and Management Strategy, published in 2012 (89). However, such frameworks don't address the full scope of adaptation needs, for they are largely oriented around retroactive disaster responses, rather than proactive risk mitigation measures. Similar shortcomings have been reported in the East African health sector specifically, where progress has been slow in the use of climate information to specifically *prevent* climate-sensitive diseases (90). While climate and health committees have been set up by the Intergovernmental Authority on Development's Climate Prediction and Applications Centre in several East African countries, committees are largely tasked with integrating meteorological forecasting with epidemiological data to detect outbreaks and epidemics, which also reflects a more disaster response-oriented (i.e., retroactive) approach to the climate response (90). The same can be said about the CMAM Surge approach for community-based management of acute malnutrition, which has been adopted in two of the LVB nations, namely Kenya and Uganda (59). While this approach reflects efforts to develop a more shock-responsive healthcare system, particularly in the face of climate/drought-driven acute food shortages, it is once again an embodiment of just that: a shock response measure, as opposed to a shock prevention one.

While the more formal political, institutional, and governance processes of climate adaptation planning across the LVB nations are further discussed in the summary of results from the document review conducted in the preliminary phase of this study, other climate adaptation initiatives worth noting have been documented in the literature. Among these are numerous ecosystem-based adaptation initiatives, which appear to have gained traction in the region as of late. In East Africa and other settings, ecosystem-based adaptation has been largely advocated as the ultimate solution for building local adaptive capacities and resilience (46). Recognizing its potential, many organizations, and communities themselves, have taken up wetland restoration, afforestation, and reforestation initiatives, amongst others. The benefits of these approaches have already been established, with evidence of massive biodiversity increases in the reforested regions of Kenya's Kakamega, Nandi and Cherengani Hills, Mount Elgon, and Mau forests, and improved water quality and pollution control within wetlands restored with papyrus vegetation across Siaya and Kisumu counties (46). Other nature-based solutions have been used to address water security challenges in lakeside communities, such as rooftop rainwater harvesting and water treatment with traditional herbs (90,91). In-country capacity development has increased the number of trained and

experienced NGOs, technicians, and masons in the use of rainwater harvesting technology, while community-based water committees have formed to support households in management of rainwater harvesting systems (91). Cross-regional connections in this domain have been especially facilitated by exchange visits, regional workshops, and annual learning events involving key players in the sector, such as SEARNET (Southern and Eastern Africa Rainwater Network), IRHA (International Rainwater Harvesting Alliance), GHARP (Greater Horn of Africa Rainwater Partnership), the MUS Group (Multiple Use Water Services), and CGIAR (Consultative Group on International Agricultural Research) (91).

Collectively, existing literature sheds light on important developments on both climate adaptation and WASH fronts across LVB nations, but evidence is limited on the degree to which the two priorities have seen strategic integration in both policy and practical domains (see Ch. 3 document analysis results for a more thorough assessment of secondary data). Another important knowledge gap stems from the ambiguity of literature on community-based adaptation in the LVB regarding whether communities are thoroughly involved in project planning and design, as opposed to simply being engaged during the implementation of a pre-developed (i.e. imported) project plan. The difference between these two paradigms is significant, for one can be seen as only marginally inclusive as opposed to truly emancipatory. Moreover, from a practical standpoint, failure to involve communities from the earliest stages of program design precludes the possibility of integrating the wisdom, thought contributions, knowledge, and insights of those most intimately connected with their environment. Indeed, existing evidence from the LVB already suggests these contributions hold potential (92,93).

1.6 Climate-Resilient WASH Sector Development- Global Progress to Date

Given the breadth of evidence on climate-WASH intersections, the last several years have seen a rise in focus on mainstreaming climate change adaptation into WASH sector planning. The topic of climate-WASH integration has not only engaged the academic community, but is also attracting attention from an increasing number of policymakers and civil society players, who are channeling energy and resources into legislative and practical initiatives which build climate resilience in the WASH sector while leveraging the adaptation benefits of WASH promotion (94-101). An early catalyst for this trend came in 2010, when the WHO released a technical report on the resilience of water supply and sanitation in the face of climate change (102). This report offered detailed assessments on the risks posed by various weather conditions on select water and sanitation infrastructures, and called for more consideration of such hazards in their design (102). This call was echoed in 2019 by the UN-Water Expert Group on Water and Climate Change which reiterated the need for "integration of climate-resilient water resource management in health,

sanitation, and development planning" (1). Most recently, at the COP26 summit held in Glasgow in November 2021, the notion of climate-resilient WASH planning gained further salience, with a series of related talks led by the Stockholm International Water Institute as part of a dedicated Water Pavilion, coupled with the first ever health pavilion (103).

Still, arguably the most important development in the climate-WASH integration domain has been the 2017 release of an updated (and much improved) version of the "Strategic Framework for WASH Climate Resilient Development" by UNICEF, in collaboration with the Global Water Partnership. This document was published in combination with a series of technical briefs and learning modules to support implementation actors in conducting strategic risk assessments, appraising and prioritizing options, and delivering locally-tailored climate-resilient WASH solutions (104). Most importantly, this document formally defined what climate adaptation in the WASH sector entails, which has not always been clear given the inherent climate resiliency gains conferred by even basic water security and sanitation promotion initiatives (independent of their "climate"-specific focus). Specifically, with respect to the WASH sector, it was stated that climate-resilient development requires a focus on:

1. Ensuring that WASH infrastructure and services are sustainable, safe, and resilient to climate-related risks; and
2. Ensuring that WASH systems contribute to helping build community resilience to the impacts of climate change (104).

The guidance provided in this framework offers rich insight into various adaptation options for responding to climate-related WASH hazards, such as flooding, drought, heatwaves, storm damage, sea-level rise, and natural resource degradation (104). Important information is also provided on how to assess the suitability and feasibility of a certain adaptation option for any given vulnerability context, making the tool directly translatable into both policy and practice while easily adaptable across diverse settings.

As the notion of climate risk assessment has gained traction in the WASH sector, other researchers have reported upon the climate resiliency of different technologies using increasingly advanced assessment frameworks (105-107). Luh et al. (2017), for example, undertook an expert assessment of drinking water and sanitation systems to a range of climate-related hazards (107). From this assessment, they applied resilience scores to a range of water and sanitation technologies, to provide indications of the likelihood of both hardware and software components to continue functioning undisrupted in the face of either drought, decreased inter-annual precipitation, flooding, superstorms, wind damage, or saline intrusion (107). A

similar methodology was applied more recently by Howard et al. (2021), but additional domains of WASH resilience were considered beyond physical infrastructure, including the environmental setting, water and sanitation management systems, supply chains, community governance and engagement, and institutional support (108). Results from studies such as these, in combination with the strategic guidelines offered by UNICEF and other actors, can play an important role in informing policy development on climate adaptation and WASH integration.

Yet even if international enthusiasm for climate-resilient WASH sector development is reflected in the growth of related policy documents and research, the degree to which these recommendations have been translated into concrete practices is less clear from available literature. While many climate adaptation water projects have been reported upon, particularly rainwater harvesting (109), few exclusively adaptation-driven sanitation projects have been documented. An exception to this is offered by a recent summary published by WaterAid on lessons learned from case studies across four countries on integrating sanitation and climate change adaptation (110). However, it was noted in this report that "WaterAid's integration of climate change and sanitation has largely been concentrated at the project level, with its broader consideration at the strategic planning and decision-making levels not as evident" (110). Other commentators have noted that sanitation actors have been relatively slow to integrate climate concerns into thinking and programming, and that climate-related WASH discussions remain predominantly focused on water (8,110). Similarly, the limited progress that has been noted in the sanitation sector has been largely in the area of technological—as opposed to institutional, legislative, and other—improvements (8). More nuanced critiques concerning the general neglect of the WASH sector in climate adaptation planning have been provided by other scholars, with some calling for updated SDG 6 targets to reflect new climate priorities (111-113). Considering this, in combination with the fact that WASH still receives only a tiny allocation of climate finance (i.e. 0.3%), there appears to be considerable scope for further progress on climate-WASH integration globally, as well as specifically in the LVB context (114).

1.8 Ch. 1 References

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Ch. 2: Research Questions, Objectives, and Methodology

2.1 Research Questions and Objectives

Combining existing evidence on the need for climate-resilient WASH as an adaptive strategy against climate impacts on water and sanitation systems worldwide, knowledge of the climate vulnerabilities of the LVB, and the scarcity of documented frameworks and strategies for regional integration of climate adaptation and WASH promotion, this study sought to address the following research questions:

1. What institutional progress has been achieved in mainstreaming climate adaptation into WASH sector planning in the LVB, and how can prior successes be tapped, and existing barriers be mitigated, to accelerate regional climate-WASH policy and practical integration?
2. How have lakeside communities in the LVB adapted their WASH practices to cope in the face of climate-driven rainfall changes, and how can these insights inform the development of more locally-tailored, community-driven approaches to climate resiliency strengthening within WASH programming?

In addressing these research questions, the objective of this project was to be able to formulate a series of evidence-based recommendations for LVB WASH sector stakeholders, to inform the accelerated integration of climate adaptation into WASH program planning at local, national, and regional levels. Such recommendations were intended to both address current barriers identified while drawing upon the innovations and knowledge underlying the observed adaptation strategies of community members to both flooding and drought, particularly in the domain of WASH-related behaviour change. As such, this project was designed to contribute towards positive regional shifts in climate-resilient WASH sector planning within the LVB, by providing more contextually applicable insights than those offered by current global guidelines on climate-resilient WASH, and by leveraging the innovation potential of communities in the development of novel adaptation approaches.

2.2 Research Ethics Protocols

Ethics approval for this project was obtained from both the University of Alberta Research Ethics Board (REB-1) and the Maseno University Ethics Review Committee, which is one of several bodies which oversees research conducted in Kenya. In compliance with ethical requirements and with the Tri-Agency Framework on the Responsible Conduct of Research, various ethical protocols were followed to ensure the dignity and safety of all participants throughout the study. Three different consent forms were used to obtain informed consent: one for survey participation, one for focus group participation, and one for interview participation. Each consent form detailed all study protocols including the research purpose and proposed use of

collected data, foreseeable risks and potential benefits, confidentiality assurances, processes for study withdrawal, data management procedures, and plans for the dissemination of study findings. All consent forms were written in English and reviewed by Kar Geno staff to ensure their appropriateness and language comprehensibility. Consent forms were read aloud and translated for illiterate and/or non-English-speaking participants, which included most Mabinju community members. Participants had a chance to ask questions before signing or finger stamping the consent form.

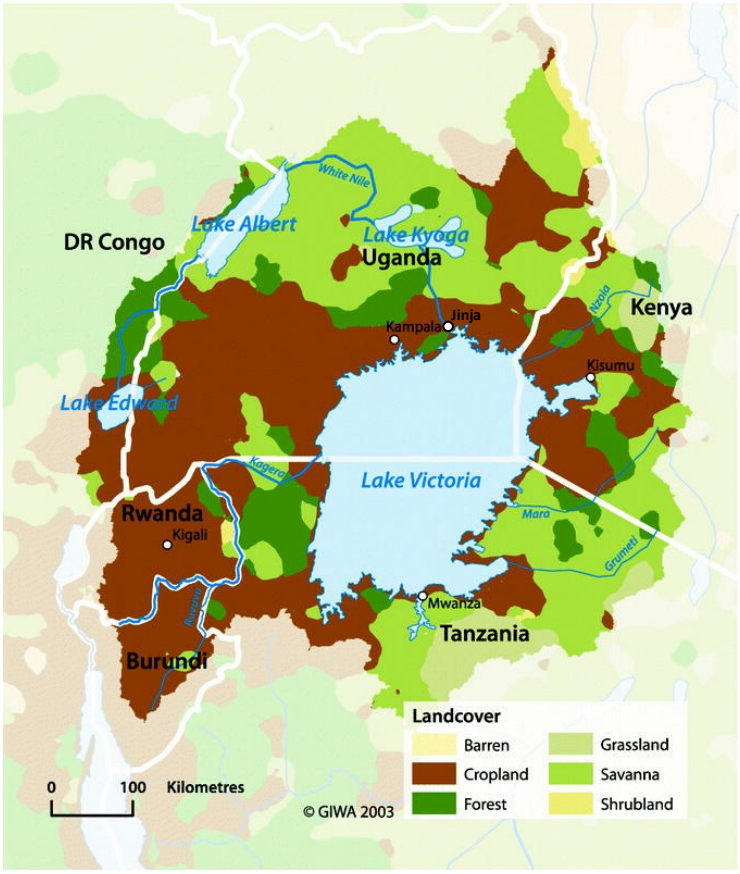
Participants were fairly compensated for their involvement in the study, and were each given a cash stipend with a value deemed appropriate by Kar Geno staff, considering local CDC study compensation norms. Participants were given the chance to withdraw from the study at any point without consequence, and were informed of local contact people to reach out to if any questions or concerns arose during or after completion of the study. Interview subjects were also given the opportunity to choose the location/setting of their interview, to ensure maximal privacy where necessary. Survey data, interview/focus group recordings, and interview/focus group transcripts were all stored in a cyber-secure, password-protected data file, and will be permanently deleted from the computer hard drive after 5 years time in accordance with REB protocols.

2.3 Methodology: Data Collection

2.3.1 Field site

For the purpose of addressing the first research question on broader institutional progress achieved in mainstreaming climate adaptation into WASH programming in the LVB, the geographic region from which key informants were recruited included farming-based lakeside settings spanning the three countries directly sharing Lake Victoria's waters—that is, Kenya, Uganda, and Tanzania. Major locations targeted included Kisumu (Kenya), Jinja (Uganda), Kampala (Uganda), and Mwanza (Tanzania). A full map of the LVB is provided in Figure 1 below, on which most of these cities are marked and the various eco-zones are delineated (2).

Figure 1: Map of Lake Victoria Basin with Ecozones and Major Urban Centers Marked



Besides discussing with stakeholders their observations on community coping strategies against flooding and drought, the community of Mabinju served as the main study site from which insights were drawn on community-level climate adaptation for WASH. While the ability to extrapolate such insights to the entire LVB were inherently limited, it was hoped that, in representing a lakeside community with similar environmental and social vulnerabilities as others in the LVB, Mabinju could still offer insights of relevance to other LVB settings.

The reason that Mabinju was selected to serve as the main study site was due to its relative accessibility given a research collaboration with the community-based organization Kar Geno Center for Hope, Kenya. As Kar Geno works primarily in Mabinju, alongside a few other areas in Western Kenya, it could provide easy access to interview subjects and local field assistants. Furthermore, given its long history of working in Mabinju on agriculture, income-generation, and HIV/AIDS prevention and awareness projects, Kar Geno could offer the needed sociocultural expertise to inform the development of appropriate data collection strategies and approaches to engaging study participants.

Given the vulnerabilities of Mabinju community members from health, socioeconomic, and environmental standpoints, Mabinju also served as a relevant setting to investigate WASH challenges in the context of climate change. Mabinju is a small farming-based community of about 300 homes located in Western Kenya on the banks of Lake Victoria. It is in Siaya county which, in 2018, had an HIV prevalence rate of 15.3% (1)—one of the highest rates in the world. With many suffering from HIV/AIDS, Mabinju's inhabitants have long been subject to extreme poverty, stigmatization, and marginalization despite ongoing development efforts in the region. While Kar Geno's work has come a long way in addressing the economic, social, and health barriers faced by Mabinju community members in achieving prosperity and success, WASH in Mabinju has been identified as an area in need of more attention, given the ongoing shortage of clean water supplies and safe sanitation systems.

2.3.2 Baseline community survey

The first phase of this project was comprised of a quantitative household-level WASH survey, intended to enhance the preliminary understanding of the WASH situation in Mabinju, including dominant behaviours and practices. Survey questions were developed in collaboration with Engineers Without Borders- USA, which had a shared interest in assessing WASH practices in Mabinju as part of their long-term planning for a borehole construction project. The WHO/UNICEF "core questions on drinking water and sanitation for household surveys" (3) were used as a guide to inform question content and phrasing.

As the survey was conducted at a time when Mabinju was experiencing a sharp rise in COVID-19 cases, resulting in increased need for improved hygiene, the household administration of the survey was coupled with the distribution of handwashing stations and hygiene kits—a Kar Geno-led initiative already underway, but which research funding provided further support for. The combined survey administration and hygiene supply distribution process was used as an opportunity to sensitize community members on upcoming WASH activities in Mabinju, including both the conduct of this study and the borehole drilling project to be launched by Engineers Without Borders- USA shortly thereafter. Two locally hired field staff (i.e. female, English-speaking, and fully literate Mabinju community members) were assigned these responsibilities. They were also directed to consult with adult members within each home on whether they would be willing to be contacted for further involvement in the study, including participation in subsequently held interviews or focus groups. Those households with members which agreed were noted down and targeted in later participant recruitment. Demographic information for these members was also taken and used to inform purposive sampling of participants from certain age, gender, social, and other categories.

As funding permitted distribution of handwashing stations to 214 homes, only these 214 homes were sampled for inclusion in the survey. Within each home where the survey was administered, it was requested that the primary household member responsible for water collection be the one to complete the survey if they were available and willing, even if this meant involvement of predominantly female participants. Using the following formula, where the population size is considered as 300 homes, this sample size provides a 3.25% margin of error at the 95% confidence level, which is relatively robust.

Finite population:

$$CI' = \hat{p} \pm z \times \sqrt{\frac{\hat{p}(1-\hat{p})}{n'} \times \frac{N-n'}{N-1}}$$

where
z is z score
p̂ is the population proportion
n and **n'** are sample size
N is the population size

The field assistants tasked with administering the survey brought with them printed copies to each home, which they wrote the answers on after translating the questions to each participant. The answers indicated on the paper copies were then input by a Kar Geno staff member working in the main office onto a digital Google form, allowing survey responses to be accessed remotely by other members of the research team. Due to time constraints, no verification procedures were taken, but the staff member who inputted the answers was able to contact the field assistants if anything was unclear on the paper versions.

2.3.3 Document analysis

A document analysis was conducted prior to field-based data collection to establish a preliminary understanding of the institutions and policies currently in place to support integration of climate adaptation and WASH in the LVB. To achieve sufficient methodological rigor, the READ approach to document analysis in health policy research was used as a guiding framework in the conduct of this review (4). This began with a thorough literature review to identify relevant documents for inclusion in the analysis. Inclusion criteria were limited to documents produced by governments, academics, implementation partners, and non-governmental institutions which offered commentary on any one of the following:

a) policy plans, internal strategy documents, and/or national/regional guidelines for climate adaptation or WASH development in the LVB,

b) achievements, successes, and challenges associated with climate adaptation in the health and water sectors of the LVB, and

c) regionally-scaled projects launched to address climate-driven threats to health and water resources in the LVB.

Three scholarly databases (Embase, OVID Medline, and OVID Global Health) were searched for the identification of all external assessments by academics, implementation partners, and non-governmental institutions on current progress on regional climate-health and climate-water adaptation. An appropriate search strategy was developed in collaboration with a librarian, and included all relevant terms intended to capture the three core concepts of climate adaptation, WASH, and the Lake Victoria Basin region. As these scholarly databases are not well suited to obtaining government- and NGO-authored policy/strategy documents, program assessments, and situation analyses, an alternative approach was taken to extract such grey-literature materials. This included inputting relevant search terms into UN-iLibrary, Unite Search, United Nations Digital Library, and the World Health Organization Country Planning Cycle Database. Additionally, government websites were visited directly to obtain publicized government policy/strategy documents. Finally, other grey literature sources, including Google Scholar and the websites of various institutional actors engaged in climate change and environmental health programming in East Africa, were explored to identify additional information on LVB-specific water projects.

An excel spreadsheet was developed for systematically extracting all clauses of text containing relevant information to the focus of this review. Here, file details (i.e., file name, source, publication year, and authorship) were recorded, alongside extra notes and internal decision points made in the data extraction process. Particularly relevant terms and text scripts were highlighted for easier identification upon secondary review of extracted data.

2.3.4 Qualitative focus group and interview discussions

Qualitative focus groups and interviews were conducted with individuals residing in Mabinju, who could best discuss their own lived experiences (note: more details on participant profiles to follow). A total of 7 semi-structured focus groups and 17 individual interviews were conducted in Mabinju, to solicit community perspectives on changing weather patterns and to discuss their WASH impacts in the village. Various WASH practices were explored, including adaptative/coping strategies used in response to any of the experiences with flooding or drought that were discussed. Existing support systems for waterborne disease prevention and treatment were also explored, including relationships with community health volunteers (CHVs), village elders, clan representatives, public health officers, and other government officials. Health beliefs and healthcare service utilization were also investigated, mainly in relation to diarrhea and other waterborne diseases. Finally, respondents were encouraged to discuss and brainstorm solutions to any of the WASH concerns or challenges presented. Each focus group concluded as an open discussion forum for the generation and exchange of ideas on this topic, and each interview was wrapped up with a final question

on what could be done to improve the current WASH situation in Mabinju. Drawing on principles of participatory action research, focus groups always concluded with statements of intent from Kar Geno and the broader research team to utilize the knowledge gained to inform the planning and design of projects responsive to critical WASH needs.

All focus groups were conducted prior to community members interviews, as they were intended to inform the development of more detailed question guides with which to probe individuals about personal beliefs and practices not elaborated upon in the larger group setting. All focus groups included between 6 and 16 members, with a target (and cap) of 8 members imposed after the third group to foster greater engagement and dialogue within each circle. Three of the 7 focus groups were untargeted in their participant selection, meaning that any community member within a given village cluster was eligible to participate. The remaining 4 focus groups were designed to include specific types of subjects and incorporated additional questions on issues relevant to the corresponding subject category. These four subject categories included: 1) people living with disabilities (1 focus group), 2) pregnant women (1 focus group), 3) village elders and clan representatives (1 focus group), and 4) CHVs (1 focus group). A similar approach was taken with the community member interviews whereby individuals from pre-specified subject categories were targeted for participation. The subject categories targeted in the interview phase included: 1) HIV-positive individuals (3 interviews), 2) pregnant women (2 interviews), 3) lactating women (2 interviews), 4) seniors (i.e. individuals 65 and over; 8 interviews), 5) single mothers (2 interviews). Three interview subjects (2 men and 1 woman) happened to fall in the senior category, but were not purposively recruited but rather added at the end to confirm that data saturation had been reached, after which interviews were stopped.

The recruitment of participants for both interviews and focus groups was conducted with the support of the two locally-hired field assistants, who selected homes which indicated willingness to be contacted for further study involvement during the survey administration phase. Demographic details provided by these participants at the time of survey administration were also used to identify their subject category and target them for recruitment accordingly. Upon visiting the targeted homes, field assistants re-introduced the study purpose, protocol, and procedures, and reviewed consent forms with participants still indicating an interest in being involved. Different consent forms were used for focus group and interview participation, but both addressed the following key issues, as needed to gain approval from the University of Alberta Research Ethics Board (REB-1) and the Maseno University Ethics Review Committee:

- The research purpose and proposed use of data collected

- Foreseeable risks and potential benefits
- Extent of confidentiality promised
- Requirements of the study (e.g. duration, frequency, nature of tasks and/or measures)
- Withdrawal procedure
- Extent of incentives
- Data management (access and safeguards)
- Plans for provision of new information
- Plans for dissemination of results

Consent forms were written in English but read aloud to participants in Luo. Participants were given a chance to ask the field assistant questions before signing (or finger stamping, for illiterate participants) the form. Once individuals agreed to participate in a focus group, they were given a time and place to be the following day, which was typically the house of one member willing to host the group in their yard. For individuals agreeing to interview participation, they were offered a chance to select the location for their interview, in response to which all participants opted for the interview to be conducted in their own home. During the conduct of any given interview or focus group, field assistants were present throughout, helping with distribution of refreshments and stipends and translation of both questions (from English to Luo) and responses (from Luo back to English). It should be noted, however, that translations were not provided in the form of verbatim responses, but rather as summaries of the statements and comments provided by each respondent. The only exception to this was for the small number of participants able to respond directly in English. The limitations of this approach, however, are noted in the limitations section in Ch. 7.

Finally, for the stakeholder interviews, potential participants were identified through preliminary research (and consultation with pre-existing regional contacts) on WASH sector organizations and actors (including government health ministries) active in the lakeside regions of Kenya, Uganda, and Tanzania. For organizations that were not exclusively WASH focused, requests were made to be connected with representatives from their respective WASH departments or with any other individuals with relevant climate adaptation- or WASH-related knowledge or field experience. Emails were sent out to all organizations and individuals identified as appropriate subjects, and those who agreed to participate in an interview were either consulted with virtually, or through an in-person meeting at a location of their choice. The focus of all interview discussions with stakeholders was on current projects, efforts, initiatives, and policy developments underway to support the integration of climate adaptation and WASH within their geographic focus area of the LVB. Participants were also probed on their observations on the impacts of

climate change in the region, existing intersectoral, transdisciplinary, and international collaborations for regional climate adaptation and WASH planning, and community-driven climate adaptation patterns in contexts of flooding and drought. Additional participants were continuously recruited, and often identified from the networks of prior subjects, until there was sufficient confidence that data saturation had been reached, as determined by the emergence of no new codes in the data set. The full set of codes (both weighted and unweighted) used for each of the datasets (i.e. community member interviews/focus groups, stakeholder interviews) are provided in Tables 4-5. All of the initially developed (a priori) codes were retained, and are indicated with a ***. The remaining codes represent emerging codes which were added as the study progressed. Only once an emerging code appeared more than twice within the transcripts was it retained in the final code list. Weightings were later added to certain codes based on their thematic relevance.

Table 4: Transcript Analysis Coding Scheme- Community Member Interviews and Focus Groups

Categories	Codes
Water	Unweighted: • Surface water collection***, rainwater collection***, water storage***, water use***, water scarcity*** Weighted: • Water purification*** ○ WEIGHTING BASED ON: unadvanced practices (1) → advanced practices (5)

Sanitation	Unweighted:
	• Latrine construction***, latrine maintenance***, latrine innovation, sanitation enforcement
	Weighted:
	• Latrine destruction
	  ○ WEIGHTING BASED ON: low sanitation resiliency (1) → high sanitation resiliency (5)
	• Latrine sharing
	  ○ WEIGHTING BASED ON: negative experiences (1) → positive experiences (5)

Hygiene	Unweighted: • Hygiene beliefs*** Weighted • Hygiene practices*** ○ WEIGHTING BASED ON: negative practices (1) → positive practices (5)

Health	Unweighted:
	• Malaria***, healthcare access***, health beliefs***
	Weighted:
	• Diarrheal disease***
	  ○ WEIGHTING BASED ON: high frequency occurrence (1) → low frequency occurrence (5)
	• Medication access
	  ○ WEIGHTING BASED ON: high informal sector reliance (1) → low informal sector reliance (5)
	• Traditional herb use

	○ WEIGHTING BASED ON: high traditional herb reliance (1) → low traditional herb reliance (5) • Pregnancy/lactation*** ○ WEIGHTING BASED ON: high health vulnerability (1) → low health vulnerability (5) • HIV/AIDS*** ○ WEIGHTING BASED ON: high health vulnerability (1) → low health vulnerability (5) • Age*** ○ WEIGHTING BASED ON: high health vulnerability (1) → low health vulnerability (5) • Disability*** ○ WEIGHTING BASED ON: high health vulnerability (1) → low health vulnerability (5)
Environmental Change	Unweighted: • Lake water quality deterioration, climate change observations*** Weighted: • Heavy rainfall/flooding*** ○ WEIGHTING BASED ON: high frequency occurrence (1) → low frequency occurrence (5) • Drought*** ○ WEIGHTING BASED ON: high frequency occurrence (1) → low frequency occurrence (5) • Climate change beliefs*** ○ WEIGHTING BASED ON: low knowledge on causes (1) → high knowledge on causes (5)
Support	Unweighted: • Diffusion of ideas, barriers to tree planting Weighted: • Support from CHVs***, **support from village elders and clan reps, support from government (note: these were initially one code titled "support from higher level representatives" but later needed to be separated),** support from family, support from peers ○ ALL WEIGHTINGS BASED ON: low support (1) → high support (5)
Coping Strategies	Weighted: • Coping with diarrhea***, coping with latrine destruction, coping with food insecurity, coping with water insecurity***, coping with unreliable rainfall, coping with flooding*** ○ ALL WEIGHTING BASED ON: negative coping/maladaptive (1) → positive coping/adaptive (5)

Table 5: Transcript Analysis Coding Scheme- Stakeholder Interviews

Categories	Codes
Water	Weighted: • Water infrastructure***, water access***, water quality*** ○ ALL WEIGHTINGS BASED ON: deterioration (1) → improvement (5)
Sanitation	Unweighted: • Faecal waste management***, **sanitation in facilities/camps, household level sanitation (note: these were initially one code titled "sanitation infrastructure" but later needed to be separated)**

Hygiene	Unweighted: • Handwashing, social and behaviour change communication***
Environmental Change	Unweighted: • Lake Victoria***, heavy rainfall/flooding***, drought***, weather predictability***
Climate Adaptation	Unweighted: • Adaptation technologies, adaptation projects*** Weighted: • Adaptation prioritization*** o WEIGHTING BASED ON: low prioritization (1) → high prioritization (5) • Adaptation-WASH integration*** o WEIGHTING BASED ON: low integration (1) → high integration (5) • Grassroots initiatives*** o WEIGHTING BASED ON: minimal (1) → advanced (5)
Facilitators/Barriers	Unweighted: • Community resistance to change Weighted: • Climate action*** o WEIGHTING BASED ON: barrier (1) → facilitator (5) • Adaptation-WASH integration*** o WEIGHTING BASED ON: barrier (1) → facilitator (5)
Engagement of Multiple Actors	Weighted: • Collaboration across sectors, collaboration across ministries, collaboration across countries, community engagement, decentralization of responsibilities (note: all these codes were initially one code titled "multistakeholder collaboration" but later needed to be separated) o ALL WEIGHTINGS BASED ON: minimal (1) → advanced (5)
Disaster Risk Management	Unweighted: • Emergency response***, early warning***
Research	Unweighted: • Climate change***, WASH***

In the end, a total of 13 stakeholder interviews were conducted, with representatives from each of the following organizations/institutions included (organizations marked with an asterisk denote those from which more than one representative was interviewed):

- Kenya:
    - AMPATH Kenya
    - FreeKenya Foundation
    - The Safe Water and Aids Project*
    - Siaya County CDC office
    - Kombewa County Referral Hospital Infection Prevention and Control Department
- Uganda:
    - Water Mission Uganda

    - Uganda Ministry of Water and Environment
    - Uganda Water and Sanitation Network
- Tanzania:
    - Tanzania Water and Sanitation Network
    - Tanzania Institute of Rural Development Planning
- Region-wide:
    - The Lake Victoria Basin Commission* (specific contacts consulted with from the climate adaptation program board)

All interviews and focus groups were recorded (using a password-locked mobile recording app), transcribed (on Microsoft Word), and reviewed shortly afterwards. This concurrent process of data collection and analysis was fitting with qualitative research principles, and allowed for an iterative approach to data collection involving the regular revision of focus group and interview guides to fill emerging knowledge gaps (5). Due to the potential for information to be lost in translation, and given the non-verbatim process by which subject responses were translated in community member interviews and focus groups, all transcripts were retroactively reviewed with the locally-hired field assistants to ensure their accuracy and sufficiency in summarizing the participants' responses. Recordings were played simultaneously, and wherever information was even slightly mistranslated or certain details were missed in the translation, the field assistants provided immediate notice of this, and any necessary revisions or comments were added to the transcript documents.

2.4 Methodology: Analysis

2.4.1 Baseline community survey

As the survey was used solely for descriptive purposes, no advanced statistical analyses were conducted. Drawing on the assumption that the sample (214 out of approx. 300 homes) was sufficiently representative, the survey responses were graphically visualized, and calculations were made of the proportion of respondents selecting each answer choice. The insights drawn from this assessment were then used to refine pre-developed community member interview and focus group guides, to ensure that all questions were both relevant and applicable and that major issues identifiable from survey responses were sufficiently explored.

2.4.2 Document analysis

A qualitative thematic content analysis was conducted on all extracted clauses of text. Again, the READ approach to document analysis in health policy research was used as a guide, therefore the development

of initial theories and thematic categories was used to inform and modify document selection criteria throughout (4). Data was coded solely by the PI (myself, Hannah Marcus) according to the overarching constructs represented (i.e. a-priori codes included policy and legislation, strategy development, project planning, project implementation, funding, multistakeholder collaboration, and community engagement) and then thematic tags were developed and assigned to corresponding scripts. The first iteration of thematic tags consisted of generic domains, which the PI further divided into thematic conclusions. As the coding process progressed, the thematic tags and conclusions were continually refined by the PI until it was felt that they comprehensively described and codified the content of the dataset. The ideas derived from this phase of the study were then used to refine stakeholder interview guides, targeting major progress gaps identified through the document review.

2.4.3 Qualitative interviews and focus group discussions

Finalized interview and focus group transcripts served as the primary data source for this component of the study. Using Dedoose qualitative data analysis software, a thematic content analysis was conducted using a Grounded Theory approach, whereby principles of constant comparison were employed, and used to iteratively develop a theoretical model from a qualitative coding scheme (6). Inductive coding was used to develop a set of codes and categories which fit the data, with separate schemes developed and applied to community member interview/focus group transcripts and to stakeholder transcripts (7). The PI regularly refined the coding scheme in the process of reviewing and tagging transcript excerpts, to optimize its suitability in capturing the various constructs presented by the data. Once all transcripts were coded, the excerpts for each code were compiled and analyzed to ascertain a set of interconnected themes which tied the various ideas together and articulated core meanings derived (7). These themes serve as the section headings in Ch. 3, where a summary of the study findings is presented.

2.5 Ch. 2 References

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Ch. 3: Summary and Discussion of Findings

3.1 Document Analysis Findings

3.1.1 Documents identified, selected, and reviewed

A total of 31 documents were selected for inclusion in this analysis. These included the following government policy documents (i.e. the most updated version), external assessments/reports, conference statements, and project overviews:

- Government policy documents:
    - Intended Nationally Determined Contributions (INDC) for each of the 5 LVB countries (Kenya, Uganda, Tanzania, Rwanda, Burundi) (1-5)
    - National Adaptation Plan (NAP) or National Adaptation Plan of Action (NAPA) for each of the 5 LVB countries (Kenya, Uganda, Tanzania, Rwanda, Burundi) (6-10)
    - National Health Sector Strategy Plan for each of the 5 LVB countries (Kenya, Uganda, Tanzania, Rwanda, Burundi) (11-15)
- External assessments/reports:
    - Lake Victoria Basin Climate Change Adaptation Strategy and Action Plan 2018-2023 (USAID report) (16)
    - Integrating Climate Adaptation in Water Catchment Planning in Uganda (NAP Global Network briefing note) (17)
    - Perceptions of Climate-Related Risk Among Water Sector Professionals in Africa—Insights from the 2016 African Water Association Congress (academic paper) (18)
    - Review of Research and Policy for Climate Change Adaptation in the Health Sector in East Africa (International Development Research Centre working paper) (19)
    - Towards Climate Resilient Environmental and Natural Resources Management in the Lake Victoria Basin (World Bank report) (20)
    - Climate Change Situation in Kenya and Measures Towards Adaptive Management in the Water Sector (academic paper) (21)
    - Climate and Health Country Profiles for Kenya, Uganda, and Tanzania (WHO country assessment) (22-24)
- Conference statements:
    - Resolution of the African Great Lakes Conference: Conservation and Development in a Changing Climate (Entebbe, Uganda), 5th May 2017 (25)

- Project overviews:
    - Adaptation to Climate Change in the Lake Victoria Basin (ACC-LVB) Program (Lake Victoria Basin Commission) (26)
    - Lake Victoria Basin Integrated Water Resources Management (LVB IWRM) Programme (Lake Victoria Basin Commission) (27)
    - Planning for Resilience in East Africa through Policy, Adaptation, Research and Economic Development (PREPARED) Programme (Lake Victoria Basin Commission) (28)
    - Lake Victoria Water Supply and Sanitation (LVWATSAN II) Programme (Lake Victoria Basin Commission) (29)
    - Adapting to Climate Change in Lake Victoria Basin Project (Adaptation Fund) (30)
    - Healthy Futures Project (commentary, Geospatial Health journal) (31)

3.1.2 Major themes: policy orientation

An in-depth review of the selected documents unveiled important insights on the current policy landscape surrounding climate adaptation and waterborne disease control in the LVB. On a positive note, the documents revealed that the climate-health nexus, and notably the climate-WASH nexus, is now well recognized by stakeholders active in this space, and that such recognition is likely growing in conjunction with advancements in related research. In all of the five NAP(A)s assessed, detailed commentary was provided on the links between climate change and human health (6-10). Furthermore, such links were used to justify more robust adaptation planning and action, reflecting an appreciation amongst stakeholders of the public health impetus for responding to climate hazards. Specific links were also drawn in all NAP(A) documents between climate change and waterborne disease risk (6-10). Declining water quality, compromised sanitation and hygiene, and outbreaks of diarrheal diseases were all listed in vulnerability assessments used to inform subsequent adaptation planning (6-10). In Uganda's NAPA, water resources and health were both identified as priority intervention areas in discussions with communities on traditional coping strategies to climate variability risks (7). Furthermore, in the 2017 Resolution of the African Great Lakes conference, the following key areas were agreed upon by participants as key issues to be addressed:

a) changes in the hydrologic cycle which affect human health and water quality and quantity,

b) the effect of climate change on malaria, bilharzia, cholera and other water-related diseases, and

c) inadequate infrastructure to support supply of clean and healthy water and improved sanitation (25).

The increasing weight placed on these issues was also reflected, in part, by the exceptionally rich climate-related content included in Tanzania's new Health Sector Strategic Plan (July 2021-June 2026) (13)—the newest health strategy document included in this analysis.

Likely as a function of the recognition of the interrelatedness between climate change, human health, and WASH, this review also illuminated clear efforts to mainstream public health and WASH into climate adaptation planning in the LVB. As revealed in the climate and health country profiles for Kenya, Uganda, and Tanzania, all three countries have identified a national focal point for climate change in the Ministry of Health (22-24). Both Kenya and Uganda have an approved national health adaptation strategy (22,23), while Tanzania is in the process of "taking initiatives to implement health adaptation programmes and building institutional and technical capacities to work on climate change and health" (24). The improvement of Integrated Disease Surveillance systems through more robust use of meteorological data was mentioned in the NAP(A) documents for both Kenya and Tanzania (6,8). In Kenya's NAPA, a specific agenda is outlined for "mainstreaming climate change adaptation in the water and sanitation sector" (6). Additionally, in all five of the NAP(A)s assessed, there are specifically delineated sections for climate adaptation in the health sector (6-10). The same can be said for most of the INDCs reviewed (2-4). The Lake Victoria Basin Climate Change Adaptation Strategy and Action Plan details five recommended adaptation options for the health sector, which include:

1) building the capacity of the health workforce on climate change preparedness and response,
2) strengthening and institutionalizing surveillance, early warning, and communication systems on climate-sensitive diseases,
3) developing a robust research program within the LVB to identify, prioritize, and assess the interaction and correlation of climate change on health and key disease vectors,
4) using climate-appropriate technologies for health and sanitation infrastructure, and
5) improving maritime security and safety (16).

All of these items have direct or indirect implications for waterborne disease control.

Still, this review made it clear that there remains much room for further convergence and collaboration of the climate adaptation, WASH, and health sectors in the LVB. For one, with the exception of Tanzania's Health Sector Strategic Plan (July 2021-June 2026) (13), which was written particularly recently, none of the health strategy documents reviewed made substantive mention of climate change in relation to national health priorities, including those falling under the umbrella of WASH (11,12,14,15). In the "Review of Research and Policy for Climate Change Adaptation in the Health Sector in East Africa", it was also noted

that "while there have been many projects in the region to reduce the incidence of diarrhoea, little has been done in the area of adaptation to climate change" (19). Some of the barriers that the authors of this review identified to mainstreaming climate change adaptation in the health sector in East Africa included low research capacity and lack of high-quality data, lack of funds for implementation of adaptation projects, and inadequate national policies for adaptation in the health sector (20). Shortcomings were further reflected in the three climate and health country profiles reviewed (22-24).

Other gaps identified in this review concern current conceptualizations of climate-related hydrological changes, as they relate to WASH risks. There was minimal explicit recognition in the reviewed policy documents of the relationship between drought and WASH. When WASH issues were explicitly addressed, it was most often in relation to flood hazards and excessive (as opposed to inadequate) rainfall. The potential for water scarcity to impact hygiene behaviors, water use, and waterborne disease spread was never explicitly addressed. This is despite research cited in Tanzania's NAPA wherein 42% of participants affected by disease outbreaks reported prolonged rainfall *and* drought to be the cause (8). The general under-recognition of drought-WASH linkages was also apparent in a study of perceptions of climate-related risk among water sector professionals in Africa in which respondents expressed notable concerns around water scarcity, but only in relation to the operation of utility water supplies, with no reference made to waterborne disease spread or other public health risks (18).

In general, when climate-related drought was discussed in formal policy documents, the risks emphasized were almost exclusively limited to those of declining agricultural yields, food insecurity, and loss of livelihoods. For example, in Tanzania's INDC, it is touted that adaptation contributions, by reducing the impacts of spatial and temporal variability of declining rainfall, will confer the greatest benefits to the agricultural sector (3). Similarly, in Kenya's NAP, the El Nino Southern Oscillation is presented as an economic risk to agriculture value-added growth (6), despite the breadth of (externally) reported impacts of this phenomenon on waterborne diseases in East Africa. The review of both water and climate adaptation projects in the LVB further verified that drought is primarily perceived by climate-engaged stakeholders as a risk to agriculture. That is, virtually all of the projects which intended to address climate-driven water scarcity were centered upon the improvement of technologies and local capacities for enhancing crop resiliency and reducing yield losses. While the agricultural impacts of climate-related drought undoubtedly present one of the greatest economic and food security challenges of the 21st century, any risk assessments of declining rainfall are incomplete without due consideration of the health, including WASH, implications.

Finally, the document analysis revealed the overarching and important theme that policy guidelines on climate adaptation and WASH will need to be further elaborated to be made fully actionable. This theme was apparent in the ambitious yet highly generic language used for policy objectives relating to climate adaptation in the health and WASH sectors. Relevant terms commonly used, but seldom elaborated in formal policy documents included "vulnerability risk mapping", "early warning systems", "disaster risk reduction", and "disease forecasting". Undoubtedly, these concepts are indispensable components of a comprehensive public health response strategy to the impacts of climate change. Yet, without further articulation of the steps needed to actualize them, they risk remaining empty rhetoric with little practical relevance. This sentiment is supported by the reviewed World Bank assessment on "Climate Resilient Environmental and Natural Resources Management in the Lake Victoria Basin" in which it is stated that "climate considerations have not yet been mainstreamed in many activities and programs, despite high-level strategies and plans" (20). Furthermore, in the Lake Victoria Basin Climate Change Adaptation Strategy and Action Plan, the adaptive strategy for the health sector in the LVB is summarized in the following single statement: "to develop and implement programs that strengthen the resilience of health systems and communities to adapt to climate change vulnerabilities" (16). This policy, which serves as a stand-alone statement, exemplifies an ambitious yet insufficiently detailed agenda for operationalizing public health measures in the context of climate adaptation. Analysing this and other similar discourse used, it becomes clear that current mandates for addressing climate-driven WASH hazards in the LVB must be made more action-oriented through the development of clearer operational guidelines.

3.1.3 Major themes: multisectoral collaboration

Given the vast array of disciplines which have a stake in climate adaptation, it is not surprising that the concept of multisectoral collaboration appeared frequently across the documents explored. An emergent theme was that there exists widespread recognition of the need for multisectoral collaboration and a clear intention to facilitate it amongst stakeholders active in this space, but an ill-defined roadmap for doing so. This theme was evident by the consistently vague language used in formal policy documents and project proposals concerning the integration of water, health, and environmental resource management sectors for climate adaptation. Stated in the adaptation sections of the INDCs for Uganda and Rwanda are the objectives of "mainstreaming climate resilience in all sectors" (2) and "strengthening the institutional framework" (4) for collaboration with the health sector. Similarly, in the NAPAs for Tanzania and Rwanda, there are explicitly stated intentions of increasing "intersectoral concertation" for integrated water resource management (9) and establishing "Health & Climate collaboration & synthesis programs" (8). In none of these examples are the stated objectives further elaborated upon, as needed to provide a clear

roadmap for operationalizing them. While Kenya's NAP comes closest to achieving this by outlining the formation of a National Climate Change Steering Committee with representation from diverse sectors (6), limited further detail on this process is provided. Of further concern is the fact that as recently as 2014, it was stated that climate change was not yet on the agenda of USAID's Health Policy Project, which plays a major role in assisting developing countries with health policy formation (19).

Equally vague language is used in the health sector strategy plans for the LVB countries. Tanzania's Health Sector Strategic Plan calls for a "health-in-all-policies" approach in reference to the management of water supply and sanitation, but fails to discuss the specific involvement of other ministries in national-level WASH planning (13). While Kenya's Health Policy document explicitly lists the sectors to be engaged in its "Health in all Policies" approach, it does little to outline its vision for the nature of this involvement. Burundi's National Health Policy, however, is an exception in this regard. Not only does it have a specific section dedicated to discussing intersectoral collaboration in addressing the effects of the environment on human health, but it also describes some already developed platforms for collaboration, including the national risk management platform piloted by the Ministry of Security, with representation from the Ministry of Health (15). Additional details are provided on inter-ministerial commissions convened by the Ministry of Public Health and the Fight Against AIDS (15). While it is likely that other countries have also convened similar commissions and multisectoral forums for shared planning and strategy development, the language expressed in the reviewed documents fails to provide clear evidence, suggesting there may be shortcomings. Such shortcomings also appear to be reflected in practice, considering reports that among the national medical research institutions in East Africa, it is only the Kenya Medical Research Institute that has a climate and human health research programme addressing epidemic malaria (19).

Possible reasons for existing gaps may include the existence of rigid disciplinary divisions in climate response programming—another major theme identified in the document analysis. One of the most explicit indicators of this fragmentation is the separation of adaptation plans, programs, and priorities into sector-specific subsections within country NAPs, NAPAs, and INDCs. With the exception of Rwanda whose INDC has a section for "cross-cutting prioritized adaptation measures" (4), most other policy documents have independent sections for adaptation in the health and water sectors. Even in Uganda's Health Sector Development Plan, responsibility for provision of sanitation services is delegated to the "Ministry of Water and Environment" (12). Also, one of the stated achievements in Uganda's INDC is the integration of climate change into sectoral policies, plans, and programmes (2). While such integration is a laudable achievement, the very requirement that plans be sector-specific, with climate change considerations absorbed into these

plans, rather than multisectoral approaches being linked under a common climate response umbrella, is indicative of the persistence of sectoral silos. This is fitting with Kenya's NAP which references "climate change coordination units" in different ministries, departments, and agencies (6), but fails to illuminate if and how the individual units collaborate under one operational agenda. The need to bridge research and policy spaces was emphasized in the analyzed document titled "Review of Research and Policy for Climate Change Adaptation in the Health Sector in East Africa", in which the authors stated that "A key barrier for uptake of research into policy in the region is the fact that the researchers and the users of their products reside in separate worlds. Many research projects do not have a sound knowledge sharing and communication strategy nor do they engage end users and stakeholders at the inception of the project" (19). The idea that there is need for more effective channels for multisectoral collaboration in climate adaptation in the LVB is further affirmed by an explicit call for such in the reviewed World Bank report on climate resilient environmental and natural resource management in the LVB (20).

3.1.4 Major themes: community input

Recent years have seen greater recognition of the potential role for Indigenous knowledge, experiences, and perspectives in informing climate resiliency methods. The degree to which such knowledge has been formally reflected in climate adaptation policy on national and regional levels was an important area of inquiry for this review. Analysis of the selected documents revealed relatively promising trends, with clear indication of early efforts to institutionalize community-driven approaches into local adaptation planning. The most notable example of this was Uganda's NAPA which was formulated using a participatory rural appraisal process, explicitly intended to "integrate traditional knowledge into the adaptation framework" (7). The decision to do such was based on an expressed recognition that many of Uganda's communities have evolved complex environmental coping strategies, passed between generations through traditional and cultural practices, which could be leveraged in the design of climate adaptation projects (7). As such, Uganda's NAPA reflects some of the richness of Indigenous knowledge systems, specifically encouraging adaptation actions including, but not limited to, use of herbal medicines for treatment of environmental illnesses, application of traditional modes of vector control, and adoption of Indigenous approaches to water harvesting, rainmaking, and thunderstorm prevention (7).

National policy documents for Kenya also reflect a similar recognition of the value of Indigenous knowledge in the development of innovative climate resiliency schemes. In Kenya's INDC, one of the explicitly stated aims is to draw upon *both* scientific and Indigenous knowledge to enhance the uptake of adaptation technology (1). Similar aims are stated in Kenya's more recently drafted NAP. In this document, the use of

Indigenous knowledge is further discussed in the context of developing community-informed early warning systems for prediction of extreme weather—an area to which Indigenous knowledge has been shown to offer valuable insights (6).

Still, these examples come from the national policy documents of only two of the five LVB countries accounted for in this analysis. Indeed, scant commentary on Indigenous knowledge was identified in policy documents of other countries, reflecting scope for further expansion of Indigenous knowledge integration into national climate adaptation planning. With regards to WASH planning in particular, none of the language used in official documents was found to reflect a strong recognition that communities could collectively engage in the development of locally-informed WASH strategies. Rather, most language was indicative of the predominant ethos around WASH planning, namely that community members are ill-informed and ill-equipped to uphold the level of sanitation needed to avert climate-driven waterborne disease spread, and thus it is the role of governments and other non-local stakeholders to train and equip communities to adopt better practices. This stands in contrast to the more bottom-up approach used to inform climate adaptation in other areas, such as vector control and agricultural production. Still, more participatory planning may be needed in all domains of climate adaptation. This is reflected, for example, by an institutional analysis conducted during fieldwork in the lakeside Mwanza Region of Tanzania which identified a lack of participatory planning, leading communities to be disconnected from decision making on climate adaptation measures (20).

3.1.5 Major themes: policy operationalization

While this review offered knowledge primarily on the policy planning and development domain of climate adaptation, limited insights on policy operationalization were gleaned from the analysis of documented achievements and relevant projects launched in the LVB. From this analysis, it became clear that water has been a major focus area of climate adaptation efforts in the region, but that few water projects have been specifically health- or WASH-oriented. Instead, more common adaptation actions in the water sector have included activities such as strengthened integrated water resource management, conservation and management of water catchments, wetland restoration, upgraded dam infrastructure, alternative water storage and harvesting technologies for irrigation, industrial wastewater reuse and recycling, and more coordinated transboundary water sharing, amongst others. The Adaptation to Climate Change in the Lake Victoria Basin (ACC-LVB) Program, one of the largest adaptation projects in the region, does not feature WASH in any of its stated objectives or implemented technologies (26). More recently, in 2016, a large program was launched by the Adaptation Fund across several lakeside project sites, following endorsement

by the five LVB nations (30). Still, in the proposal for this program, nowhere is there mention of specific WASH activities to be conducted. Rather, the only time WASH is mentioned is in relation to using lessons learned from past WASH projects to identify appropriate project sites (30). In an external assessment on integration of climate adaptation into water catchment planning in Uganda, catchment management plans for 15 hotspot catchments were discussed (17). However, in none of the catchment management plans were WASH-specific activities proposed (e.g. monitoring water quality for microbial contaminants, including groundwater monitoring for contamination with fecal matter), and no public health representatives were included in the list of stakeholders to engage with (17). Of further concern is that in the development of Rwanda's NAPA, access to health facilities and fighting vectors of water-borne diseases were ranked last in priority out of 11 initially prioritized actions (9). Similarly, in the Participatory Rural Appraisal on which Uganda's NAPA was based, only 2% of respondents gave preference to health as a priority intervention area, despite high priority given to water sector adaptation (7). The discrepant levels of priority given to health and water sectors seems to reflect an under-recognition of their interrelatedness in the context of climate risk management.

Still, many water sector adaptation measures, despite lacking explicit health promotion objectives, are essentially health promotive in nature. Examples included groundwater resource exploitation, intended to improve water supply for domestic and other purposes, flood risk management and water quality testing, both important waterborne disease prevention measures, and better domestic wastewater management, which relates to household sanitation. Indeed, such measures were frequently mentioned in adaptation programs and achievements, reflecting a degree of implicit public health consideration in water sector planning. Importantly, the Lake Victoria Basin Integrated Water Resources Management (LVB IWRM) Programme aims to improve the water quality of Lake Victoria by reducing effluent discharge (27)—one of the largest sources of drinking water contamination amongst lakeside communities.

A limited number of regional adaptation projects, however, have a predominantly WASH agenda. Kenya's INDC is particularly notable in this regard, for it includes in its adaptation programme potential upgrades to water and sanitation infrastructure, alongside the development of broader health programmes for climate-sensitive diseases (1). An external assessment of measures for adaptive management in Kenya's water sector also discussed the adoption of WASH-relevant climate change responses such as the construction of flood-proof wells and sanitary latrines, particularly in areas where the water table is close to the surface (21). The NAPA's for Rwanda and Uganda also include projects directly focused on WASH, namely the Community Water and Sanitation Project, outlined in Uganda's NAPA (7), and the project of

"Increasing the capacity of adaptation of villages 'Imidugudu' in vulnerable regions through improvement of drinking water and sanitation" in Rwanda (9). On a regional level, the Planning for Resilience in East Africa through Policy, Adaptation, Research and Economic Development (PREPARED) Programme incorporates the specific objective of enhancing drinking water supply, sanitation, and wastewater treatment services in the region (28). Similarly, the Lake Victoria Water Supply and Sanitation (LVWATSAN II) Programme is exclusively WASH-focused, however it is unclear the degree to which climate change is considered as a distal WASH risk factor (29). The Lake Victoria Environmental Management Project, financed by the World Bank and implemented in two phases from 1995 to 2005 and from 2009 to 2017, has been shown to have had positive impacts on waterborne disease control in the region, however gaps in monitoring have supposedly "reduced the ability to understand the baseline and the impacts of some investments" (20). This highlights another important theme, namely the importance of monitoring and evaluation in informing iterative strategy development for the integration of WASH and climate adaptation.

3.1.6 Concluding remarks on document analysis

Many important insights emerged from the document analysis, which helped situate current progress on climate adaptation and WASH integration in the LVB. Several encouraging themes were identified, including the widespread and growing recognition amongst climate-engaged stakeholders of climate-health and climate-WASH intersections, and clear efforts to mainstream WASH into climate adaptation planning. This was seen in conjunction with efforts to advance an agenda for multisectoral collaboration and inclusion of Indigenous knowledge systems into adaptation program design. Still, recognition appeared to be lacking on the implications of water scarcity for waterborne disease spread, considering the dialogue on projected drought scenarios was almost exclusively agriculture focused. Evidence of practical actions extending beyond the strategy planning stage was also scarce across documents reviewed. Finally, this analysis illustrated room for more collaboration between the environment, health, and water sectors in the LVB in order to dissolve sectoral silos, and pave way for the collaborative development of a shared vision for building climate resiliency in the WASH sector.

3.2 WASH Survey Results Summary

3.2.1 Characteristics of Surveyed Households

A total of 214 households were surveyed in this initial phase of the study. Of the household members who participated in the survey (one representative over 18 years within each home), 53% were male and 47% were female, representing a relatively even gender distribution. They ranged in age from 21 to 85 years, with the majority married (64%). Most households had multiple members, including children of varied ages.

3.2.2 Water

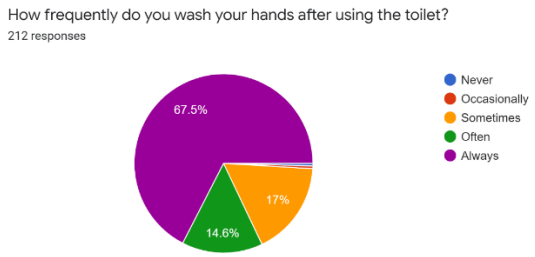
The main sources of drinking water selected were rainwater and lake water, with 100% of respondents indicating at least one (or both) as their primary source. The water sources indicated were essentially the same for personal hygiene, but for irrigation, 96% of respondents indicated reliance on rainwater (i.e. rainfed agriculture). As there are currently no community taps or boreholes drilled in Mabinju from which groundwater can be extracted, no participants indicated use of water from these sources. A small percentage, however, indicated reliance on streams as an additional source.

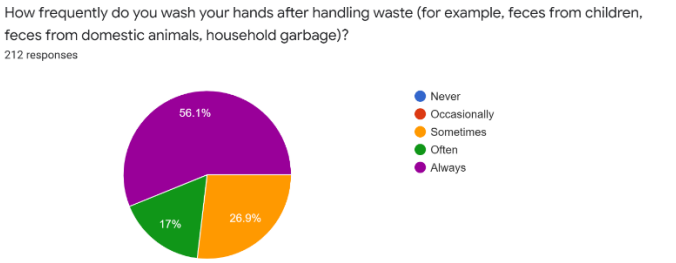
With regards to methods of treating water, responses were more mixed, but the predominant methods used were boiling (53%) and the addition of chemicals such as chlorine and water treatment tablets (63%). Fewer than 20% indicated use of settling, straining, and filtration, and 10% of participants reported rarely or never treating their water before use.

Most respondents reported collecting water about 2-3 times per day; a small number indicated having to fetch water 4 to 7 times a day. Most respondents reported walking between 300 and 400 meters to complete a round trip to the lake to fetch water, but the distances varied greatly from as little as 100 meters (for households directly adjacent to the lake) to as great as 1200 meters. Almost all respondents (98.6%) indicated use of plastic buckets to collect water, while 80.4% reported using jerry cans for water storage. Relatively few (30.8%) had access to larger storage cylinders such as Skyplast or water drums. The majority reported only storing water for 1-2 days before use, and almost all (97%) reported never recycling or reusing water. In the context of climate change where lengthening dry seasons mean less rainfall access, recycling and reusing of water may become more necessary in the coming years, even if it is not a widely practiced strategy currently.

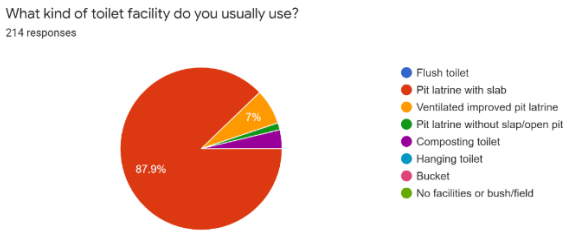
3.2.3 Sanitation and Hygiene

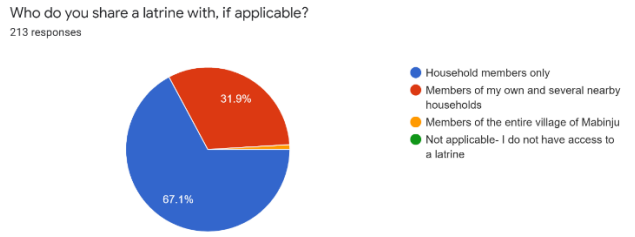
As shown in the following figures, reported handwashing frequencies for different activities were quite high, although overreporting is expected for such practices. Additionally, 73% of respondents reported always using soap when washing their hands.





With regards to sanitation, a vast majority of respondents indicated use of a basic pit latrine with a slab. However, small percentages reported use of more advanced technologies such as ventilated improved pit latrines and composting toilets (see figure below). While most participants reported sharing their latrine only with household members, one third (32%) reported sharing a latrine with neighboring households. This finding was later found to stem, in part, from flood-related damage to pit latrines, resulting in the need for frequent household latrine sharing during the rainy season. The following figures summarize these responses.





3.2.5 Observed Weather and Water Resource Changes

The changes which a majority of respondents stated to have observed over the past several years included:

- Changes in frequency or intensity of rainfall (97.2%)
- Changes in frequency or intensity of drought (100%)
- Changes in availability of or access to water used for drinking, cooking, and hygiene (99.1%)

- Changes in safety or cleanliness of water used for drinking, cooking, and hygiene (86.3%)

These findings strongly illustrate the climate- and water-related changes underway in Mabinju and suggest that these changes have become readily observable by community members.

3.3 Key Findings from Community Interviews and Focus Group Discussions

3.3.1 Observations on climate and environmental change

Rainfall patterns are no longer predictable

When asked if they had observed any recent changes in rainfall patterns in Mabinju, a significant number of respondents commented upon the growing unreliability of rainfall. Several respondents discussed how they were no longer able to predict the timing of onset of either rainy or dry seasons, describing the seasons as having lost their cyclical nature and taken on a more anarchic pattern. This was expressed as a sharp divergence from the traditional bimodal rainfall pattern experienced in Mabinju, with the long rains typically occurring from March to May and the short rains typically occurring from September to November. Not only did respondents comment upon the difficulty predicting when the rain would come, but some also went further to describe the pattern as one of intense, chaotic intervals. As stated by one respondent:

"In the past, …you could know the exact time when it was going to rain and when the drought would come. But nowadays it's just like….boom!" (Mabinju community member; December 6, 2021)

Some respondents also made reference to traditional "signs" of rainfall, claiming that they no longer indicated what they used to. Other respondents went as far as dismissing the very bimodality of rainfall in Mabinju, arguing that the trend no longer holds (i.e. as opposed to acknowledging the continued existence of two distinct rainy seasons even if their start and end points have become more variable). Several respondents also exhibited distress when discussing these changes, given the impact it has on agricultural viability and their livelihood potential. Interestingly, but not surprisingly, a disproportionate number of seniors were among the respondents who commented upon the theme of rainfall unpredictability. This is fitting with the expectation that they would have a longer memory of (and/or greater experience with) traditional bimodal rainfall patterns.

Recently documented trends on rainfall in Western Kenya concur with the observations of these respondents. Indeed, research has shown that as climate disruption drives new fluctuations in previously stable atmospheric conditions, the paradigm of two rainy seasons resulting from the biannual equatorial

passage of the Intertropical Convergence Zone has become an unsuitable model for weather forecasting in East Africa (32).

Flood and drought frequency are both increasing, but lengthening dry seasons pose the greatest threat

An even more heavily commented upon trend when asked about rainfall-related observations was that of lengthening dry seasons. An overwhelming number of respondents described rainfall as having simply become "insufficient" to support local production needs, with frequent delays or failures in rainfall onset giving rise to extended periods of drought. Given Mabinju's heavy reliance on rain-fed agriculture for both income generation and food production, it was not surprising that comments on this trend were articulated with extreme concern and fear about the future. As summarized by one respondent:

"Once there is a climate change, there is not enough rainfall. And there is hunger. We have hunger, because we do not have things like vegetables. And our cows will die because of the climate change." (Mabinju community member; December 8, 2021)

Not only were concerns about food insecurity voiced, but concerns about water insecurity also featured heavily in discussions on drought, independent of irrigation challenges. Some respondents, for example, shared their experiences with nearby rivers and streams "drying up", leaving them with fewer accessible sources of water for domestic use.

The issue of flooding featured less frequently in discussions on weather changes, but was still discussed by a significant number of respondents. While few disputed recent drought intensification, many also commented upon rainfall being more intense in the (often shorter) periods during which it occurs. One respondent simply described recent rainfall patterns as being "more extreme on both ends". Others shared their experiences with flooding during what they suggested were increasingly frequent periods of heavy rainfall, sometimes describing extensive destruction of crops, property, and personal belongings. Still, such experiences of extreme flooding were far from unanimous. Indeed, when asked if they had experienced any major flooding events in recent years, many community members reported never having experienced one personally. However, some stated that while they themselves had not been affected, they had observed intense water buildup in other homesteads, including ones explicitly identified as residing in "low-lying" areas. This reflects the uneven topography of Mabinju, leaving some homesteads more vulnerable to flooding than others. Still, there were no reported experiences of displacement due to flooding or heavy rainfall.

Finally, when asked about when they began observing any described changes in rainfall, participants were remarkably aligned in their responses, with all respondents giving estimates between 2015 and 2020. The most common response to this question was that these changes began around 2018 or 2019. These responses are consistent with the recent rainfall extremes documented in Western Kenya, with intense flooding reported for both 2019 and 2020 (33,34), followed by an extended drought due to the failure of the 2021 short rains (35).

3.3.2 Beliefs about climate change and WASH-health linkages

Climate knowledge is rising, particularly in younger generations, but important knowledge gaps remain

For the purpose of this analysis, climate knowledge was conceptualized in two domains: climate change awareness and climate change understanding, with the former referring to simple awareness of the phenomenon and the latter comprising beliefs on causation. Participant responses indicated a relatively high degree of climate change awareness but a more limited understanding of climate change drivers, with a few notable exceptions among younger respondents.

When asked if they were familiar with the term "climate change"—for which there is a direct Luo translation which was used in these discussions—only 3 of the 17 interview subjects indicated zero awareness, all of whom were seniors. While not comparable in representativeness, this finding still shows more awareness than that of a recent African-wide study, which found that four in 10 Africans are unfamiliar with the concept of climate change (36). However, it is important to view these findings in light of the fact that the term "climate change" itself is not used by all groups to describe what academics consider to be climate change-related weather phenomena, even if such groups hold a similarly deep understanding and recognition of "climate change". Furthermore, this finding may have been biased by the fact that, by virtue of their high English language comprehension, most of the younger respondents were asked the question through direct use of the term "climate change" as opposed to the Luo equivalent ("*korl wasi*"). As the English term is increasingly used in public media outlets and national dialogues, universal application of the English term throughout all interviews may have solicited different results, as some of the seniors unaware of the term "*korl wasi*" may still have heard of the term "climate change". This awareness is also suggested by the fact that all of the participants interviewed were aware of weather and rainfall patterns changing, regardless of whether or not they explicitly linked these phenomena with the notion of "climate change". This highlights the importance of framing in soliciting different responses on climate-related beliefs.

A majority of respondents indirectly alluded to key causes of climate change by describing the loss of trees as a driver of reduced rainfall. This was described in various ways, with some indicating that there were simply insufficient trees in Mabinju to "attract" or "bring" rain, and others going further to relate tree cutting to a larger global trend of environmental destruction. There therefore appeared to be a spectrum in the conceptualization of climate change (or changing rainfall patterns) as an exclusively local versus global phenomenon. Still, many respondents had no ideas to share when asked what they thought was driving the changes in rainfall they were observing. Many simply stated they could "not explain" it; many attributed it to the "will of God", deeming it unexplainable from any other (e.g. scientific) standpoint. The ideas that rainfall is something which only "God controls", that extreme flooding or drought are all part of "God's plan", and that nothing can be done as God cannot be "forced" to do something differently, all featured in discussions on climate change beliefs.

Two responses were unique in their mention of atmospheric pollution, with one respondent asserting that smoke from factories "interferes with the movement of clouds". Still, understanding of the causes of climate change in Mabinju may differ from Western understandings, which is expected in light of differing lived experiences and conceptualizations of natural phenomena. Any campaigns aimed at infusing a deeper sense of collective agency within communities and mobilizing climate activism should therefore draw upon the currently salient knowledge frameworks which drive local understandings of climate change.

Awareness of WASH-health linkages is high but capacity for behavior change is limited

While knowledge on climate change varied across study participants, almost all acknowledged that WASH practices have an important impact on health and that unsafe drinking water contributes directly towards diarrheal diseases. This theme was apparent not only in direct statements affirming that water quality is linked with health outcomes, but also in numerous remarks concerning the use of water treatment methods, such as addition of WaterGuard, chlorination, and boiling, to prevent diarrheal and other diseases. Another indication of this awareness came from the commonly expressed assumption that the reason why diarrheal diseases are more common during the dry season is because people are relying on lake (as opposed to rain) water for drinking, which is a far more polluted source. As summarized by the translator in one focus group discussion:

"Another problem, she's saying like when it comes to water besides rain, they don't really have clean water. During drought, they get water from the river, or from the stream, and this water is kind of not clean.

Whenever they take this water there is kind of several diseases which they experience." (Mabinju community member, translated; November 22, 2021)

The importance of general environmental hygiene, including regular maintenance and emptying of latrines and refraining from bathing or depositing waste in open water sources, was also recognized by a handful of respondents. This idea is notably apparent in the following translation of a comment shared in a focus group:

"Okay, she is saying that during that heavy rain—the rain we have said—it's affecting them, because that sewage from the latrine, is coming and affecting the internal part. That here, is affecting the internal part of their kids, even themselves—those adult people—so they find that they have diarrhea, and when they go to the hospital, they are saying, it's like, they are contaminating…they are close to those…bad things." (Mabinju community member, translated; November 15, 2021)

Almost all respondents also acknowledged the importance of handwashing for health and disease prevention. The only area of slight variation across responses concerned the safety and purity of rainwater. While most respondents expressed the belief that rainwater is fully clean and safe for drinking (in many cases, even without treatment), some respondents disputed this notion, describing issues like dirt on the roof entering rooftop harvested rainwater and bugs or other contaminants building up in rainwater stored overtime. On the other end of the spectrum was the articulated belief that rainwater is a "blessed source"—an idea which likely stems from its relative standing when compared with the only available drinking water alternative in Mabinju (i.e. lake/stream water). In any case, the recognition that not all water sources are safe and that treatment procedures must be applied represents progress since a time when, according to one longstanding CHV, people in Mabinju believed that all water was "blessed by God, and you should just take it the way it is". This shift in beliefs may be attributed, in part, to the ongoing efforts of CHVs in sensitizing community members on the importance of boiling and treating water before drinking it.

Still, this study added evidence to numerous other studies showing that WASH beliefs do not always accord with WASH practices; that is, the belief that good WASH practices are necessary for disease prevention among other purposes is not always sufficient to drive positive WASH behaviour change such as adoption of regular handwashing, water treatment, and sanitation maintenance (37-39). The reasons for this are complex and multifaceted, and are best understood with due consideration of advanced behaviour change theory, which is beyond the scope of this paper (40-43). Nonetheless, the findings of this study lend credence to the well-established notion that poverty-driven resource and capacity shortages constrain full

uptake of best WASH practices even when there may be motivation for change. Indeed, when asked about water use prioritization in times of water scarcity, no participants mentioned handwashing as a prioritized water use activity, and a handful openly admitted that they forgo regular handwashing when water is scarce. Others may have opted not to report forgoing handwashing due to the social shame associated with the practice (44). This aligns with research conducted in other communities facing water shortages, including a study from Pacific Island Countries where virtually no handwashing sources were reported in the dry season making the practice impossible at these times (45). Other barriers reported by participants of this study to adopting recommend WASH practices, despite knowledge of their importance, included inability to afford water purification tablets (e.g. chlorine or WaterGuard), scarcity of firewood for water boiling, inability to afford latrine emptying equipment or services, and lack of materials for reconstructing damaged latrines. Similar findings on resource constraints to WASH behaviour change in spite of high awareness of WASH-health linkages have been reported in studies from Nepal and other regions of Western Kenya (46,47). This highlights the need for a shift in focus from individual agency to structural (and community-wide) determinants of behaviour when designing health behavioural change interventions, as noted by other researchers (48). In relation to climate change, any attempts by outside organisations to encourage health-promotive adaptation strategies must consider the social context in which behaviour change can or cannot occur.

3.3.3 Major WASH challenges in Mabinju

Poor access to safe drinking water persists despite newly available technologies

Throughout the interviews and focus groups conducted with Mabinju village members, several persistent and mounting challenges associated with safe drinking water procurement became apparent. Indeed, when provided an open forum to discuss any issues under the generic umbrella of WASH, most community members voiced, first and foremost, their challenges in accessing clean water. This is not surprising given the immense importance of water security, granting it a level of salience that few other concerns, included sanitation-related ones, can match.

While Mabinju is on the shore of Lake Victoria, ensuring a year-round, reliable water source, the lake has seen massive water quality deterioration over the past few decades due to both industrial pollution and excess nutrient inputs from contaminated surface runoff, causing eutrophication and massive cyanobacteria, algae, and water hyacinth blooms (49). This has rendered the water unsafe for raw consumption, requiring increasingly advanced water treatment techniques to make it potable (50). Not surprisingly, this issue was raised numerous times by study participants. Several people spoke about the

explosion of water hyacinth that has occurred in recent years, and how sometimes the entire lake surface becomes covered with it, making water collection nearly impossible. Besides describing the water as generally polluted, many also described it as being green and foul smelling—both considered strong indicators of its unsuitability for human consumption. Notably, among older village members, there were several respondents who could describe a time when the lake water was "completely clean", "clear", and "safe to drink raw", highlighting the recent nature of this phenomenon. This is consistent with findings from environmental assessments of the lake (49).

Given the poor quality of the lake water, Mabinju community members (and disproportionately women) are burdened with the task of boiling or treating the water before using it for cooking or drinking. Consistent with the findings of the baseline survey, most focus group and interview respondents reported using boiling, WaterGuard, or chlorine tablets (or a combination) as their primary water treatment strategies, with a few participants reporting other methods including filtration, settling, and letting it stand in the sun (i.e. solar disinfection). Still, almost all reported financial challenges with regularly purchasing WaterGuard and chlorine tablets, and many reported an increasing scarcity of firewood in Mabinju, requiring longer, more extensive trips to procure sufficient amounts for boiling water, amongst other uses. A small number of respondents also reported experiencing "stomach problems" with WaterGuard, and therefore resorting exclusively to boiling or other methods. While generic comments about people "drinking lake water raw" (i.e. without treating it) due to feasibility and affordability constraints came up numerous times during focus group discussions, only two interview participants openly admitted to frequently drinking lake water without treating it. While social acceptability bias may have resulted in underreporting this practice, the fact that some acknowledged this practice is concerning considering current microbial water contamination levels (49). Additionally, while the advent of WaterGuard has been a positive development, consumer demand is particularly sensitive to price increases (50), meaning that families (poorer families especially) may opt out of purchasing it with even minor rises in cost or reductions in household income. This notion is backed by widespread reports from interview subjects of forgoing use of WaterGuard during times of increased financial stress.

In the background of growing water pollution are the ongoing challenges that most communities without piped water face in collecting water for domestic use. As expected, numerous concerns were raised over the time and energy required to collect water from the lake, with most people able to carry only two 20L jerrycans at a time for a round trip ranging anywhere between 15 minutes and 1 hour in length, depending on household location. As the responsibility of water collection in Mabinju falls upon women, some women

spend up to 2-3 hours daily collecting water, given that most families require 2-3 trips per day. While some people living farther from the lake are able to get water from more accessible rivers and streams, many of those reliant on these sources reported witnessing them "drying up" during increasingly lengthy periods of drought. With the abundance of ephemeral streams in Kenya, this trend has been reported upon extensively by other researchers concerned with climate-driven droughts in the region, particularly in arid and semi-arid lands (51,52). Reduced water access is also one of the major gendered dimensions of climate injustice, given the disproportionate impact it has on women.

Finally, the more recently established practice of rooftop rainwater harvesting in Mabinju (the advent of which is described in more detail in following sections) also has its limitations, even though rainwater is a significantly cleaner drinking water source. Interview subjects spoke at length about their challenges in collecting and storing adequate rainwater due to poor access to advanced rainwater harvesting equipment such as gutters and storage tanks. Of the 17 subjects interviewed, only one had a gutter system for water diversion, and less than half (7 subjects) had even a single Sky Plast water storage tank. Thus, as shown in the initial WASH survey conducted, a majority of community members are still relying on the most basic rainwater harvesting techniques, namely placement of small (typically 20L) jerrycans alongside their houses to capture roof-top rainwater during the declining number of annual rainy days. Not surprisingly, not one interview subject reported being able to capture and store sufficient rainwater to last through the dry season, with most having only enough storage capacity (i.e. jerrycans) to last 2-3 days without having to retrieve water from the lake. The result is that, while rainwater harvesting has contributed to reducing water insecurity in Mabinju, it remains insufficient to address outstanding water access gaps, particularly as climate change reduces the average length of the rainy season.

This finding generally aligns with what has been reported in the literature in regards to rainwater harvesting. That is, while it has been shown to be an important climate adaptation measure (53-56), providing a buffer against climate-linked extreme weather events, its reliability and performance depends largely on factors related to the sophistication of harvesting technologies and practices. Both roof area and tank size are important determinants of the potential for rainwater harvesting systems to improve water security, and additional storage is needed to compensate for reductions in runoff capture in contexts of climate-driven reductions in rainfall frequency (53,55,56).

Pit latrines are not well-suited to the current conditions in Mabinju

Though participants voiced concerns particularly over water access challenges, the issue of submerging, collapsing, and overflowing latrines was commonly raised in discussions with Mabinju community members. From the initial WASH survey which showed that 88% of people in Mabinju are using the most basic form of sanitation, namely an on-site pit latrine with a slab, reports of sanitation inadequacies in the qualitative interviews were expected. When asked about their sanitation challenges, a majority of respondents discussed experiences with their latrines collapsing or submerging (i.e. the walls caving in or giving way) and/or overflowing or flooding (i.e. water coming out from the pit) during the rainy season. Only a small number reported not having experienced this, and most acknowledged it was due to the location of their household on higher ground, as they had seen other households afflicted. When asked if this has became a more frequent problem in recent years, most participants were unable to identify such trends, but many reported this is most typically experienced during the long rains, with the rare recent exception of it having occurred during the 2019 short rains, which happened to be one of the wettest seasons recorded in East Africa (57). This is concerning considering that climate model projections suggest that such events, including those associated with the short rains-, may become more frequent with future climate change (57).

Many individuals attributed this phenomenon not only to the impacts of heavy rain, but also to the weak structure of the soil in Mabinju, making it vulnerable to collapse following excess water absorption. This is supported by studies which show that the soil composition of the Lake Victoria banks has a particularly high sand content, reducing its structural integrity (58). Structural weaknesses are also exacerbated by the fact that a vast majority of Mabinju community members cannot afford to purchase materials (e.g. brick, concrete, stone) to line the pits of their latrines, which would provide the needed durability for them to withstand heavy rainfall. Indeed, only one interview subject of the 16 had a lined pit latrine. As summarized by one individual:

"Even if it rains for even one month, but heavy rain, the soil here cannot sustain the toilet for more than that." (Mabinju community member, translated; November 22, 2021)

Another issue raised in relation to the hydrogeological conditions of the region was that of the high groundwater table. As summarized by the translator in one focus group discussion:

"And, with the toilets which they normally build here, you can't go more than 8 feet. Because if you dig deeper, to 10 feet or more, the toilet will submerge…it will collapse. And this is so common when it rains." (Mabinju community member, translated; November 22, 2021)

The high groundwater table in Mabinju, a consequence of its low elevation and the interface of its aquifer system with the rising Lake Victoria (59), is problematic for several reasons. Not only does it reduce the viability of pit latrines given the limited depth to which they can be dug, but it also increases the risk of groundwater contamination with faecal matter and other human waste, which will become more consequential when a borehole is dug to provide well water to local resident. This is particularly concerning given the low percentage of pit latrines in Mabinju which are lined, and the village's proximity to Lake Victoria, resulting in intermixing of its groundwater with a lake that happens to serve as a primary water source for millions resident along its banks (49).

The consequences of collapsing, submerging, and overflowing pit latrines are also multifold. Most notably, when pit latrines are destroyed (i.e. when they collapse or submerge), families are faced with the difficult dilemma of having to invest scarce time, money, and resources in the reconstruction of a new latrine—something they can be fined by public health authorities for not doing within 14 days of latrine collapse—or to make do without a toilet, resorting to open defecation or sharing a latrine with a neighbour. Both options present special challenges. To reconstruct their latrine, most families claimed they would need to invest money in both purchasing the new materials (e.g. wood, concrete, iron sheets, etc) and hiring a contractor to drill a hole to an adequate depth. In many cases, this money was simply not available immediately, with reports of individuals having to "save up" to construct a new latrine. In other cases, people opted not to immediately rebuild their latrine, knowing the high chances it would collapse again before the end of the rainy season and such resources would be wasted. The result of these barriers was that most households would go for extended periods of time during the rainy season without an on-site toilet. Indeed, a shocking 35% of interviewed homes—more than a third—did not currently have access to an on-site toilet at the time of the interview (which coincided with the short rainy season) due to recent destruction. This was especially surprising given that community members seldom associated the short rains with latrine collapse, though some did admit that they still had not rebuilt their latrine since its collapse during the prior long rains. Even more concerning was the fact that half of individuals interviewed (53%) admitted to practicing open defecation (typically on their farms or homesteads) when their latrine collapses or submerges in the rainy season—a practice that may well be underreported given the shame associated with it. Only a few people mentioned being able to share latrines with a neighbour at this time, with such access highly dependent on the "goodwill" of the neighbour or the present state of their neighbour's toilet at the time, which would also be subject to the same weather hazards. Still, some participants admitted feeling reluctant to ask neighbours to use their toilet out of guilt. Others expressed more concern about the undignified nature of open defecation. As stated by one interview subject:

"(When the latrines collapse), I don't know what we can really do as human beings. Because as a human being, you should have a place to…deposit your waste. But during the collapse of the latrine, what other things can we do?" (Mabinju community member; December 1, 2021)

While open defecation itself is closely correlated with outbreaks of diarrheal, intestinal helminths, and other waterborne diseases (60), overflowing latrines can also substantially compromise household hygiene. As summarized by the translator in one focus group discussion:

"She's trying to say that during heavy rain, that rain is affecting their latrine in that there will be a constant water around the latrine, and even that waste product in the…that waste will come out from the latrine…and that water is coming to their house." (Mabinju community member, translated; November 15, 2021)

Indeed, collapsing, submerging, and overflowing pit latrines have been reported in other flood-vulnerable settings, leading to similar issues of environmental contamination (61-63). Even if climate change is not a sole driver of this phenomenon, its effect of increasing the average frequency and intensity of heavy rainfall events means that this issue may be exacerbated in already flood-prone settings in the years to come. Pit latrines have, therefore, been flagged for their flood vulnerabilities and associated design modifications have been recommended in both the World Health Organization's Vision 2030 and the more recently released "Strategic Framework for WASH Climate Resilient Development" (further discussion on this is featured in later sections of this report) (64,65).

Diarrheal illnesses have decreased but still afflict the most vulnerable

Despite ongoing issues of inadequate safe drinking water access and continued practices of open defecation, it was quite surprising that there were relatively few reports of experiences with extreme diarrheal illness. Nearly half of respondents claimed to have never experienced (i.e. neither themselves nor their children, where applicable) an extreme case of diarrhea in recent memory. While Kenya has adopted the rotavirus vaccine into its routine immunization schedule, recent epidemiological surveys of Siaya county have found that diarrheal disease remains the fifth leading cause of death county-wide (66), with over 26,000 cases reported in 2019 (67). Still, what constitutes a "severe" case of diarrheal illness is highly subjective, and if respondents referred to memories of hospitalization as an assessment criterion, it is unlikely that many cases would have been reported given the general tendency to avoid seeking what is largely unaffordable hospital care (further discussed below). For those cases that were reported in individual interviews, the diarrheal disease incident was almost always linked to having not boiled or treated drinking water due to having run out of (and being unable to purchase more) chlorine or

WaterGuard, and/or being unable to retrieve sufficient firewood. This highlights the heightened vulnerability of those facing more severe socioeconomic and resource constraints.

Considering the minimal reporting of individual-level diarrhea incidences, the issue of diarrhea came up remarkably frequently in general discussions on current WASH challenges in Mabinju. Many community members referenced diarrhea as something frequently experienced during the dry season when individuals must rely on contaminated surface water (i.e. water from the lake and nearby streams) for drinking, as opposed to rainwater, which comprises the main drinking water source when it is available. As summarized by the translator in a focus group discussion held with CHVs:

"According to her experience, they face a lot of challenges during the drought related to waterborne diseases. Because many people go to the lake and get lake water…like infected lake water." (CHV working in Mabinju, translated; December 10, 2021)

Generic reports of "diarrheal disease outbreaks" occurring in the village, and explicit references to diseases such as cholera and typhoid, came up in discussions as well. Likewise, the CHVs consulted in one focus group discussed their ongoing experiences handling diarrheal illnesses in Mabinju. Yet the CHVs were also quick to boast the progress achieved in reducing diarrheal disease spread in Mabinju—an accomplishment they expressed personal pride in contributing towards through their "advocacy and work". Of note, this trend is backed by evidence of declining diarrheal disease incidence in the region (67), through extensive WASH promotion including the incorporation of WASH behavior change communication into national CHV guidelines (68). Thus, the overall picture of diarrheal diseases in Mabinju appears mixed, with progress having been achieved but poor WASH practices still resulting in otherwise preventable cases. Considering the projected impacts of climate change on diarrheal diseases in flood-prone areas, including low-lying lakeside regions like Mabinju, a reversal in progress on diarrheal disease reduction may inevitably occur in the absence of adequate adaptation measures.

3.3.4 Healthcare access and health service utilization

Poor relationships with community health volunteers impede their effectiveness

While the issue of inadequate support from CHVs is discussed in more detail in the later section concerning lack of community support from various external actors, this section is intended to outline the few identified ways this issue has tarnished CHV-community member relations and consequently impeded the effectiveness of CHVs in Mabinju. The most obvious indication of this problem was the general aggravation apparent in the voices of respondents when asked if they ever received WASH-related resource or other

supports from CHVs (e.g. medications or ORS for diarrhea, water purification tablets, soap for handwashing, materials for latrine reconstruction, etc). Almost every participant responded to this question with a flat "no", followed by something along the lines of "they don't do anything" or "they never help us". In a few exceptional cases, community members reported being given useful information by CHVs, or being given malaria medication under a time-limited CDC-run program. Still, most of the recommendations received were either not new to them or infeasible due to resource or other restraints, such as purchasing certain medications for diarrhea or only drinking treated water. The negative impact that service and resource provision gaps can have on community trust and faith in community health workers has been documented elsewhere in the literature (69).

While not all community members expressed frustration in relation to CHV support gaps—indeed, some empathized with CHVs as being victims of the same system of government neglect they too deemed themselves subject to—most implied that they would not turn to CHVs for support during a "water" or "health" crisis, given the poor chances of receiving useful assistance. This undoubtedly undermines the capacity of CHVs to support collective problem solving in such contexts, and also limits their ability to facilitate early referrals for care, track diarrheal disease cases, and become knowledgeable on patterns of waterborne disease spread in Mabinju. At the same time, an inability to adequately respond to requests can adversely affect community relationships with and general perceptions of CHVs, as summarized in the following translated excerpt from the focus group held with CHVs:

"So for her, because of the requests, …the relations are not good with some people. Because of the requests which they cannot meet." (CHV working in Mabinju, translated; December 10, 2021)

Given the abundance of research which demonstrates the sociocultural importance of relationships of trust between community members and community health workers (70-72), the absence of such can be expected to undermine CHV effectiveness in fulfilling key health service functions in Mabinju. Should CHVs be given a larger role in disseminating and spreading awareness of climate-health impacts as part of a broader adaptation campaign, the degree of trust that they hold will be an important determinant of how deeply their messages resonate with recipients.

Geographic and financial barriers compromise access to healthcare, leaving traditional herbs and informal medicine providers to fill the gap

Hospital access in Mabinju is limited by both the inadequate care provided at public hospitals and the financial and geographic barriers which impede access to private ones. Of the 17 subjects interviewed, not

one reported accessing care from the nearest public hospital. Reasons stated for this largely concerned the unavailability of medications at public hospitals, making them ill-equipped to provide adequate care. As stated by one (English-speaking) interview subject:

"They used to tell us that public is free—that they have free medication. But if you go there, [there is] nothing." (Mabinju community member; November 29, 2021)

Given this situation, essentially every interview subject stated that when they had to go to the hospital, they would go to the nearest private mission hospital, located about 4km away from the village. Still, most people stated that going to the hospital was an absolute last resort option, and therefore only pursued in dire health emergencies, due to the challenges of reaching there (i.e. lack of public transport and need to pay for a motorbike) and the financial costs incurred by utilizing services or dispensing medications—costs which some families could not cover. The challenges in accessing private hospital care were potently highlighted in the focus group conducted with CHVs, as shown in the following comment summarized by the translator:

"Yeah, so another problem is accessing the health facility. As much as they (the CHVs) are telling people to go to the hospital, there …there is no money available. And whenever any emergency arises, they (the CHVs) are the first ones that people run to. And they don't have resources to… rush you to the hospital, or provide immediate first aid." (CHV working in Mabinju, translated; December 10, 2021)

To fill the gap in healthcare (and medication) access, some people reported using traditional herbs for medicinal purposes, and a greater number reported resorting to informal medicine providers (i.e. referred to by participants as "local pharmacies", "medicine shops", or "kiosks"). Nine of the 17 interview subjects reported informal medicine providers as one of their primary medication sources, and three mentioned use of traditional herbs. However, both themes were raised frequently in focus group discussions, and one discussion even culminated in an exchange of ideas on traditional herbs that people have found helpful with diarrhea.

Published literature has documented the important role the private sector plays in health service provision in Kenya, and reliance on informal medicine providers. In a secondary analysis conducted by Hodgins et. al (2013) using Demographic and Health Survey and Multiple Indicator Cluster Survey data, it was reported that 14% of caregivers in Kenya sourced care for child fevers from informal sector providers (e.g. shops), while 39% sourced care from the public sector (73). While this was lower than that reported in many other countries, the large variability in estimates may be indicative of significant regional variabilities. In a 2013

drug outlet census specifically conducted in rural Western Kenya, only 13% of the outlets identified were registered pharmacies (74). When reviewing out-of-pocket healthcare expenditures, Kenya does not stand out amongst sub-Saharan African countries, with out-of-pocket expenditures constituting 24% of total health expenditures in 2018 (75). Still, this is almost twice the recommended World Health Organization target of 12-15% (76), and studies have shown that up to 600,000 Kenyans are pushed into poverty annually as a result of out-of-pocket spending (77). Moreover, with large disparities in healthcare expenditure identified across socioeconomic groups (78) and notably reduced healthcare access in rural areas (79), national averages may hide important sub-national variation. Given the findings of this study, at least, it seems reasonable to conclude that Mabinju still faces notable healthcare access gaps which may become more critical if external forces like climate change trigger the emergence of new outbreaks of waterborne and other climate-sensitive diseases.

3.3.5 WASH vulnerability factors

Old age can drive enhanced WASH vulnerability

A sub-analysis of the themes derived from interviews with seniors (over age 65) yielded the conclusion that old age and associated health implications, can compound the WASH challenges in this setting. Few of the senior village members interviewed were able to collect water from the lake on their own, due to physical weakness, frailty, or medical conditions. As a result, most had to rely on family members and neighbors to collect water for them, often resulting in having to ration meagre water supplies to meet minimum daily requirements. One senior interviewed mentioned that she would sometimes have to go 2-3 days without water, and often went for over a week without bathing. She mentioned the impacts this had on her health and well-being, noting a sense of fatigue, difficulty taking medications, and “loss of mobility” in her joints when short on water. Other challenges expressed by senior village members interviewed included trouble collecting firewood for boiling water (due to the same physical and/or medical restrictions), and respiratory issues associated with smoke inhalation—both of which resulted in water boiling being largely unfeasible for these individuals, resulting in use of raw water for drinking when unable to purchase bottled water, WaterGuard, or chlorine tablets.

Some interview subjects reported an emotional burden from constantly seeking help from neighbors, who already have their own challenges providing sufficient water for their own families. When asked if they could rely on family, some reported they were unable to due to many family members having pre-deceased them or having left the village in pursuit of jobs elsewhere. The physical challenges faced, coupled with a limited social support network, contribute to disproportionate water insecurities faced by this population.

While having a disability is more common amongst elderly people, and individuals with disabilities are frequently included as a targeted subgroup for inclusive WASH strategies (80,81), an exclusive focus on old age as a contributor to WASH vulnerability appears limited beyond acute humanitarian settings (82). While some elderly-targeted initiatives have been piloted by major WASH players working outside the humanitarian sector (83), a more recent review showed that elderly people are still frequently overlooked in WASH vulnerability mapping (84). This, in combination with the (albeit limited) evidence of age-related WASH vulnerabilities provided by this study, justifies calls for greater consideration of this subgroup in inclusive (and climate-resilient) WASH sector program planning and guideline development.

Disability can drive enhanced WASH vulnerability

The compounding effects of disability on WASH challenges have been widely recognized by stakeholders focused on equity in WASH programming (80,81,85). It was therefore not surprising that this study lent further weight to such conclusions. In the focus group with individuals with disabilities, several key WASH vulnerability drivers emerged specific to this population, including: physical and/or cognitive incapacity to collect water, bathe, or access the latrine on one's own, resulting in heavy reliance on external support providers, along with excessive stigma and discrimination faced, leading to feelings of neglect and isolation when dealing with WASH-related issues. While all of the individuals in the group had at least one family member which was able to support them, most reported they had a limited social support network beyond the immediate disability community of which they were part (through the Mabinju disability support group), and some spoke about the challenges attracting or retaining a partner due to the negative perceptions associated with their disability. Many felt that the perception of being needy and incapable was exacerbated by their inability to secure long-term employment and financial independence, due to lack of education (also sometimes discrimination-related), discrimination in the workforce, or physical or cognitive limitations.

Besides relying on (often minimal) support with water collection, sanitation access, and hygiene, another major concern voiced by some group members was the poor suitability of latrines given their physical conditions. Some reported having trouble crouching or maintaining balance when using a pit latrine, particularly in the absence of a slab or during times of heavy rainfall such that the walls themselves become less stable. As summarized by the translator in the following excerpt, one individual who didn't have a toilet in her home spoke about her difficulties accessing the nearest public latrine during the rainy season:

"Because she doesn't have a toilet in her home, she walks ki several kilometres with her walker. And then, sometimes when it is muddy, she has to keep on pulling it, and then even when she reaches, the floor of that toilet is not even cemented…" (Mabinju community member, translated; November 17, 2021)

With regards to more formal networks of support (e.g. from government, village elders, CHVs, etc), participants had largely negative sentiments to share. While they discussed a previously launched government initiative of cash transfers for people with disabilities, they claimed they seldom benefited from them due to corruption and mismanagement in their distribution, as summarized by the translator in the following excerpt:

"So he is saying there is money from the government. And this money, it is being channelled to the office maybe in this region, and the person who is the head in this office is not a person living with a disability. So, the person who is in charge, is not the person living with a disability. And whenever—and they're saying that there is money which is coming and they are paying people and for them, they don't know who is earning this money." (Mabinju community member, translated; November 17, 2021)

Participants also discussed how discrimination against them by area chiefs led to other groups being favored in local development projects. An example was given where in 2018, the disability support group in Mabinju wrote a proposal to the county government to be given a water kiosk from a pipe passing through the region, in hopes of being able to store and sell the pumped water from their location as an income-generating activity. With much frustration, they expressed how when the funding was received and the kiosks were built, they were given by county officials to other community members instead. In the end, there were 10 water kiosks in operation, and not one managed by an individual with a disability. Experiences like this, amongst others, they described as being highly "demoralizing", yet reflective of the pervasive ableism in their community.

From the standpoint of WASH intervention planning, these findings reveal the need for broader, more inclusive frameworks that aim to mitigate the vulnerabilities of individuals with disabilities to water insecurity, and to poor sanitation and hygiene access. Assistive technologies, such as specially designed handles for water pumps, moveable toilet seats, raised pit latrines, ramps and handrails, and wider doors, have all been tested in other settings to accommodate the unique WASH needs of this group (86). Notable successes achieved in the piloting of such technologies should be more extensively documented and widely reported upon to support their diffusion and replication. Mabinju, amongst countless other communities, would undoubtedly benefit from these more inclusive systems.

HIV/AIDS can drive enhanced WASH vulnerability

Due to the challenges in accessing HIV/AIDS-positive interview subjects, only three people with HIV/AIDS could be interviewed in this study. While this undoubtedly limits the generalizability of the themes identified in these conversations, they are nonetheless worth reporting, given the additional pathways of WASH vulnerability they reveal. The unique vulnerabilities identified in this population included stigma leading to lack of social support, perceived vulnerabilities to infection from waterborne and other microbes, water needs for taking medications, and general physical weaknesses that can render water collection more challenging. Still, the responses across the three subjects were highly varied, and did not offer the needed consistency to give these conclusions heavy weight. While one subject discussed how her ongoing headaches—something she attributed to her HIV—made her unable to go to the lake more than once a day to collect water, another individual claimed that her antiretrovirals had brought her back to complete health, leaving her no more medically vulnerable than anyone else. Likewise, this individual stated that, in contrast with the others, she did not deem herself any more vulnerable to getting sick from drinking contaminated water than the average person. Only two of the three subjects, meanwhile, voiced concerns around stigma-related judgement from others, and a resulting reluctancy to ask neighbors for supports (e.g. to share their latrine, borrow water or firewood, etc). These same two individuals also happened to express more concerns over their health, and the extra efforts they felt were necessary to ensure their water was safe for drinking. As stated by one (English-speaking) subject:

"I have realized that I cannot drink any water apart from this one (points to pre-treated water in her home) because I fear that maybe it will complicate my stomach. Because I know that my body's always weak. When you are HIV-positive, you always…at least you are weak in one way or another. So at least I'm trying to drink the water that is best for my stomach." (Mabinju community member; November 29, 2021)

The heterogeneity in responses suggests that HIV-driven WASH vulnerabilities may be highly dependent on individual-level factors such as disease severity, access to antiretroviral drugs, and sources of social support in times of greater need. This latter factor has been described in other WASH-related studies on HIV as a household's 'stock' of social capital, and defined as the "reciprocity networks, norms and trust that facilitate coordination and cooperation for mutual benefit" (87).

Individual-level variability generally concords with the literature, which also presents mixed findings on HIV-WASH intersections. Still, diarrhea has been reported as one of the main causes of death among people living with HIV (88). Meanwhile, a sizeable number of studies have shown that people living with HIV/AIDS

who are immunocompromised due to lack of or suboptimal antiretroviral therapy have greater immune susceptibility to waterborne diseases (89-92), that people with HIV/AIDS have increased daily water needs relative to the average population (89,90,93-95), that stigma and discrimination can limit access of HIV-positive individuals to public water sources and sanitation facilities (89,94,96-100), and that discrimination-related exclusion from the job market can drive reduced WASH access through poverty-mediated pathways (100). Taken together, there seems to be an adequate empirical base to justify giving heightened attention to WASH sector development in disproportionately HIV/AIDS-affected communities like Mabinju.

Pregnancy and lactation can drive enhanced WASH vulnerability

Through interviews with pregnant and lactating women, and a focus group held exclusively with pregnant women, additional drivers of WASH vulnerability were uncovered. Many of the pregnant women who participated spoke about the challenges in carrying out traditional water responsibilities when close to term. Specifically, they talked about the difficulty in walking the distance to the lake and carrying back the heavy load of filled jerrycans, given the extra weight they would already be carrying. The same challenges applied to collecting firewood for boiling water. One (near-term) participant also spoke about her current inability to bend down, making it impossible to clean her latrine and carry out other household duties. When participants were asked if they could solicit support from family (e.g. husbands or children) at this time, to aid in water collection or latrine maintenance, among other tasks, no one reported being able to rely on such support. One participant even laughed and claimed she had "never seen her husband carry a jerrycan in his life". This is compatible with other research from Western Kenya showing that carrying water was the most "female" aspect of water acquisition, and that even in late pregnancy and shortly after delivery, women still remained responsible for water collection, even when it meant walking over steep, rocky, or otherwise dangerous terrain (101).

Not surprisingly, given the largely health promotion-based mandate of CHVs in Mabinju, pregnant women had little to say when asked if they received special supports and/or home visits from CHVs, beyond the typical reminders to attend antenatal clinics and go to the hospital for delivery. Pregnant women also reported being told by doctors and CHVs to take extra caution in ensuring consumption of only treated drinking water—a recommendation which was difficult to always uphold, particularly during the dry season when rainwater (considered to be sufficiently clean without treatment) was unavailable. Some participants felt their pregnancy rendered them more vulnerable to infection and waterborne disease, while others did not perceive this to be the case. For those who did hold this perception, however, they admitted that it made them more preoccupied with matters concerning personal hygiene and safe water consumption.

Both pregnant and lactating women also reported needing to consume more water during their pregnancy or lactating period, which is fitting with biomedical science (102).

With regards to the unique WASH needs of lactating women, most related to the care of their young infant. These included needing extra water for bathing their infant and for maintaining personal hand hygiene when caring for and handling the waste of the child, along with experiencing more difficulty leaving the home to collect water due to childcare responsibilities. As summarized by the translator in one interview with a lactating woman:

"It's always very difficult to find the time to get water. And sometimes she plans to get the lake water in the morning but he (her baby) is crying awake, and she has to get him. So, if she plans to go in the morning, it can even take her up to the evening, and if she goes there, it's just for maybe one trip." (Mabinju community member, translated; December 8, 2021)

This mother, in particular, also mentioned that because she could often only make it to the lake one time in a day, she would have to severely ration her water use to ensure enough for herself, her husband, and her other kids. Such water scarcity often forced her to forgo washing her hands at critical times.

Other studies have similarly exposed the unique WASH vulnerabilities of pregnant and lactating women. One study conducted in India, for example, showed that women who did not have access to a toilet within the house had a higher risk of adverse pregnancy outcomes (103). Another study conducted in Western Kenya concluded that water insecurity is particularly burdensome to women and their infants in the first 1,000 days of life, for a combination of psychosocial, physical, nutrition-related, and economic reasons (101). A scoping review on the impacts of WASH on pregnant women, foetuses, and newborns, also elaborated on several similar pathways through which the health of these groups is affected by both "in water" related (microorganisms or chemicals) and "behaviour" related (cultural beliefs and actions) aspects of WASH (104). From both health and gender equity perspectives, this further supports calls to mainstream WASH interventions within antenatal and maternal health programming.

3.3.6 WASH-related resource and social supports

Erosion of social capital reduces communal buffers against WASH challenges

To explore the role of social capital in adaptation to WASH challenges, interview participants were asked about the sources of support they could turn to in response to any of the emergencies they described having experienced, such as having their latrine collapse, being unable to collect water, or needing money for urgent healthcare. While responses were varied, the dominant theme was of there being little available

support. Besides people within their immediate household, most reported they would need to "pay" neighbors for even simple favors such as collecting water for them. Only two mentioned being able to solicit help from non-family members, and in both cases it was help from the neighbor's kids. Mothers with older daughters seemed to be in a better position, as they could rely on their own daughters to collect water for them when not in school. Still, recruitment of husbands for anything related to water collection was never mentioned as an option, given the predominantly women's task it represents.

With regards to latrine sharing, responses were also mixed, but predominantly negative. In general, people described varied experiences with requesting to use a neighbor's latrine when theirs had collapsed or become full (i.e. in the case that they needed time to save up to hire someone to come empty it). Some reported their neighbors were usually willing, while others reported being unable to make such a request of their neighbors, forcing them to opt for open defecation instead. One woman spoke of locking her latrine door to prevent others from using it, as she reported having had people use it without her permission. Still, others opted not to ask to use someone's else's latrine out of embarrassment or guilt, choosing open defecation until they could reconstruct their own latrine. The general feeling around latrine sharing seemed to be that it was not a dignified practice and should be avoided unless absolutely necessary.

Still, the occasional stories of positive help received, however infrequent, are worth noting. Indeed, reports of latrine sharing were not uncommon, even if there was resistance to it. Likewise, some participants spoke of being able to borrow water from their neighbors when they ran out, and one reported she could sometimes borrow timber or poles to reconstruct her latrine after it had collapsed. In contrast with the stigma that some HIV-positive subjects claimed to experience, one HIV-positive subject described how people being "aware of her health status" made them more willing to take her to the hospital in a crisis. Another participant currently facing a medical crisis described how people had rallied to support her, pooling their funds to save up for surgery she needed.

The theme of reciprocity came up in the context of a discussion around latrine sharing. In this discussion, the participant attributed the neighbor's willingness to share her toilet to the fact that she had done the same when the neighbor was in need. Additionally, when CHVs spoke of having "negotiations" with families over sharing their latrines, they mentioned convincing them that they too may be in such a situation one day and need the reciprocal support. While reciprocity is an aspect of social capital, its fulfillment is dependent on both players having the resources to support each other when the other is in need. This may not always be the case in Mabinju, particularly in recent years when lengthening dry seasons have simultaneously subjected everyone to a state of water insecurity, and collapsing latrines (notably in low-

lying areas) have resulted in several neighboring households lacking access to a toilet. In other words, when an entire group's state of poverty becomes too great, it may simply become too difficult, if not impossible, to uphold principles of reciprocity. As summarized by the translator in one focus group:

"She's saying that if you release your… water tank, where people can go and get water, it will finish very fast, and you will also be in a problem. And then even if you allow people to use your toilet, so it will fill up very fast and then again, nobody will help you. Even by the time you are digging your toilet, no one will come to help you." (Mabinju community member, translated; November 22, 2021)

If climate change, by virtue of driving such material poverty and subjecting everyone to the same misfortunes, is in fact one of the factors underlying this trend, it can be said that climate change has the potential, through such pathways, to erode capacities for reciprocity and consequently reduce social capital in a given community. Still, the findings of this study alone are insufficient to support such a conclusion, warranting more research on the matter. Indeed, such research could offer particularly valuable knowledge considering the established role that social capital plays in promoting greater collective resiliency against climate change, and therefore facilitating positive adaptation (105-109). If the reverse causation is indeed true—that climate change can erode social capital—then it would be important to identify interventions that can halt the cycle to prevent further loss of adaptive capacity in its wake.

Lack of support from government, CHVs, village elders, and clan representatives amplifies WASH challenges

While the relative availability of social supports varied across interview subjects, participants offered virtually unanimous reports of receiving little support from external actors and higher-level representatives including governments, CHVs, village elders, and clan representatives. This was largely in response to questions around whether they could get access to medications, water treatment technologies, latrine construction materials, or emergency cash transfers in extenuating circumstances. The couple of exceptions to this trend were only for individuals in unique subject categories. One HIV-positive individual claimed that CHVs, on the basis of her status, were able to provide her a free "basic care package" which included a handwashing station and bed nets. The individuals with disabilities also spoke about the government initiative of targeted cash transfers for people in their group, despite the money not ultimately reaching them. The village elders and clan representatives consulted in one of the focus groups also stated that sometimes drugs can be mobilized to support families experiencing severe waterborne illnesses, following the submission of a report to the county administrative office. However, there were no reports

of resources or supports being mobilized to aid in household latrine reconstruction. This is consistent with the general policy in this setting that household sanitation is an individual responsibility, but concerning given the levels of sanitation enforcement by public health officers and clan representatives, and consequences of failures to comply. As illustrated in the following exchange with a clan representative:

""Translator: whenever they report these cases, for example maybe a toilet has submerged in Mabinju, they tell these households to rebuild, and people are so reluctant. So they share to the chief that there is a need for Mabinju people, for each home to have a toilet. So through the office of the chief, someone comes with an order, a government authoritative [order] ~~*household*~~*, that now …you have been given 14 days to build and you have been reluctant. So the government just comes to impose what they said earlier…* Interviewer: *Okay…and uh…what are the consequences if they don't follow up?* Translator: *the next step is that you are being caught and taken to the police station. And from there, you will be fined. So once you are fined there, they give you like another, duration to build another—* Interviewer: *I see. And then, it repeats…* Translator: *Yeah…so you will see, , the consequences of not having… that is their role, that they do with the chief, to deal with these people that don't want to build the toilet.* Interviewer: *Okay. But they don't provide the family with any resources to build the toilet, right?* Translator: *No, no resources." (Conversation with Mabinju clan representative, translated; November 8, 2021)*

When asked to share their sentiments concerning this general lack of higher level support received, most Mabinju community members surprisingly didn't express frustration or anger against anyone but the national government, whose corruption and apathy towards communities like theirs was perceived as the source of few resources trickling down to the local level. This perception was validated by the clan representatives and CHVs, who claimed they were ultimately constrained by the limits of what was made available to them from the national level. Indeed, when it came to medication stockouts, Mabinju community members were quick to recognize that it was not a county- or community-specific problem but rather a national one.

Many participants reported that the support and resource shortages experienced have become notably worse in recent years. Some, including CHVs, spoke of a time (supposedly several years back) when the CHVs were resourced with drugs (e.g. antimalarials, medications for diarrhea) to deliver at the household level—something which extended their mandate beyond health promotion and into the domain of health service delivery. Many participants couldn't suggest what had caused this change, but some attributed it to changes in government, resulting in certain sources of funding having "dried up". This is consistent with a major change over the last decade that have affected financial flows across the Kenyan health sector: the

devolution of governance authority to the county level. Even though allocations to the national health sector increased from 7.8 percent pre-devolution in fiscal year 2012/13, to 9.1 percent in fiscal year 2019/20, county allocations for drugs and non-pharmaceutical supplies decreased sharply as counties focused roughly half of their funds on the development of health infrastructure for which they had been devolved new responsibilities (110). Furthermore, Kenya's graduation from the World Bank category of low-income country to lower-middle-income country in 2014 resulted in sizeable reductions of donor funding, leaving a financing gap for key health inputs (110). Since the start of the COVID-19 pandemic, donor support has continued to decline while growth in gross domestic product dropped from 5.7% to 1.5% in 2020 (110). Considering these factors, the inadequate government supports reported by Mabinju community members are consistent with current national trends and represent the ongoing ripple effects of Kenya's continued failure to meet the government's pledged target of 15 percent of the total national budget to health, as articulated in the 2001 Abuja Declaration (111). With climate-driven health threats on the rise, the urgency to meet such targets may become more critical.

3.3.7 Climate adaptation, resiliency, and coping

Creativity spurs resiliency but poverty limits room to maneuver, leading to maladaptation

As community-level WASH adaptation in response to changing rainfall patterns was the primary focus of this phase of the study, a later section of this report is dedicated exclusively to fleshing out this theme and fleshing out the implications of the findings. Thus, this section will serve as a brief summary of the main conclusions derived from the analysis of adaptive responses identified. Adversity can trigger impressive feats of innovation and resourcefulness, but the scope of possible response options remains limited by poverty-related resource constraints.

A number of positive adaptation strategies were identified in this study, including several arising exclusively from the creativity of community members when faced with critical water and sanitation challenges. The most notable was the radical shift in water collection practices that occurred over the last decade, resulting from the construction of iron sheet roofs to replace traditional grass thatched ones. This represented a substantial improvement in water security in Mabinju, as it enabled rooftop rainwater harvesting, introducing an entirely new and relatively clean water source (rainwater) that wasn't previously available. Indeed, this shift is not unique to Mabinju and has been made in countless settings worldwide, as water scarcity has driven a new reliance on rainwater harvesting for drinking water procurement (112-115). The other major adaptation strategy identified in the interviews —in relation to water insecurity—was that of tree planting, used to enhance soil water retention, assist in flood control, and bring more rain. Indeed, a

number of drought-resilient tree species had already been identified by Mabinju community members, and some members were actively planting such trees in their homesteads. Many of these tree species are included in current recommendations aimed to inform the next Kenya National Agroforestry Strategy (116). This highlights the knowledge potential of communities forced to find new ways of mitigating risks. Other examples of creativity in the face of WASH threats identified in this study included the use of dykes for flood control, reliance on traditional knowledge for forecasting rainfall, proactive resource pooling for latrine reconstruction, and construction of latrines on higher plots of land and with more durable materials to enhance resistance against collapse.

Still, the challenges faced in being able to alter WASH practices in the face of new hazards were widely apparent across the interviews and focus groups. At their core, these challenges all related to monetary and resource shortages, which were expectedly driven by the poverty of most families in Mabinju. Without sufficient money, people could not purchase enough chlorine and WaterGuard to consistently treat the increasingly polluted lake water they are forced to rely on in the dry season. Meanwhile, without large enough rainwater collection and storage tanks, and without equipment to optimally channel rooftop water into storage containers, rainwater harvesting itself could only go so far in improving local water security. Similarly, with regards to latrines, even if people were aware that the use of pit covers would prevent water pooling and that concrete slabs and pit liners would enhance structural durability against collapse, few could afford to purchase these materials. Unable to fully address ongoing water scarcity challenges and prevent flooding-related latrine collapse, people were forced to rely on what could be considered maladaptive coping practices including compromising personal hygiene, drinking polluted water, and practicing open defecation. This relationship between poverty and maladaptation has been identified and reported upon by other researchers (117), and highlights the important role that targeted resource supports and the creation of new income generation opportunities can play in facilitating more positive community adaptation to climate change (discussed in more detail in Ch. 4).

Social networks facilitate diffusion of ideas

Mechanisms which facilitate diffusion of ideas were only minimally explored in this study, but still given some attention considering their established role in climate resiliency building and adaptation strategy innovation (118-120). In general, the loss of social spaces for WASH-related knowledge exchange aligned with the trend of dwindling resources from higher up. Only the clan representatives claimed there was still a regularly convened discussion space where community members could engage in collective problem solving on WASH and other social, environmental, or health issues. In contrast, other community members

discussed how these initiatives had been discontinued several years ago, as summarized by the translator in one focus group:

"Over 15 years ago, the area public health officer would walk around …in a forum like this, or a chief baraza. We have what they call the chief barazas, which were being organized weekly or maybe twice in a week. And then a public health officer could come and teach the community about, like, the healthy issues and the hygiene. And this one stopped many years ago, and for him, the reason could be that there is no government allocation for this, there is no funding for this. it could be that many years ago there was funding, but nowadays, there is no funding to address this." (Mabinju community member, translated; November 10, 2021)

The funding shortages described by this participant may be driven by similar factors as those reported upon previously, alongside recent attempts to replace international organizations in Kenya with locally run ones, resulting in the discontinuation of certain INGO-run programs (121,122). This has implications, in particular, for the channels through which climate finance will need to flow to reach target groups. Still, the manner in which the practice of rainwater harvesting—one of the key climate adaptation strategies identified in this study—spread within Mabinju, suggests that formal spaces for exchanging ideas are not the only means of facilitating knowledge spread. When asked about how this practice came about, considering the sudden and almost simultaneous shift that all families in Mabinju underwent from traditional grass-thatched houses to ones with iron sheet roofs, most participants claimed it was simply something that "everyone was doing" so they too felt compelled to do it. In his book entitled "Diffusion of Innovations", Rogers (2003) describes how at the heart of diffusion lies a process of "modeling and imitation by potential adopters of their network partners who have previously adopted" (123). This social process appears to apply appropriately to climate adaptation spread, as exemplified in this study and others.

Moreover, seeing the benefits enjoyed by those families who had made the switch (including the ability to collect rainwater and the enhanced durability of homes against damage during heavy rain) was sufficient to motivate others to follow suite. This trend likely holds for several unexpectedly successful innovations initially piloted on a small scale. As illustrated in the following translator's summary of one CHV's response to a question about new water practices observed within Mabinju:

"What she has seen in her area of coverage is that many people are going for the water storage tanks. And even in some homes in which she has not advocated for people to buy. So, she thinks it's kind of a technology which people just see by themselves, or they read somewhere. But in her area, she has seen many people

buying tanks, and even some people are having more than two. And this one (pointing at a nearby home), in her area, is also kind of urging other people, saying 'if so and so is having two tanks, I also need to save and have a tank'. So this is something which she is also seeing which is kind of so unique which is happening in her area." (CHV working in Mabinju, translated; December 10, 2021)

This finding demonstrates the role of social influences and the demonstration effect on adoption of new practices at the household level—something that should be further tapped in the dissemination and scale-up of climate adaptation technologies and strategies across communities with shared climate vulnerabilities.

3.4 Key Findings from Stakeholder Interviews

3.4.1 Perceived climate and WASH vulnerabilities of the LVB

Socioeconomic and sociocultural characteristics of LVB population drive increased climate and WASH vulnerability

Consultation with stakeholders over the present vulnerability context of the LVB elicited insights highly in line with those extracted from the initial literature review (see relevant background sections in Ch. 1). That is, the LVB population remains highly vulnerable to the impacts of climate change as a result of both poverty and enduring norms which contribute to resistance to change. One interview subject described the LVB as "one of the most vulnerable basins to climate change", referencing findings from the USAID-led PREPARED project, which included preliminary mapping of vulnerability sites within the region (124).

Poverty, was mentioned by certain stakeholders as factor which:

a) limits access to resources to support community-level adaptation (e.g. adaptation technologies),

b) forces maladaptation in the face of no alternative (e.g. rationing food and water, practicing open defecation, cutting down trees for charcoal production, delaying the emptying of septic tanks and pit latrines increasing risks of environmental contamination during rainfall), and

c) orients people's attention away from long-term planning towards meeting immediate, short-term needs—a mindset counterproductive to dealing with climate change, including the proactive mitigation of future threats.

As stated by one interview subject:

"Our communities are set in the thinking that "I invest where I see change". So if you tell me that trees bring about rainfall, when I construct, let's say, a hectare of trees, I should be in a position to see rain next year. Or in the next three years. HERE. And that doesn't happen with climate change. So it's more of a goodwill

thing. Climate change activities are goodwill activities, which we do not know the direct effects of. Of course, from a global point of view, they are doing something. But people are not thinking globally. They are thinking about their district. Their country. Their community." (Water Mission Uganda representative; December 18, 2021)

One stakeholder also conflated poverty with low education which, in turns, contributes to lack of access to information and, therefore, of awareness of climate change and the need to take preventative action.

Cultural norms were also reported as contributors to such resistance to change. Several stakeholders commented on the tendency of communities to continue doing things they have always done in a "business as usual" scenario, failing to acknowledge the need for adaptation. This was related to cultural norms with regard to interactions between humans and the environment (justifying full entitlement to unrestricted use of natural resources such as trees for charcoal production) and enduring practices of open defecation despite growing awareness of its consequences, as conveyed through ongoing social and behavior change communication on the matter. In summary, the inertia resulting from years of consistent practice impedes adoption of new techniques—a factor often reported upon in other studies as a "cultural" barrier to climate change adaptation (125-127). As suggested by many stakeholders, this warrants the need for "champions" to lead and demonstrate new possibilities and the potential benefits that can come from embracing them.

Climate change is a further disruptor to an already fragile ecosystem

The interactions of climate change with pre-existing and ongoing environmental disruptors in the LVB, discussed in more detail in the corresponding background sections of Ch. 1, were also commented upon by some interview subjects. Many stakeholders expressed concerns about the extreme pollution levels in lake water that community members also observed, sometimes describing lake water as "green" due to algae blooms and also mentioning the excessive water hyacinth blooms. The ongoing deteriorations of lake water quality were identified by one stakeholder as contributing to increased reliance on groundwater resources for drinking water, leading to aquifers drying up—an issue likely resulting from the confluence of heavy groundwater extraction with climate-related reductions in annual rainfall. Rising lake water levels were also mentioned by some interview subjects—something validated by research (59) and which was attributed by one subject to increased sediment deposition by surface runoff during flooding. In one interview, the direct consequences of rising lake water levels on water infrastructure were mentioned. One stakeholder reported that the overflow of the lake during times of heavy rain led had resulted in the need for Water Mission Uganda to relocate some of their water extraction systems to higher grounds after

having been submerged. Still, according to one interview subject, the fact that Lake Victoria remains a relatively shallow water body (in spite of net rises in water levels) means that it is vulnerable to excessive evaporation associated with high temperatures. The implications of this were summarized as follows:

"The more you are evaporating, the more you are losing the water. If you are taking more water through evaporation, and you are not recharging through precipitation, you can see how—even the lake itself—how it is really very vulnerable to climatic changes. And you know, for the recharge, there are ecosystems. And with any shift in the particular environmental balances, you are changing the balance of nature. You are affecting the ecosystem functions, and services. If you are changing the ecosystem functions and services, you are really killing the ecosystem. You are killing productivity." (Lake Victoria Basin Commission representative; December 3, 2021)

Finally, population growth in the region was considered by many interview subjects as another major pressure on the LVB environment. This is consistent with the LVB's documented population growth trends (49). The implications of this mentioned by interview subjects included increased lake water pollution, growth of informal settlements that could be considered high risk from both climate and WASH standpoints, and extension of agriculture along the lake and riverbanks resulting in the loss of important buffer zones which would otherwise temper the impacts of flooding on the lake. A few interview subjects expressed particular concern about the inadequacy of current waste management infrastructure to support the present population, given that it was built to serve a far smaller population and has not been upgraded since. One stakeholder summarized this well, further affirming the findings of the background literature review concerning the current climate and WASH vulnerability context of the LVB:

"…considering we have floods, droughts, and informal settlements, and pit latrines…when these things come together, they create a more disastrous environment." (Tanzania Institute of Rural Development Planning representative; January 10, 2022)

3.4.2 Climate adaptation and WASH prioritization

WASH has long been seen as an indispensable component of community development planning and has attained even greater prominence during the pandemic

Not surprisingly, given the concentrated focus on WASH and extensive WASH-promotive policy developments discussed in the corresponding background section in Ch. 1, findings from the interviews conducted in this study affirmed the importance of WASH in community development planning in the LVB. Indeed, the large number of organizations working in the WASH sector in this region testifies to the high

attention paid to WASH. Of the organizations consulted, many had a long history working in the WASH sector of their targeted catchments. Water Mission Uganda, for example, has been operating since 2008, and has implemented approximately 160 projects country wide, with a focus on the construction and design of piped water systems using primarily solar pumping technologies. In Western Kenya, the Safe Water and AIDS Project has been running since 2006, offering innovative water treatment, sanitation, and hygiene products across 7 counties, and now running one of the country's most advanced laboratories for water testing and quality control. Most CDC offices in the region also focus heavily on WASH and waterborne disease control.

Meanwhile, each of the three countries on the shores of Lake Victoria (Kenya, Uganda, and Tanzania) has its own WASH "network" to lead national coordination of the multitude of active WASH-related organizations. Many of the stakeholders interviewed emphasized the importance of WASH from environmental, health, social development, and gender equity perspectives, highlighting its transcendence as a common focus area cutting across multiple sectors. The engagement of a more diverse network of partners engaged in WASH was likely accelerated by the release of the UN Sustainable Development Goals (SDGs) in 2015. Under this framework, WASH became its own focus area (SDG 6), replete with 8 targets and 11 indicators, as opposed to being relegated to a single target (target 7C) under the more limited Millennium Development Goals section on "Environmental Sustainability" (128,129).

The role of COVID-19 in drawing greater attention to WASH promotion as an indispensable goal was highlighted by some of the stakeholders as well. This was reported to contribute towards the expansion of WASH in schools, and the mobilization of new funds to support WASH activities. Referring to ongoing WASH improvements in local healthcare facilities, one representative from Kombewa County Referral Hospital's infection control department stated the following:

"When COVID came about, we were just, we were just happy. We were so happy because we said 'wow, this is now strengthening on what we already have'. Yeah, we were so happy, and we are maintaining it, and we have continued to maintain it." (Kombewa County Referral Hospital infection control representative; November 19, 2021)

Indeed, these trends of greater focus on WASH in response to new pandemic-driven hygiene priorities have been reported in multiple low- and middle-income countries worldwide, indicating important progress in this domain (130-133). From this study and others, it therefore appears we are already well past the point of establishing a critical need for improved WASH, and taking steps to redirect our efforts accordingly. It

will be crucial, however, to sustain recent improvements driven by the COVID-19 pandemic, if we are to meet the multiple targets under SDG 6 by 2030.

Climate change is rapidly gaining salience in community development planning

The rising importance of climate change in the minds of community development actors in the LVB became apparent across the interviews conducted. The majority of stakeholders interviewed strongly affirmed that climate change can no longer be ignored by those focused on development in the region, regardless of the sector. After describing the extensive effect that climate change is having on their projects in Uganda, including requiring the relocation of project sites as wells dry up and swamps and wetlands shift their borders, a representative from Water Mission Uganda stated the following:

"We are at the level that even the communities can see what is happening. It is no longer the story they used to tell out of myths—like "oh it's climate change, oh it's global warming", when no one understands. Now they see." (Water Mission Uganda representative; December 18, 2021)

Other stakeholders backed this sentiment, stating that the very nature of their economic dependence on climate-sensitive sectors means that communities in the region cannot be oblivious to the impacts of climate change. Still, the degree to which identification and acknowledgement of climate change has translated into practical shifts in project planning was less clear, however this theme is explored more in later sections.

It is worth noting, however, that a small number of respondents explicitly stated that climate change is not being given the attention that it needs. One described climate change as an "after-thought", with other development priorities taking precedence. While perceived conflicts between climate mitigation and development are more frequently mentioned in related dialogue, with adaptation largely seen as a synergistic development strategy (134), there remain barriers to long-term development-path transformations in the face of new climate threats. According to Burch et al. (2014), such transformations may be stifled by a lack of collaborative, open-ended, and horizontal policy planning for development, as needed to create the "policy linkages" between vertical operations included in the climate change response (135). This theme of intersectoral, horizontal development planning is discussed more in the later section on ministerial siloes. Still, the possibility for conflicts to arise between poverty reduction and vulnerability reduction has been discussed in Håkon Inderberg et. al's (2015) book on "Climate Change Adaptation and Development", most notably in relation to charcoal production for livelihood diversification (136). In response, Ansohn & Pleskovic (2010) have recommended that if adaptation must involve designing and

implementing measures that are more targeted to specific threats than development activities tend to be, mainstreaming can then ensure that development activities themselves are not maladapted to climate change (137).

3.4.3 Climate adaptation and WASH programming

Early warning and emergency response mechanisms have improved but remain limited in scope

Despite the large role that early warning and emergency response play in climate adaptation-related disaster risk reduction, the interviews conducted for this study did not allow a deep analysis of this theme. Still, it came up frequently enough to conclude that such efforts in this setting are well underway but, at least in relation to climate-driven WASH hazards, there is still room for more progress. With regards to emergency response during flooding, only one interview participant had sufficient experience to elaborate on coordination mechanisms. This respondent described the role of county/district representatives, church and faith-based organizations, and members of the global humanitarian hub such as UNICEF, Red Cross, and World Vision. WASH-specific initiatives discussed included distribution of soap, handwashing stations, and safe drinking water in displacement camps. However, in spite of extensive discussions on the severity of sanitation collapse and sewage contamination during such flooding events, only one of the organizations consulted spoke of sanitation initiatives in such camps, and reported they were the main actor focusing on this in the region. Meanwhile, another interview respondent stated that most attention is directed towards determining where and how to temporarily house displaced people, with the risk of waterborne disease outbreaks given secondary consideration.

Similarly, with regards to early warning systems, the main inadequacy identified in the interview responses was a lag in early warning systems for waterborne disease outbreaks relative to those established for extreme weather forecasting. When asked about early warning and epidemiological monitoring for waterborne disease spread in flooding-related displacement settings, one interview participant stated the following:

"We don't have—we are not really collecting data for these things. But we've really improved to make sure we also focus on the type of diseases that you're mentioning. Um…the way I told you, the last time that you came, you can see—if you have flooding, expect waterborne diseases. You have to predict them. But for now, we don't have such powerful systems." (Lake Victoria Basin Commission representative; December 3, 2021)

The shortcomings identified in this domain are concerning when one considers the WASH hazards that are known to emerge in emergency, humanitarian, and displacement settings (138,139). Streamlining WASH risk mitigation into both climate adaptation and disaster risk management planning thus remains an important goal to take further steps towards, in both the LVB and other climate-vulnerable regions.

While efforts have been made to enhance community engagement in climate adaptation and WASH programming, top-down initiatives are still predominant

The engagement of communities in projects run by the organizations consulted with was prominently reflected in most implementation plans, indicating positive efforts to mainstream community-engaged practice into climate adaptation and WASH programming. In contexts where knowledge-related barriers to behavior change were identified, extensive social and behavior change communication strategies were employed in an effort to shift behavior on environmental issues, natural resource use, and sanitation and hygiene practices. To motivate people to adopt proposed lifestyle changes, one stakeholder reported the importance of first dispelling climate change myths which attribute the phenomenon to spiritual and other forces beyond the realm of human control. Meanwhile, those stakeholders interviewed who had experience leading or coordinating community tree planting, environmental conservation, and reforestation campaigns commented extensively on the need to garner support from communities. This was deemed essential to sustain engagement, given the proclivity of those facing poverty to prioritize fulfillment of immediate, short-term needs, even if it means compromising longer term ones. Embedding income generation opportunities within such projects (e.g. training communities to harvest and sell newly available products from replanted trees, enabling sales of gas stoves made to replace traditional charcoal burning techniques) was an important means of garnering the needed commitment of communities. This is consistent with research on community-engaged ecological restoration which has documented that ignoring livelihood impacts is often detrimental to restoration outcomes as it can breed conflict and resentment within communities who may feel further dispossessed of their rightful entitlement to accessing natural resources on which their survival depends (140). Many stakeholders recognized the importance of project ownership, , most notably a representative from Water Mission Uganda who spoke about the predominant community management model they use for long-term operation and maintenance of water systems. Another representative from the Lake Victoria Basin Commission stated that:

"If the project is technically designed, community designed, it means you are addressing community problems. It's still their project. You capture their views. But if we do the top-down approach, it will be

impossible to bridge the gap between institutions and communities." (Lake Victoria Basin Commission representative; December 3, 2021)

However, despite the apparent efforts of regional players to adopt community-engaged practices in climate adaptation and WASH programming, discussions with multiple stakeholders revealed limitations in the level of engagement in the program design phase preceding actual implementation. Although communities appeared to be highly engaged in the implementation and long-term maintenance of new adaptation- and WASH-related systems, infrastructures, and practices, the project plans themselves were most often pre-developed by organization staff and technical implementing partners. Indeed, when asked about their observations on "grassroots" initiation of climate adaptation, most stakeholders had little to say, claiming that when communities do take up a new practice on their own accord, it is most often because of governments or outside actors enforcing it. This was reported to be the case for most community-led tree planting initiatives, given the Kenyan government's continued enforcement that households designate at least 10% of their land to trees. One stakeholder acknowledged that their projects most often come as an "external" force, with plans fully developed at the headquarters level before introduction in the community. This leaves little room for community input on program design, even if the implementation approach —at which point, communities may be consulted—is inherently iterative. The difference in engagement approach between the design and implementation phases illustrates a prevailing legacy of top-down program planning, in-spite of progress towards more community-led development language in strategy documents. In an analysis of the political economy of climate change and development, it was found that while there are many examples of bottom-up initiatives, especially on community-based adaptation and decentralised energy, more macro-level political forces still dictate the strategic direction of most projects in this domain (141). Coupled with the findings from this study, it appears there is more work to be done in shifting climate adaptation planning towards greater involvement of targeted beneficiaries in generating the ideas, innovations, and technologies their knowledge may be well suited to inform.

Climate adaptation and WASH in the LVB have seen important achievements but reflect a skewed focus on water resources over sanitation and hygiene, precluding full climate-WASH integration

When asked specifically about WASH-related climate adaptation projects aiming to enhance community resiliency against the WASH impacts of climate change stakeholders spoke of a breadth of initiatives currently underway. While most had a predominantly climate adaptation or WASH focus (depending on the primary mandate of the implementing organization), those which integrated both components were

most often exclusively water security focused. These included projects such as decentralized water pumping systems tapping into less weather-dependent ground and surface water sources, solar-powered water treatment technologies, tree planting for flood control and groundwater resource retention, more robust water quality monitoring and control mechanisms in response to flood-intensified surface water contamination, and relocation of drinking water pumps to sites with more reliable aquifers, amongst others. Two interview subjects mentioned involvement in promotion of composting toilets as an alternative to the flood-vulnerable put latrines. However, none of the other subjects reporting upon sanitation and hygiene projects were able to identify or comment upon specific climate resiliency components. This appeared to be another manifestation of the general neglect of sanitation itself, in contrast to the prominent attention paid to water security from both climate adaptation and development perspectives. As stated by one interview subject:

"The problem is that little emphasis has been put into hygiene and sanitation. Because we still consider it to be an individual issue…that someone is sick. Maybe we have waterborne diseases and an outbreak somewhere, or maybe there has been floods, a specific area has been swept away. But the only concern will be 'where will these people live?' But other effects like where the wastewater produced in this household has gone, nobody cares about." (Tanzania Institute of Rural Development Planning representative; January 10, 2022)

Without consideration of climate-related hazards in the planning and design of sanitation projects equal to that seen for both water supply and water resource management projects, climate-WASH integration in the LVB appears to fall short. Further discussion is found in Ch. 6 on potential factors contributing to the relative neglect of sanitation in relation to water supply, and the dearth of sanitation projects integrating climate risk assessments. Chapters 5 and 6 address in more detail the inadequate investments in climate-resilient sanitation drawing on both the findings of this study and other literature reporting similar trends (142,143)

3.4.4 Climate adaptation and WASH funding

Funding shortages persist in both climate adaptation and WASH sectors, with donors largely dictating the strategic direction

While project financing and the role of donors were not extensively discussed in the interviews conducted, when these themes did arise, it was largely in relation to reports of funding shortages and heavy reliance on donors. The stakeholders who raised these concerns spoke of the impact this has had on project

planning, including reliance on less advanced adaptation technologies, limitations on decentralization of wastewater treatment systems, and limiting capacity for project scale up. Donor influence was framed as an important driver of project plans, largely because donors have their own perceptions of "where the problem lies" as well as the power to define the range of possible responses, from a financial standpoint. One participant discussed how at the joint water sector review in Tanzania—an annual event which sets the agenda for sector-led activities in the following year—conversations are largely on options donors are willing to support. It is plausible that has contributed towards the large focus on tree planting in climate adaptation-related water resource management plans, as companies are now opening new funding channels for such as part of global carbon trading schemes (144). As highlighted by one interview subject, this further affirms the need for in country agencies to become self-sustaining in the long run, as reliance on donors cannot be indefinite. Considering the persistent scarcity of funds for climate adaptation relative to mitigation (145), novel fund generation schemes such as income from training, research, and product sales, as well as collaboration with larger bodies with broader development mandates may be worth pursuing, as explored in one study on donor fatigue circumvention in Northern Ghana (146).

Sector-specific and earmarked budgeting norms limit climate-WASH integration

Given the limited interview material specifically on funding, only tentative conclusions can be drawn. Still, a number of interview subjects either directly or indirectly commented on earmarked funds and the limitations they impose on flexibility in project planning.

A number of interview subjects commented on the sector-specific compartmentalization of government budgets and how this results in access to funds being contingent on a project's compatibility with the specific mandate of the sector. This sometimes renders the grant application process a delicate balancing act, where what would otherwise be a more holistic, horizontal development program must be presented predominantly as a "water", "climate change", or "agriculture" program to qualify for access to funds from the corresponding sectoral budget. This can make horizontal integration of cross-cutting development priorities (e.g. climate resiliency, food security, health promotion, livelihood generation) more challenging, as plans may need to be tailored to the focus areas for which their funds are earmarked. In the case of projects like tree planting, this becomes inherently limiting, as WASH sector funding may not be available if the focus is deemed to be primarily environmental, conservation, or climate-change related. Indeed, this may be the case even in spite of evidence that tree planting can improve the quality of surface water bodies—a major drinking water source for many communities—by reducing contamination through surface runoff (147,148).

For accessing funds from multilateral and charitable donors, similar barriers seem to apply. One interview subject specifically commented upon how WASH in Tanzania is financed through two mechanisms: basket funding and earmarked funding. He then described how since 2015 in particular, the trend of donor funding has been a preference for earmarked rather than basket funding, due to prior challenges in tracking the flows (and destinations) of funds distributed through pooled channels. He commented that:

"This affected where and how to re-allocate the funding. Because earmarked is just applied to the one who has funding. And so in some of the areas we find several investments, while in others there are fewer investors. And for example, in Tanzania, if the sector is not a priority sector for that financial year, it may not receive sufficient funding." (Tanzania Water and Sanitation Network; January 19, 2022)

Pooled funding has been advocated as more conducive to integrated policy-making and horizontal program planning (149,150). The challenge in facilitating greater adoption of this mechanism, however, may lie in implementing sufficient anti-corruption safeguards to reassure funders that there are adequate protections from misallocation of funds. Still, considering the ongoing impact of corruption on foreign aid flows (151,152), simple solutions are not available.

3.4.5 Multistakeholder collaborations

Civil society, public, and private sectors are increasingly coming together under a common development umbrella

The collaborations between civil society, public, and private actors in the climate adaptation and WASH space were widely discussed by the interviewees, and mark encouraging progress in dissolving operational siloes. Indeed, numerous projects under both climate adaptation and WASH umbrellas relied heavily upon public-private partnerships in the procurement and application of innovative technologies to achieve program goals. In Uganda, for example, a wide network of utility companies works directly with the water ministry at varying levels of governance to support full geographic coverage of clean water supply. Likewise, wastewater treatment companies in Tanzania are delegated responsibility from district authorities for given catchment areas. The role of public-private partnerships in climate adaptation has been explored elsewhere, with many positive outcomes reported (153). The value of such partnerships was particularly promoted by one stakeholder interviewed:

"You know, private sectors are also centers of innovation. And the fact that they are driven by profit means that certainly they also push the element of reducing costs…you know, coming up with a mechanism that

can help reduce costs. And therefore, we also need to make sure that they are part and parcel of this cause on climate change adaptation." (Lake Victoria Basin Commission representative; January 6, 2022)

Under a more complex arrangement, the Safe Water and Aids Project in Kenya produces for-sale hygiene and sanitation products which it sells to other WASH-sector civil society organizations (CSOs) and implementing partners in the region. It also partners with the CDC in testing different technologies for schistosomiasis diagnosis from urine and stool samples, amongst multiple other global collaborations. The transnational nature of such collaborations was consistently highlighted as subjects described their involvement in global humanitarian hubs or network societies, alongside exchanges with international headquarters for those organizations serving as regional bodies.

Likewise, collaborations between government and civil society were highlighted by explanations from interview participants on the role of community-based organizations serving as mediating bodies between higher level governments and communities and carrying out field-based implementation of national development plans. The Lake Victoria Basin Commission, for example, oversees a diverse network of CSOs under its climate adaptation program and brings them together at regularly held capacity building and knowledge dissemination forums. Similar forums were described by representatives from both the Uganda and Tanzania Water and Sanitation Networks.

In an analysis of the role of regional partnerships in climate adaptation, Bauer and Steurer (2014) identified three distinct ways that such partnerships catalyze policy innovations, one of which included the promotion of regional scale-up through diffusion mechanisms (154). Similar pathways of scale-up were observed in the reports of stakeholders interviewed in this study on regional forums for climate adaptation and WASH sector planning. In many cases, this resulted in the complete transfer of models with proven success from one setting to another. Taken together, it is clear that the role of such forums should be leveraged in the regional dissemination and scale-up of evidence-backed strategies for climate-resilient WASH.

Ministerial siloes continue to limit horizontal development planning

Despite the encouraging progress in efforts to coordinate the initiatives of public, private, and civil society actors, collaboration across ministries appeared to be more limited, according to interview participants. As this theme is also commented more heavily upon in Ch. 5—considering it constitutes a major barrier to climate-WASH integration—, this section is only meant to serve as an overview of the major conclusions drawn and substantiating evidence.

In summary, interview subjects commented in detail upon the role of individual ministry plans, budgets, and mandates in constraining their engagement on more cross-cutting efforts. The fragmented mandates of different ministries, particularly in the context of WASH sector planning, was best summarized by one interview subject from Water Mission Uganda:

"In Uganda, oftentimes it works to our disadvantage that WaSH is integrated into so many sectors. When we go for coordination, we find the Ministry of Health. And the Ministry of Health is basically interested in sanitation. Then we have the Ministry of Water and Environment. That one is interested in water catchments and all of that. Then we have Ministry of Gender, Labour, and Social Development, which is interested in the inclusiveness. Then the Ministry of Education comes in. Because our children spend 80% of their time at school. So they are in charge of school sanitation and hygiene. So that component of sanitation goes there, then the health sector deals with sanitation in healthcare and also sanitation at the household level. So there is that split in the sector, and it's very complex." (Water Mission Uganda representative; December 18, 2021)

With regards to climate adaptation specifically, one interview subject described how despite climate change being mentioned as a cross-cutting issue across various ministries, it is primarily "championed" by the environmental education department of the vice president's office, which in turn, prepares the budgets for climate adaptation projects. As such, it is rare to find specific budgets for climate adaptation in other ministries, for they rely on funds from the central level while channeling their own resources exclusively towards their more vertical focus areas.

Stakeholders also reported shortcomings in operational collaboration across ministries. This was most apparent in the general isolation of environment, agriculture, and natural resource management sectors from ministries of health, despite their shared stake in climate adaptation planning. As discussed in more detail later in the thesis and in other published reports (155-157), this remains a major challenge that needs to be overcome to achieve a more horizontal development paradigm under which issues like WASH and climate change can be treated as the interlinked issues that they are.

3.5 Ch. 3 References

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Ch. 4: Climate Adaptation and WASH Behavior Change in the Lake Victoria Basin

****Note that this chapter has been prepared as a focused analysis of this sub-theme and is formatted according to guidelines for the Journal of Water, Sanitation & Hygiene for Development, which it is targeted for later submission to, under the "Research Papers" submission category*

4.1 Abstract

As climate change disrupts the global hydrological cycle, bringing more frequent extremes of flooding and drought, many communities will experience changes in water supply, water quality, and sanitation access. These changes will fundamentally alter water, sanitation, and hygiene (WASH)-related behaviors and practices in affected settings, by virtue of requiring individuals to adapt their patterns of water use, hygiene care, and sanitation maintenance in the face of new disturbances. Some of the strategies employed to cope with WASH-related impacts of flooding and drought may represent positive adaptations to climate change, promoting greater climate resiliency. Still, other measures may be maladaptive, resulting in long-term increases in climate vulnerability. Mapping the adaptation patterns of communities to climate-driven WASH impacts can serve to identify strategies on both ends of this spectrum. This study sought to undertake a mapping exercise of this sort, specifically in the context of the Lake Victoria Basin (LVB), selected for its climate vulnerability and dual extremes of flooding and drought. Through qualitative interviews and focus groups with lakeside residents of Mabinju village, located in Western Kenya, a series of innovative community-driven adaptation measures were documented, alongside other potentially determinantal coping strategies, which were found to be largely driven by resource-related adaptation constraints. These findings highlight the need for climate adaptation interventions in the WASH sector to simultaneously build on existing resiliency-enhancing measures while addressing the root causes of maladaptation.

4.2 Introduction

Climate change is causing massive changes in rainfall patterns worldwide, upending traditional practices driven by seasonal precipitation cycles. In some settings, net precipitation has been on the rise (1-3), while in other more drought-prone regions, the opposite has been the case (4-6). Regardless, a consistent trend has been documented whereby rainfall patterns in many settings no longer follow cyclical norms, rendering them increasingly unpredictable (7,8). Simultaneously, extremes on both ends of the spectrum have become more common in many settings, with flooding and drought taking an increasing toll on climate-vulnerable populations globally (7,8).

In LVB which encompasses the full 194,000 km^2 catchment zone of Lake Victoria, spanning Kenya, Uganda, Tanzania, Rwanda, and Burundi, typical precipitation patterns are characterized by a bimodal seasonal distribution with peaks occurring during March-May (long rains) and October-December (short rains), albeit with some regional variation (9,10). Yet as climate change impacts the monsoon patterns which drive the movement of the inter-tropical convergence zone (rainband) across East Africa, this pattern is being disrupted (10). The "East Africa Climate Change Paradox" has emerged as a term to describe paradoxical observations of increased annual rainfall coupled with a decline in the East African Long Rains, producing longer dry seasons and increasing drought intensity in many regions (11). With this phenomenon, it is generally accepted that the LVB is experiencing less predictable rainfall alongside heavier bouts of precipitation separated by extended periods of drought (12). This combination creates a multitude of challenges in the region, as rainfed agriculture becomes less viable and populations face both flood- and drought-related weather hazards.

Given the confluence of climate hazards in the LVB, the region serves as a unique and important site for studying the adaptive responses of communities to climate-driven rainfall disruptions. This investigation is further compelled by the existence of apparently conflicting research findings suggesting that communities, with their complex knowledge systems, hold the potential to spur profound innovation and resiliency-building in the face of climate change, while simultaneously they exhibit a tendency for maladaptive coping when adaptation options are limited. Indeed, Indigenous and traditional knowledge systems and a needs-driven proclivity for adaptive evolution of practices and norms, have been identified as important contributors to positive climate adaptation in communities worldwide (13,14). Yet at the same time, maladaptive responses have also been documented, whereby individuals facing poverty resort to such measures as selling livestock, marrying daughters, or rationing food to cope with rising food and economic insecurity, spurring a vicious cycle of increasing climate vulnerability and reduced adaptive capacity (15,16). Systematically mapping the responses of communities to climate change therefore becomes an important endeavour, for it unveils the mosaic of adaptation patterns which can inform differentially designed interventions, from facilitated uptake (for positive strategies) to promotion of better adaptation alternatives (for maladaptive responses). Using the LVB as a suitable setting in which to conduct this investigation, the purpose of this study was to identify the array of WASH-specific adaptation responses of communities to changing rainfall patterns in the LVB. Subsequently, the study aim was to use such knowledge to inform more locally contextualized adaptation in the LVB's WASH sector, which carefully consider the potential contributions of community knowledge while simultaneously targeting poverty-related drivers of maladaptation.

4.3 Methods

This study employed qualitative research methods, drawing on principles and tools of both grounded theory and participatory action research. Through a collaboration between an MSc student from the University of Alberta School of Public Health and the community-based organization *Kar Geno Center for Hope, Kenya*, individuals residing in Kar Geno's main project site were identified as potential research participants.

The study site was Mabinju village, a small farming-based community of about 300 homes located in Western Kenya's Siaya County on the shores of Lake Victoria, approximately an hour west of Kisumu. The predominant economic activities of Mabinju residents including fishing and rainfed agriculture. Mabinju is inhabited by members of the Luo community, a Nilotic ethnic group which historically migrated from southern Sudan and settled on the shores of Lake Victoria. With many suffering from HIV/AIDS, Mabinju's inhabitants have long been subject to extreme poverty, stigmatization, and marginalization despite ongoing development efforts in the region. While Kar Geno's work has come a long way in addressing the economic, social, and health barriers faced by Mabinju community members in achieving prosperity and success, major challenges remain. Given the vulnerabilities of Mabinju community members from health, socioeconomic, and environmental standpoints, Mabinju served as a relevant setting to investigate WASH challenges in the context of climate change. Kar Geno's long-term work in Mabinju and rapport with its residents also offered an easy entry-point as an outside research team.

Beyond the collaboration with Kar Geno, additional connections were forged with a network of WASH sector organizations based throughout lakeside regions of the LVB, with interviews conducted with representatives of these organizations.

4.3.1 Participant Recruitment

Within Mabinju, participant recruitment was conducted with the support of the two locally-hired field assistants, who selected households which indicated willingness to be contacted for study involvement during a village-wide WASH campaign. Purposive sampling was employed to recruit participants across designated subject categories. For focus groups, these categories included village elders and clan representatives, people with disabilities, pregnant women, and community health volunteers (CHVs), amongst other community members. For individual semi-structured interviews, subject categories included HIV-positive individuals, pregnant women, lactating women, seniors ($\geq$65 years of age), and single mothers, amongst other community members.

For the organizational stakeholder interviews, potential participants were identified through preliminary research and consultation with pre-existing regional contacts on WASH sector organizations and actors, including government health ministries, active in the lakeside regions of Kenya, Uganda, and Tanzania. For organizations that were not exclusively WASH focused, requests were made to be connected with representatives from their respective WASH departments or with any other individuals with relevant climate adaptation- or WASH-related knowledge or field experience.

4.3.2 Data Collection

Data collection involved in-person semi-structured individual interviews and focus group interviews with the recruited community members and stakeholders at the subject's household or another location of choice within Mabinju village. These community interviews focused on recent experiences with changing rainfall patterns in Mabinju and corresponding modifications made to water use, collection, and prioritization habits, alongside altered practices of sanitation and hygiene maintenance used to cope with increasingly frequent flood and drought events. As most Mabinju community members only speak their local language (Luo), local field assistants were present for all interviews and focus groups to provide translation services. It should be noted, however, that translations for the (majority) non-English-speaking participants were not provided in the form of verbatim responses, but rather as summaries of the statements and comments provided by each respondent, despite the acknowledged limitations of this approach. Semi-structured individual interviews were conducted with organizational stakeholders (some virtually) and focused largely on their operational conduct in the field, but focused on their observations of community-driven initiatives and adaptations in contexts of flooding and drought. In keeping with qualitative research principles, focus groups and interviews were discontinued when no new codes emerged in the data, indicating a point of saturation.

4.3.3 Data Management and Analysis

All interviews and focus groups were recorded and manually transcribed shortly afterwards. Transcripts were reviewed with local (Luo-speaking) field assistants to ensure accuracy and that no information was lost during translation. Transcripts were then analyzed using Dedoose qualitative data analysis software. A thematic content analysis was conducted using a Grounded Theory framework, whereby principles of constant comparison were employed, and used iteratively to develop a theoretical model from a qualitative coding scheme. Inductive coding was used to develop a set of codes and categories which fit the data, from which broader themes were later derived. To ensure data privacy and confidentiality, recordings,

transcripts, and documents uploaded to Dedoose were all stored in cyber-secure, password-protected data files, which will be permanently deleted from the computer hard drive after 5 years.

4.3.4 Research Ethics

Ethics approval for this project was obtained from both the University of Alberta Research Ethics Board (REB-1) and the Maseno University Ethics Review Committee. Informed consent was sought prior to all interviews and focus groups, and participants were fairly compensated for their involvement in the study in the form of a cash stipend with a value in line with local CDC study compensation norms. Participants were offered the chance to withdraw from the study at any point without consequence and were informed of local contact people to reach out to if any questions or concerns arose during or after the completion of the study.

4.4 Results

4.4.1 Characteristics of Study Participants

Semi-structured individual interviews were conducted with 17 community members from the village of Mabinju and 13 organizational stakeholder from the LVB region (including Kenya, Uganda and Tanzania). Further, 7 focus group interviews (including four targeted groups conducted exclusively with pregnant/lactating women, people with disabilities, community health volunteers, and village elders/clan representatives) were conducted, with a total of 66 Mabinju community members participating. Key characteristics of study participants are summarized in Tables 6-7 below:

Table 6: Characteristics of Community Members Involved

Mabinju Community Members	
Characteristic (Individual Interviews)	**No. of Participants**
Male	2
Female	15
Age 20-34 yrs	5
Age 35-64 yrs	4
Age ≥ 65 yrs	8
Pregnant	2
Lactating	2
HIV-Positive	3
Single Mother	2
Characteristic (Focus Groups)	**No. of Participants**
Male	16
Female	50
Disability	7

Pregnant	6
Village Elder	1
Clan Representative	13
Community Health Volunteer	7

Note:
The large number of both female and elderly community members reflects the purposive recruitment strategy to ensure heavy representation of those responsible for household water collection (women) and those more knowledgeable on long-term weather patterns in Mabinju including changes over time (the elderly).

Table 7: Characteristics of Organizational Stakeholders Interviewed

Stakeholders	
Organization (Country)	**No. of Participants (with Sex)**
AMPATH (Kenya)	1 (F)
FreeKenya Foundation (Kenya)	1 (F)
Safe Water and Aids Project (Kenya)	2 (1M, 1F)
Siaya County CDC Office (Kenya)	1 (M)
Kombewa County Referral Hospital Infection Prevention and Control Dep. (Kenya)	1 (F)
Water Mission (Uganda)	1 (F)
Uganda Ministry of Water and Environment (Uganda)	1 (F)
Uganda Water and Sanitation Network (Uganda)	1 (F)
Tanzania Institute of Rural Development Planning (Tanzania)	1 (F)
Tanzania Water and Sanitation Network (Tanzania)	1 (M)
Lake Victoria Basin Commission Climate Adaptation Department (regional across 5 LVB countries)	2 (M)

4.4.2 Coping with Flooding and Latrine Damage

As extreme flooding was a less commonly reported weather hazard by Mabinju study participants, adaptation through flood response measures was not as pertinent in the context of this study. Still, several positive adaptation strategies to flooding were shared by Mabinju community members, including building dams surrounding their homes, planting trees in their yards to improve soil water retention, and relocating important structures (e.g., crops, latrines, airing racks) to higher grounds within their homesteads. Some organizational stakeholders also commented on ecosystem-based adaptation measures they had seen community members take up on their own, including collective tree planting and conservation of river buffer zones.

Responses to flooding in Mabinju were referred to more often, however, in relation to collapse, damage, or overflow of pit latrines during heavy rainfall events. A majority of respondents discussed experiences

with their latrines collapsing or submerging (i.e., the walls caving in or giving way) and/or overflowing (i.e., water coming out from the pit) during the rainy season, with most reporting they had personally experienced this phenomenon. Responses to latrine damage varied greatly. Some households had the resources to take proactive measures such as pooling savings before the rainy season in anticipation of potential costs for latrine reconstruction, or designing latrines from the outset to have greater structural integrity and flood resilience through use of concrete slabs, iron sheets, wooden or concrete walls, and strong pit liners. Other households could not afford these measures, leaving no choice but to "dig and bury" their waste, share latrines with a neighbor, or defecate in the open from the time of latrine collapse until having the necessary funds to construct a new one. Virtually all participants stated that even when orders by public health officers to install a new latrine, they would choose to wait until the end of the rainy season to invest (if/when able) in such work, aware of the risks of it collapsing again.

4.4.3 Coping with Water Contamination and Diarrheal Illness

Issues of diarrheal illness due to the increased pollution of Lake Victoria and its surrounding river system cannot be exclusively attributed to climate change, considering the long-term patterns of environmental degradation the region has seen as a function of population growth, natural resource exploitation, and poor industrial waste management, among other factors. Nonetheless, climate change could well exacerbate this phenomenon, given its impact on heavy rainfall which in turn increases waste deposition into the lake through heavy surface runoff. This issue was therefore explored in discussions with both community members and regional organizational stakeholders.

The most significant adaptation response identified to rising contamination of Lake Victoria—which previously served as the primary drinking water source for residents of Mabinju—was the advent of rainwater harvesting as a means of procuring a safer drinking water alternative. Indeed, Mabinju community members were particularly enthusiastic about their relatively recent uptake of rooftop rainwater harvesting as a new water collection method (adopted particularly over the past 5 years). When asked, most reported that the impetus for this shift came from both rising concerns about the safety of drinking the increasingly contaminated lake water and a transition already underway from traditional grass-thatched roofing to iron sheet roofs, making rainwater harvesting possible. Many community members discussed their rainwater harvesting strategies, which ranged from simple techniques (e.g., placing jerry cans around sides of the house) to more advanced technologies (e.g., installing gutters and large water storage tanks). The practice of rainwater harvesting was also widely reported by organizational stakeholders as a common community-led initiative for improving domestic water access.

Still, by no means was rainwater harvesting considered a panacea to the issue of contaminated surface bodies, considering it could only be used during times of consistent rainfall, which were becoming increasingly scarce with the lengthening dry seasons. During these dry seasons, participants reported coping with the issue of contaminated lake (and river) water by purchasing either treated/bottled water directly from nearby vendors or, more commonly, Water Guard, chlorine, or other water treatment tablets with which to treat collected surface water prior to consumption. However, such options were unaffordable and out of reach for many, leading to reliance on other measures such as use of traditional herbs for water treatment, solar water disinfection (i.e., leaving water in the sun for extended periods before consumption), and, most commonly, boiling water. The practice of boiling water was also reported to have become increasingly challenging due to problems accessing firewood. Both Mabinju community members and organizational stakeholders associated the increased need for fuel for boiling water with increased tree cutting. At the same time, they acknowledged the widespread practice of residents drinking "raw" lake water when such fuel was unavailable or too difficult to obtain. Stakeholders also linked the rise in tree cutting to the increased use of charcoal production as an income-generating strategy by communities no longer able to rely on rainfed agriculture as a livelihood.

As far as responding to the impact of use of contaminated lake (and river) water on risk of diarrheal illness, Mabinju community members reported having few viable options. As their geographic and financial access to healthcare was limited, most participants reported purchasing medications for diarrhea from informal drug providers from nearby vendors. Only a few reported taking more proactive measures such as starting an emergency savings fund for future hospital visits.

4.4.4 Coping with Drought, Water Scarcity, and Unreliable Rainfall

Concerns and experiences with drought featured heavily in interviews with both organizational stakeholders and Mabinju community members, reflecting its salience in the current LVB climate context. While rainwater harvesting itself was seen as an important promoter of household water security, the trend of lengthening dry seasons renders this practice useful for ever more limited periods of the year. The shortening of the rainy seasons (and lengthening of the dry seasons) was reported to be a trigger for Mabinju community members to become more creative and resourceful in their rainwater collection and storage practices. Not only did community members begin investing, where financially able, in increasingly large rainwater storage tanks (to last them longer into the dry season), but they also began adopting other rainwater harvesting techniques including building wells in their homesteads for rainwater collection. To counter the risks posed by storing water under stagnant conditions for an extended period, one participant

even reported a new strategy of intermittently moving water between storage containers to “disrupt any breeding bugs”.

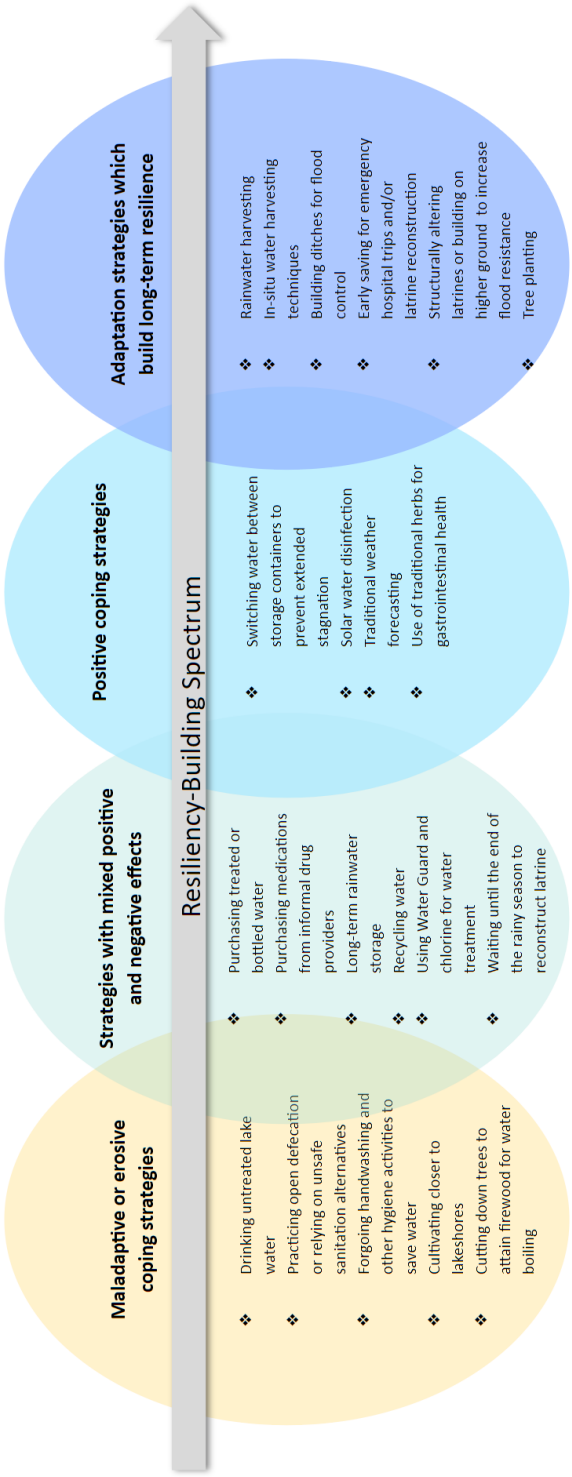
Many of the organizational stakeholders interviewed shared their observations on a breadth of in-situ water harvesting techniques being adopted by LVB communities. Notably, one stakeholder shared the results of a region-wide study on community climate adaptation strategies in which it was found that many communities are naturally adopting climate-smart agriculture techniques in the face of drought, including use of mulching and Zai holes to enhance rainwater absorption for irrigation. Use of traditional weather forecasting was also reported by both Mabinju community members and stakeholders as a new method for coping with unreliable rainfall and the challenges it presents to decision-making on when to plant. In relation to agriculture, though not the main focus of this study, another stakeholder spoke about farmers cultivating closer to the lake to access lake water for irrigation—a practice which has unfortunately led to further degradation of the buffer zone.

Another major drought response measure reported by both community members and organizational stakeholders was tree planting. In Mabinju, community members were able to identify an array of drought-resilient tree varieties, including ones which, when planted on their homesteads, they understood would “bring” more rain. Still, the cost of purchasing trees, scarcity of land, and fears of trees “competing” with crops for soil water and nutrients were all reported as barriers to tree planting. Organizational stakeholders describing how tree planting has largely become a government mandated climate adaptation strategy of which communities often fail to see the immediate benefit.

In times of extreme water scarcity, Mabinju community members reported rationing their meagre water supplies by either recycling water for multiple uses, using less of it for certain uses, or forgoing certain hygiene practices, including handwashing, in attempt to conserve water. Most people reported having to take these measures exclusively in the dry season, however, due to the increased pressures of meeting daily household water needs at this time. During the dry season, accessing enough water required taking several roundtrips to the lake—something unfeasible for mothers of young children, individuals with physical illness or disability, or those residing far from the lake, for example. Both Mabinju community members and organizational stakeholders discussed the rising trend of streams “drying up”, resulting in the need for communities otherwise reliant on these ephemeral water bodies to resort to new water sources during the dry season (e.g., bottled water, lake water, tap water).

Figure 2 below depicts where the various WASH coping strategies identified in this study fall on a spectrum ranging from maladaptation to positive adaptation and resiliency-building.

Figure 2: Spectrum of WASH Coping Strategies from Maladaptive to Resiliency-Building



4.5 Discussion

4.5.1 Community Knowledge and Adaptation Potential

This study uncovered a series of adaptation strategies developed and initiated by LVB communities largely independent of the inputs, educational and resource supports, and capacity building initiatives of external organizations. These findings confirm the previously documented evidence that communities hold the knowledge potential and ingenuity needed to independently problem solve in the face of climate-related hazards (17-19). With regards to WASH in particular, this study offered unique insights into the awareness of one community of how environmental change threatens the safety and accessibility of water resources, with implications for health, livelihood, and overall well-being. Indeed, the intimate knowledge of Mabinju community members on the specific links between waterborne diseases and practices such as drinking polluted water, depositing household waste into the lake, and defecating in the open demonstrates deep understanding of how environmental determinants influence health outcomes.

Other studies from have similarly demonstrated the keen awareness and understanding of communities on how their own health is intricately bound up with that of the environment and the ecosystem services it provides, with systems of Indigenous knowledge contributing greatly to such insights (17-19). This is important because such knowledge and awareness can be an important driver of both climate adaptation and collective efforts at environmental restoration, as needed to counter the degradation due to climate change. Moreover, the presence of this knowledge suggests that in many locations, civil society organizations (CSOs) can afford to redirect efforts and resources away from awareness raising campaigns and towards greater focus on building the capacity of communities to act upon existing knowledge—a capacity which may be constrained by limitations of resources or technical skills. This is not to suggest that WASH programs, for example, should eliminate their often large social and behavior change communication components, but rather that assessments of prior community knowledge and perspectives should be conducted before determining which, if any, knowledge gaps warrant targeted behavior change campaigns. In a setting such as Mabinju, for example, CSOs would be wiser to spend their resources on training families in the construction of latrines with low material costs rather than on extensive education on the health impacts of open defecation—something which families are well aware of but must ignore when latrine reconstruction is financially out of reach.

With regards to the design of climate adaptation and WASH programs, the creative potential of communities can and should be tapped to design interventions which are both helpfully innovative and compatible with the sociocultural context. Indeed, it would be a lost opportunity not to integrate innovate

community-generated strategies into broader adaptation programs in both WASH and other sectors. This has been highlighted by other scholars who have called on WASH practitioners to look for the "positive deviants" – individuals or communities who do something differently from the rest and accrue benefits — and to pilot the transfer and scale-up of such adaptations within and across communities (20). Many community-based adaptation models already adopt an approach of integrating local knowledge into intervention planning. In drought-afflicted communities of Maharashtra, for example, CSOs have helped to build on traditional methods of rainwater harvesting by supporting wider uptake of proven effective techniques like rooftop water channelling, contour bunding, and construction of terrace-margin ridges to impound monsoon waters on hillsides (21). At the same time, CSOs have provided technical supports to increase the effectiveness of community-developed techniques, such as excavating soil surface clay and silt layers which reduce water filtration along terrace margins (21). This embodies a paradigm which is not only participatory in the sense of having community members take a lead on implementing climate adaptation measures, but also represents a community-driven approach utilizing traditional techniques as a template for the design of initiatives which leverage their successes while addressing their limitations. Similar initiatives have been documented in flood-friendly aquaculture development in Bangladesh, sand dam construction in semi-arid regions of Kenya, and community-led livelihood diversification in Zimbabwe (21). As early warning and weather forecasting systems are an important component of climate adaptation, particularly in communities like Mabinju which are highly vulnerable to the impacts of climate change on rainfed agriculture, incorporation of traditional knowledge, shown to be highly advanced in this domain (22,23), could remarkably enhance the robustness of meteorological forecasting models.

Still, there are widespread shortcomings documented in efforts to incorporate traditional and community-based knowledge into the design of climate adaptation projects, even in cases where substantive community engagement is present at the stage of implementation. In several settings, for example, communities have been intimately "engaged" in ecosystem-based adaptation programs through provision of economic and livelihood incentives for environmental conservation and restoration activities, however in many instances the actual planning and inception of these activities is done by external technical experts (24-26). This pattern was reported by organizational stakeholders interviewed in this study as well, validating its relevance in the LVB context. Similarly, the top-down governance of natural resource management programs continues to be criticized by actors favouring a more community-driven approach (27).

With regards to WASH programming in particular, many projects are still informed by a relatively static set of best practice guidelines which, while "evidence-based," do not necessarily provide space for strategic integration of local knowledge, let alone community adaptation strategies spurred by the WASH impacts of climate change or other principles of complex adaptive systems (20,28). As shown by this study and others (29-31), not only can such strategies manifest deep innovation, creativity, and ingenuity, but they may also be more likely to gain widespread acceptance while making optimal use of limited resources. This is based on the fact that individuals would have already had the time to personally experiment with these techniques, many of which may have been driven by priorities of optimizing use of minimal resources, as required in contexts of poverty. Considering the flaws in existing approaches to estimating costs of adaptation, Chaudhury (2012) proposes a novel Participatory Social Return on Investment framework that values the bottom-up cost of climate change adaptation (32). This shift in cost-benefit analysis approaches is compatible with the needed shift in both WASH and climate adaptation program design towards greater integration of community ideas and approaches.

4.5.2 Poverty, Capacity Restraints, and Maladaptive Coping

Another important insight which emerged from this study concerns the issue of maladaptation, also sometimes called erosive coping. These two terms are often used to refer to strategies which have the unintended effect of increasing long-term exposure and sensitivity to climate change impacts, even if immediate, short-term relief is achieved (33). In the context of flooding, the term erosive coping has been used to describe actions undertaken by households to return to normal life after flood events that have long-term negative effects on the household economy and livelihood sustainability (34). It is worth noting the potentially detrimental long-term effects of adaptation measures documented in this study (see Figure 1) such as drinking untreated lake water to save firewood or cutting down trees to procure firewood, cultivating closer to the lakeshores, forgoing handwashing and other hygiene activities to save water, and practicing open defecation following latrine collapse. The long-term (and short-term) consequences of these practices on general well-being and adaptive capacity are multifaceted, and differ by adaptation strategy. Still, the maladaptive practices observed all appear to share the feature of being driven largely by poverty-related resource and capacity constraints. For example, the choice to drink untreated water is a response to the inability to collect sufficient firewood or purchase water treatment tablets. Likewise, water rationing by reducing frequency of hygiene practices is also a direct function of extreme water shortages. Meanwhile, open defecation, or depositing one's waste into a shallow hole in one's farm, becomes the only viable option when one's latrine has collapsed in the rain and there are no funds available to purchase the

wood, concrete, and iron sheets with which to construct a new one, or to hire someone to dig a 10-foot-deep pit.

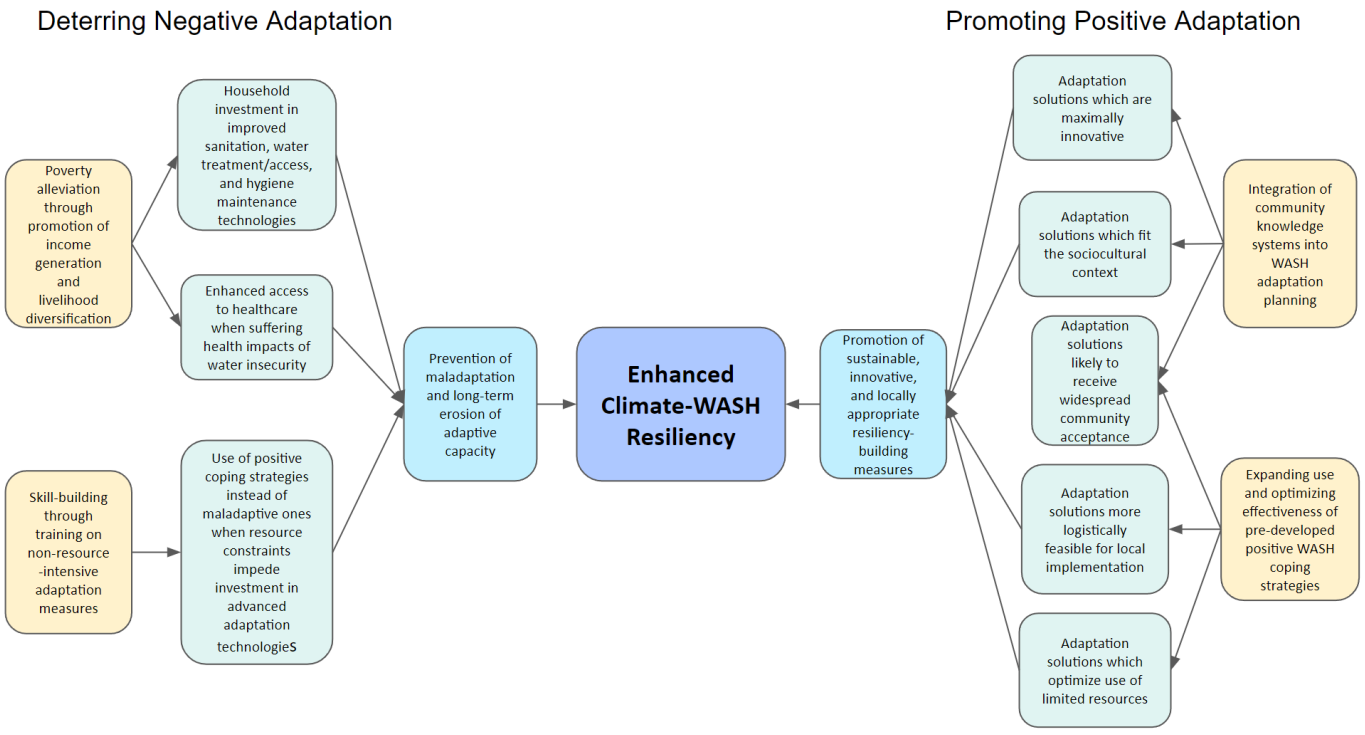
Maladaptive and erosive coping practices in response to climate hazards have been documented in other communities as well. The sale of livestock as a drought-coping measure, for example, has been widely reported across the Sahel and other semi-arid regions of Africa, even if it means permanently losing what may be a pastoralist's only productive asset and livelihood source (35,36). Similar erosive coping measures have been seen in the face of flooding, such as after the 2011 floods in Kenya where families not only sold property, livestock, and other assets, but also withdrew their children from school for labor, took up precarious jobs, or reduced expenditures on drugs and other health needs (34). Similar findings have been reported in other flood-vulnerable parts Western Kenya not far from the site of this study, and were not surprisingly linked to a lack of financial resources to adopt more positive, long-term resiliency-building measures (37). In another study conducted in Kenya, wide disparities were identified between adaptation measures that farmers wanted to implement (e.g., drip irrigation, agroforestry) and those which they actually could actually employ (e.g., new crop rotations and planting patterns) with the available financial resources (38).

The implications of maladaptation are far-reaching and warrant close attention. Since maladaptive and erosive coping strategies have the opposite effect of positive climate adaptation—that is, they reduce rather than increase long-term climate resiliency—they can become embedded in the same vicious cycles of poverty and vulnerability that drive the disproportionate impacts of climate change on low- and- middle-income countries. The destructive and self-perpetuating nature of these practices were described at length by organizational stakeholders interviewed for this study, who recognized that communities facing extreme poverty must often use short-term survival tactics which compromise long-term well-being. As CSOs have an important role to play in breaking many of the vicious cycles associated with poverty, this issue should not be treated any differently. In practice, this means designing adaptation efforts to address the socioeconomic drivers of maladaptation by integrating opportunities for income generation and livelihood diversification, as well as building the capacity of community members to adopt measures which don't require extensive resource inputs. Construction of dry toilets with locally available materials, for example, has been identified as a feasible sanitation solution in water-scarce urban settings across Haiti (39). Similarly, low-resource agro-sanitation systems have been used to promote better handling of agricultural waste across Asia and Africa (40). Other less technical but equally effective resiliency building measures can be promoted, such as water resource management and community health committees. In a recent

study conducted in Zimbabwe, community health clubs were found to improve latrine construction through savings, loans, and income-generating activities (41). The results of both this study and others therefore support the conclusion that addressing drivers of maladaptation through poverty reduction and community training in the implementation of low-cost WASH and other adaptation strategies, can go a long way towards breaking the cycle of climate vulnerability. Coupled with findings on potential contributions of community knowledge, this further underscores the need for systematic mapping of pre-existing adaptation measures, as they relate to WASH or other vulnerability domains, before attempting to devise best approaches for supporting communities to build maximal resiliency to climate change.

Figure 3 below is intended to illustrate the synergistic effects of the proposed approaches to designing WASH-related adaptation interventions (i.e. preventing maladaptation while simultaneously integrating community knowledge and innovation). This proposed strategy is targeted at CSOs and other implementing partners active in this space.

Figure 3: Proposed Strategy for Maximizing Impact of Climate Adaptative WASH Interventions



4.6 Conclusion

Given the impacts of climate change on rainfall patterns, we must brace ourselves for significant WASH-related behavior change in both flood- and drought-prone settings worldwide. Knowing that this behavior

change will occur through evolving processes of climate adaptation at the community level, CSOs in both WASH and environmental sectors need to modify their interventions to new WASH behavior patterns. This will require a better understanding of how communities are adapting to the WASH impacts of climate change, as a key input to inform the design of suitable interventions which optimize climate resiliency. This study has presented original findings from qualitative research conducted in the LVB, and demonstrated that poverty limits adaptation options at the same time as it drives innovation in responding to the WASH impacts of flooding and drought. This finding illustrates the potential inherent in communities' ability to adapt, while revealing how the poverty-related factors underlying climate vulnerability can themselves drive practices which exacerbate that vulnerability through a negative reinforcing feedback loop. Taken together, this highlights the importance of systematically mapping WASH-related climate adaptation patterns in a community targeted for intervention, and building on this knowledge to design interventions which leverage positive behaviors while facilitating practical alternatives to what may otherwise be negative coping measures. Adopting this paradigm can enable CSOs and other actors to become more supportive partners to communities in their fight against climate-driven WASH and other threats.

4.7 Ch. 4 References

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Ch. 5: Engaging the Health Sector in Climate-Resilient WASH Development

****Note that this chapter has been prepared as a focused analysis of this sub-theme and is formatted according to guidelines for the Journal of Water & Health, which it is targeted for later submission to, under the "Short Communications" submission category*

5.1 Abstract

The impact of climate change on water, sanitation, and hygiene (WASH) has driven an increased focus on climate-resilient WASH development. Evidence suggests that adaptation in the WASH sector is underway, but that progress is limited in certain domains and that participation of the public health community may be lacking. Using the Lake Victoria Basin (LVB) as a climate vulnerability setting on which to base this analysis, this study aimed to identify factors which impede full engagement of the health sector in climate-resilient WASH development. In-depth semi-structured interviews were conducted with 13 WASH sector organizational stakeholders across lakeside urban centers in Kenya, Uganda, and Tanzania. Several barriers to health sector engagement were identified, including factors related to donor-driven financing and priority setting, a relative neglect of climate vulnerabilities associated with sanitation and hygiene, ministerial siloes, and broader systems of adaptation governance which militate against health sector leadership in climate adaptation. These results suggest room for expansion of interdisciplinary collaborations and deepened involvement of the health sector in WASH-related climate adaptation, which starts with addressing these and other barriers to full health sector engagement.

5.2 Introduction

The impacts of climate change on WASH have become an increasing cause for concern, particularly as they threaten to undermine decades of WASH progress in countless climate-vulnerable settings worldwide. Not only do extreme weather events cause damage to essential water and sanitation infrastructure, but flooding and drought compromise water quality and access, driving water insecurity and undermining the capacity of individuals to uphold safe hygiene and sanitation practices (1). It is in this context that the notion of climate-resilient WASH planning, also understood as climate adaptation in the WASH sector, has gained salience.

In 2017, UNICEF, in collaboration with the Global Water Partnership, released an updated version of their "Strategic Framework for WASH Climate Resilient Development", together with a series of technical briefs and learning modules to support implementation actors in conducting strategic risk assessments,

appraising and prioritizing options, and delivering locally-tailored climate-resilient WASH solutions (2). In 2019, the UN-Water Expert Group on Water and Climate Change followed this initiative with an added call for the "integration of climate-resilient water resource management in health, sanitation, and development planning" (3). More recently, at the COP26 summit held in Glasgow in November 2021, the notion of climate-resilient WASH planning attracted further attention, with a series of related talks led by the Stockholm International Water Institute as part of a dedicated Water Pavilion (4).

However, despite the increased attention being drawn to this area, much of the dialogue has reflected a disproportionate focus on the water sector, including broader issues of water resource use and integrated watershed management, amongst others (5-7). Consequently, stakeholders from the agriculture, energy, infrastructure, and environment sectors have taken a leading role in the planning and piloting of solutions to climate-driven impacts on the WASH sector, with the health sector less engaged. This has occurred despite the myriad health-specific implications of water insecurity and reduced sanitation access under projected climate scenarios (8). To better understand the barriers to engaging the health sector in climate-resilient WASH development, WASH sector stakeholders across the LVB were consulted on their experiences and observations while working in this intersectoral space.

5.3 Methods

A total of 13 in-depth semi-structured individual interviews were conducted with both civil society and government representatives involved in climate adaptation and WASH planning in the LVB, with all representatives based in lakeside urban centers across Kenya, Uganda, and Tanzania. Additional details on interviewed subjects are provided in Table 6 below. Interviews were conducted both in-person and virtually, by the author, and were recorded and manually transcribed afterwards. The transcripts were then inductively coded and thematically analyzed to derive overarching conclusions on major barriers to health sector engagement in climate-resilient WASH development in the region. Ethics approval for this project was obtained from both the University of Alberta Research Ethics Board (REB-1) and the Maseno University Ethics Review Committee.

Table 8: Characteristics of Organizational Stakeholders Interviewed

Stakeholders	
Organization (Country)	No. of Participants (with Sex)
AMPATH (Kenya)	1 (F)
FreeKenya Foundation (Kenya)	1 (F)
Safe Water and Aids Project (Kenya)	2 (1M, 1F)
Siaya County CDC Office (Kenya)	1 (M)

Kombewa County Referral Hospital Infection Prevention and Control Dep. (Kenya)	1 (F)
Water Mission (Uganda)	1 (F)
Uganda Ministry of Water and Environment (Uganda)	1 (F)
Uganda Water and Sanitation Network (Uganda)	1 (F)
Tanzania Institute of Rural Development Planning (Tanzania)	1 (F)
Tanzania Water and Sanitation Network (Tanzania)	1 (M)
Lake Victoria Basin Commission Climate Adaptation Department (regional across 5 LVB countries)	2 (M)

5.4 Results

Several interconnected barriers to health sector involvement in climate adaptation in the WASH sector were identified in this study.

The first was the role of donors in driving the strategic direction of adaptation financing. When asked about common donor-supported climate adaptation projects in the WASH sector, study participants overwhelmingly reported upon water projects involving nature-based solutions (e.g., agroforestry, tree planting, wetland restoration, river catchment regeneration, etc) or water infrastructure development. Few exclusively sanitation- or hygiene-related projects were reported as donor-funded "climate adaptation" projects.

Other comments from interview participants shed light on why a donor preference for water-oriented and ecosystem-based adaptation projects may preclude full involvement of health actors in WASH and adaptation planning and implementation. Several interviewees explicitly noted that only sanitation and hygiene, among the three WASH pillars, are considered to fall under the exclusive auspices of the health sector at both national and district planning levels. As such, "WASH" projects which focus primarily on the "water" component of WASH tend to give stakeholders in the fields of environment, energy, and agriculture, amongst others, a more central role, even if involvement of community health workers or other health-related staff is solicited for social and behavior change communication around domestic water use. Even for projects exclusively focused on clean water supply, it was only when the supply was targeted for healthcare facilities that health stakeholders, as opposed to utility companies, engineers, and hydrogeologists, would play a central role in project planning and oversight.

The issue of responsibility, including budgeting and strategy planning, across WASH development domains came up frequently in discussions on ministerial division of labor within government. Many interview participants spoke about the relative isolation of different departments all loosely involved in WASH, including Ministries of Education, Health, Agriculture, Environment, Infrastructure, Social Development,

etc. This isolation was reported to take the form of both separate strategy development and planning and separate (sector-specific) budgeting. While interview participants spoke of joint forums where representatives from various ministries would meet to discuss their shared investments in WASH, these forums were reported to be few and far between, with the majority of WASH planning happening in isolated department spaces.

As stated by one interviewee, not only does a lack of cross-sectoral dialogue limit collaborative WASH planning, but it also means that each sector tends to focus on the specific area of WASH related to their mandate, whether it be WASH in schools (Ministry of Education), WASH in healthcare facilities (Ministry of Health), gender-inclusive WASH (Ministry of Social Development), etc. This makes integrated planning more complicated when joint forums are held, as each department has become habituated to a culture of more vertical programming. In the case of early warning systems for extreme weather events, for example, one interview participant highlighted the selack of integration between meteorological forecasting systems and epidemiological data tracking for waterborne disease surveillance—another reflection of the sector-driven approach to WASH planning emerging from the findings of this study.

5.5 Discussion

This study presents novel findings on some of the interrelated barriers contributing to the relative marginalization of the health sector from policy and practice in building climate-resiliency in the WASH sector, specifically in the LVB region. The small number of participants and limited geographic scope limit conclusions that can be drawn. Nevertheless, they do offer useful insights on what is needed to move towards more interdisciplinary collaboration addressing the intersection between climate change and WASH.

The findings of this study that donors tend to set the strategic direction of adaptation financing is not new, and is consistent with the structure of the international adaptation finance system. Adaptation finance is generally the business of multilateral entities such as the UN Development Programme and the World Bank (9). Major funds such as the Least Developed Country Fund, the Special Climate Change Fund, and the Adaptation Fund, are administered by bodies which operate largely independently of recipient country governments, and have been accused of failing to provide in-country stakeholders sufficient control over funding priorities (9). As such, international actors have a large influence over the climate adaptation agenda and may direct investments towards preferred target areas. Given the rise in prominence of ecosystem-based adaptation on the global adaptation finance agenda, it is not surprising that many adaptation-related WASH sector initiatives would fall under this category (10). Such findings have also been

reported in other settings, such as Bangladesh, where the main water-related adaptation tasks were found to include management of watercourses, protection of riverbanks, and amelioration of waterlogging (11). Tree-planting schemes have also proliferated as climate adaptation initiatives worldwide, owing to their mitigation co-benefits and the carbon credit investment opportunities they have come to represent (12).

The finding that sanitation is given less attention in climate adaptation investment planning is also consistent with other research. Several authors have noted that sanitation actors have been slow to integrate climate concerns into thinking and programming, and that climate-related WASH discussions remain predominantly water-focused (5,6). Similarly, the limited progress that has been noted in the sanitation sector has been largely technological—as opposed to institutional or legislative (6). Taken together, it is conceivable that the role of the health sector would be marginal in this space, considering that the one pillar they play a lead role in championing is underfunded, and when funding is allocated for it, it is disproportionately targeted at sanitation infrastructure and engineering. The reasons for this general underinvestment in sanitation deserve further exploration but may be driven by a perception that sanitation systems are generally less directly vulnerable to the impacts of climate change than global water systems—something which, despite supportive evidence, does not negate well-documented sanitation risks associated with extreme weather events (13). Considering the role that vulnerability assessments play in adaptation planning and financing, however, more compelling and tangible evidence on climate-water linkages may be sufficient to result in this disproportionate investment scenario (14). More direct climate-water linkages may also be more conducive to meeting quantitative targets for water, as opposed to sanitation-oriented adaptation projects, making them more attractive to investors.

The culture of vertical siloing between ministries observed in this study raises concerns about multisectoral planning for the many domains of climate adaptation (e.g., WASH, food security, livelihood promotion) which transcend traditional sectoral boundaries. The published literature suggests, however, that not only do more forums for inter-ministry planning and dialogue on climate adaptation need to be created, but that more ministries need to be engaged from the outset, including, most notably, the health ministry. In a review of climate change adaptation planning in Bangladesh, departments related to public health were found to have negligible involvement in the management and use of the adaptation fund under the Annual Development Program (11). Interestingly, the Water Development Board leads this fund, but was reported to engage primarily with the Local Engineering Department, as well as weith several agencies related to food, agriculture, forestry, rural development, and disaster risk management (11). This is another indication of the limited direct participation of health stakeholders in the water sector, despite their critical role in

WASH promotion. In several countries, including Malawi, Tanzania, and Uganda, climate change working groups and steering committees are typically governed under the Ministry of Environment, Natural Resource Management, or Economic Planning and Development, amongst others, but seldom assigned supervision by the Ministry of Health (15). This likely also contributes towards the general marginalization of the health sector from climate-resilient WASH planning, since their role in climate adaptation is limited. The findings of both this study and others (16), therefore, support existing calls on the need for more integration of climate adaptation and public health.

5.6 Conclusion

As climate change threatens WASH systems globally, there is increasing need to mainstream climate adaptation into WASH sector development. While progress in this domain has undoubtedly occurred, there appear to be shortcomings in the scope and multi-sectoral collaborations which drive it. This study has presented new evidence derived from consultation with WASH-sector stakeholders in the LVB on how the involvement of the health sector, specifically, has been limited in climate-resilient WASH development, and on how factors such as donor-driven financing and priority setting, a relative neglect of sanitation and hygiene, ministerial siloes, and broader systems of adaptation governance, contribute towards this state of affairs. When combined with findings from the literature, these results suggest that climate adaptation is still legislated and operationalized in a sector-specific manner, and that there is a need for greater inter-sectoral collaboration, so that health and other sectors may play a larger role. In the context of climate-resilient WASH, a failure to adapt WASH services to climate-related hazards could have important adverse consequences with regard to human health The health sector therefore has an important role to play. Facilitating more involvement on the part of the health sector starts with addressing the barriers to its full inclusion.

5.7 Ch. 5 References

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Ch. 6: Considering Sanitation in Climate-Resilient WASH Development

****Note that this chapter has been prepared as a focused analysis of this sub-theme and is formatted according to guidelines for the Journal of Climate and Development, which it is targeted for later submission to, under the "Viewpoints" submission category*

6.1 Abstract

As climate change threatens to undermine water, sanitation, and hygiene (WASH) progress globally through extreme weather events, rising water insecurity, and disruptions to hydrological systems, the need to mainstream climate adaptation into the WASH sector is becoming ever-more apparent. Still, progress on building climate resiliency in the WASH sector has been limited, particularly in the area of sanitation planning. Possible reasons for this are multifold but reflect underlying patterns of sectoral silos, health sector marginalization from climate adaptation planning, donor-driven climate financing systems, and under-recognition of climate-sanitation linkages, amongst others. Addressing these barriers is important to facilitate the restructuring of sanitation systems to be made more resilient against climate change, which will become increasingly necessary as climate hazards intensify. First and foremost, this requires more focus on the pillar of sanitation within broader climate-resilient WASH development planning. Beyond that, there is a need for a broader paradigm change within WASH programming, to direct attention beyond the technological components of sanitation systems and towards the institutional environments in which they are situated. Through a more holistic approach, engaging actors across diverse disciplines, various levers of change can be targeted and sanitation systems can be restructured to be made more robust under future climate scenarios, preventing avoidable environmental, health, economic, and social consequences in countless climate-vulnerable settings.

6.2 Introduction

The impacts of climate change on WASH have become an increasing cause for concern, particularly as they threaten to undermine decades of WASH progress in countless climate-vulnerable settings worldwide. Considering these impacts, the notion of climate-resilient WASH planning, also understood as climate adaptation in the WASH sector, has gained salience. In 2017, UNICEF, in collaboration with the Global Water Partnership, released an updated version of their "Strategic Framework for WASH Climate Resilient Development", along with a series of technical briefs and learning modules to support implementation actors in conducting strategic risk assessments, appraising and prioritizing options, and delivering locally-tailored climate-resilient WASH solutions (1). In 2019, the UN-Water Expert Group on Water and Climate Change followed this initiative with a call for the "integration of climate-resilient water resource

management in health, sanitation, and development planning" (2). Most recently, at the COP26 summit held in Glasgow in November 2021, climate-resilient WASH planning attracted further attention, with a series of related talks led by the Stockholm International Water Institute as part of a dedicated Water Pavilion (3).

However, despite the increased attention being drawn to this issue, recent talks have reflected a greater focus on the broader topics of water resource use, integrated watershed management, and domestic water supply, which naturally engage actors across diverse sectors. Conversely, with sanitation promotion relegated largely to the health sector, and responsibility for on-site toilet construction and maintenance typically devolved to the household level, sanitation has remained a relatively neglected subcomponent in the ongoing dialogue on climate-resilient WASH development. This is consistent with the relative dearth of published evidence on sanitation in relation to water supply (4). In a research project which we (the authors) conducted under the auspices of the University of Alberta School of Public Health, poor integration of sanitation with climate adaptation efforts was further brought to light, specifically in the Lake Victoria Basin (LVB) context.

Drawing upon both previously published research and primary data from this research project, this article is intended to present the array of sanitation-specific risks associated with climate change, while identifying current shortcomings of the WASH sector in incorporating considerations of future climate hazards into the design of global and local sanitation solutions. Factors that may be contributing to this phenomenon are discussed, and concrete actions are recommended for ensuring that sanitation planning better responds to the evolving threats posed by the climate crisis.

6.3 Impacts of Climate Change on Sanitation

A mounting body of evidence has shed light on the potential impacts that climate change can have on sanitation (5-11). The impacts of climate change may be less than that those posed to the water sector. Nevertheless, available evidence suggests that attention to climate change is also warranted in the design of sanitation initiatives in climate-vulnerable settings.

Indeed, collapsing, submerging, and overflowing pit latrines—which serve as the predominant form of rural sanitation in many areas in low- and middle-income countries—have become increasingly commonplace in flood-vulnerable settings, leading to contamination of local water supplies and increased rates of open defecation (5-7). In the LVB in particular, our research has shown that loose soil structures due to a high sand content have rendered pit latrines highly vulnerable to collapse during heavy rainfall. The result is that

household pit latrines regularly overflow, submerge, or collapse during the rainy season—a problem which has become more frequent in recent years. In the qualitative interviews our team conducted with community members residing in the lakeside village of Mabinju, more than half of subjects admitted to practicing open defecation when their latrine collapses or submerges in the rainy season.

Besides collapsing pit latrines, other sanitation consequences of climate-driven rainfall extremes have been documented. Sewerage and wastewater treatment plants, for example, are designed to manage a certain flow of wastewater, with a limited additional reserve capacity to deal with extreme events (8). Thus, excessively heavy rainfall can cause back-flooding of raw sewage into homes, while damaging sewer infrastructure, resulting in leakage of sewage into the environment (8). Environmental contamination has also been reported as a result of the flooding of septic tanks and their corresponding drain fields (8). As wastewater treatment plants are also often located in low-lying or coastal areas, they are subject to inundation/flooding, storm surge, erosion, and saltwater intrusion due to sea level rise (9).

Meanwhile, in dry and drought-prone environments, water scarcity may affect sewers, as water flows may be reduced, leading to greater deposition of solids and consequent blocking (8). In drying environments, the volumes of water required to keep both septic tanks and flush toilets functioning may also be difficult to sustain (8). Water shortages can also lead to higher pollution concentrations in wastewater and reduce the capacity of receiving waterbodies to dilute discharged wastewater (10). Given the rising number of observably interlinking pathways through which climate change impacts sanitation, Kohlitz and Iyer (2021) of the Sanitation Learning Hub published the first conceptual framework for understanding these impact pathways, and how they are mediated by social and behavioral factors (11). As discussed below, these factors warrant deeper consideration when building climate resiliency in the sanitation sector.

6.4 Neglect of Sanitation in Climate-Resilient WASH Development

A number of researchers concerned with WASH and climate adaptation have commented on the relative neglect of sanitation both in general WASH programming and in climate-resilient WASH initiatives, specifically. Dicken et al. (2020) has observed that there are a range of mitigation and adaptation strategies available for sanitation and wastewater systems but that opportunities for climate action within sanitation service provision have been largely overlooked (12). In their review of nationally determined contributions (NDCs), they found few concrete actions proposed related to sanitation, despite widespread acknowledgement of water as one of the top five climate-vulnerable sectors across NDCs (12). Additionally, in a recent summary published by WaterAid on lessons learned from case studies across four countries on integrating sanitation and climate change adaptation, it was noted that “WaterAid’s integration of climate

change and sanitation has largely been concentrated at the project level, with its broader consideration at the strategic planning and decision-making levels not as evident" (Gordon & Hueso, 2021) (13). This is consistent with an analysis of approved project proposals by the Green Climate Fund (GCF) which found that out of 99 projects approved, only 7 had a specific sanitation or wastewater element (12).

Other investigators have noted the paucity of published literature on climate impacts on sanitation, despite the potentially significant consequences, and have called for the inclusion of more climate-relevant stakeholders in sanitation working groups (14). Another consistent theme noted by scholars is the predominant focus on technological improvements in climate risk planning for sanitation, as opposed to a broader consideration of the social systems, institutional landscape, and behavioural norms associated with sanitation service use and management (11,14). This has generated criticisms of sanitation actors placing a disproportionate emphasis on "hardware" adaptation measures in the few cases where climate change is given consideration, while neglecting the "software" of services, behaviour change, public awareness, and governance, amongst other factors (11,14).

These views of commentators are supported by findings from interviews we conducted with WASH sector stakeholders in the LVB region. Of the few projects that stakeholders discussed which had a climate resiliency component, most were focused exclusively on reducing climate impacts on water systems. These included projects such as decentralized water pumping systems, solar-powered water treatment technologies, tree planting for flood control and groundwater resource retention, and relocation of drinking water pumps to sites with more reliable aquifers, amongst others. Other than two interview participants who mentioned involvement in the promotion of composting toilets as an alternative to the more flood-vulnerable pit latrines, none of the stakeholders interviewed who discussed sanitation projects commented on the strategic incorporation of climate risk projections. When asked about flood response protocols, one stakeholder from the Tanzania Institute of Rural Development Planning stated that: *"The only concern will be 'where will these people live?' But other effects like where the wastewater produced in this household has gone, nobody cares about."* This is consistent with sentiments expressed by other stakeholders interviewed, as well as with views expressed by other scholars in the field.

6.5 Barriers to Mainstreaming Climate Change in Sanitation Planning

The factors underlying the general neglect of sanitation in climate-resilient WASH development appear to be multifold and undoubtedly warrant more comprehensive investigation to inform efforts to promote mainstreaming of climate change into sanitation planning. Nevertheless, based on prior published work and findings of our inquiry LVB WASH sector stakeholders several conclusions can be drawn. One of the

most prominent themes emerging from our stakeholder interviews was that sanitation falls almost exclusively under the auspices of the health sector, but climate change planning, including relevant task forces and committees, are led by environment and natural resource management departments, with the health sector playing only a marginal role, if represented at all. This presents challenges to the development of climate-resilient sanitation solutions because the budgetary resources and political incentives for sanitation promotion lie with actors under-represented in discussions on climate adaptation. As stated by one of the stakeholders interviewed who is involved in a climate change adaptation project led by the LVB Commission: *"Within the adapting to climate change program, we don't have much of a component with sanitation. The water supply is there, but with sanitation and hygiene, there's not very much, because we're not directly collaborating with the health workers."*

Other interview participants commented on how sanitation is considered a "household-level" issue, for in most rural areas in the LVB region, there is limited centralized utility management so responsibility for sanitation lies almost exclusively with individual families. Without government-led efforts to institutionalize and financially support the use of climate-resilient sanitation alternatives, poverty-affected communities are often unable to adopt technological solutions needed to, for example, increase the flood durability or reduce the contamination risk of household pit latrines in response to heavy rainfall. One interviewed stakeholder observed that there is insufficient integration of meteorological data with waterborne disease monitoring, and therefore a paucity of direct evidence on the linkages between extreme weather, waterborne disease outbreaks, and fecal contamination of water supplies, which would limit the capacity of stakeholders to make a compelling investment case for upgrading sanitation technologies to accommodate weather extremes. Considering the role that vulnerability assessments play in adaptation planning, a shortage of relevant evidence on the linkages between sanitation, weather, and public health can greatly affect the risk perceptions which inform decision-making on allocation of limited adaptation finances (15). More direct linkages between climate change and other sectors (e.g., water, energy, agriculture) may also make related projects easier to frame as "adaptation" than sanitation projects, rendering them more eligible for adaptation-marked funding.

The shortage of published evidence on the impacts of climate change on sanitation has been noted by other scholars, and may account for the limited number of sanitation projects approved under the GCF, whose board places heavy weight on the robustness of evidence for potential impact (12). Still, it is unclear if the scarcity of research evidence on the topic is a cause or a result of the general neglect of sanitation in climate-resilient WASH development, and it is likely that the two are mutually reinforcing. The same can be

said for financing of sanitation, which received only 3% of total climate-related Official Development Assistance in 2017; inadequate finance would naturally limit the development of initiatives in this area and under-acknowledgement of the importance of sanitation would limit the budgetary resources allocated to it (16). The constraining effect of climate finance has also been discussed in relation to the disproportionate focus on the technical aspects of adaptation in the sanitation sector. Dicken et al. (2020) has noted that the focus on specific "hard" adaptation measures to upgrade existing sanitation technologies has been reinforced by eligibility for climate finance, which has often been limited to these additional infrastructure elements (12). This trend may be attributed to the greater measurability of such "hard" components, in comparison with the complexity of measuring outputs of "soft" adaptation measures, such as improved planning, institutional and regulatory arrangements, capacity building, monitoring, public awareness, or behavioural responses (12).

The Sanitation Learning Hub has also publicized the results of a systematic assessment they conducted on barriers to climate action in the rural sanitation sector, drawing on literature and key informant interviews with sanitation practitioners (11). Barriers are categorized in relation to: "perception of the climate change problem", "how impacts are understood", and "appropriate engagement and responses". In summary, key barriers identified included:

- perceptions of climate change as a slow-developing problem and therefore overlooked by WASH actors,
- the complexity of climate data and risk assessments which discourages engagement of WASH practitioners,
- the intersectoral coordination required for climate adaptation in the WASH sector which complicates governance procedures,
- lack of evidence on linkages between climate change and sanitation,
- delegation of climate planning to specific government ministries,
- exclusion of WASH actors from intersectoral working groups, and
- limited tools and actionable recommendations for responding to climate change within sanitation programming (11).

These findings are compatible with the views of other scholars and the LVB WASH stakeholders we interviewed.

Finally, it has been noted that the division between adaptation and development has limited mainstreaming of climate considerations into sanitation planning (12). Indeed, the IPCC Fifth Assessment Report suggests

that the most effective actions to reduce vulnerability in the short-term relate to the implementation of "basic public health measures such as provision of clean water and sanitation" (17). However, investments in essential services are not commonly viewed as adaptation but rather tagged as general development, reducing eligibility of such projects to receive climate adaptation funds. This points to the need for broader recognition of how general development itself can boost climate resiliency through multiple pathways and justifies greater incorporation of development strategies into programming targeted at building adaptive capacity against the impacts of climate change.

6.6 Moving Forward: Developing Sanitation Solutions Which Consider Climate Change

The relative neglect of sanitation in efforts to plan for and mitigate the impacts of climate change on the WASH sector is cause for concern. Considering that external assessments have found that most sanitation technologies in use have low to medium resilience against climate change, there is a clear need to adapt sanitation systems to ensure their functionality during and after climate change-related extreme weather events (18). Without such adaptations, there may be important consequences including avoidable public health risks, environmental contamination, and loss of social-ecological resilience in communities already disproportionately affected by climate change.

To date, for climate risk planning, most sanitation actors have focused on engineering aspects. There is a growing body of relevant evidence available for improving resilience of sanitation systems in response to climatic extremes. Pit latrines, for example, are amenable to adaptation despite their structural vulnerability to flood and storm damage (8). Examples of successful measures found to improve latrine resiliency against flood hazards (that is, reduce likelihood of collapse, overflow, or fecal contamination) include building drains to divert flow away from latrines, siting latrines at higher elevation and away from areas of known flood risk, improving structural integrity through use of concrete pit liners and other design modifications, using raised/elevated latrines, and constructing smaller pits that require more frequent emptying (8,19). Innovative toilet designs such as low-cost, temporary sanitation facilities that can be easily moved and re-built following disasters, composting toilets, and urine diversion dehydration toilets have also been tested in diverse flood-prone settings, and shown indication of effectiveness (19,20). For many of these designs, it has been noted that economic co-benefits can also result from the avoided emptying costs and the added value of using human excreta as fertilizer (11,20).

Septic tanks and sewerage systems can also be made more flood-proof. In the case of septic tanks, several design features have been shown to reduce risk of discharge during floods, such as installing sealed covers, fitting non-return valves to pipes to prevent back flows, and ensuring that any vents on the sewer are above

the expected flood line (19,21). Sewerage systems can be engineered to separate stormwater flow or provide additional storage for stormwater during extreme weather events (19,21). In dry environments and drought-prone settings, dry and low-flush toilets can provide a feasible alternative to more water-intensive alternatives (19). Pit liners can also increase pit stability where dryness causes loss of soil strength (19). More resource-efficient wastewater treatment processes which require less dilution, rely on constructed wetlands, and allow for wastewater reuse, have also been identified, providing some more viable options for drought-prone areas (22,23). Given the impacts of sanitation on water quality, some have suggested that national water safety plans include requirements for such climate risk mitigation measures to be embedded in sanitation design (19).

It has become increasingly necessary, however, for climate adaptation efforts in the sanitation sector to extend beyond such "hard" engineering adaptation measures. Carrard & Willetts (2017) state that the current focus on sanitation technologies and on technological adaptations reflects the WASH sector's general tendency to view technology as a solution to all environmental problems. This must be challenged with a perspective which sees sanitation in relation to climate change and the broader social-ecological systems in which it is embedded. This starts with undertaking proactive risk assessments and appraising and prioritizing more cross-cutting measures for building climate resiliency in sanitation systems, on which UNICEF's WASH Climate Resilient Development Strategic Framework is intended to offer strategic guidance (1). "Soft" approaches to climate adaptation in the sanitation sector can involve changing the systems of management and governance of sanitation. Decentralization of wastewater treatment and fecal sludge management services to the municipal or local level has been proposed as a measure to spread risks across the service chain, while opening up the potential for more on-site and localised approaches to separating, treating, and reusing excreta and wastewater (25). This, in turn, can generate economic benefits by enabling recovery, re-use, and sale of valuable by-products, since energy and nutrients can more easily be recovered from separated streams (25). This can build climate resilience by providing financial support to the service chain, reducing collection fees at the household level, and increasing demand for upgrades to sanitation infrastructure to make it more durable against storm and other hazards (25). In general, decentralization also enables more flexibility in testing new approaches and exchanging ideas on piloted innovations, facilitating continued adaptation of sanitation systems to evolving climate risks.

An early study conducted by the World Health Organization found that the resilience of sanitation is not as dependent on utility management structures as the resilience of drinking water supply, since most sanitation facilities are constructed, operated, and maintained at the household level, with the exception

of urban areas where there is heavier reliance on more centralized arrangements (8). This suggests the need for more household-level interventions to facilitate adaptation to climate-driven sanitation challenges, particularly in rural areas. Social and behaviour change communication, for example, can be used to "build climate change literacy" at the local level by both raising awareness of sanitation planners about the impacts of climate change, and by boosting the knowledge of local communities on low-cost modifications that can be made to latrines, offering better protection under extreme weather scenarios (14). UNICEF's WASH Climate Resilient Development Strategic Framework, for example, calls for "risk-based guidance" on sanitation selection, not only for programme designers, but also for households which can be made aware of the health and environmental risks of traditional sanitation practices and latrine design features that may be less suitable under extreme weather scenarios. As stated by Fleming et al. (2019), "this will require going beyond the current Community-Led Total Sanitation policy, including contextualized health messaging, behaviour change interventions, and financial assistance to overcome supply chain barriers in rural areas" (26). A range of financing options for household-level sanitation support have been explored, including cash transfers to help with re-investment and rebuilding, microfinancing for sanitation loan distribution, and community savings schemes for latrine reconstruction (19). In emergency contexts, which are rising in relevance with the increased frequency of natural disasters, the use of cash transfers to support WASH is growing, particularly because they allow for a degree of household choice and are relatively easy to administer and monitor (27). Where there is fear that cash may be used for more immediate needs such as food, water, and healthcare, targeted voucher schemes have been used, such as toilet vouchers that can be exchanged for sanitation goods or services (27). Oxfam-supplied vouchers in Haiti, Jordan, and Lebanon have also been successfully used to pay for emptying latrines, among other critical WASH services (28).

Finally, more intersectoral coordination can enable the necessary exchange of expertise and the collaborative governance needed to facilitate adaptation in the sanitation sector. This can involve the creation of interdisciplinary working groups for sanitation planning at local and national levels, with representation of health, education, livelihood, agriculture, energy, emergency response, and meteorological experts, amongst others. Kohlitz and Iyer (2021) have highlighted the range of sanitation-livelihood links that can be addressed through partnerships between sanitation stakeholders and agriculture or other livelihood specialists (11). Incorporating livelihood promotion into sanitation planning

would target root causes of household vulnerability, building broader social-ecological resilience against climate threats.

6.7 Conclusion

Overall, available evidence suggests that progress is lagging in adapting sanitation systems to promote resilience in the face of current and projected climate hazards. This contrasts with the attention given to water systems in climate-resilient WASH development planning. There is a need for greater acknowledgement of the threats that climate change poses to the sanitation sector. Further, concrete action is needed to more robust measures to reduce risk of climate-related weather hazards to sanitation systems, in the absence of which we can expect widespread adverse environmental, social, economic, and health consequences for local populations already disproportionately affected by such weather extremes. Multiple approaches should be taken to enhance climate resiliency in the sanitation sector, and should look beyond the conventionally prioritized engineering aspects of sanitation design, wastewater management, and sewerage systems. By redirecting focus towards the sociocultural, policy, and institutional determinants of sanitation system resiliency, we can target additional levers of change while facilitating needed interlinkages between climate adaptation and broader development efforts. This will help in preparations for future climate hazards in the sanitation sector while simultaneously advancing the objectives of universal access to safe sanitation that have been championed for decades.

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Ch. 7: Implications of Findings and Recommendations

7.1 Global and Regional Implications of Findings

The results of this thesis project offer new insights on how climate change is impacting the LVB, most notably in terms of challenges faced in the WASH sector under current and intensifying climate vulnerabilities. Yet the findings of this study go beyond the identification and illustration of these challenges. Importantly, they offer novel insights on how lakeside communities are adapting WASH behaviors and practices in response to climate change, the relative merits and risks of common community-driven adaptation patterns, and the broader institutional and policy barriers to incorporating climate change adaptation into the WASH sector activities at local, national, and regional planning levels across the LVB.

Globally, these findings hold significance in that they elucidate important themes relating to both WASH and climate adaptation governance that may be applicable across diverse institutional and geographic settings. Additionally, by providing a glimpse into the current barriers to mainstreaming climate adaptation into the LVB's WASH sector, this study sheds light not only on local governance siloes, but also on broader global divisions between the various sectors that share an interest in climate change. Most importantly, stakeholders worldwide can glean important insights from the findings of this study on how to advance climate-resilient WASH sector development more broadly, in terms of engaging and supporting communities in local adaptation while institutionalizing best practices across networks of implementing actors (e.g. CSOs, private sector players, civil servants, etc).

These findings have several implications for regional planning across the LVB, as they highlight the overall need for further initiative in mainstreaming climate change adaptation into the region's WASH sector at large. Notably, the findings shed needed light on the reality that climate change acts (and will continue to act) as a multiplier of ongoing threats to ecosystem services[1] in the LVB, compromising the ability of residents to achieve sustained health and well-being, alongside food, water, and socioeconomic security. As the results of this research show, damage to WASH infrastructures, disruptions to the enabling environment for achieving WASH goals, and rising health risks posed by water scarcity, water pollution, and

[1] Ecosystem services referred to here include, but are not limited to, health-promotive ecosystem functions like crop production (disrupted by drought-driven threats to rainfed agriculture), stream flow regulation (disrupted by drought-driven loss of ephemeral streams), and lake level regulation (disrupted by increased sediment deposition triggered, in part, by the impacts of flooding on surface runoff)

water-related diseases will be among the major manifestations of accelerated environmental devastation in the LVB under projected climate scenarios and weather extremes. The inevitability of these trends makes climate adaptation in the WASH sector of the LVB and other climate-vulnerable settings an imperative. Thus, attention should be paid first and foremost to the shortcomings identified in this study to achieving progress on this front, both regionally and globally, with corresponding actions taken to rectify progress gaps in the wake of the ongoing climate crisis.

7.2 Recommendations

Drawing upon the findings of this study and evidence presented in this report from the growing body of literature on climate-resilient WASH, the following recommendations are proposed as mechanisms to accelerate action on building needed climate resiliency in the WASH sector, both within the LVB and other climate-vulnerable settings, as well as at the international policy level. These recommendations are targeted at all stakeholders engaged in climate adaptation and WASH planning (spanning the LVB and beyond) across public, private, and civil society domains. Note that this list is meant to be broad, but by no means exhaustive.

- Build climate literacy at the community level through awareness raising on the WASH and other risks posed by climate change and the need for reforms to be made to traditional practices to mitigate and respond to both current and projected climate hazards; this can be facilitated through widespread educational campaigns led by CSOs, district officers, grassroots climate activists, and other climate leaders from the communities themselves
    - Similar climate literacy should also be built amongst health and WASH professionals to encourage incorporation of climate considerations into sector-wide planning efforts
- Encourage implementing partners to undertake preliminary mapping exercises of the existing array of adaptation strategies being practiced at the community level (as they relate to WASH and other climate vulnerabilities), enabling identification of both maladaptive and resiliency-building measures; this should then inform the design of programs which leverage community creativity and innovation, while addressing root causes of maladaptation (e.g. knowledge, capacity, or resource gaps) through strategic provision of resource inputs, creation of income-generating opportunities, and training in low-cost adaptation measures
    - Such measures should account for broader social and structural determinants of WASH behavior change that go beyond simple knowledge gaps and consider the underlying capacity of individuals to act upon their knowledge

- Facilitate the formation of community health and water committees to build communities of practice while fostering increased dialogue and collaborative problem solving on strategies for coping with the WASH impacts of climate change; technical experts can utilize such committees as a target platform for training sessions while CSOs can play a role in systematically documenting generated ideas and strategies with proven effectiveness, in turn supporting their diffusion and replication across other settings facing similar climate-WASH challenges
- Equip community health workers with the knowledge and capacity to build awareness across communities on the impacts of climate change and the associated WASH (and other health) risks, while equipping them with resources to distribute which can further support household coping against WASH and other climate hazards (e.g., ORS, water treatment tablets, handwashing soap, materials for latrine reconstruction and regular pit emptying, flood barriers to place around latrines, etc); community health workers can also be equipped to conduct trainings on use of climate-adaptive WASH strategies such as building latrines on higher elevation grounds, optimizing flood resistance in latrine design, maximizing rainwater harvesting capacity, use of traditional and other natural water treatment techniques, etc..
- (Continue to) leverage the potential of nature-based solutions to boost the climate resiliency of water systems including but not limited to watershed management, conservation of buffer zones, forest landscape and ecological restoration, and rainwater harvesting
    - As advocated by RAIN (1), practices such as rainwater harvesting can be supported through broader frameworks enacted at the institutional level which increase the adoption and awareness of rainwater harvesting by both public and private actors, promoting safe water supply in hospitals, schools, and other public facilities, and encouraging innovation of low-cost technologies for household use
- Update local, national, and regional operational frameworks for WASH in emergencies to incorporate climate resiliency standards for WASH services in disaster- and flood-vulnerable areas while planning for the impacts of extreme weather events on WASH in current camp settings
- Support stronger integration of meteorological and epidemiological data in early warning systems to enable prediction of and proactive planning for climate-related waterborne disease outbreaks
    - Proactive preparations can involve ensuring availability of health facilities, equipment, and medicine to assist in early diagnosis and treatment of water-related diseases (2)

    - Similar strategies to those adopted under the CMAM approach in Kenya (3) can be used to build shock-responsiveness in the healthcare system as a complement to stronger early warning systems
- Advocate for the strategic consideration of vulnerable groups in WASH programming (e.g., children, pregnant or lactating women, elderly, people with disabilities, people living with HIV/AIDS, etc) and incorporate targeted supports to accommodate their needs, with a focus on how climate factors intersect with other drivers of WASH vulnerability
- Incorporate climate resiliency considerations into national water safety plans, including but not limited to contingency measures for extreme weather shocks to water systems, sanitation design standards which minimize fecal contamination in settings where groundwater levels are currently or projected to be heightened due to heavy rainfall, sea-level rise, storm surges, etc, and utility management systems which are responsive to extreme weather-related system disturbances
    - Water systems climate resiliency measurement tools can be embedded in regular monitoring and evaluation programs, as outlined in national water safety plans (see ref. 4 for a good example)
- Support more research and knowledge diffusion on the specific impacts of climate change on sanitation to bolster support for increased focus and investments on building climate-resilient sanitation systems where the sanitation sector has been otherwise neglected
    - Consider the range of both hard and soft measures discussed in Ch. 6 that have potential to build climate resilience in the sanitation sector
- Champion adaptation measures in the WASH sector which go beyond technological improvements and build broader social-ecological resilience through knowledge and capacity building, addressing structural determinants of WASH behaviour, and leveraging institutions, polices, and legal tools to create an enabling environment for climate risk planning and responsiveness in the WASH sector
- Advocate for the allocation of more funds towards both WASH and climate adaptation sectors, making strategic use of health and other evidence to frame the investment case; this should be coupled with efforts to promote a shift away from earmarked budgeting norms and towards pooled adaptation financing under which broader WASH and development programs which build climate resiliency (through both direct *and* indirect pathways) can be eligible for funds
- Engage the health sector in continued monitoring and evaluation of the health impacts of WASH system modifications to increase attention to the health dimensions of WASH and optimize the health promotion potential of climate-resilient WASH initiatives

- Create interdisciplinary coalitions for both climate adaptation and WASH planning and regularly convene joint forums for dialogue and strategy planning, with representation from diverse ministries and sectors; public, private, and civil society players should all be represented in these forums to facilitate new partnerships, recognizing the unique role each group can play
    - Make use of joint forums as a platform for exchanging knowledge on piloted measures that have shown success, both at community and institutional planning levels
    - Where possible, advocate for the creation of one climate adaptation budget that is shared across ministries who hold a joint stake in WASH and other climate-sensitive sectors
- Refer regularly to UNICEF'S "Strategic Framework for WASH Climate Resilient Development" (5) to inform approaches taken towards assessing risks, and appraising and prioritizing options for responding to them

7.3 Limitations

While it is suggested that these recommendations be considered by diverse stakeholders including, but not limited to, those operating in the LVB, there are nonetheless limitations to this study worth noting. First and foremost, the small sample size (and selection of participants from a single lakeside community) limits the generalizability of the findings to the LVB at large, considering the geographically and socio-demographically diverse region it represents. Also worth noting is the fact that the qualitative research principles employed in this project inevitably introduce the possibility of researcher bias in the thematic analysis and conceptual interpretation of findings, despite efforts to exercise reflexivity throughout. Additionally, the cross-cultural scope of this project introduces risks of misinterpretation of the comments and sentiments shared by research subjects. This is particularly the case for the majority of Mabinju community members whose interviews occurred in Luo. As translation services did not provide a verbatim representation of participant responses, meaning may have been lost in translation and additional bias may have been introduced through the subjective interpretations of the translator on what was stated in interviews and focus groups. While the review of transcripts with independent field assistants was intended to address this, residual effects likely remain. Finally, despite the use of data saturation as a benchmark for deciding when to stop data collection, some may view the size and diversity of the sample as insufficient to yield the broader conclusions drawn in this study, as they relate to the LVB at large and to other settings towards whom recommendations are also targeted.

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