SOCIOECONOMIC AND ENVIRONMENTAL DIMENSIONS OF ABANDONED MAQALIKA DAM TO THE SURROUNDING COMMUNITIES IN MASERU, LESOTHO

By

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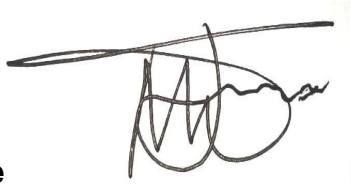
STATEMENT OF ORIGINALITY

The work contained in this dissertation was completed by the author (Rosemary Masentle Maloisane) at the Water Institute National University of Lesotho in 2025. It is an original work except where due reference is made and neither has it been nor will it be submitted for the award of any other University degree.

Signature…… Date 09/October/2025

As the candidate's supervisor, Professor Musibau Jelili, I certify the above statement to be correct to my knowledge and have recommended this dissertation for submission.



Supervisor Signature **Date 09/October/2025**

Dedication

This dissertation is dedicated to my maternal grandmother, my late mother and father, whom taught me the importance of education and the need for hard work, perseverance and determination. If it was not because of them, I would never have made it to where I am today and I will forever be grateful. I know granny believes in me and her words of wisdom and encouragement in my heart keeps driving me and gives me strength no matter how hard the situation is.

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LIST OF ACRONYMS

AfDB	African Development Bank
DWA	Department of Water Affairs
DOE	Department of Environment
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Development Agency)
ICOLD	International Commission on Large Dams
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IUWM	Integrated Urban Water Management
LHWP	Lesotho Highlands Water Project
LWC	Lesotho Water Commission
MCC	Maseru City Council
NGO	Non-Governmental Organization
SABS	South African Bureau of Standards
SD	Standard Deviation
SDG	Sustainable Development Goal
SES	Social-Ecological Systems
SOP	Standard Operating Procedure
UN	United Nations

UN-Habitat United Nations Human Settlements Programme

WASCO Water and Sewerage Company

WHO World Health Organization

WCD World Commission on Dams

WWAP World Water Assessment Programme

ABSTRACT

Maqalika Dam was constructed in 1983 to supply potable water for households and other uses in Maseru. However, since its abandonment for some time it has suffered progressive degradation due to pollution, sedimentation, and unregulated urban encroachment. Against that backdrop, this study examined the socioeconomic and environmental dimensions of the abandonment of Maqalika Dam in Maseru Lesotho. A mixed-methods approach comprising household surveys (n=310), key informant interviews with institutional stakeholders, and field observations was used with tabulations and content analysis to assess the multifaceted consequences of the dam's discontinued use. Findings indicated that over 55% of nearby residents experienced livelihood disruptions, especially in irrigation, livestock watering, and small-scale fishing. Environmentally, over 94% of respondents reported pollution, waste dumping, and eutrophication as prominent challenges which posed risks to public health and aquatic life. Institutional neglect, rapid urbanization, and intentional pollution were identified as key drivers of abandonment. Although Metolong Dam now supplies Maseru, the Maqalika site remains a source of socio-environmental concern. Stakeholders proposed strategies including pollution source mapping, ecological rehabilitation, and participatory reuse planning. The study concludes that there is an urgent need for integrated water resource governance, emphasizing rehabilitation or sustainable repurposing to transform abandoned urban dams from liabilities into community assets.

CHAPTER 1: INTRODUCTION

1.1. Background

Abandonment, in the context of dams, refers to the process of decommissioning or removing a dam, or rendering it incapable of impounding water, often due to safety concerns, environmental issues, or a lack of maintenance (Walker, 2008). Water corporations that no longer require reservoirs for their water supply network are increasingly choosing to discontinue them, especially those held by aging embankment dams. However, this has long-term effects (Poff *et al.*, 2007). Dimensions are measurable or conceptual components of a phenomenon that help break down its complexity into understandable parts (Salawu & Shamsuddin, 2023). In research especially in socio-environmental studies the term dimensions refer to the key aspects, perspectives, or categories through which a complex issue is understood, analyzed, or assessed. Socio-economic dimensions include the implications on community livelihoods, health risks, economic opportunities, access to water and sanitation, and land value changes resulting from infrastructure changes such as dam abandonment (Vanclay, 2003; Cernea & Maldonado, 2018). In addition, environmental dimensions relate to the degradation of water quality, loss of aquatic biodiversity, eutrophication, habitat fragmentation, and ecosystem instability resulting from the lack of dam maintenance or abandonment (Brown *et al*., 2024; Poff *et al*., 2007)

All dams exist in a shifting cultural framework of values, including economic, social, and environmental. There are economic reasons for a dam changes with time, therefore physical changes are unavoidable, requiring attention and rehabilitation (McCulloch, *et al*. 2008). Dams provide numerous benefits to meet human needs, including water supply, flood mitigation, recreational activities, and electricity generation. However, the dangers and hazards are frequently underestimated (Shahrim *et al.,* 2019). In other circumstances, the dam's initial purpose may have changed or disappeared, rendering its use obsolete. Similarly, rationalizing systems and reducing the utilization of minor resources causes a lot of sources to become redundant.

For these reasons, reservoir owners frequently consider ending obsolete assets; yet, reservoirs can provide amenity value to local populations while also contributing to a desirable environmental habitat. When considering whether to stop a reservoir, it is critical to carefully weigh the benefits and drawbacks.

The manner in which a dam is decommissioned is frequently determined by its geographical location, the degree of public access, land value and potential future land use, how the site will be left, and public sentiment. Living downstream of a dam poses severe risks of a life threatening event that is difficult to predict; therefore, dam risk management should be a government and societal priority in order to reduce the incidence of unwanted incidents (Li *et al*., 2019). A flood's impact on the social, economic, and environmental fabric of a downstream community must be considered (Gleick, 2018). Access must be safe and free of hazards such as deep water, soft sediments, and steep slopes. Any body of water within a residential neighborhood must be considered for public use, as well as the access requirements.

The Maqalika Dam has historically played a crucial role in supplying potable water to Maseru. However, the declining water quality and storage capacity have raised concerns about its continued viability (Letsie, 2005). In addition, the reservoir's degradation impacts not only water supply but also public health and economic activities dependent on clean water. Furthermore, the high costs associated with looking for alternative water supply sources and need for purification of such waters place a financial strain on local authorities and residents (Letsie, 2005). Therefore, this study explored socioeconomic and environmental dimensions of an abandoned urban water supply Maqalika Dam Maseru.

1.2. Statement of the Research problem

The Maqalika Reservoir was established in 1983 to suit Maseru's water demands. The reservoir is located in a densely populated area and is extremely contaminated due to waste from residential and commercial outlets surrounding the dam, resulting in expensive purification expenditures, which may be one of the reasons for its

abandonment (Letsie, 2019). Masupha (2005) discovered that storage is gradually decreasing as material from natural runoff builds in the reservoir.

In addition, Masupha (2005) analyzed the physico-chemical properties of water and compared the results with WHO and SABS. Nitrates, phosphates, and fecal coliform levels were discovered to be significantly higher than minimum criteria, indicating that the water was highly contaminated, with the source being leaking sewers, defecation in dongas, and leachate from the Ts'osane and Lower Thamae dumping sites. Iron levels were likewise excessive, with mean values greater than 0.3mg/l, and the cause was leachate from dumping sites, improper scrap disposal, and minerals from the soil. In addition, Selimo (2020) assessed concentrations of arsenic, lead, and zinc in both sediments and the gills of Cyprinus carpio (common carp) where levels were above WHO standards.

The Water and Sewage Company (WASCO) issued an alert in 2023 warning the nation of a significant number of dead fish discovered in Maqalika Dam. During the dead fish incident in 2023, the Ministries of Water Affairs, Natural Resources, Environment, and Agriculture worked together to combat the problem. Representatives from these ministries gathered water samples and dead fish for disposal and testing in Maqalika. An announcement urged the nation not to swim, fish, or bring animals to drink this water while studies were still being conducted to determine the causes of the fish's mass death. Eutrophic waters are supposed to eventually become dead zones incapable of supporting life because animals living in water lack oxygen. Any reservoir can outlive its original function or design, and it may be more cost effective to stop it than to carry out reservoir safety measures (Telford, 2012). The water was reported to be green with algae, indicating eutrophication.

The studies, which showed contamination had rendered fish unsafe for consumption, posing health risks to consumers and economic challenges to fishermen, were not so comprehensive to touch on socio-economic impact the dam has on the community as well as the environmental impacts. The degradation of Maqalika has had profound socio-economic and environmental implications. Despite these challenges, the existing studies are inadequate and less comprehensive especially in addressing the full spectrum of socioeconomic and environmental consequences resulting from the reservoir's

abandonment, leading to quite a number of research questions from different aspects of the problem which are begging for answers.

1.2.1 Research Questions:

1. How has the dam's abandonment affected the socioeconomic well-being of surrounding communities?
2. What are the environmental dimensions associated with the Dam?
3. What are the primary factors contributing to the abandonment of Maqalika Dam?
4. What remediation strategies can be implemented to restore the reservoir's ecological balance for resuscitation or repurposing?

1.3. Justification for the Study

The reservoir is located in a very densely populated area where there are fishermen and community that utilize the dam for different purposes. Gwimbi et al. (2020) evaluated the amounts of heavy metals (As, Pb, and Zn) in the sediments and gills of Common Carp fish (Cyprinus carpio) from Maqalika Reservoir in Maseru, as well as the potential health risks to fish consumers. Sediment and Cyprinus carpio samples were collected from the upstream, midstream, and downstream portions of Maqalika Reservoir and tested for As, Pb, and Zn using an atomic absorption spectrometer. As and Pb concentrations in Cyprinus carpio gills above the WHO's allowed limits for fish intake of 1 mg/kg and 0.2 mg/kg, respectively, meaning that residents may suffer considerable health hazards from particular metals absorbed through fish diet. This study emphasizes that the dam might have some impacts on the socioeconomic wellbeing and environment-related health condition of residents fishing or consuming the fish from the dam. This calls for intervention since it has been abandoned and its usage is on hold. Hence this study focuses on socioeconomic and environmental aspects of the dam due to its abandonment. This research will help city planners and policymakers make informed decisions on repurposing abandoned dams. It will further contribute to sustainable urban development by exploring alternative uses for unused water infrastructure.

1.4. Aim of the Study

The aim of the study was to appraise the socioeconomic and Environmental implications of abandoned Maqalika Dam in Maseru.

1.5. Specific Objectives

The specific objectives of the study were to:

1. Appraise the socioeconomic dimensions of the dam on the well-being of the surrounding communities.

2. Analyze environmental dimensions associated with the abandoned dam.

3. Analyze the primary factors responsible for the dam's abandonment.

4. Identify strategies for sustainable resuscitation of the dam or otherwise.

1.6. Hypothesis

The research is directed by the guiding hypothesis that: The discontinued use and abandonment of Maqalika Dam has implications for socioeconomic development and environmental sustainability of the surrounding communities.

1.7 Scope of the study

This research focused exclusively on the Maqalika Dam catchment and adjacent communities in Maseru, Lesotho as well as examined the socioeconomic and environmental implications of its abandonment through a mixed-methods approach. In particular, on adjacent communities upstream and downstream zones affected by dam operations and abandonment. The socio-economic dimensions such as livelihood impacts (fishing, irrigation, tourism), household income changes, health risks, and community perceptions in general were examined. The study further established environmental dimensions such as water quality degradation, biodiversity loss, pollution sources, and habitat fragmentation as well primary factors driving abandonment (pollution, institutional failures, urban pressures). Finally, it looked at feasible strategies for ecological restoration or repurposing. The analysis spans from dam construction (1983) to current status (2025), with emphasis on post-abandonment impacts. The study used mixed methods, qualitative and quantitative design through household surveys (310

respondents) and key informant interviews (6 institutional stakeholders) as well field observations limited to visual assessments of dam infrastructure and pollution hotspots.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Chapter 1 sets out the context and objectives for this research. This chapter (Chapter 2) critically reviews the existing literature or rather body of knowledge, in broader areas of dam discontinue and abandonment more specifically on its implications on socio-economic and environmental dynamics in Maqalika dam river catchment. This chapter also introduces the key concepts and terminologies that are in line or relevant to this study. Further, the chapter provides an overview on the factors that have led to discontinued use and abandonment of the dam. It also gives an overview on the water supply and demand as it is one of the main reasons while the water is dammed along the river.

2.2 Dam abandonment

Dam abandonment refers to the process where dams are either deliberately decommissioned or fall into disuse due to factors such as pollution, sedimentation, structural degradation, or changing socioeconomic and institutional contexts (Walker, 2008; Telford, 2012). As cities expand and infrastructure ages, many urban dams worldwide particularly those built in the 20th century have become redundant or hazardous, leading to their abandonment (Ikezema *et al*., 2025; Nicol *et al.,* 2018). The abandonment of dams, particularly in urban settings, has been attributed to both natural and anthropogenic pressures. These include deteriorating water quality due to urban runoff and waste discharge, catchment encroachment, lack of maintenance, and institutional inefficiencies (Luqman, 2024; Letsie, 2019). In the case of Maqalika Dam in Maseru, growing urban pressures, direct dumping of waste, and leachate from upstream landfill sites have made the dam's water quality unsuitable for potable use, leading to its abandonment by WASCO (Gwimbi et al., 2020; Masupha, 2008).

Recent global evidence suggests that intentional and unintentional pollution, coupled with inadequate urban planning, are common drivers of dam abandonment. For instance, Zhang et al. (2021) highlight that urban dams in developing countries are often situated in densely populated areas with poor waste management systems, which accelerates

ecological degradation. Similarly, Chanza and Musakwa (2022) observed that abandoned dams in Southern Africa tend to result in reduced water access, declining land values, and missed economic opportunities. From a governance perspective, weak institutional coordination, fragmented policies, and lack of community engagement have been linked to poor dam management and eventual abandonment (Nicol et al., 2018; Schulz & Adams, 2019). In some cases, authorities discontinue dam operations without formal decommissioning, leaving the structure and surrounding area to decay, thereby exposing downstream communities to potential hazards (Li et al., 2019).

The environmental and socioeconomic dimensions of dam abandonment are profound. Abandoned dams often become pollution hotspots, encourage biodiversity loss, and pose public health risks (Brown et al., 2024). Moreover, as seen in Maqalika and other urban dams like Hartebeespoort in South Africa, the surrounding communities suffer economic setbacks due to loss of livelihoods (fishing, irrigation) and increased health costs linked to waterborne diseases (Selimo, 2020; Fan *et al*., 2022).

Globally, there's a growing discourse on sustainable repurposing of abandoned dams. Palmer and Ruhi (2021) advocate for transforming such structures into urban wetlands or recreational parks, while ensuring ecological restoration. Integrated Urban Water Management (IUWM) frameworks have also been proposed to guide the revitalization of abandoned urban reservoirs, ensuring that environmental, social, and institutional aspects are collectively addressed (Behzadian and Kapelan, 2015). Dam abandonment is not merely a technical or environmental issue but a multi-dimensional challenge influenced by ecological degradation, urbanization pressures, socio-political factors, and institutional dynamics.

2.3 Water supply and demand

Water resources are both essential natural assets and important economic resources that are critical to human life and national development (Gleick, 2018). They contribute significantly to environmental quality and socioeconomic sustainability (Zhu and Cao 2024). Water resources govern productive operations in agriculture, industry, domestic usage, and ecosystems, with far-reaching implications for food security, livelihoods, and

ecosystem services. In water-scarce areas, they hinder the future development of agriculture and industry (Bozorgzadeh and Mousavi, 2023). According to the IPCC's 6th Assessment Report, water security threats exist all throughout the world, posing serious difficulties to long-term economic and social development. These factors may escalate tensions and lead to international conflicts (Jain et al., 2024). Since the twentieth century, global water consumption has increased six fold, with about 5 billion people living in locations that are severely threatened by water scarcity. Meanwhile, climate change, population growth, and human activity have exacerbated the issue, raising water security worries (Bogardi et al. 2012). As a result, water resource management has become a critical environmental concern in the twenty-first century. Under changing environmental conditions, water security has emerged as a global issue critical to human long-term development (Wei et al. 2023).

As populations grow and urbanization accelerates, particularly in developing regions, the balance between water supply and demand has become increasingly strained. Globally, water demand has tripled over the last 50 years due to increased consumption in agriculture, industry, and domestic sectors (WWAP, 2023). Yet, in many urban areas, water infrastructure has not expanded proportionately, resulting in a widening gap between supply and demand.

Water supply refers to the systems and sources such as rivers, dams, groundwater, and reservoirs that provide water for human use. In contrast, water demand encompasses the quantity or amount of water required to meet various needs, including drinking, sanitation, agriculture, and industrial processes. This demand is influenced by demographic trends, economic activities, climate variability, and governance structures (Gleick, 2018). The balance between water supply and demand is a growing global concern, particularly in light of increasing population, urbanization, industrialization, and climate variability. According to the United Nations World Water Development Report (WWAP, 2023), global water use has increased by approximately 1% annually since the 1980s and is projected to continue rising due to growing demands in agriculture, energy production, and

domestic use. Despite these increasing demands, water availability remains finite and unevenly distributed, creating challenges for sustainable management.

In many developing regions, particularly sub-Saharan Africa, the gap between water supply and demand is exacerbated by aging infrastructure, institutional weaknesses, and inadequate investment in water systems (UN-Habitat, 2020). Studies shows that the continent faces a dual burden of high water stress in some regions and underutilization of available resources in others. Rapid urban expansion and informal settlement growth often outpace the capacity of municipal water services, leading to inequalities in access and service delivery (Gleick, 2018).

Lesotho, despite being considered the "Water Tower of Southern Africa" due to its mountainous terrain and water-rich highlands, faces its own set of challenges. While the country exports significant volumes of water through the Lesotho Highlands Water Project (LHWP), internal water supply systems, particularly in urban areas like Maseru, remain underdeveloped and inconsistently managed (Letsie, 2019). Seasonal variability, infrastructure neglect, and administrative inefficiencies have contributed to supply shortages and unmet demand, especially in low-income areas. The case of the Maqalika Dam, once a vital source of potable water for Maseru, reflects the broader national issues in managing water infrastructure. Its abandonment or discontinued use has raised concerns about the socioeconomic and environmental implications of neglected water assets. The failure to maintain or rehabilitate existing infrastructure, such as dams and reservoirs, has critical implications for sustainable urban water provision (FAO, 2021).

2.4 River Dam and its importance in urban water supply

Major cities today have many difficult problems, and one of the most significant one been managing waster in general ones is water management. The amount of wastewater is increasing, potable water from pure sources is scarce, and other water sources require expensive treatment. In many parts of the world, city inhabitants suffer from waterborne ailments and lack access to clean water (Zhang *et al*., 2021). A river dam is a barrier built across a river to control, manage, or store the flow of water. Dams give a life-sustaining supply to many communities. They are as crucial as bridges, roads, airports, and other significant components of any region's infrastructure. As multipurpose infrastructure,

dams are constructed not only to store water for domestic use but also to support agriculture, hydropower generation, flood control, and recreation (ICOLD, 2021). Globally, dams contribute to the supply of freshwater to more than 50% of the world's population, directly or indirectly (WWAP, 2023). However, the sustainability of these systems depends on proper operation, maintenance, and integration with broader water resource management strategies (Tortajada, 2016).

As people have grown and moved to desert or flood-prone areas, the demand for dams has skyrocketed. In addition, with climate change exacerbating already frequent droughts, with growing urban populations needing more water, guaranteeing water supply is vital to Lesotho's socioeconomic development (World Bank Group, 2020). The solution to rising water demand has concentrated on dam construction, among other options (Al-Taani et al., 2020). While this is a costly strategy of addressing water scarcity (Karami and Karami, 2020), other governments are already making significant investments in storage reservoirs to ensure sustainable water supply during drought (Al-Taani, 2014). Many sections of the world have long experienced acute water scarcity, with serious consequences for agriculture, industry, and domestic consumption. Most of river dams are multipurpose dams such that they built water storage for different uses or benefits such as for renewable, clean energy, flood control, water storage, irrigation, recreation and navigation and flood control.

2.5 Socioeconomic Dimension of River Dam for Water Supply.

2.5.1 Social Impacts

According to Vanclay (2003), social impacts are the effects that actions, programs, or policies have on individuals and communities. These effects can be both favorable and harmful, affecting many facets of social life, such as health, well-being, and relationships. Rivers have an important role in human survival and socioeconomic growth. While rivers provide industrial, irrigation, and drinking water, they are also critical for ecosystem connectivity and conservation (Zang *et al.* 2024). The increasing population and urbanization rate, together with the rise of industry and agriculture, have greatly raised the demand for water resources (Zang *et al.* 2024).

In response, dams have been built extensively to improve resource utilization and mitigate droughts and floods (Javadinejad et al., 2019a; Rabiei et al., 2022). Uncertain future climatic, social, and economic patterns pose a challenge to global river basin water management, potentially resulting in divergence water demands and availability, as well as multi-stakeholder dynamics, which result in changing conflicts and tradeoffs (Xu et al., 2024). In such cases, a better understanding of the sensitivity of water management to various sources of uncertainty can assist policymakers in developing strong water supply policies that balance optimality with low vulnerability to expected adverse future situations (Amaranto et al., 2021). According to Zhang et al. (2024), the reservoir is an appealing component in the surrounding landscape that is legitimately utilized for dog exercise and walking. However, the water bodies attracted less desirable activities such as outdoor parties, camping, and swimming, all of which are associated with problems such as alcohol and drug misuse. It is obvious that when a dam is decommissioned, there are numerous options available, and the method chosen is frequently determined by the desired outcome and land usage. As a result, it is always vital to interact and consult with the general public and other interested parties in order to obtain the best possible outcome.

However, dam construction is plagued with controversy. Dam supporters (i.e., dam authorities, governments, and engineering firms) argue that dams bring modernization, technological advancement, national development, national prestige, control over water sources, and energy security.

2.5.2 Economic Impacts

A lot of economic impacts may be associated with dam construction and use as water reservoir, among other uses. For example, hydropower is the world's top source of low-carbon electricity (IEA, 2021a). It will remain a primary energy source, notably in the Global South (also known as the Group of 77 and China) and emerging nations with a surge in dam construction (Fan et al., 2022, Moran et al., 2018, Zarfl et al., 2015). National governments and the private sector have encouraged the construction of hydroelectric dams, claiming that it will boost economic growth and energy independence (Fan et al.,

2022; Gürbüz, 2006; Namy, 2010; Smyth and Vanclay, 2017), as well as provide a solution to the energy shortage that millions of people face worldwide (IEA, 2018).
However, research has revealed that dam construction has a severe influence on people's lives, livelihoods, and ecosystems (Cernea, 1997, Cernea and Maldonado, 2018, Scudder, 2005), with many people lacking access to energy (Aeria, 2016, Siciliano *et al*., 2018). For example, Fan *et al.* (2022) discovered that newly built dams in Asia, Africa, and Latin America are connected with lower GDP, population, and land cover around construction sites. According to the World Bank, 9% of the world's population, or 733 million people, did not have access to electricity in 2020, with the Global South accounting for a sizable portion of that figure. Dams are viewed as a means of delivering energy to those without access.

According to Null *et al.* (2021), historically, hydroelectric dam planning and construction have taken precedence over environmental impact analysis. Hydropower dams generate renewable electricity, but they also modify streamflow, trap sediment, fracture rivers, disturb fish migration and breeding, degrade ecosystems, and destroy biodiversity (Baird *et al.* 2020). Large-scale hydropower projects are being considered in some of the world's most biodiverse ecosystems, including as the Mekong, Amazon, and Congo basins (Winemiller *et al*., 2016). These projects will have far-reaching consequences for local populations and food security (Soukhaphon *et al*., 2021).

2.6 Environmental dimensions of river dam

River dams have significant environmental dimensions, impacting river ecosystems and surrounding environments. These impacts can be positive or negative which include changes to water flow and quality, sediment transport, and aquatic habitats, as well as potential effects on terrestrial ecosystems and human communities (Brown *et al*., 2024). Human habitat alteration is the primary driver of habitat loss which has significant impact on biodiversity (Foley *et al.*, 2005). Dam construction, a common example of anthropogenic activity, leads to significant habitat loss and fragmentation, mainly impacting aquatic ecosystems but also affecting surrounding terrestrial habitats. Rehabilitation can be a simple option if the dam's original function persists; for example, if the dam is still used for water supply, public flood control, hydroelectric generation, or

supports the local or regional economy. In other circumstances, the obvious solution may not be the best option (Ikezema *et al*., 2025). Unneeded dams, such as old, inactive, or abandoned water supply reservoirs, or municipally owned ponds with old dams bought many years ago, can be scenic areas. They can also serve other societal purposes, such as a fishing hole or a source of firefighting water.

On the contrary, Petheman *et al*. (2014) argued that fire-fighting water sources may be given in a variety of methods, and that there are better ways to preserve infrastructure than to maintain unnecessary dams. In many circumstances, keeping a dam for minor benefits may not be worthwhile. Discontinuance of reservoirs, particularly those held by old embankment dams, is becoming a popular alternative for water utilities that no longer require these assets for their water supply network.

Dams, according to Brown (2024), have a bigger impact on water quality, resulting in lower downstream dissolved oxygen and higher temperatures. Larger dams reduced inorganic nutrients (N, P, and Si) and increased particulate nutrients (N and P) in downstream reaches. Under larger dams, aquatic organisms showed greater dissimilarity in species composition (for fish and periphyton), decreased taxonomic diversity (for macroinvertebrates), and increased pollution tolerance. Plants responded differently below large and small dams, with fewer invasive species under large dams and more under small dams. Dams affect river ecosystems in a variety of ways, including water storage, reservoir elevation, decreased runoff velocity, and reduced seasonal and yearly flow variability (Poff *et al*., 2007; Javadinejad *et al.,* 2019b). These alterations may contribute to nutrient enrichment and eutrophication.

Dams affect almost half of the world's main river systems, impounding approximately 15% of worldwide yearly runoff (Nilsson *et al*., 2010). Damming has an impact on many riparian environments because it regulates flow. As global efforts to rehabilitate the ecological status of damaged rivers develop, there is an urgent need for study on the most efficient restoration strategies for ecosystem recovery (Wohl *et al*., 2015). This is especially true for initiatives to restore rivers through dam removal, which has grown considerably in the United States over the last three decades (O'Connor *et al*., 2015) and is gaining traction in

many other regions of the world (Schiermeier, 2018). The intensity and frequency of disturbances, as well as the availability of resources, define riparian plant communities.

Reservoir management can influence the composition and abundance of riparian vegetation by changing the flood regime and trapping fine sediments and nutrients inside the reservoir system (Beauchamp and Stromberg, 2008).

2.7 Sustainable services and water supply

Sustainable water supply and services means ensuring reliable, affordable, and sufficient access to water of good quality for current and future generations, without causing harm to the environment or the local economy. Studies shows that it involves a combination of technical, environmental, economic, and social considerations. Freshwater supply is a limiting issue for global food production, energy generation, and industrial usage (Hermoso, 2017; Zampieri *et al.,* 2018). Investing in new infrastructure remains the most popular choice for increasing storing and conveying capacity, particularly in Sub-Saharan Africa and South-east Asia, which have the most untapped potential (Fields *et al*., 2009). However, this hard path water solution is sparking heated debates about the significant environmental and social costs of damming 25 rivers (Moran *et al*., 2018), to the point where efficient operation of existing infrastructure, rather than planning new ones, is becoming critical to balance tradeoffs between supply and demand.

More than 2000 dams have been erected in Sub-Saharan Africa, with another 200 under construction to improve food security and hydropower production (Kibret *et al*., 2016). However, expected changes in climate, population growth, and agricultural patterns will certainly test the ability of current and proposed dams to provide the benefits that prompted their construction (Giuliani *et al.,* 2016b). Understanding the impact of these uncertainty sources on reservoir operation is therefore critical for formulating strong operating regulations that assist policymakers in achieving sustainable river basin management.

2.8 Conceptual framework

Figure 2.1 below presents the conceptual framework of the study. The figure below shows that the dam is constructed on a river within an urban setting, typically for purposes such

as water supply, flood control, recreation, or ecological regulation. However, Maqalika dam was initially constructed for water supply. Urban river dams often serve as multi-purpose infrastructure. However, due to complex pressures (urban expansion, pollution, underfunding), they may become underutilized or deteriorate (Zhang *et al*., 2021). If the dam ceases to operate as initially intended which on normal circumstances it could be due to technical issues such as poor maintenance, underfunding, governance and policy failures, pollution, urban expansion, alternative supply of water, environmental degradation, safety concerns, or institutional neglect, abandonment occurs silently, without formal decommissioning which leads to cascading effects on urban systems (Ho *et al*., 2020). Study conducted by (Chanza and Musakwa, 2022) found out that consequences to socio-economic shifts and urban livelihoods include:

- Reduced water access
- Health and sanitation risks
- Decline in land value
- Missed economic opportunities (e.g., tourism, irrigation)

On the other hand, Grill (2019) stated that environmental degradation resulting from dam neglect includes:

- Stagnant water bodies and pollution
- Biodiversity loss
- River system fragmentation

Hence there is a need for sustainable resuscitation or repurposing so that a dam does not remain liabilities but can be rehabilitated for original or new use or rather be repurposed into urban parks, wetlands, or decentralized water systems (Palmer and Ruhi, 2021). In addition, Nicol *et al*. (2018) stressed that one more thing that could lead to dam abandonment is governance and policy failures where inadequate governance often hinders sustainable dam management weak institutional coordination policy fragmentation and lack of political will. The final outcome or goal a resilient and inclusive water management plan built on participatory approaches involving communities and

stakeholders, integrated water resource management resilience to climate, demographic, and institutional shocks.

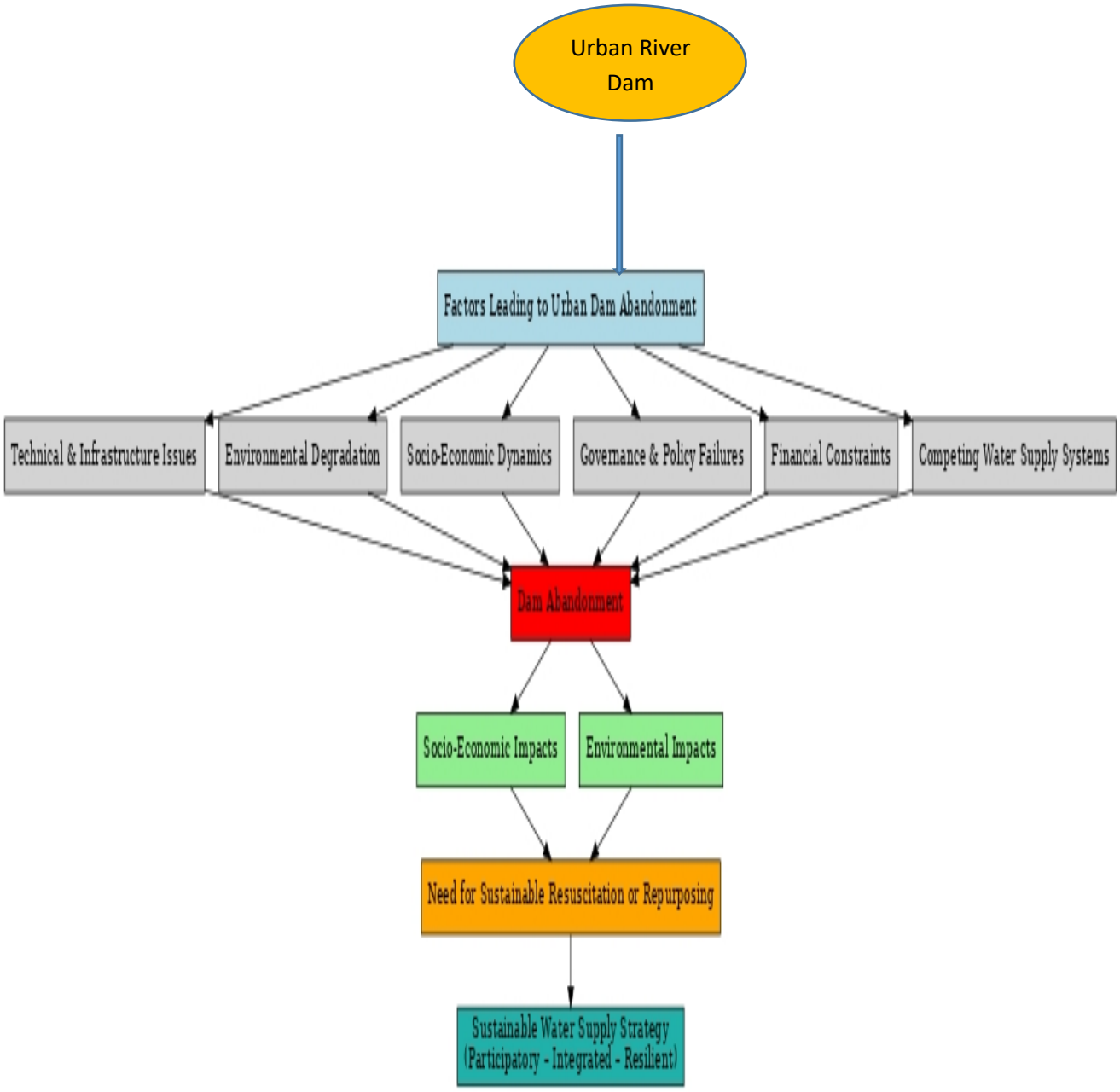

Figure 2.1 Conceptual framework Source: Author, 2025

2.9 Theoretical Framework

A theoretical framework is a foundational structure that supports and guides research by providing a systematic view of the relationships among key concepts and variables and also serves as a roadmap for researchers, helping one to explain phenomena, draw connections, and make predictions based on existing theories, which may be upheld, modified, or rejected (Salawu and Shamsuddin, 2023). Many studies incorporated interdisciplinary perspectives to analyze the complex interplay between environmental or ecological degradation, socio-economic challenges, and governance issues. Ostrom (2009) utilized the Social-Ecological Systems (SES) framework which conceptualizes the interdependence between human societies and ecological systems. Until recently, mainstream theory held that resource consumers would never self-organize to sustain their resources, and that governments must impose solutions (Ostrom, 2009). However, research across different disciplines has discovered that some government policies hasten resource destruction, whereas some resource users have dedicated time and work in achieving sustainability. As a result, it emphasizes the importance of adaptive governance and resilience when managing shared resources such as metropolitan water bodies.

Di Baldassarre (2019) investigated the significance of sociohydrology in tackling social big issues offered by the SDGs. It was stated that sociohydrology is an acceptable analytical framework for conceptualizing and evaluating the SDGs' water implications, with socio-hydrology serving as an interface between the SDGs and IWRM principles.

Sociohydrology conceptualizes water concerns by taking into account socio-cultural and socio-political components, as well as the short- and long-term effects of water governance processes (Di Baldassarre, 2019). The development-induced displacement and resettlement (DIDR) concept investigates the social effects of development projects that cause community displacement (Cernea, 2006). While in the case of Maqalika Dam's abandonment has not led to physical displacement, the loss of livelihoods for local fishermen and the health risks posed by polluted water can be viewed through the lens of socio-economic displacement. Therefore, this perspective highlights the need for policies that mitigate adverse impacts on affected populations.

Behzadian and Kapelan (2015) highlighted that Integrated Urban Water Management (IUWM) framework promotes a holistic approach to managing the urban water cycle, integrating freshwater, wastewater, and storm water systems within the broader river basin context. According to Masupha (2008), this approach is pertinent to Maqalika Dam, which has suffered from pollution due to leachate from nearby dumping sites and leaking sewers, leading to high purification costs and water quality issues. Therefore, this study will utilize Social-Ecological Systems (SES) framework which emphasizes the need for adaptive governance and resilience in managing common-pool resources like urban water bodies. By applying this framework to Maqalika Dam allows for an analysis of how ecological degradation such as pollution and eutrophication interacts with socioeconomic factors like community livelihoods and public health.

2.10 Gap analysis

Previous studies attempted to address this issue by looking into the specific effects of dams on various aspects of society, the economy, and the environment. For example, studies have been undertaken on local resident migration, biodiversity loss, and alterations in downstream river systems (Shabu and Musa, 2015; Lin *et al*., 2020). However, they are typically restricted in scope and fail to convey the interconnection and dynamic character of these issues. Furthermore, earlier research had focused on other factors rather than the social and environmental repercussions. For instance, research conducted by Letsie (2005) assessed the water quality of Maqalika Reservoir, revealing high levels of nitrates, phosphates, and faecal coliforms, primarily due to pollution from leaking sewers, open defecation, and leachate from nearby dumping sites. These contaminants have led to increased water purification costs, making the treatment process more expensive compared to other regions. Another study by Letsie and Allopi (2008) analyzed the sedimentation in Maqalika Reservoir, highlighting that sediment accumulation from natural catchment runoff and sediment laden water pumped from the Caledon River has significantly reduced the reservoir's storage capacity.

Finally, a study published by Ranoosi *et al.* (2020) analyzed the concentrations of heavy metals in the sediments and in the gills of Cyprinus carpio (common carp) from Maqalika Reservoir. The findings indicated that levels of arsenic and lead in fish gills exceeded

permissible limits recommended by FAO/WHO, suggesting potential health risks to consumers. The contamination is due to untreated sewage discharge, unregulated garbage, and agricultural activities in the reservoir's catchment area. Furthermore, while some academics, such as Samsuddin *et al.* (2024), have attempted to develop frameworks for quantifying dam impacts or water quality, their scope has been limited, with some focusing on only one aspect of the problem, such as environmental, social, or economic. The observed shortcomings included a failure to evaluate social, economic, and environmental implications. This research aims to appraise a combination of socioeconomic and environmental dimensions as a result of abandoned Maqalika dam as no adequate research has been conducted so far on the dam.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Introduction

The previous chapter, Chapter 2 reviews the body of knowledge on Socioeconomic and Environmental Implications of a discontinued and an abandoned urban Water Supply Dam, Maqalika Dam Maseru. This chapter (chapter 3) discussed the methods used to conduct the research. More specifically, the chapter discusses the design of the study, data collection methods and analysis, among others.

3.2. Description of the study area

The study area is located on the north-east outskirts of Maseru. The Maqalika Dam catchment covers area of 44 km^2, has a length of approximately 13 km, and a channel slope of 0.4 km/km. The Maqalika Reservoir was established in 1983 to suit Maseru city's water demands, and it has a storage capacity of 3.7 Mm^3. However, storage is rapidly declining as material from natural runoff builds in the reservoir (Molaoa, 2007). Furthermore, water pumped into the reservoir from the Caledon River (which contains a high concentration of sediment) contributes silt. The reservoir is located in a densely populated area and is heavily polluted, which results in significant treatment expenses. This location was chosen because of its abandonment and direct exposure to socio-environmental dynamics. Plates 3.1 and 3.2 explicitly illustrate the dam's position.

Plate 3.1 Cross section of Maliqaka dam. **Source:** Letso'ara (2024)

Plate 3.2 Maqalika Dam: **Source:** Goggle Earth

3.3. Study design

The research design refers to the general method used to integrate the many study components in a coherent and logical manner, ensuring that the research problem is effectively addressed. It

serves as the blueprint for data gathering, measurement, and analysis (McNabb 2008). The primary goal of the study design is to help avoid situations in which the data does not answer the initial research objectives (Seale, 2004).
To address the research objectives, a case study approach was chosen as the best strategy. Case study research is a research design strategy that generates an in-depth, multifaceted understanding of a complicated subject in its real world environment (Frechtling *et al*., 1998).

According to Bryman (2004) the hope is that learning gained from studying one case can be generalized to many others. It allows one to explore the key characteristics, meanings and implications of the case. Therefore, the case study research design keeps the project manageable and focused more especially if there is no enough time or resources to do a large scale.

Research methods can be classified in various ways. The main categories are qualitative, quantitative research and triangulation which is known as the mixed method (Taherdoost, 2022). The quantitative research method is primarily about obtaining numerical data so that it may be quantified and examined. This research method involves collecting information from relatively numerous participants or respondents who meet certain pre-determined criteria; in this case it has collected numerical data from residents around Maqalika dam as they are the ones experiencing socio-economic and environmental impacts more than other Maseru residents.

On the other hand, qualitative research is primarily about exploring and describing personal experiences and may be employed when identifying contextual factors that contribute to the abandonment of the Maqalika dam in this context. Since the two approaches seem to work against each other, a new hybrid research method known as mixed methods was developed (Barda and Hoschheiser, 2020). The mixed-methods approach was chosen as this enabled the research to answer the research questions from two perspectives, strengthen the external validity of the research findings, and provide additional explanation to the quantitative research findings that would not be forthcoming if the study focused on a single approach (Taherdoost, 2022)

Karunarathna and Gunathilake (2024) further stated that the use of both qualitative and quantitative methods for data collection and analysis help strengthen the credibility, validity, and reliability of the findings in this research study. The collection of qualitative data ensures more in-

depth information on the research topic. The collection of quantitative data using structured questionnaires for the study participants generate a lot of data on the study objectives that not carry researcher bias (Karunarathna and Gunathilake, 2024).

Oranga and Matere (2023) pointed out that examining issues in depth allows for more profound insight, in contrast to the generalized nature of quantitative research methods. Some of the absolute advantages of qualitative research methods include in-depth insight on a complex issue, allowing the researcher to learn from the research process, exploring people's perceptions of events, views, opinions, dissatisfaction, emotions, meaning, and motivation, providing stories, narratives, repetition, themes, categories, and offering an opportunity to voice participants' opinions on the issue intended for research. According to (McNabb, 2020), the use of qualitative methods can capture subjective experiences in a way that quantitative methods cannot. In addition, recommendations for combining the two approaches are made. This study adopted a mixed-methods approach, through using both qualitative and quantitative research methods to comprehensively address the research questions.

3.4 Data collection techniques

The underlying need for data gathering was to capture high-quality information that could answer all of the study questions posed. To increase the quality of information, data must be collected in order to draw conclusions and make informed decisions about what is considered factual (Shamiso, 2016).

This study used triangulation method, quantitative through household survey and qualitative method through key informants interview for primary data collection. These mixed methods are well established in previous studies on socioeconomic and environmental implications. Examples include different projects such as socioeconomic impacts of ring road project in the Republic of China and also Geo-environmental and socioeconomic impacts of artisanal and small-scale mining in Ethiopia particularly where one method either quantitative or quantitative method technique may not yield comprehensive results. See Ikezam *et al*., (2025) and Siqi and Heli (2025). More specifically, the study used key informant interviews, stakeholder's representatives in water

and environmental sector, household survey with residents around Maqalika Dam to establish both socioeconomic and environmental impacts due to an abandoned dam.

3.4.1 OBJECTIVE 1. Appraise the Socioeconomic Dimensions of the dam

To address this objective, data collection was done through administration of structured questionnaire in household surveys to local resident's and stakeholders living near the dam. The objective of the survey was to gather data on livelihoods, health impacts, economic activities, and public perception of the dam as they live at close proximity to it. The sampling technique was to suit the objectives and available resources. According to United Nations (2005) it is simple random sampling method where every household had an equal chance of being selected. There is no population statistics for Upper Mohokare sub catchment where the Maqalika Dam is located. Population size assisted in estimation of a valid and reliable sample size. Adhikari (2021), stated that sample size determination or estimation is the process of selecting the number of observations or replicates to include in a statistical sample. In addition, the sample size is a crucial aspect of any empirical study in which the purpose is to draw conclusions about a population from a sample.

Sample size determination

There are many small villages both upstream and downstream of the Maqalika Dam of unknown population and for validity and reliability appropriate sample size will be of a paramount importance for the validity of the household survey results. The sample size is determined by the desired confidence level, margin of error, and the expected proportion of the population showing the trait of interest (Adhikari, 2021). The following is the standard formula for calculating sample size when estimating a proportion (Das and Mitra, 2016);

$$n = \frac{Z^2 \cdot p \cdot (1-p)}{e^2}$$

Where:

- n = sample size
- Z= Z-score corresponding to the desired confidence level (95% confidence)
- p = estimated proportion of the population (0.5 since the population is unknown)
- e = desired margin of error (in decimal form, e.g., 0.05 for 5%)

Therefore, $n = \frac{0.95^2 * 0.5 * (1 - 0.5)}{0.05^2}$

= 385 sample size

The confidence level reflects how certain it is that the true population parameter lies within the confidence interval derived from the sample. A 95% confidence level is widely accepted in social sciences and public health research, balancing precision and resource constraints. It also indicates that if the survey were repeated multiple times, the results would fall within the specified margin of error 95% of the time (Adhikari, 2021). The margin of error is the range of predicted values for the true population parameter in relation to the sample estimate. A 5% margin of error is a conventional choice that provides a reasonable balance between accuracy and the resources required for data collection. It implies that the sample estimate will be within ±5 percentage points of the true population value. Probability of 0.5 is used for proportion of population of interest when there is no prior knowledge of population and this maximizes the required sample size, ensuring adequacy (Adhikari, 2021). Development of household questionnaires was done in a manner that questions aligns with objectives of the study. Further ensuring that questions are clear, concise, and culturally appropriate. The questionnaire sample is put in the appendices.

3.4.2 OBJECTIVE 2. Analyze Environmental Dimensions of the abandoned dam.

Field direct observations were used to gain insight about the Maqalika Dam. In particular, visual inspection to assess the structural integrity or physical condition of the dam, noting any signs of deterioration, erosion, or vegetation overgrowth. Capturing images of key features was done, including spillways, embankments, and areas showing significant environmental changes to document evidence where possible. In addition, comprehensive literature search was conducted

previously on studies that have been conducted previous in relation to environmental impacts of the Maqalika dam including the overall ecosystem.

3.4.3 OBJECTIVE 3. Analyze factors responsible for the dam's abandonment

Semi-structured key informant interviews were conducted to achieve this objective. Key informant interviewing is a method of conducting systematic conversations and listening to people who have expertise and information about a specific study issue (Kurma 1989). It provides detailed information and is a flexible strategy because the interviewer can reconstruct questions to fit the scenario (Kothari, 1984). The objective of the key informant's interviews was to explore the causes of abandonment and possible revitalization strategies. The interviews were carried out using the checklist with the following stakeholder's categories such as from;

- **Lesotho Water Commission**

The LWC provides policy direction for water resource development and management in Lesotho. It ensures that infrastructure like Maqalika Dam complies with national water policies, safety standards, and environmental regulations. Nicol *et al*. (2018) conducted a study of governing water where it focused on institutions, frameworks, and processes in Africa. It was emphasized that the role of central regulatory bodies in ensuring sustainable water governance and inter-agency collaboration while Ostrom, (2009) highlights that effective governance bodies are key in managing common-pool water resources.

Checklist;

- ❖ Describe your role and responsibilities in relation to water infrastructure management in Lesotho.
- ❖ What was the original purpose and design of the Maqalika Dam?
- ❖ key factors or events that led to the abandonment or discontinuation of the Maqalika Dam as a water supply source.
- ❖ Commission's perspective, what were the expected or observed socio-economic consequences of abandoning the dam.

- ❖ Any plan to mitigate the economic impact on communities previously dependent on the dam.
- ❖ Are there known environmental issues currently associated with the abandoned site (e.g., water quality degradation, illegal dumping, biodiversity loss)
- ❖ Was the local community engaged or consulted during the decision to abandon the dam
- ❖ Are there any current or future plans to rehabilitate, repurpose, or manage the Maqalika Dam site?
- ❖ In your opinion, what should be done to improve the situation at the Maqalika Dam site.
- ❖ What policy or institutional reforms would you recommend to avoid similar outcomes in future projects.

- **The department of Environment,**

It is responsible for environmental management and promoting sustainable development in Lesotho. Their insights are important as they can assist with the environmental factors that might have contributed to the dam's abandonment, such as ecological degradation, pollution, or non-compliance with environmental regulations. Brown *et al*. (2024) emphasize the ecological monitoring role of environment departments while Foley *et al.* (2005) detailed how environmental departments must be consulted on land-water interactions and biodiversity threats.

Interview checklist;

- ❖ Key environmental concerns related to the Maqalika Dam prior to its abandonment.
- ❖ Any documented instances of pollution, ecological degradation, or biodiversity loss around the dam.
- ❖ Any environmental regulations that were not complied with during the dam's operational phase.
- ❖ Any departmental assessments and monitoring of the environmental impacts related to the dam.
- ❖ Environmental Impact Assessment (EIA) conducted for the dam either before or after its construction.

- ❖ Environmental sustainability (or lack thereof) in the decision to abandon the dam
- ❖ Any recommendations for environmentally sound repurposing of the dam

- **Maseru City Council,**

As the local governing body, MCC is directly involved in urban management and service delivery in Maseru. Their input will shed light on local governance issues, community engagement, and infrastructural challenges related to the dam. They will also provide historical context on municipal decisions affecting the dam's status. Garcia *et al*. (2021) stresses the role of municipalities in managing public assets and urban services hence their input is crucial.

Interview checklist;

- ❖ MCC's role in the operation of the Maqalika Dam.
- ❖ Municipal challenges either (budget, staffing, infrastructure) that affected dam management.
- ❖ Any local complaints, community demands issues tied to the dam.
- ❖ Historical decisions or policies that has let to dam's abandonment.
- ❖ MCC's current stance or vision on the future use of the Maqalika Dam site.
- ❖ Municipal strategies or plans to revitalize the dam for public benefit.
- ❖ Community-based initiatives or partnerships in repurposing efforts.

- **Department of Water affairs**

DWA manages the quantity and quality of Lesotho's water resources. Their expertise is crucial in understanding hydrological factors, water resource management decisions, and technical issues that may have led to the dam's abandonment. They can also provide data on water usage patterns and resource allocation. FAO (2021) emphasizes the technical expertise needed to address systemic water supply failures.

Interview checklist;

- ❖ Challenges led to the dams discontinue use or neglect.

- ❖ Water quality, inflow outflow, or siltation or sedimentation.
- ❖ Water management or drought mitigation strategies.
- ❖ Records of the dam's water levels, infrastructure condition before and until its abandonment, or operational costs.
- ❖ A role the dam could possibly still play in Maseru city water supply
- ❖ Any rehabilitation, desilting or structural repair feasible.
- ❖ Decentralized or small-scale water storage uses (e.g., for parks, fire services) be possible alternatives if need be.

- **Water and Sewage Company**

WASCO is responsible for the supply of potable water and sewage treatment in urban areas. Their involvement is important as they are in a position to know about the dam operational challenges, maintenance issues, and service delivery problems that may have influenced the dam's functionality and eventual abandonment. Ikezema *et al*. (2025) discuss how operational agencies face challenges balancing infrastructure costs and water quality demands.

Interview checklist;

- ❖ Main issues that have led to the discontinue/abandonment of the Maqalika Dam (financial limitation, staff, infrastructure).
- ❖ Operational challenges.
- ❖ Maqalika dam water quality and reliability.
- ❖ Maintenance and operational costs in comparison to the benefits at the time.
- ❖ Economic potential for reusing the dam into WASCO's water supply system again.
- ❖ Upgrades or operational changes that would be necessary for reuse.
- ❖ Any innovative models or means in a pipeline for revitalization.

3.4.4 OBJECTIVE 4. Identify strategies for sustainable resuscitation of the dam or otherwise.

Desk-top study was conducted to research on what strategies have been adopted in the past by other countries especially dealing with similar case analyzing case studies of similar urban dam

reuse projects such as the one of Hartebeespoort Dam in South Africa to inform local strategies. In addition, the key informants interviewed from objective 3 also shared on what they think can be suitable strategies for sustainable resuscitation of the dam or otherwise.

3.5 Data Analysis

This study used a mixed methodologies approach, employing both qualitative and quantitative research methods. As a result, data processing and analysis entailed summarizing and interpreting the data and information gathered. After data collection, taped interviews were transcribed, and the home survey was captured into the Statistical Package of Social Sciences version 27 software. Qualitative data was primarily obtained with key informants and field observations while quantitative data were obtained from household's survey through questionnaires.

3.5.1 Quantitative data analysis

Numerical data from households' survey were captured using Kobo Collect software and then transferred for analysis in Statistical Package for Social Sciences software version 27 to check on correlation and relationship between variables. After the data collection, was data preparation and analysis. Descriptive statistics was used to analyze the characteristics of the variables then followed by the interpretation of results.

3.5.2 Qualitative data analysis

Qualitative data from structured interviews were examined for contents and were organized into themes to reflect the research objectives that this study sought to answer. Content analysis, which is defined as any technique for drawing conclusions by objectively and systematically detecting specific qualities of messages from texts and/or responses to open-ended questions, was used to analyze the qualitative data that were obtained. Content analysis was identified as the best method for assessing lengthy key informant interview replies by condensing them into a few descriptive words (McNabb, 2008). According to Stemler (2001), words are organized into enormous volumes of text, then into codes, summarized into categories, and possibly tabulated to calculate the frequency of specific concepts or variables.

Using content analysis, Jennings (2005) stated that the analysis can quantify and analyze the presence, meanings and relationships of such main certain words in research questions, themes, or concepts. This includes all interviews, documents, and any other types of research performed such as observations and/or videotaped studies (Stemler, 2001). It can give one comprehensiveness on one's intentions, biases, prejudices, and oversights of those who are collecting the data as well as those interviewed or those who were observed (Harvosen and Palmquist, 1980).

After the collection of quantitative data, reading of interview transcripts was done by quickly browsing through all the transcripts, where notes were made about first impressions. Then reading of the transcripts was done carefully line by line. There were important words from the research questions that were written down, such as socioeconomic impacts, environmental impacts, dam abandonment and also be categorized as themes. Since each interviewee was given responses that differed in words from another though they might actually give the same meaning the codes were drawn from the transcripts. The codes were categorized depending on several reasons. Furthermore, the codes were categorized together to lesser number of categories labeling the number the certain theme appeared and were matched with the theme they belong in. Finally, results were analyzed and discussed.

3.6. Quality assurance

Standard Operating Procedures (SOPs) was developed for all stages of data collection and analysis to ensure consistency and reliability. Comprehensive training was provided for research assistants involved in data collection to ensure they understood protocols. To ensure the validity and reliability of the research findings, several quality assurance measures were put in place throughout the study process. The questionnaire was carefully designed and reviewed by experts in environmental management, socio-economic research, water resource governance, and more importantly, scrutinized by the supervisor, who was an expert in studies involving environmental and socioeconomic issues, as well as household surveys, to ensure that the questions were clear, relevant, and aligned with the study objectives. Trained enumerators were engaged to conduct

household surveys, and they received detailed orientation on ethical data collection, neutrality, and avoiding bias before the commencement of the survey.

3.7. Ethical Consideration

This study strictly adhered to ethical principles in line with international and national research standards. Informed consent was sought from all participants before they got engaged in the study. The purpose of the research, and potential benefits, were clearly explained in the local language, and participants were assured of no risk associated with their involvement which was voluntary. They were assured of the right to withdraw from the study at any time without any penalty. To maintain confidentiality and anonymity Participants were treated with respect and dignity, and sensitive questions were handled with discretion to minimize discomfort.

3.8. Study limitations

Despite the rigorous methodology, the study had a few limitations. First, due to time and resource constraints, the sample size was limited to specific communities near the Maqalika Dam, which affected the generalizability of the findings to other regions. Secondly, some respondents exhibited recall bias, especially when answering questions about the conditions before the dam's abandonment. Additionally, because the study relied partly on self-reported data, potential for subjective bias in assessing socio-economic impacts and environmental changes was not completely ruled out. Another limitation was the occasional difficulty in accessing certain households due to logistical and safety reasons, especially in informal settlements therefore out of 385 sample that was anticipated only 310 were accessible while other scripts were not fully answered. Despite these limitations, the study provided valuable insights into the dimensions of dam abandonment in urban settings such as at Maqalika Dam in Maseru district and contributes to the discourse on sustainable water infrastructure management in Southern Africa sub-region.

CHAPTER 4: RESULTS AND DISCUSSIONS

4.1 Introduction

Chapter 3 discussed the methodology that was used to carry out this research. More specifically, it discussed the design of the study, data collection methods for each objective and data analysis. This chapter (Chapter 4) presents and discusses the results emanating from the collection and analysis of data from the methodology discussed in Chapter 3. For primary data collection, the study used mixed methods, quantitative method through household surveys as well as qualitative method through key informant interviews and field observations.

Household survey was carried with the households that are around the Maqalika dam communities or are at close proximity to the dam, while key informant interviews were carried out with representatives from stakeholders in the water sector or rather those that regulate and monitor the activities in Maseru city such as Maseru City Council. The household questionnaire had four sections, socio-economic characteristics, socioeconomic dimension of the dam activities, environmental implications as well as suggestions and perspectives. Field observations were carried out at the dam both downstream and upstream to observe the physical condition of the dam, noting any signs of deterioration, erosion, or vegetation overgrowth which will add on the analysis of the environmental conditions. The chapter is organized into a number of sections: the socioeconomic characteristics communities, the environmental implications associated with the Dam, primary factors contributing to the abandonment of Maqalika Dam, and finally the remediation strategies that can be implemented to restore the reservoir's ecological balance for resuscitation or repurposing.

4.2 The socioeconomic characteristics of the residents and dimensions of the dam.

The study established the socioeconomic characteristics of the residents around Maqalika dam through administering 310 household surveys from the sample size equation provided in the methodology. Table 4.1 below consists of the summary of characteristics such as gender, age

group, level of education, employment status source of income household income and years lived in the Maqalika dam catchment. Out of 310 households that participated, the percentage of males was 51.9% while females accounted for 48.1% as shown in the table. This near equal gender distribution indicates that the survey adequately captured perspectives from both male- and female-headed households, thereby strengthening the representativeness of the socioeconomic data for communities surrounding the abandoned Maqalika Dam.

The balanced distribution also reflects the peri-urban nature of the study area, where migration and settlement patterns often result in more equitable gender representation compared to predominantly rural catchments. Similar trends were observed in earlier studies of the Maqalika catchment, which highlighted its mixed land-use and peri-urban character by (Rowntree, Ntsaba and Weaver, 1991). However, national level analyses in Lesotho have reported a higher proportion of male-headed households (Mturi, Makatjane and Molise, 1999; Makatjane, 2011), suggesting that the Maqalika context diverges from broader national patterns. Despite this parity in household headship, gendered roles around domestic responsibilities and access to resources such as water remain critical (World Bank, 2024). These findings imply that while household headship appears evenly distributed, disaggregated analysis is still necessary to uncover underlying inequalities in livelihoods and resource access that may persist around the abandoned Maqalika Dam.

Table 4.1: The socioeconomic characteristics of the residents

Gender	**Frequency**	**Percentage %**
Male	161	51.9
Female	149	48.1
Total	**310**	**100.0**
Age Group		
18-24	6	1.9
25-34	102	32.9
35-44	118	38.1
45-54	54	17.4
55-64	22	7.1
64+	8	2.6
Total	**310**	**100.0**
Level of Education		
No formal Education	2	0.6
Primary	14	4.5
Secondary	90	29.0
Tertiary	204	65.8
Total	**310**	**100.0**
Employment Status		
Employed full time	130	41.9
Part time	10	3.2
Self Employed	14	4.5
Unemployed	100	32.3
Student	54	17.4
Retired	2	.6
Total	**310**	**100.0**
Source of Income		
Formal Job	132	42.6
Informal work	12	3.9
Corporate Business	8	2.6
Farming	102	32.9
Social grants	56	18.1
Total	**310**	**100.0**
Household income		
<M1000	16	5.2
M1000-M1999	120	38.7
M2000-M4999	110	35.5
M5000- M9999	56	18.1
M100000- M19999	8	2.6
Total	**310**	**100.0**
Years lived		
<1 year	6	1.9
1-5 years	62	20.0
6-10 years	90	29.0
Over 10 years	152	49.0
Total	**310**	**100.0**

Source: Field Data Analysis, 2025

The age group that has the highest percentage is 35-44 years with 38.1% and lowest heads of the house hold age group being 1.9% while the age group of 64 year or more was found to be 2.6%. It was further found out that 65.8 % of respondents went to tertiary education while only 0.6% had no formal education. Household size ranged from 1 member per household to 7 members per house hold as shown on the pie chart (Figure 4.1) below, there are 10 households with 1 member, 44 households with 2 members and others.

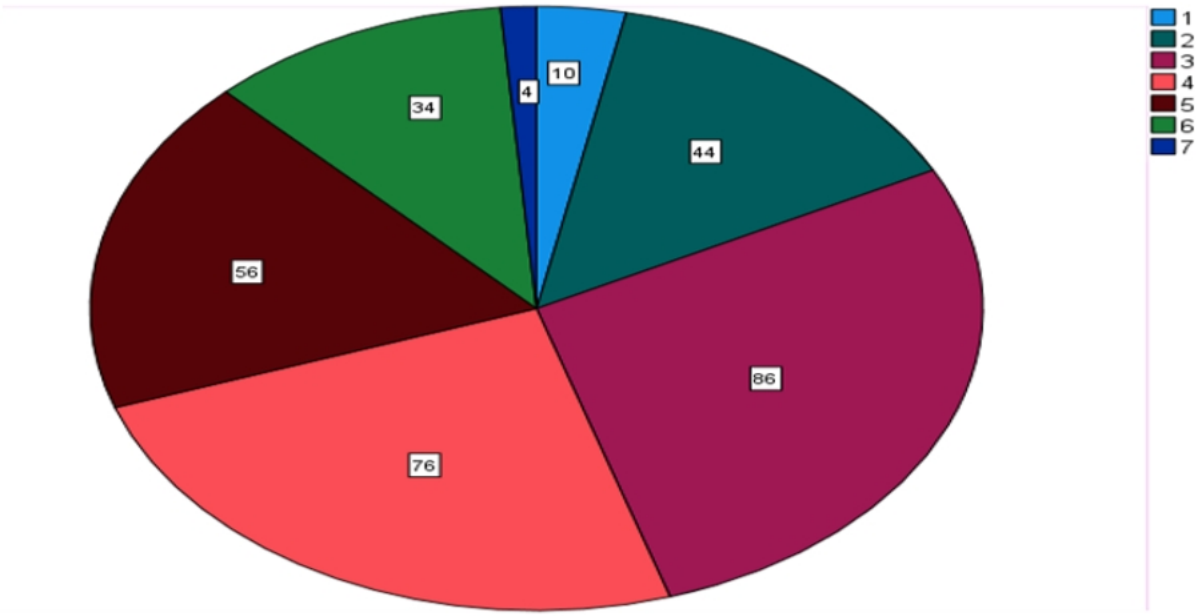

Figure 4.1 House hold size proportions **Source:** Field Data Analysis, 2025

The Maqalika Dam provided the residents with different benefits, such as using the dam water for irrigation, fish farming, brick laying, livestock watering and tourism. Figure 4.2 to 4.6 below show how residents/households used to benefit from the dam before the abandonment. Approximately 42% of people benefitted from dam water for irrigation, 13.6% for fishing, 5.8% for brick making for their small businesses while 31.6% benefited through livestock watering. Therefore, as a result of the dam abandonment, their house hold income changed even though it was only 55.48% of the respondents who got impacted. Since the majority of the respondents were employed full time maybe they fall under proportions of the respondents who were not sure if their house hold income was impacted. These findings are similar with Selimo (2020); Fan et al.

(2022) where they found out that the surrounding communities of the abandoned Hartebeespoort in South Africa suffer economic setbacks due to loss of livelihoods (fishing, irrigation) and increased health costs linked to waterborne diseases leading to a complete household change (Selimo, 2020; Fan et al., 2022).

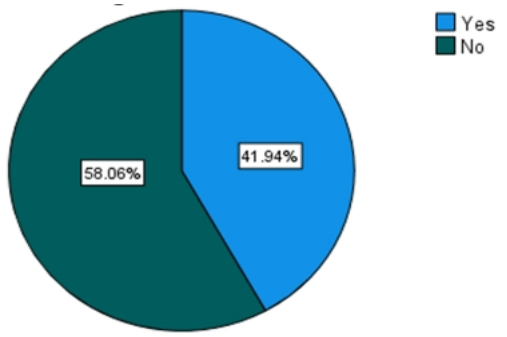

Figure 4.2 Proportions (%) of Irrigation as a benefit

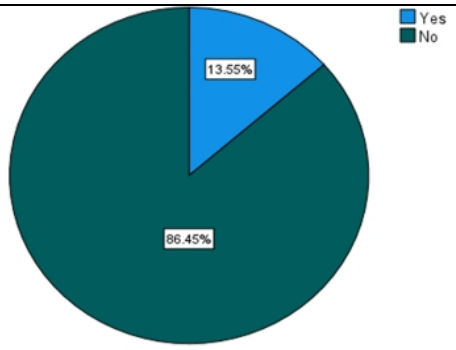

Figure 4.3 Proportions (%) of fish farming as a benefit

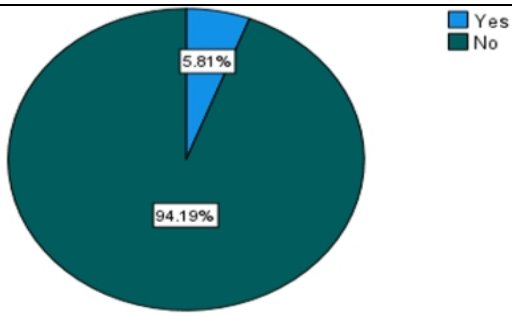

Figure 4.4 Proportions (%) of brick making as a benefit.

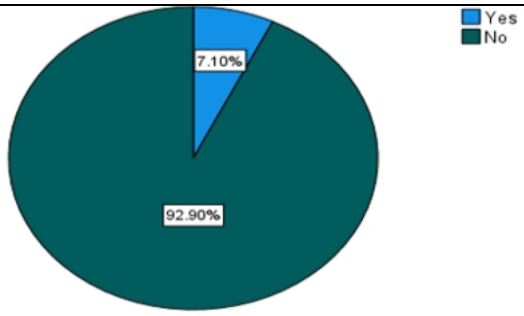

Figure 4.5 Proportions(%) of tourism as a benefit

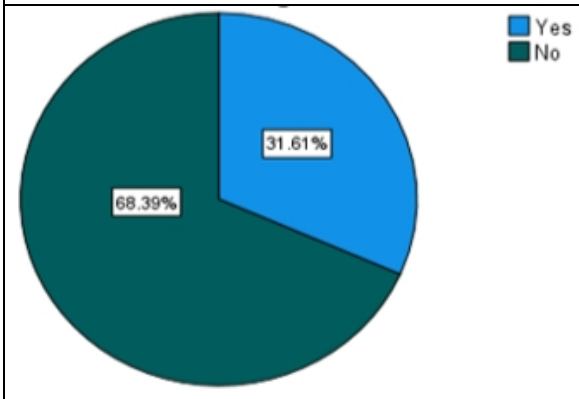

Figure 4.6 Proportions (%) of livestock watering as a benefit.

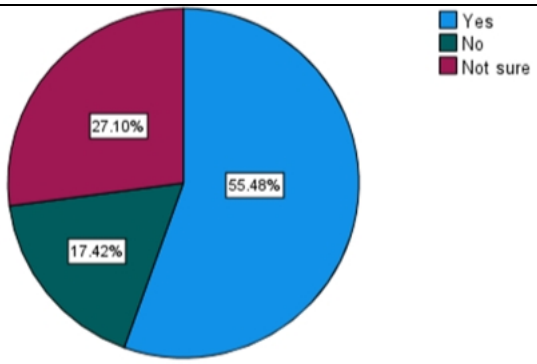

Figure 4.7 Household change due to dam abandonment.

Source: Field Data Analysis, 2025

Table 4.2 below presents the challenges the households face since the abandonment such as the lack of water, (49.7%) even though there is an alternative source of water which is Metolong dam that is recently used for abstraction of water for treatment for domestic water supply. The lack of water in this case might necessarily not be linked to the abandonment of the dam rather to other issues such as climate change during dry season when the water dries up or sometimes the water gets cut due to maintenance of distribution system. Only small percentage of respondents experienced reduced productivity, this productivity can be linked to agricultural productivity, fishing and tourism as hotels around the dam catchment used to accommodate the tourists coming to the Maqalika dam and now such has changed.

Table 4.2 Challenges faced to sustain economic activities.

Challenges	Frequency	Frequency %
Lack of water		
Yes	154	49.7
No	156	50.3
Total	**310**	**100.0**
Loss of land		
Yes	8	2.6
No	302	97.4
Total	**310**	**100.0**
Reduced Productivity		
Yes	96	31.0
No	214	69.0
Total	310	100.0
Increased costs		
Yes	120	38.7
No	190	61.3
Total	**310**	**100.0**

Source: Field Data Analysis, 2025

Similarly, Chanza and Musakwa (2022) observed that abandoned dams in Southern Africa tend to result in reduced water access, declining land values, and missed economic opportunities. This can be viewed from a governance perspective, weak institutional coordination, fragmented policies, and lack of community engagement have been linked to poor dam management and eventual abandonment (Nicol *et al*., 2018; Schulz & Adams, 2019).

4.3 The environmental dimensions associated with the Dam

The environmental dimensions were established through the household's survey. Among the questionnaire options, there was the question on environmental changes that the house hold head observed since the abandonment of the dam. Table 4.3 below shows the situation of

environmental changes associated with the abandoned dam, including an overgrown vegetation, solid waste dumping, smell or pollution, mosquitoes and also whether the environmental situation seem to be a public health concern. Over 77.4% of the respondents indicated overgrown vegetation along the dam as a major environmental change (Figure 4.8). The more vegetation that is mostly overgrown is Azolla species which is believed to grow in water where there is high concentration of nutrients such as phosphorus and nitrates for it to grow. According to Miranda et al. (2016) the development of Azolla filiculoides in synthetic wastewater resulted in a 25, 69, 24, and 40% reduction in NH_4-N, NO_3-N, PO_4-P, and selenium, indicating that the plant species feeds on the aforementioned wastewater components. This resulted in a 2.6-fold reduction in wastewater toxicity to shrimps, which are common inhabitants of wetlands (Miranda et al. 2016). The studies show that the presence of such plant species indicates that there is water pollution.

Table 4.3 Environmental changes and implications

Environmental Changes	Frequency	Frequency %
Overgrown Vegetation		
Yes	240	77.4
No	70	22.6
Total	310	100.0
Waste dumping		
Yes	248	80.0
No	62	20.0
Total	310	100.0
Erosion		
Yes	16	5.2
No	294	94.8
Total	310	100.0
Smell or Pollution		
Yes	292	94.2
No	18	5.8
Total	310	100.0
Flooding		
Yes	10	3.2
No	300	96.8
Total	**310**	**100.0**
More Mosquitoes		
Yes	142	45.8
No	168	54.2
Total	**310**	**100.0**
Dam been Public health Concern		
Yes	250	80.6
No	6	1.9
Not Sure	54	17.4
Total	**310**	**100.0**
Visible Signs of Pollution		
Yes	260	83.9
No	50	16.1
Total	310	100.0
Aquatic life change		
Yes	236	76.1
No	74	23.9
Total	**310**	**100.0**
Environmental State of the dam		
Very poor	192	61.9
Poor	116	37.4
Fair	2	.6
Good		
Very Good		
Total	**310**	**100.0**

Source: Field Data Analysis, 2025

On Figure 4.9 below it can be seen that 80% of the population agree that there is dumping of solid waste in the Maqalika Dam. In support of the dumping of waste challenge, the Plate 19 is the picture that was captured during field observation where it was observed that different types of solid waste which seemed to be mostly house hold waste was dumped along the dam. Abandoned dams often become pollution hotspots, encourage biodiversity loss, and pose public health risks (Brown et al., 2024).

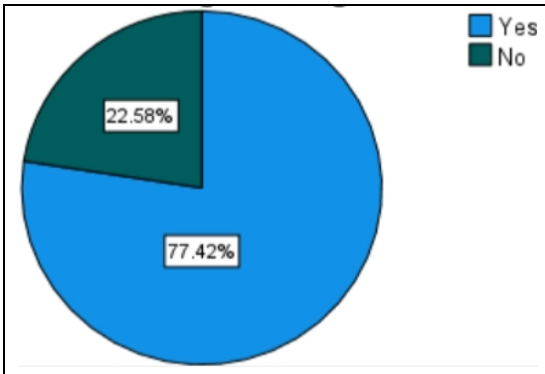

Figure 4.8 Proportions of Overgrown Vegetation

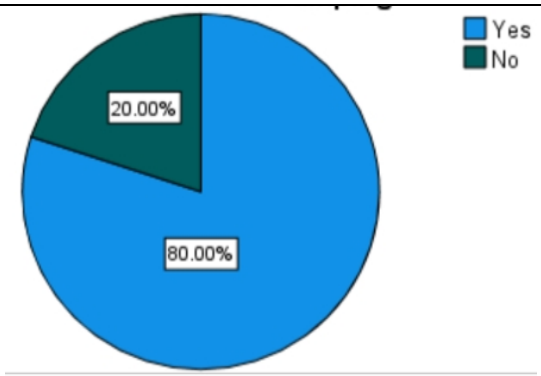

Figure 4.9 Proportions of Waste Dumping

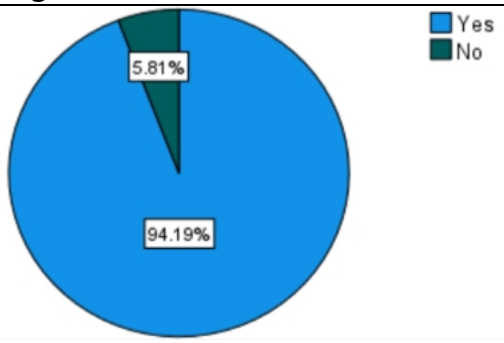

Figure 4.10 Proportions of bad smell encounter

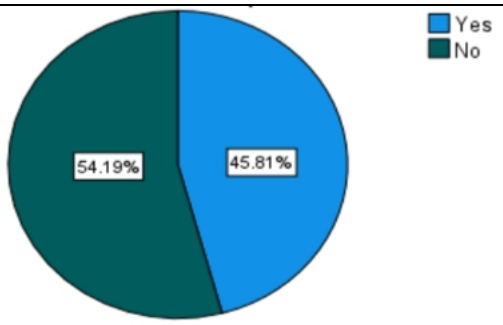

Figure 4.11 Proportions of Mosquitoes encounter

Source: Field Data Analysis, 2025

Plate 4.1 Overgrown Vegetation along the Dam and at Spillway. **Source:** Author (2025)

Plate 4.2 Solid waste dumping along Maqalika Dam. **Source:** Author (2025)

One of the questions under environmental implications section was on whether the dam environment has become a public health concern and 80.65% responded yes to the question due to the obvious pollution signs that they observe around the area. Majority of respondents stated that the dam water has an awful smell which was also proved during field observation. Masupha (2005) analyzed the physico- chemical properties of water and compared the results with WHO and SABS. Nitrates, phosphates, and faecal coliform levels were discovered to be significantly higher than minimum criteria, indicating that the water was highly contaminated, with the source being leaking sewers, defecation in dongas, and leachate from the Ts'osane and Lower Thamae dumping sites. Iron levels were likewise excessive, with mean values greater than 0.3mg/l, and the cause was leachate from dumping sites, improper scrap disposal, and minerals from the soil. Furthermore, Selimo (2020) measured arsenic, lead, and zinc levels in both sediments and the gills of Cyprinus carpio (common carp), which were higher than WHO guidelines.

Furthermore, in 2023, the Water and Sewage Company (WASCO) issued an alert warning the nation about a huge number of fish discovered dead in Maqalika Dam; please see Plate 4.3 below. The Ministries of Water Affairs, Natural Resources, Environment, and Agriculture joined together to combat the disease. Representatives from these ministries gathered water samples and dead fish for disposal and testing in Maqalika. Awareness campaigns on the potential dangers of eating fish from the dam were launched, warning the community against polluting the facility, which

poses a risk to human health. According to reports, fishermen who made a living by fishing at Maqalika Dam were afraid that the dam's closure would have a significant impact on their business because they would be unable to fish and sell their catch. It was not confirmed whether the pollution was caused by water flowing from streams over the dam. This message cautioned the nation to avoid swimming, fishing, and bringing animals to drink this water because tests have yet to determine the causes of the fish's mass death.

However, during field observation, it was observed that the community members are still fishing in the Maqalika dam which is now posing a threat to the lives of the people some minerals and heavy metals such as lead are linked to diseases such as cancer therefore, it is no longer safe to be fishing from the dam.

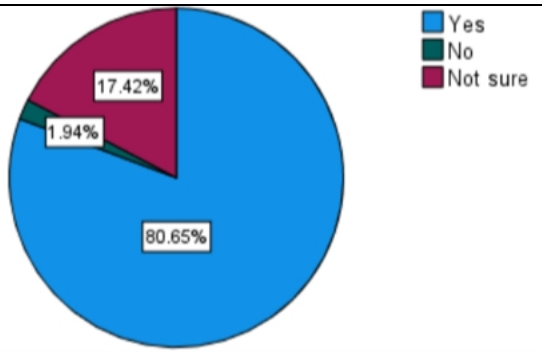

Figure 4.12 Proportions of Public Health Concern

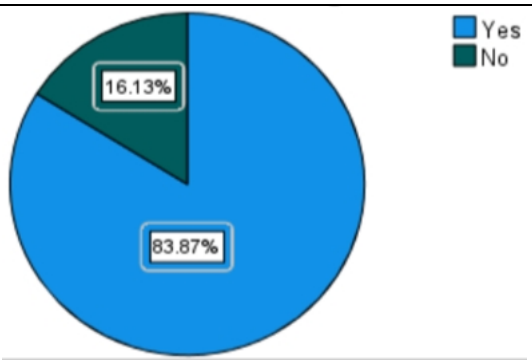

Figure 4.13 Proportions of Pollution Signs

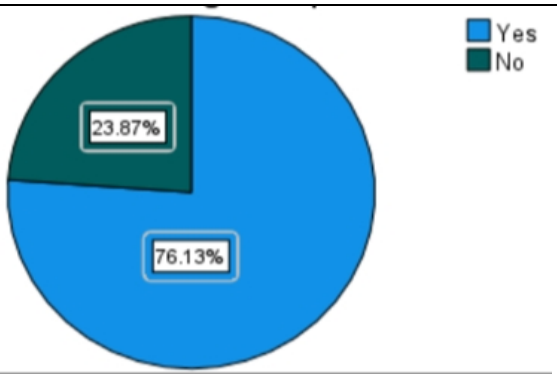

Figure 4.14 Proportions of changes in aquatic life.

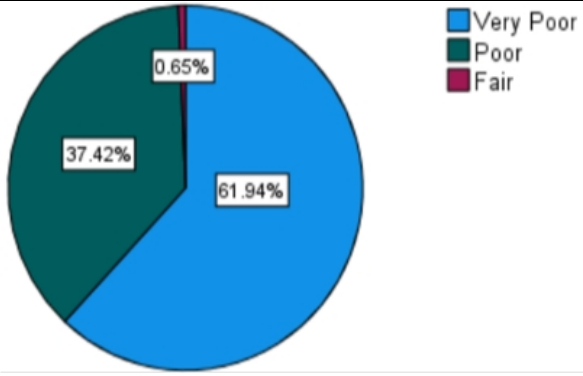

Figure 4.15 Environmental state proportions

Source: Field Data Analysis, 2025

Plate 4.3 Dead fishes at Maqalika dam in 2023. **Source:** Pulane (2023)

4.4 The primary factors contributing to the abandonment of Maqalika Dam

To establish factors contributing to the abandonment of Maqalika Dam, key informants interview was conducted with the relevant authorities used to utilize the Maqalika dam as a water source. Until recently, water is no longer abstracted for treatment from the dam. When the Participant 1 addressed the question of the factors that has led to Maqalika dam abandonment, he had this to say:

> *Participant 1. "When Maqalika was first constructed Maseru pollution was not high like today. Due to population growth there has been many industrial activities, mechanical workshops for fixing cars, the livestock and piggery farmers just to mention but a few in the Maqalika catchment… there is also Ts'osane landfill upstream of the dam of which the leachate join the rivers into the dam, the residents dump both animal waste and solid waste into dam and all those activities degraded the water quality of the dam to a point whereby it became very expensive for us to treat such as it had high concentrations of water quality parameters… on the note, the quantity was also not enough anymore to supply the whole city as the water levels used to go down to a point we now we would see it's a very dirty water with a lot of impurities and smell"*

What can be deduced from the extract is that, the main factor that has contributed to the Maqalika dam discontinued use or abandonment is population growth that has let the dam to be

in a densely populated area which has let to different activities such as mechanical workshops, Ts'osane dumpsite and farming systems along the dam or rather the whole catchment polluting the dam. Plate 4.4 below clearly shows how dense the dam area is with residents while Plate 4.5 shows the Ts'osane dumpsite which is believed to also having a negative impact towards the quality of the dam.

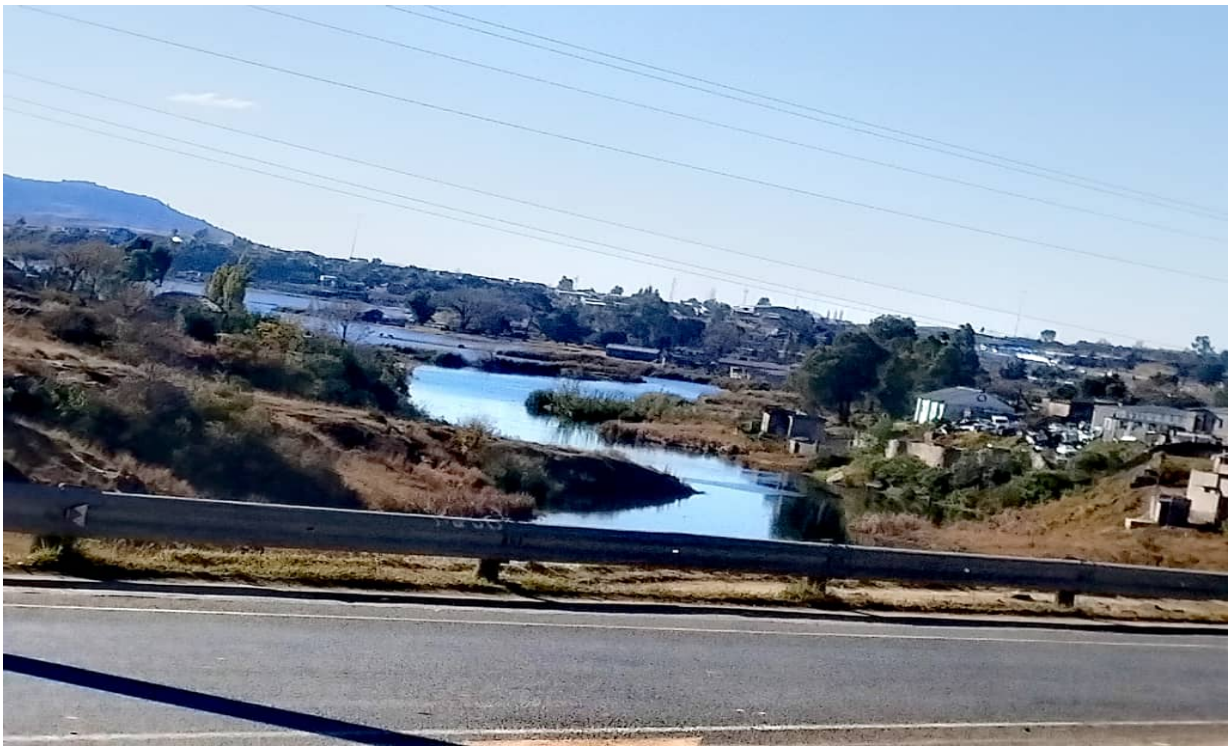

Plate 4.4. Maqalika Dam Upstream. **Source:** Author (2025)

Plate 4.5 Ts'osane dumpsite. **Source:** Lena (2024)

According to Luqman (2024), surface water contamination occurs in three ways: naturally, inadvertently, and intentionally. It is a natural phenomenon such as flooding or tsunamis gather up fertilizers, pesticides, debris, and other contaminants, resulting in surface water pollution; and inadvertently, oil spills and agricultural runoff, when pollutants from farms and fields find up in surface water. Some industries may purposefully dump garbage straight into waterways, resulting in surface water contamination, which eventually harms both the human population and marine life (Luqman, 2024). As a result, the pollution generated by the Maqalika dam appears to be primarily purposeful on the part of Maseru City residents, particularly those residing near the dam.

The *Participant 2* gave a similar view on the people intentionally polluting water. This is what the representative had to say;

> *Participant 2. "The challenges we have with Maqalika dam is people dumping both solid and liquid waste into the dam, especially those unlicensed sewage truck, the community around even people from outside the dam area. We sometimes place a police officer to guard the area unfortunately it will be quite for that particular time then they start immediately the police officer leave the place. Some residents pit latrines disposes directly*

into the dam as they open at the back, some wash their piggery houses flushing the animal waste straight into the dam."

From the extract it can be seen that intentional pollution is the one polluting the dam leading to abandonment or discontinued use.

4.5 The remediation strategies that can be implemented to restore the reservoir's ecological balance for resuscitation or repurposing

Table 4.4 below presents data on remediation strategies for restoring the reservoir's ecological balance where 310 respondents evaluated each strategy on a scale of 1 = Strongly disagree to 5 = Strongly agree during the house hold survey conducted.

Table 4.4: The extent to which the following solutions or strategies can be used.

	N	Minimum	Maximum	Mean	Std. Deviation
Complete Abandonment/Conversion	310	1	4	2.47	0.912
Resuscitation	310	2	5	3.58	0.652
Complete Overhauling	310	1	5	3.56	0.738
Waste Management Systems	310	3	5	4.24	0.456
Participatory Decision Making	310	3	5	4.04	0.568
Eco-tourism and recreation	310	2	5	3.76	0.729
Clarify land use policies	310	3	5	4.1	0.589
Enforce Environmental Regulation	310	3	5	4.36	0.52
Water Quality monitoring systems	310	4	5	4.36	0.481
Valid N (list)	310				

Source: Field Data Analysis, 2025

1= Strongly disagree, 2 = Disagree, 3 = Indifferent, 4= Agree, 5= Strongly Agree

Highest rated Strategies which is the most agreed upon by respondents is water quality monitoring systems with mean = 4.36 and standard deviation (SD)= 0.48. It had highest mean and lowest standard deviation which shows strong consensus as most respondents leaned toward agree and strongly agree. This is probably due to it being a key priority due to its important role in tracking ecological health of the water resources. Enforcement of environmental regulation with

mean = 4.36, SD = 0.52. which shows the high support for strict policies to protect the reservoir's ecosystem. The respondents really agreed to having overhauled land use policy with a mean score of 4.10 and SD = 0.59. Participatory decision-making with mean = 4.04, SD = 0.57 indicates strong recognition of involving local stakeholders in planning processes. There is a focus on a variety of detrimental social-ecological and economic repercussions on persons living near dams, their livelihoods, and ecosystems, as well as their lack of participation in decision-making processes (Atkins, 2019, Garcia *et al*., 2021, Mayer *et al.,* 2022). According to the World Commission on Dams (WCD), dam management units should include actors from various backgrounds (local communities, governments, academia, industry, and countries) (Schulz and Adams, 2019).

In 2000, WCD delivered a final report outlining strategic priorities for sustainable dam construction and maintenance, emphasizing the importance of including local players, particularly the community, in decision-making. The report supported participatory decision-making in dam planning, design, and operation (Schulz & Adams, 2019). The African Development Bank and the German KfW Development Bank have implemented the recommendations (Scheumann and Hensengerth, 2014; Schulz and Adams, 2019). Furthermore, WCD has played a critical role in legitimizing social movements around dams, raising awareness about the need for more participatory processes, and bringing to light the social and ecological impacts of dams on people's livelihoods.

Moderately endorsed strategies. are waste management systems. with mean = 4.24, SD = 0.46. It is well supported, as it reflects the importance of controlling pollution especially because the residents had shown that there is a lot of intentional pollution. Eco-tourism and recreation as well as resuscitation followed as they are both above neutral seen as beneficial but with more varied opinions. Complete overhauling with mean = 3.56, SD = 0.74 shows mixed sentiment, likely due to concerns about cost, complexity, or feasibility. The least preferred strategy which is the complete abandonment or conversion with mean = 2.47 and SD = 0.91, the respondents disagree with abandoning the reservoir or completely altering its function and also standard deviation of 0.9 shows highest spread reflecting the most varied opinions on this drastic option.

During the key informants interview, the popular response from several representatives such as from Department of Water Affair, Lesotho Water Commission as well as Water and Sanitation

Company and Department of Environment when responding to the question of what strategies or rather innovative models can be used was to revitalize the dam was that it can be used for recreational activities, wildlife conservation, fish farming provided their critical path analysis is done, that is, finding the roots where exactly the problem such as both solid and liquid waste stem as there are many activities taking place in the catchment as well as maintaining the existing water and sewage pipeline. It was further highlighted that as stakeholders in the water sector they plan to have a solid plan to guide them in the better management of Maqalika dam.

In line with the World Commission on Dams (WCD) framework and as highlighted by Schulz and Adams (2019), participatory decision-making must be institutionalized by including MCC and community representatives in planning for dam revitalization. The following Figure 4.16 is a proposed management structure with emphasize from the literature. The structure has 9 activities and shows logical dependencies between them through using arrows. Each node represents a key activity or decision for Maqalika Dam's revival, and is linked to the appropriate institutions. As a first step the LWC sets policy direction, is further proposed to facilitates stakeholder engagement, and allocates funds or mobilizes donor support. First step of critical path initiation should be led by LWC, with members from WASCO, MCC, Department of Water Affairs (DWA), and Department of Environment (DOE) where responsibilities are discussed and well defined generating plans for next activities. Secondly, pollution source mapping through Identify all pollution inputs (solid waste, sewage, runoff) using GIS, fieldwork, and surveys should be done where eventually there will be clear baseline data showing what, where, and who is polluting. Feasibility study (technical assessment) which can be led by Department of Water Affairs finding the possible means such as siltation analysis, structural assessments, cost-benefit analysis, as well as reuse options (irrigation, aquaculture) just to mention the few. Environmental Cleanup Actions can be led by MCC and DOE through removing dumped waste, Block illegal sewage channels from identified pollution hot spot, installation of fencing, as well as ecological restoration.

Institutional and financial planning can be led by LWC, Ministry of Finance and WASCO where plans may include Public-private partnerships (PPP), Seeking donor grants (e.g., AfDB, GIZ, UNEP) where budget for infrastructure work is planned. WASCO in collaboration with DWA should plan

and execute the actual construction/rehabilitation which may include activities such as desilting through dredging, repairing channels or valves around the dam as well as installing water quality monitoring systems. Community engagement and training led by MCC in collaboration with NGOs can train local groups on the importance of infrastructure management, responsible water use, clean-up campaigns, proper waste disposal practices and monitoring. Sustainable Reuse Plan Implementation options based on feasibility study recreational park, fish farming, irrigation project, emergency water storage.

Critical Path-Based Management Structure: Maqalika Dam Resuscitation.

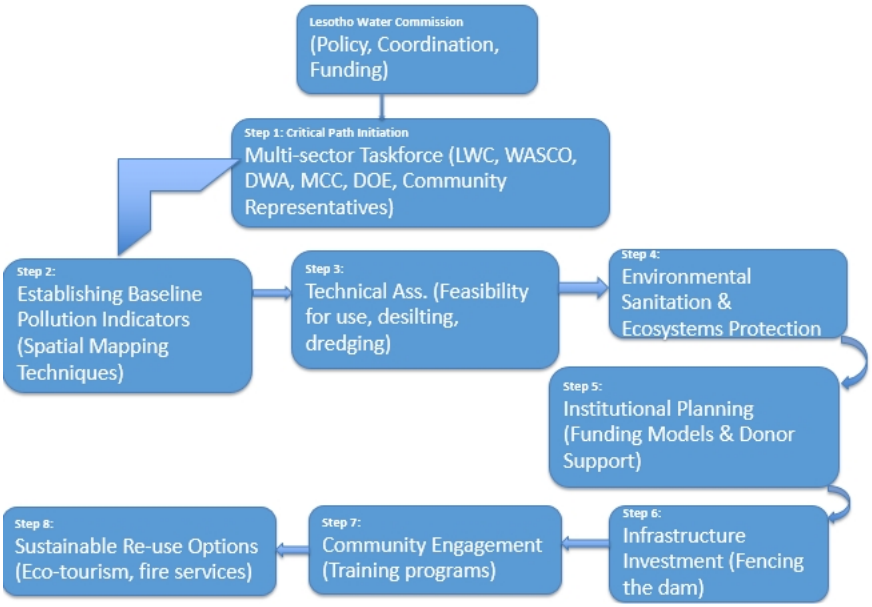

Figure 4.16 Critical Path-Based Management Structure. Source: Author, 2025

4.6 Hypothesis Validation: Socioeconomic and Environmental Dimensions

The guiding hypothesis of this study stated that the discontinued use and abandonment of Maqalika Dam has implications for socioeconomic development and environmental sustainability of the surrounding communities. The results presented in this chapter strongly support this hypothesis. On the socioeconomic side, the household survey revealed that 55.5% of respondents reported that their household income had been affected by the dam's abandonment, particularly those who had previously benefitted from irrigation (42%), fishing (13.6%), brick making (5.8%), and livestock watering (31.6%) (see Figures 4.2–4.6). Furthermore,

38.7% of households indicated increased costs, while 31% reported reduced productivity as a result of the dam no longer being functional (Table 4.2). These findings confirm that the abandonment undermined livelihoods and limited economic opportunities in the catchment.

On the environmental side, the survey data showed that 77.4% of respondents observed overgrown vegetation, 94% noted solid waste dumping, and more than 80% considered the dam a public health concern due to foul smells, mosquito breeding, and pollution (Table 4.3; Figures 4.8–4.11). Field observations further confirmed eutrophication, waste accumulation, and fish mortality incidents recorded in 2023, highlighting severe ecological degradation and declining ecosystem services. Taken together, these findings validate the guiding hypothesis by demonstrating that the abandonment of Maqalika Dam has negatively affected both the socioeconomic well-being of the surrounding communities and the environmental sustainability of the catchment. The results highlight the dual burden of lost livelihoods and environmental decline, underscoring the urgent need for integrated strategies to either rehabilitate or sustainably repurpose the dam site.

4.7 Summary of findings

In summary dam abandonment has led to severe socioeconomic conditions such as household income change, lack of water, loss of land, reduced productivity, increased costs and environmental deterioration, including grown algae, dumped solid waste, overgrown vegetation, smelling water and dead fish that were encountered in 2023. of which the root cause seems to be pollution from urbanization and industrial waste, septic leakage, agricultural runoff, and declining inflows rendered the dam impractical for water supply. Nearly half of households faced water scarcity or reduced productivity. While unemployed households were mostly affected, the overall loss of dam-based livelihoods is significant. There was an environmental crisis with high levels of pollution, vegetation overgrowth, and public health threats validated by both survey and water-quality data from other researchers signaling alarming degradation. Remediation or strategies mostly preferred are governance, water quality monitoring, community engagement, policy clarity, and better waste management systems are top priorities. Structural overhaul and eco-tourism are potential secondary options but warrant thorough analysis. People from house hold survey and key informants or rather stakeholder generally believe the dam should not be

abandoned or completely restructured unless there's a strong, well-justified reason to do so. It’s not a favored choice, and any move in that direction would require substantial community consultation and solid evidence to gain support.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Chapter 4 presents, discusses, and summarized the key findings of the study on the socioeconomic and environmental implications of the abandoned Maqalika Dam. This chapter draws conclusions aligned with the study's objectives and research questions. It further provides policy and practice-oriented recommendations as well as areas for future research to enhance sustainable management of urban water infrastructure.

5.2 Conclusions

This study aimed to assess the socio-economic and environmental implications of the abandoned Maqalika Dam in Maseru, Lesotho. It was guided by the following four objectives; To appraise the socio-economic dimensions of the dam on the well-being of the surrounding communities, to analyze the environmental implications associated with the abandoned dam, to examine the factors that led to the dam's abandonment as well as identifying strategies for sustainable resuscitation or repurposing

Findings revealed that Maqalika Dam once supported livelihoods through irrigation, livestock watering, brickmaking, fishing, and eco-tourism. However, following abandonment, these livelihood activities declined. Approximately 55.5% of households indicated reduced household income. Unemployment and increased costs were reported by 38.7% of respondents. Fishermen were among the most affected, citing total income loss. Despite Metolong Dam now serving as an alternative water supply, residents still experience water scarcity, especially during dry seasons. The community's socio-economic vulnerability has been exacerbated due to lost livelihood opportunities and health concerns. The dam's abandonment has led to significant negative socio-economic impacts, particularly on low-income households that depended on it for subsistence or informal income generating activities.

Over 80% of respondents noted increased solid waste dumping, overgrown vegetation (including Azolla sp.), foul odors, and visible pollution in and around the dam. These conditions have raised public health concerns, especially after the 2023 incident of dead fish. The dam has become a breeding ground for mosquitoes, and 80.6% of households now consider it a public health threat.

The environmental quality of Maqalika Dam has drastically deteriorated, indicating ecological degradation, loss of aquatic life, eutrophication, and increasing health risks to adjacent communities.

Key informant interviews with regulating bodies, and other relevant authorities highlighted that pollution from unregulated human activities including dumping of waste, discharge from illegal sewage lines, and industrial runoff overwhelmed the dam's natural and infrastructural capacity. Additionally, sedimentation and declining inflow made water treatment economically unviable. The dam's abandonment was driven primarily by anthropogenic pollution, lack of enforcement, urban encroachment, and institutional failure in maintaining water quality and infrastructure.

Community members and key informants suggested that the dam still holds potential for reuse in non-potable functions such as recreation, fish farming, or eco-tourism. Survey results showed strong agreement (mean = 4.36) for the introduction of water quality monitoring systems and enforcement of environmental regulations. Stakeholders also emphasized participatory decision-making, improved waste management, and clear land-use planning. There is strong community and institutional support for rehabilitating or repurposing the dam. Restoration should be evidence-based and inclusive of all stakeholders including the community, focusing on long-term sustainability and social benefit which is also supported by critical path management structure proposed for repurposing.

5.3 Recommendations

5.3.1 Recommendations for Policy and Practice

In view of the above findings, the following suggestions are proffered:

a) There is a need to strengthen pollution control and waste management practices through implementation and enforcement of by-laws and regulations that prohibit illegal dumping and sewage discharge along the dam as well as establishing formal waste collection and treatment facilities around the communities with close proximity to the dam.

b) Rehabilitation and monitor water quality through introduce real-time water quality monitoring systems to detect pollutants early and support timely intervention should be done.

c) Developing a multi-stakeholder resuscitation plan involving community members, NGOs, government departments, and the private sector in considering converting the area into a green space or recreational zone is recommended.

d) There's a need to conduct technical assessments for structural repairs, desilting, and the possible use of the dam for irrigation or storm water management.

e) Awareness and community education initiates campaigns targeting residents on the environmental and health consequences of pollution should be implemented as well as engaging schools and local leaders in sustainable water practices.

f) Exploring eco-friendly income-generating options such as fish farming, nature parks, and community-managed recreation should be put into consideration.

g) Strengthen institutional coordination through improving collaboration among WASCO, MCC, DWA, and the Department of Environment to integrate water governance, land use, and urban planning is recommended.

5.3.2 Recommendations for Further Research

Given some limitations of the study, and the need to further explore the issue of abandonment, future research may focus on:

a) Pollution source mapping and tracing through conducting hydrological and pollution-path studies to identify and eliminate primary pollution entry points.

b) Assessment of the technical and financial feasibility of turning the dam into an alternative use such as decentralized water system, retention basin, or storm water storage facility.

c) Health Impact Assessment research should be conducted through a public health risk assessment to quantify health burdens from dam pollution, especially around heavy metals, pathogens, and vector-borne diseases.

d) The research should be conducted on the evaluation of existing governance structures and propose a legislative or institutional reform model to prevent future dam abandonment in urban settings.

e) Research on exploration of community perceptions, willingness to pay, and preferred outcomes under different dam repurposing scenarios.

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APPENDICES

Appendix 1. Introduction letter for data collection

THE NATIONAL UNIVERSITY OF LESOTHO

Tel: +266 52213871
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Email: nulwi@nul.ls

P.O Roma 180
Maseru
Lesotho

WATER INSTITUTE

6th June 2025

To whom it may concern

Dear Sir/Madam

RE: Support for Student Data Collection

This letter serves to confirm that Rosemary M. Maloisane, a student enrolled in the Master of Science Programme in Integrated Water Resources Managementat the National University of Lesotho Water Institute, is conducting research as part of her academic requirements.

We support Ms Maloisane in her efforts to collect data relevant to her study. While we encourage the student to handle all data responsibly and maintain confidentiality, we have advised Ms Maloisane that appropriate care be taken to ensure data security and ethical standards throughout the research process. We therefore trust that Ms. Maloisane will uphold the highest standards of academic integrity and professionalism throughout her research.

We appreciate your cooperation and support in facilitating Ms. Maloisane's research activities and look forward to the successful completion of her study. Thank you for your assistance

Sincerely,

Dr. Mamohau Thamae (The Director)

NATIONAL UNIVERSITY OF LESOTHO
06 JUN 2025
WATER INSTITUTE

Appendix 2. Household survey sample

THE NATIONAL UNIVERSITY OF LESOTHO

Household Survey Questionnaire

Interviewers name	
Date	

Study Title: Socioeconomic and Environmental Dimensions of an Abandoned Maqalika Dam, Maseru.

Dear respondent

A study is being conducted on the subject above. Please, kindly spare a few minutes to help complete a survey on the study. The data obtained will purely be used for academic research. All information obtained will be treated in confidence.

Section 1: Socio-Economic Characteristics

1.1 What is your gender? ☐ Male ☐ Female ☐ Other

1.2 What is your age group? ☐ 18–24 ☐ 25–34 ☐ 35–44 ☐ 45–54 ☐ 55-64 ☐65+

1.3 What is your highest level of education? ☐ No formal education ☐ Primary ☐ Secondary ☐ Tertiary

1.4 What is your current employment status? ☐ Employed full-time ☐ Part-time ☐ Self-employed ☐ Unemployed ☐ Student ☐ Retired

1.5 What is your primary source of income? ☐ Formal job ☐ Informal work ☐ Corporate Business ☐ Farming ☐ Remittances ☐ Social grants

1.6 Monthly household income?
☐ <M100 ☐ M1000–M1999 ☐ M2000–M4999 ☐ M5000-M9999 ☐ M10000 – 19999 ☐ M20000+

1.7 How many people live in your household? _____ (Number)

1.8 How long have you lived in this area? ☐ <1 year ☐ 1–5 years ☐ 6–10 years ☐ Over 10 years

Section 2: Socioeconomic Dimension of the Dam Activities

2.1 Before the dam was abandoned, did your household benefit economically from it?
☐ Yes ☐ No

2.2 If yes, how? (Tick all that apply):

☐ Irrigation farming

☐ Fishing

☐ Brick-making

☐ Livestock watering

☐ Tourism/other services ☐ Other: _____

2.3 Has the dam's abandonment affected your household income? ☐ Yes ☐ No ☐ Not sure

2.4 If yes, how has your income changed? ☐ Decreased significantly ☐ Decreased slightly ☐ No change ☐ Increased slightly ☐ Increased significantly

2.5 Did you have to change or stop any economic activity because of the abandonment? ☐ Yes ☐ No

2.6 What are the current sources of livelihood for your household? ☐ Formal job ☐ Informal work ☐ Farming ☐ Casual labor ☐ Business ☐ Other: _____

2.7 What challenges have you faced in sustaining economic activities? Tick all that apply

☐ Lack of water

☐ Loss of land

☐ Reduced productivity

☐ Increased costs

☐ Other: _____

Section 3: Environmental Implications

3.1 Have you observed any environmental changes since the dam was abandoned? ☐ Yes ☐ No

3.2 If yes, what changes have you noticed? (Tick all that apply):

☐ Overgrown vegetation

☐ Waste dumping

☐ Erosion

☐ Smell or pollution

☐ Flooding

☐ More mosquitoes

☐ Other (Specify): _____

3.3 Has the area around the dam become a public health concern? ☐ Yes ☐ No ☐ Not sure

3.4 Are there any visible signs of pollution within or around the dam? ☐ Yes ☐ No

3.5 If yes to 3.4, describe

3.6 Have you seen wildlife or aquatic life disappear or change? ☐ Yes ☐ No

3.7 How would you rate the current environmental state of the dam area? ☐ Very poor ☐ Poor ☐ Fair ☐ Good ☐ Very good

3.8 In your opinion, is the abandoned dam affecting climate resilience in your area?

☐ Yes ☐ No ☐ Not sure

Section 4: Suggestions and Perspectives

4.1 Do you think the Maqalika Dam should be rehabilitated or repurposed?

☐ Yes ☐ No ☐ Not sure

4.2 If yes, how should it be used in future?

……

……

4.3 What role should the community play in the future of the dam?

……

……

4.4 What support would help you adapt to changes caused by the dam's abandonment? (Tick all that apply):

☐ Alternative water supply

☐ Job creation ☐ Waste management ☐ Public awareness ☐ Government intervention

☐ Other (Specify): _____

4.5 Additional comments or suggestions? ……

……

4.6 Indicate the extent to which any of the suggested solutions below can be used to improve the situation of the dam area

Sn	Suggestion	Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree
1	-Complete abandonment/conversion					
2	-Resuscitation of the dam					
3	-Complete overhauling of the Management					
4	-Waste management systems					
5	-Participatory decision-making					
6	-Eco-tourism and recreation					
7	-Clarify land use policies					
8	-Enforce environmental regulations					
9	-Real-time water quality monitoring systems					

Appendix 3. Key informants interview guide

THE NATIONAL UNIVERSITY OF LESOTHO

Key informant's interviews

Research Title: Socio-Economic and Environmental implications of abandoned Maqalika dam, Maseru.

You are kindly requested to spare a few minutes to help complete this interview regarding your participation in Socio-Economic and Environmental Implication of an abandoned Maqalika Dam. The data obtained will purely be used for academic research. All information obtained will be treated in confidence.

Lesotho Water Commission

Checklist;

- Describe your role and responsibilities in relation to water infrastructure management_in_Lesotho

  .....

  .....

- What was the original purpose and design of the Maqalika Dam.

  .....

  .....

- key factors or events that led to the abandonment or discontinuation of the Maqalika Dam as a water supply source.

  .....

  .....

- Commission's perspective, what were the expected or observed socio-economic consequences of abandoning the dam.

.....

.....

- Any plan to mitigate the economic impact on communities previously dependent on the dam.....

THE NATIONAL UNIVERSITY OF LESOTHO

Key informant's interviews

Research Title: Socio-Economic and Environmental implications of abandoned Maqalika dam, Maseru.

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The department of Environment

Checklist;

- Key environmental concerns related to the Maqalika Dam prior to its abandonment.....
  .....
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  .....
- Any documented instances of pollution, ecological degradation, or biodiversity loss around the dam.

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  .....
  .....
- Any environmental regulations that were not complied with during the dam's operational phase.

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- Any departmental assessments and monitoring of the environmental impacts related to the dam.

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THE NATIONAL UNIVERSITY OF LESOTHO

Key informant's interviews

Research Title: Socio-Economic and Environmental implications of abandoned Maqalika dam, Maseru.

You are kindly requested to spare a few minutes to help complete this interview regarding your participation in Socio-Economic and Environmental Implication of an abandoned Maqalika Dam. The data obtained will purely be used for academic research. All information obtained will be treated in confidence.

Maseru City Council

Interview checklist;

- MCC's role in the operation of the Maqalika Dam.

.....
.....

- Municipal challenges either (budget, staffing, infrastructure) that affected dam management.....

.....

- Any local complaints, community demands issues tied to the dam.

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- Historical decisions or policies that has let to dam's abandonment.

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- MCC's current stance or vision on the future use of the Maqalika Dam site.

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.....

- Municipal strategies or plans to revitalize the dam for public benefit.

THE NATIONAL UNIVERSITY OF LESOTHO

Key informant's interviews

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

- Community-based initiatives or partnerships in repurposing efforts.

Research Title: Socio-Economic and Environmental implications of abandoned Maqalika dam, Maseru.

You are kindly requested to spare a few minutes to help complete this interview regarding your participation in Socio-Economic and Environmental Implication of an abandoned Maqalika Dam. The data obtained will purely be used for academic research. All information obtained will be treated in confidence.

- **Department of Water affairs**

Interview checklist;

- Challenges led to the dams discontinue use or neglect.

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- Water quality, inflow outflow, or siltation or sedimentation.

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- Water management or drought mitigation strategies.

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- Records of the dam's water levels, infrastructure condition before and until its abandonment, or operational costs.

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.....

- A role the dam could possibly still play in Maseru city water supply.

THE NATIONAL UNIVERSITY OF LESOTHO

Key informant's interviews

Research Title: Socio-Economic and Environmental implications of abandoned Maqalika dam, Maseru.

You are kindly requested to spare a few minutes to help complete this interview regarding your participation in Socio-Economic and Environmental Implication of an abandoned Maqalika Dam. The data obtained will purely be used for academic research. All information obtained will be treated in confidence.

- **Water and Sewage Company**

Interview checklist;

- Main issues that has led to the discontinue/abandonment of the Maqalika Dam (financial limitation, staff, infrastructure).

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.....

- Operational challenges.

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- Maqalika dam water quality and reliability.

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- Maintenance and operational costs in comparison to the benefits at the time.

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- Economic potential for reusing the dam into WASCO's water supply system again.