



Understanding Behavioral Factors Linked to Pollution and Water Quality in Lake Bassotu

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Received Date: 23/07/2025 // Published Date: 22/11/2025

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Abstract

Water security in rural Tanzania is endangered not only by environmental pressures but also by the behaviors, perceptions, and norms shaping everyday water use. This study applied the RANAS model of behavior change to assess behavioral drivers of water insecurity in Lake Bassotu, complemented by water quality analysis. Data collection included household surveys ($n = 384$), key informant interviews ($n = 7$), structured observations, and laboratory testing of ten water samples. Quantitative data were analyzed using SPSS (descriptive statistics, chi-square tests, logistic regression), while qualitative data were thematically coded in NVivo. Results revealed while 80.6% of households depend on Lake Bassotu, 77.3% perceive it as unsafe. Yet only 4.9% practice water treatment and 17.5% engage in pollution control, revealing a wide awareness–action gap. Regression analysis demonstrated that risk perception and positive attitudes significantly predicted protective behaviors, whereas weakened social norms and limited abilities reduced engagement. Laboratory findings of high turbidity (126–214 NTU), alkaline pH (9.1–9.3), and microbial contamination (66–95 CFU/100 mL) validated community concerns but underscored behavior, not awareness, as the critical barrier. Strengthening community norms, enabling actions, and linking behavioral change with governance enforcement are essential to safeguard Lake Bassotu’s water security.

Keywords · Community behaviour; Climate change; Environmental degradation; Lake systems; Water resources; Water security.

1. Introduction

Access to clean and safe water is important to both health, and economic development globally, which also relates to sustainable development (Mishra et al., 2021; Lebu et al., 2024). The need for access to safe and clean water remains a universal concern. In Sub-Saharan Africa there are over 250 million people that currently experience high levels of water stress and this number will increase to 700 million by 2030 at the present rate of water stress (WMO, 2022). Water stress in Sub-Saharan Africa has been identified as being the result of increased pollution, climate variability, and

population pressure (Hagemann et al., 2013; Matchawe et al., 2022; UNICEF, 2023). Although access to basic drinking water in Tanzania has expanded from 56% in 2009 to 74% in 2021, about 18 million people still lack access to clean drinking water (World Bank, 2023). Therefore, as part of the broader global effort to address the need for water access, global initiatives such as the SDGs (SDG 6) focus on developing resilient access to clean drinking water (UN, 2015; Küfeoğlu, 2022), however, these efforts can only be successful if they are able to address the daily behavior and practices of individuals relating to their consumption of water.

Water security is not only about physical access to water but also about how human behavior shapes and is shaped by water systems (Conway, 2024). Communities' daily decision, such as where they collect water, how they dispose their waste, and how livestock are managed around water bodies directly impact water security (Russell and Knoeri, 2020; Conway, 2024; Monteiro et al., 2024). Evidence from behavioral sciences highlights that perceptions, cultural norms, and traditional practices are critical for promoting safe water behaviors and environmental sustainability, yet these perspectives remain underexplored in water security research (Chaudhary et al., 2017; Ferraro, Messer and Wu, 2017; Russell and Knoeri, 2020; Conway, 2024). To address this, behavioral models such as the RANA (Risk, Attitude, Norms, Abilities and self-regulatory) framework have been developed to explain why awareness of risks does not always lead to protective actions. The model has been widely applied in water, sanitation, and hygiene (WASH) research to identify psychosocial drivers of behavior. For example, studies in Ireland (Andrade et al., 2019), rural Ethiopia (Huber and Mosler, 2013), and East Africa (Nocella et al., 2022) have shown that RANAS provides strong predictive insights into safe water practices, demonstrating its adaptability across diverse contexts.

The rural villages surrounding Lake Bassotu including Bassotu, Mulbadaw and Diling'a are home to an estimated 30,000 people (NBS, 2022); and support both agricultural and pastoral livelihoods; animal grazing; agriculture; and households (Fyumagwa et al., 2014; Higgins et al., 2016; Higgins and Caretta, 2019). In the past, the Barabaig pastoralists viewed the lake as sacred and, as such, took steps to protect it through long-standing stewardship. The displacement of the Barabaig pastoralists resulting from large-scale farming and land-use changes has impacted on this norm and today the lake is under pressure from irrigation farming of the buffer zone around the lake, encroachment by animals and improper waste management, all of which have been exacerbated by

the lack of effective enforcement of rules and by the variability of the climate (Higgins et al., 2016; Higgins and Caretta, 2019). Therefore, understanding the problems facing Lake Bassotu is essential to improving the potential of water security in Tanzania, as it typifies a number of other rural lakes in the region.

Although there are policies in Tanzania that promote Integrated Water Resources Management (IWRM) (URT, 2004, URT, 2009), the effectiveness of these policies is limited due to the ineffectiveness of the implementation of the policies and also because they do not take into account the behavioral aspects of IWRM. As a result, efforts to implement IWRM in Tanzania tend to focus on the physical structures and the governance processes rather than the everyday practices, perception and social norms associated with water management. In places like Lake Bassotu, these behavioral aspects remain poorly studied and rarely integrated into interventions. This study addresses this gap by applying the RANA framework to examine how community behaviors and norms shape water security in Lake Bassotu.

2. Material and Methods

2.1 Study Area

Lake Bassotu is a small (approximately 15.1 square kilometer) freshwater lake located in Hanang District, Manyara Region, northern Tanzania (4°22'11"S latitude, 35°4'22"E longitude). The climate of this region is generally a tropical savanna type, where temperatures are generally mild throughout the year (average high/low temperature ranges 17 – 28°C), while total rainfall varies between approximately 600 – 1000 millimeters annually, falling primarily during the wet season months of November through May. Geographically, the Lake Bassotu is administered as part of both the Bassotu Ward and Mulbadaw Ward and is bounded on its north by the village of Bassotu; on the east by the village of Mulbadaw; and on the southwest by the village of Diling'a (Figure 1). A larger drainage basin of approximately 1161 square kilometers surrounds the

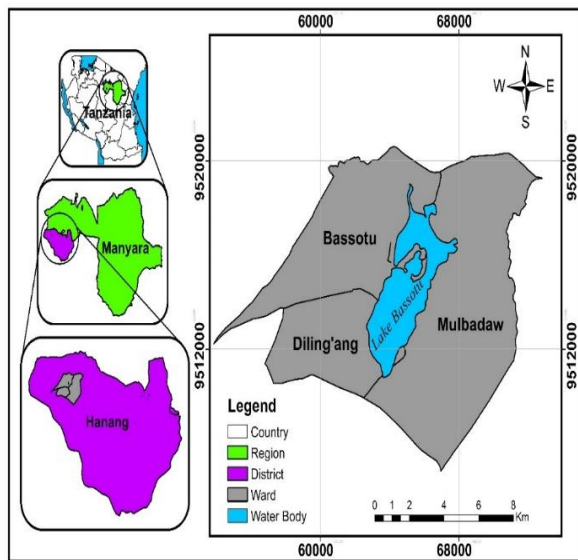


Figure 1: Administrative location of Lake Bassotu.

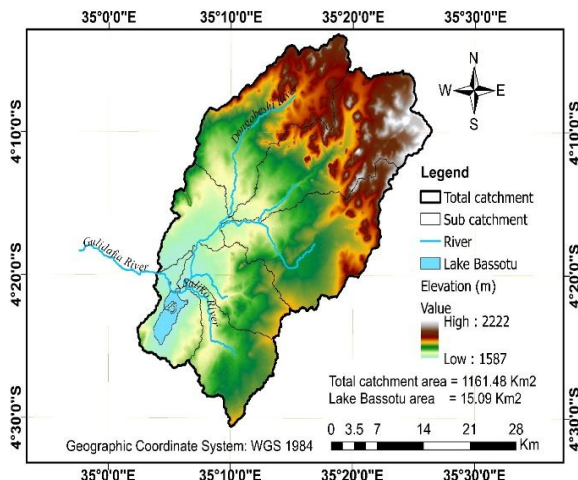


Figure 2: Catchment map of Lake Bassotu

lake which receives inflow from rivers including the Dongobeshi and Saliko and discharge into the Gulidafia River (Figure 2). The Lake Bassotu is a significant water source for the needs of local residents for drinking water, livestock and agricultural uses making it essential to the livelihood of many people living in close proximity to the lake.

2.1.1 Conceptual Framework

To guide the exploration of behavioral factors, the study applied the framework shown in Figure 3, which is adapted from the RANAS model of behavior change. The framework uses 4 RANAS determinants: Risk, Attitude, Norms, and Abilities to structure the

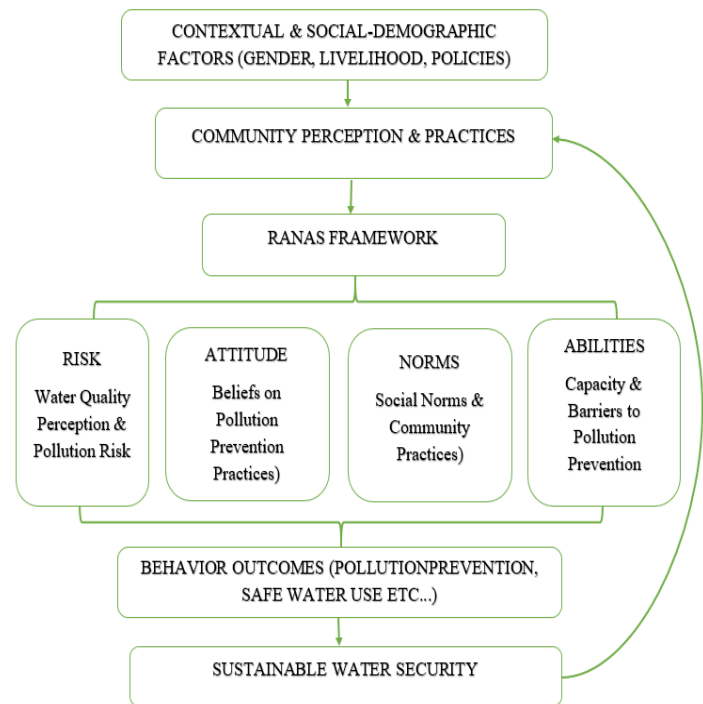


Figure 3: Conceptual framework adapted from the RANAS model

development of data collection tools and the analysis of behavioral outcomes related to water security.

As illustrated in Figure 3, the framework emphasizes how contextual factors and community perceptions shape behavioral outcomes, ultimately influencing sustainable water security.

2.2 Research Design

The study used a mixed-methods research design; that is, the study used both quantitative (household surveys and water-quality sampling) and qualitative (key-informant interviews and field-observations) data to assess the relationship between behavioral determinants and the use of alternative water sources in rural Bangladesh; the RANA framework was used to select variables for the analysis and to analyze the behavioral determinants selected in order to ensure that the results were aligned with the objectives of the study.

2.2.1 Household Questionnaires

The household sample size was calculated using Equation 1 (Cochran's formula), shown below

adjusted for a finite population of 2,544 households in Bassotu Village (WOR, 2022).

$$n = \frac{\frac{z^2 p(1-p)}{e^2}}{\frac{1 + \frac{z^2 p(1-p)}{e^2}}{e^2 N}} \dots \dots \dots (1)$$

Where

n = estimated sample size,

N = total households (2,544),

e = margin of error (0.05),

p = estimated population proportion (0.5),

z = 1.96 for 95% confidence level.

A minimum of 334 households was required, but 384 were surveyed to improve representation and account for non-responses.

Respondents were primarily head of household responsible for water-related decisions. The structured, close-ended questionnaire was administered using the mWater platform, which enabled offline data collection. The tool was tailored within RANA framework determinants to capture perceptions, practices, and barriers related to water use and pollution prevention.

2.2.2 Key Informant Interviews

Seven key informants were purposively selected for their roles in water governance and resource use. They included the WEO, village chairpersons from Bassotu, Mulbadaw, and Diling'a, the WUA leader, and a local fisher. Semi-structured interviews explored perceptions of water governance, land use, environmental changes, and adaptation strategies.

2.2.3 Water Quality Sampling Strategy

To complement perception data, a stratified random sampling design was used to capture spatial variability across four zones as shown in Figure 4: village settlements (S2, S4, S5, S6, S7, S8), inlet streams (S9, S10), outlet stream (S1), and a treated public tap (S3) for comparison.

These sites were chosen to represent pollution risks from settlements, agricultural runoff, and livestock access, as well as to provide a treated-water baseline.

Duplicate samples were collected in a single day from ten established sampling points (S1 to S10), in

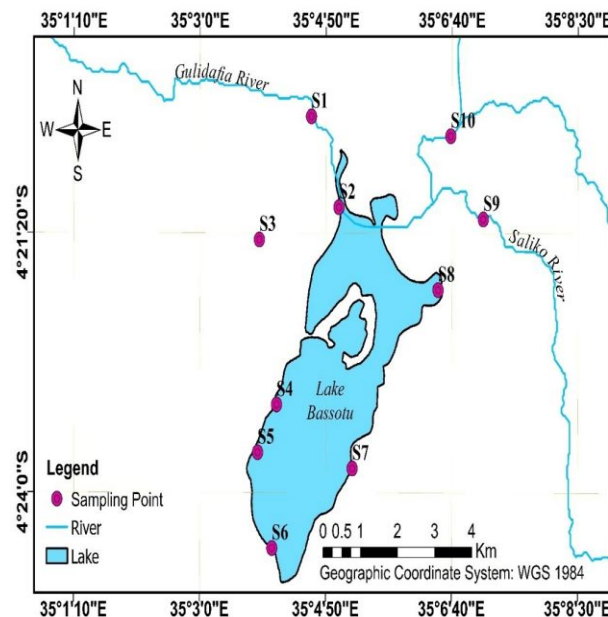


Figure 4: Sampling Design for Lake Bassotu Water Quality Assessment

15th March 2025, to represents peak of the rainy season, when runoff and inflows are highest although no rainfall occurred on the sampling days. The choice of ten points ensured full coverage of all major hydrological zones while remaining feasible for transport and laboratory analysis.

Grab samples were collected at 20 cm depth using 500 mL sterile polyethylene bottles for microbiological analysis and 1 L sterile polyethylene bottles for physico-chemical parameters. All samples were kept at approximately 4 °C in sterile cool boxes and analyzed within 6 hours of collection to minimize degradation in Singida water quality laboratory. Standard QA/QC measures were applied, including duplicate sampling, field blanks, and calibration of pH meter and Turbidimeter before sampling, to ensure data reliability and consistency. Laboratory analysis followed APHA 23rd edition (2022) protocols,

targeting physical, chemical, and microbiological parameters relevant to water pollution. The parameters, methods, and references of the analysed lake Bassotu water samples are summarized in Table 1. Results were interpreted with reference to WHO

Bassotu's overall water quality through one-way analysis of variance (ANOVA). The qualitative data from the key informants were thematically analyzed using NVivo 15 software package to identify patterns related to the water quality of Lake Bassotu. GPS

Table 1: Parameters analyzed with corresponding methods and APHA (2022) references

Parameter	Method/Instrument	Reference
pH	Electrometric Method, Combo pH & EC Meter	APHA (2022) 4500-H+
Turbidity	Nephelometric Method, Turbidimeter	APHA (2022) 2130B
Fluoride	Ion-Selective Electrode (SPADNS)	APHA (2022) 4500-F-
Nitrate-Nitrogen	Sodium Salicylate Method, Spectrophotometer	APHA (2022) 4500-NO3-
Phosphate	Ascorbic Acid Method, Spectrophotometer	APHA (2022) 4500-P E
Total Coliform	Membrane Filtration Method	APHA (2022) 9222B
Fecal Coliform	Membrane Filtration Method	APHA (2022) 9222D

(2017) and TBS (2018) drinking water standards.

2.3 Data Analysis

Quantitative data from household questionnaires were analyzed using IBM SPSS Statistics 27 for descriptive statistics and chi-square tests and binary logistic regression to examine associations and predictors of behavioral variables. The water quality data was examined both qualitatively and quantitatively to

coordinates of sampling points and catchment boundaries were mapped in ArcMap 10.8 to visualize pollution patterns around Lake Bassotu. Household survey data and water quality results were analyzed independently, providing complementary perspectives on behavioral practices and pollution risks.

3. Result and Discussion

3.1 Household Drinking Water Sources in Bassotu

Household surveys, as illustrated in Figure 5, Lake

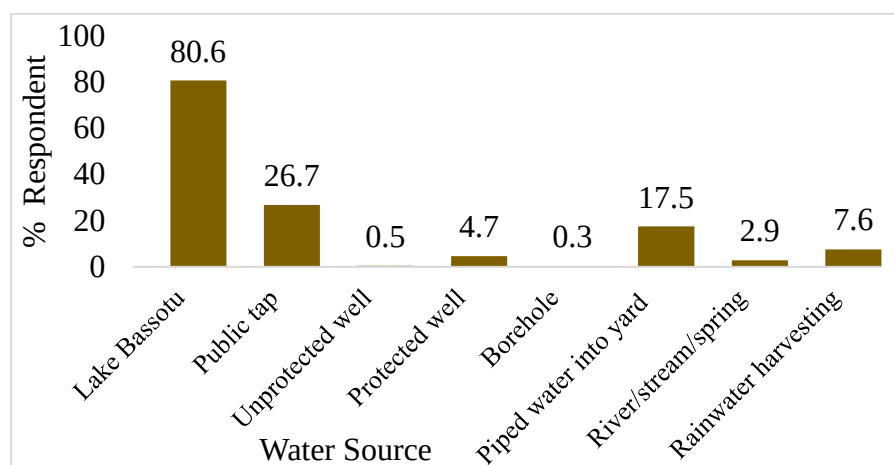


Figure 5: Primary Sources of Drinking Water in Bassotu Village

determine the impact of different zones on Lake Bassotu is the main primary source of drinking water

for as reported by 80.6% of households respondents. Followed by public standpipes (26.7%), piped systems (17.5%), rainwater harvesting (7.6%), protected wells (4.7%), and streams (2.9%).

Despite the presence of alternatives, cultural habits, affordability, and proximity anchor the lake as the default source for most households. Technical constraints also reinforce this reliance. For instance, previous borehole drilling yielded saline water, limiting its use.

Regression analysis revealed that households'

0.129, $p = 0.001$). Other factors, such as noticing changes in the lake over time ($p = 0.058$) and household participation in water decision-making ($p = 0.066$), showed negative but non-significant associations. The model explained 15.4% of the variance (Nagelkerke $R^2 = 0.154$) and demonstrated good fit (Hosmer-Lemeshow $p = 0.942$).

The results indicate that People's water selections are heavily affected by distance, affordability, and perceived risk more so than just having an option for different types of infrastructure. Sherry et al. (2019)

Table 2: Determinants (Risk, Norms, Ability) influencing household reliance on the Lake

Determinants	Predictor Variable	B	S.E.	Wald	p-value	Exp(B) (OR)
Risk	Perception on safety of Lake Bassotu water	-1.340	0.497	7.269	0.007	0.262
	Noticed changes in lake water over years	-0.862	0.456	3.581	0.058	0.422
Norms	Household participation in water decision-making	-0.510	0.278	3.374	0.066	0.600
Ability	Distance from household to water source	-2.050	0.611	11.271	0.001	0.129

reliance on Lake Bassotu as their primary water source was significantly influenced by perceptions of safety and distance to the lake (Table 2).

Those perceiving the lake as unsafe were about 74% less likely to depend on it ($OR = 0.262$, $p = 0.007$), while households located more than 2 km away were about 87% less likely to rely on the lake ($OR =$

found similar results in Tanzania where many people preferentially chose the most reliable and affordable options over access to a piped system. Perceived risk is an important factor as seen in studies out of Ethiopia and East Africa, where knowledge of the potential for contamination led to proactive water selection (Nocella et al., 2022; Huber & Mosler, 2013).

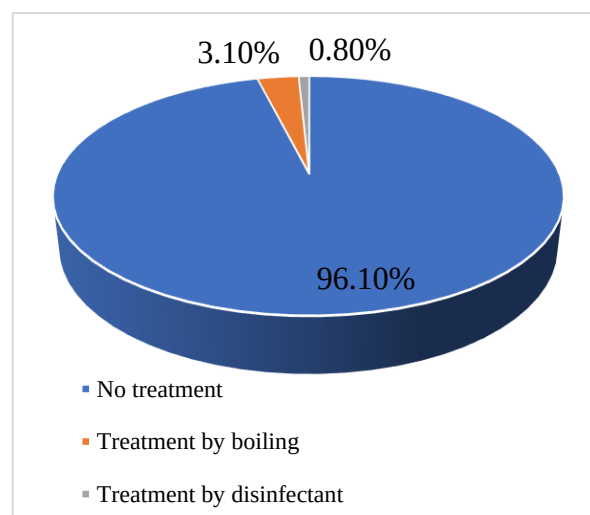


Figure 6: Household water treatment practices in

Proximity was also a significant determinant of water water treatment, with household involving all members

Table 3: Determinants influencing household water treatment behavior in Bassotu

Determinant	Predictor Variable	B	S.E.	Wald	p-value	Exp(B) (OR)
Risk	Noticed changes in lake water	1.587	0.903	3.088	0.079	4.889
	Perception of Lake Bassotu water as safe	-16.440	3731.331	0.000	0.996	0.000
Norms	Household participation in water decision-making	2.224	0.670	11.019	0.001	9.241
Ability	Distance to water source	-0.722	0.664	1.183	0.277	0.486
Context factors	Respondent gender (Female vs Male head)	0.221	0.616	0.129	0.720	1.247
	Education (Any formal vs none)	1.004	0.691	2.111	0.146	2.729
	Primary reliance on Lake Bassotu	-0.474	1.134	0.175	0.676	0.623

choice. As the distance between a home and a source increased past 2km, reliance on that source decreased, which is supported by previous research finding that physical structures significantly impact how individuals make their water usage decisions (Andrade et al., 2019). Conversely, community-level factors were less influential regarding water usage as indicated through norms such as household participation in making decisions related to water, which aligns with previous research indicating that for community-based norms to be translated into sustained behavior change there needs to be both institutional and social support (Chaudhary et al., 2017).

3.2 Water Treatment Practices

Household survey, as illustrated in Figure 6 revealed that only 3.9% of households ($n = 15$) reported treating their water prior to drinking (by boiling (3.1%) and by chemical disinfectants (0.8%)), with the vast majority (96.1%) consuming untreated water.

Household water treatment practices in Bassotu were shaped mainly by social norms and risk awareness, as shown in Table 3.

Increased participation in household water decision making dramatically increased the likelihood of using

in decisions having a 9.24 ($p=0.001$) times greater likelihood of using treatments compared to those who do not involve all family members in decisions. In addition to increased participation in decision making, households that noted changes in the appearance of Lake Bassotu's water were approximately 5 times more likely to treat their drinking water, but only at a marginally statistically significant level ($OR=4.89$, $p=0.079$). No other variables tested had statistically significant relationships to adoption of treatment practices.

In spite of some knowledge of risks associated with consumption of contaminated water, many individuals will not take action to protect themselves from these risks. This gap between risk awareness and protective action has been described in numerous studies of rural areas and has been identified as an important public health issue by numerous authors. The reasons for this gap are complex, and include issues related to cost, time, access to methods of water treatment, social norms, and the influence of intergenerational practices, in which families have consumed untreated water for generations without experiencing immediate illness (Nemeroff et al., 2020; Strauch and Almedom, 2011; Huber and Mosler, 2013).

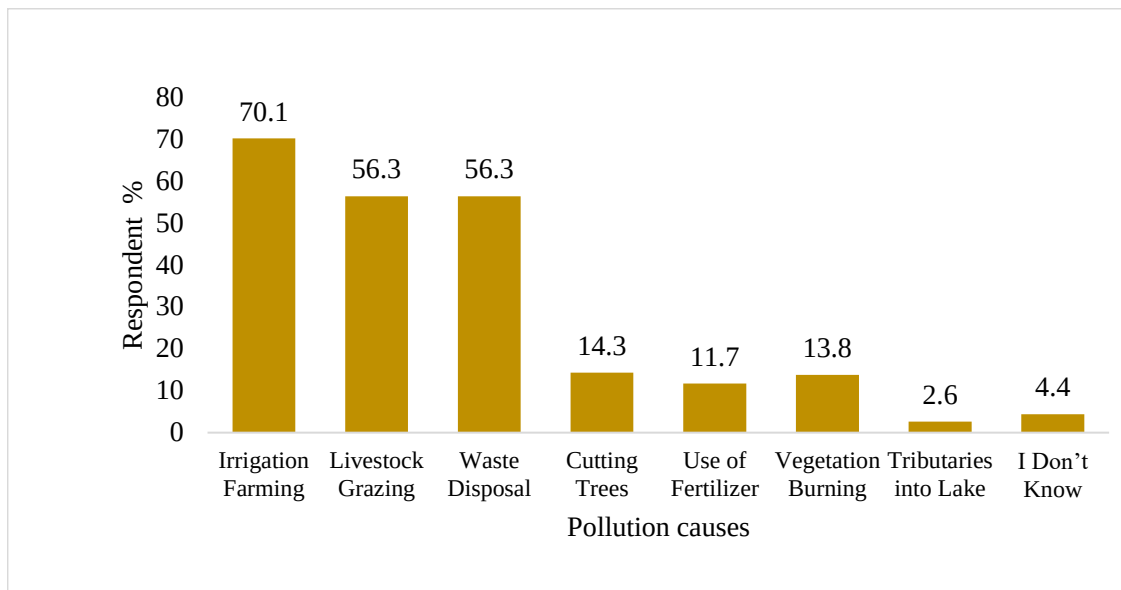


Figure 7: Reported causes of water pollution in lake Bassotu

3.3 Community Perception on Pollution Sources and Engagement

3.3.1 Community Perception on Pollution Sources

Respondents' data from a household survey as illustrated in figure 7, indicate that the major source of lake Bassotu water pollution is irrigation farming

pollution were; tree cutting (14.3%); burning of vegetation (13.8%); application of fertilizers (11.7%), and tributary water flow (2.6%). Approximately four percent of respondents (4.4%), stated they had no knowledge of what caused the pollution in their watershed.

The results emphasize that community perceptions of deteriorating water quality are largely linked to



Figure 8: Observed possible causes of pollution in Lake Bassotu; (a) scattered solid waste along the shoreline, (b) Dongobeshi inlet stream carrying turbid water, (c) livestock grazing and direct access to the lake, and (d) water abstraction pipes near the shoreline.

(70.1%); followed by livestock grazing (56.3%) and waste management (56.3%). The other causes of

human impacts on the environment and not primarily attributed to natural processes. The field data

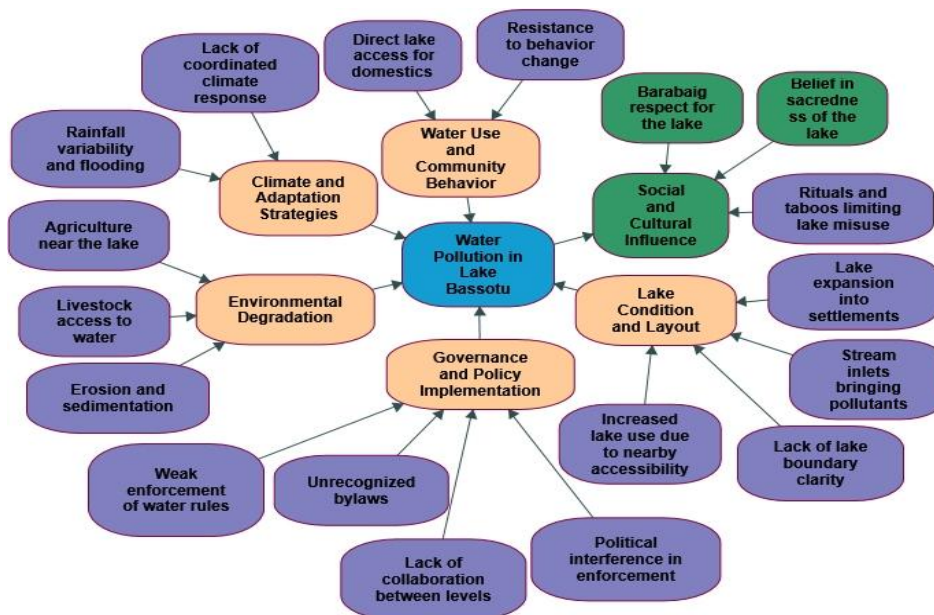


Figure 9: Concept map showing the interlinkages between different factors influencing water pollution in Lake Bassotu based on key informant interviews

confirmed this perception as illustrated in Figure 8 where livestock were observed drinking from the lake; large areas of farmland were found along the shoreline; and visible suspended solids were found in streams flowing into the lake at all times, but especially during heavy rainfall events.

Thematic analysis of key informant interviews shows that there is a clear linkage between environmental,

explained that rainfall variability, livestock access to the lake, and farming near the shoreline have increased erosion and siltation. Streams such as Dongobeshi and Saliko were mentioned as major sources of sediment inflow, and many feared that Bassotu might face the same fate as Damu Lake, which has already silted up.

Lack of adherence to the 60-meter buffer zone, lack of coordination between the leaders, and lack of

Table 4: Determinants influencing household engagement in pollution reduction in Bassotu (n = 187)

Determinant	Variables	B	S.E.	Wald	p-value	Exp(B) (OR)
Risk	Awareness of unsustainable farming impact on water	-1.739	0.403	18.650	0.000	0.176
	Noticed changes in lake water	-0.465	0.657	0.501	0.479	0.628
Attitude	Belief that sustainable practices improve water quality	-1.216	0.506	5.767	0.016	0.296
Norms	Compliance to land use restrictions	-1.567	1.017	2.373	0.123	0.209
Ability	Highest education (any formal vs none)	-0.652	0.600	1.179	0.278	0.521
	Willingness to receive pollution control training	-0.992	0.697	2.025	0.155	0.371

social, and governance factors contributing to water pollution in Lake Bassotu (Figure 9). Respondents

enthusiasm from politicians were some of the other key constraints. The chairman stated that cultural beliefs

have historically provided guidance for lake protection; the Barabaig community has traditionally viewed the lake as a sacred area and prohibited destructive behavior around the lake. However, these

governance systems and cultural values is critical in addressing the awareness-action gap regarding pollution control.

Table 5: Common methods used for pollution control (n=384)

Methods	Response (%)
Reduce chemical use in agriculture activities	40.0
Plant trees	27.7
Proper waste disposal	20.0
Educate others about pollution impact	10.8
Dispose hazardous waste (pesticide bottles) properly	1.5

traditional ways are disappearing, and therefore there are additional areas for governance and enforcement to be addressed in order to maintain the long-term sustainability of the lake.

Bassotu's conditions mirror those of many other

3.3.2 Community Engagement in Water Pollution Control Practices

Risk and attitude were the primary variables influencing household participation in the reduction of pollution. The results from Table 4 show that

Table 6: Mean value of pH, turbidity, TC, and FC in inlet, lake raw, outlet, and treated water compared with TBS (2018) and WHO (2017) standards

Parameter	Inlet Streams	Lake Raw	Outlet Stream	Treated lake water	TBS (2018) Standard	WHO (2017) Standard
FC	16.50 ± 0.71	16.33 ± 6.09	19.00	0.00	5.5–9.5	6.5–8.5
TC	71.50 ± 7.78	81.00 ± 11.22	58.00	0.00	≤25	≤5
Turbidity	169.85 ± 62.44	48.41 ± 4.63	47.70	3.15	0	0
pH	9.25 ± 0.06	9.13 ± 0.06	9.11	7.61	0	0

regions of the world where unsustainable agricultural and pastoral uses of land contribute to sedimentation and water degradation. According to Stenfert Kroese et al. (2020), agriculture was found to account for the majority of sediment input into East African basins, and Kideghesho (2009) explained how erosion and low levels of compliance with land use regulations accelerate water resource degradation. As such, it can be concluded that utilizing modern management techniques along with the encouragement of local

awareness of the negative environmental impacts of unsustainable agriculture significantly decreased the probability of non-participation (OR = 0.176, $p < 0.001$); and the belief that the adoption of sustainable agriculture will improve water quality had a very significant influence on participation (OR = 0.296, $p = 0.016$). These variables explained approximately 32% of the variation in household participation in the reduction of pollution (Nagelkerke $R^2 = 0.321$) and

provided a good model fit ($p = 0.388$ Hosmer–Lemeshow).

The two variables which indicated the greatest level

that protect the lake, such as the 60-meter buffer zone, is still lacking. Findings have shown that challenges associated with governance often create obstacles in



Figure 10: Turbid inlet water at Dongobeshi stream (left) and collapsed bridge at Gulidafia outlet stream showing sediment build-up and erosion impacts (right).

of influence on household participation in pollution control were the belief in the positive environmental impact of sustainable agriculture, and the awareness of the negative environmental impacts of unsustainable agriculture. Ross et al., (2020) stated that an individual's knowledge of pollution risks has little influence on their actions unless they are regularly exposed to information regarding those risks. Portus et al., (2024) identified the “value–action gap” where individuals have a value system that supports environmentally friendly actions, however; these values do not always lead to action because of cultural and structural barriers. In Bassotu, this can explain why education, the willingness to be trained, and compliance with regulations did not provide a significant amount of influence on participation.

For households that participated in reducing pollution in the Lake Bassotu, methods used were; reducing the utilization of chemical fertilizers and pesticides (40%), planting trees (27.7%) and properly disposing of waste (20%), as shown in Table 5.

Local community leaders stated that although communities recognize sedimentation and declining water quality in the lake; the enforcement of measures

effectively managing rural water resources (Julio et al., 2021).

3.3.3 Lake Bassotu Water Quality Assessment

3.3.3.1 Water Quality Assessment

The physical and chemical parameters of the duplicate water samples from ten established sampling points were compared to Tanzania Water Quality Standards, which show the majority of physical and chemical parameters fell into an acceptable range. However, pH levels, turbidity and microbial counts (total and fecal coliform) exceeded the standards. The results provide support for the perceptions of local communities regarding water pollution; however, they also indicate a disconnect between perceived risk and actual treatment practices by the local communities. Only 4.9% of households indicated that they treated their water prior to consumption, even though the results provided evidence of the presence of contaminants in the lake water.

Table 6 provides a summary of the results for those physical and chemical parameters that were deemed to be the most critical indicators of pollution across all the sampling points.

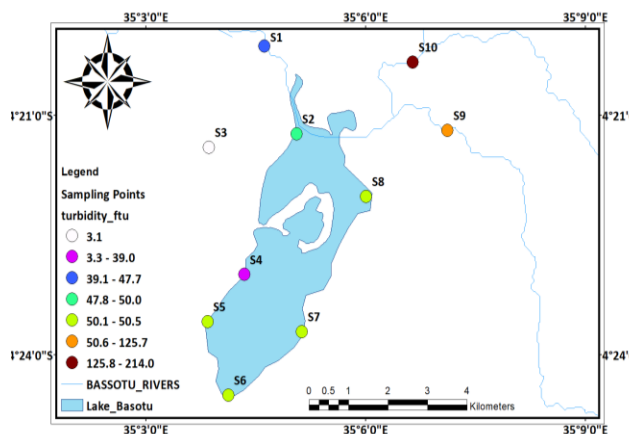


Figure 11: Spatial distribution of turbidity levels (FTU) in Lake Bassotu

Turbidity was highest in inlet streams (126–214 FTU) but declined toward the outlet (47 FTU), suggesting that much of the suspended load settles within the lake basin. Although sedimentation was not

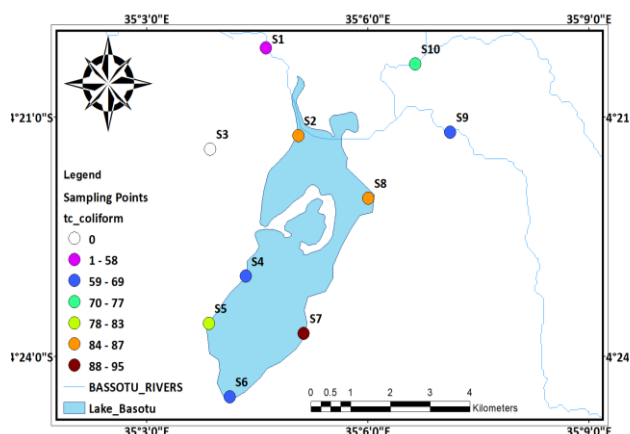


Figure 12: Spatial distribution of total coliform counts (CFU/100 mL) in Lake Bassotu

directly measured in this study, such turbidity reduction patterns are often associated with sediment deposition that can progressively reduce lake depth and affect water quality (Giambastiani et al., 2022; Noor, 2024). Photographic evidence further supports these results: Figure 10, (a) shows turbid water at the Dongobeshi inlet, while (b) shows murky yet clearer outlet water with a collapsed bridge, highlighting how sediment build-up undermines infrastructure (Lwenya and Yongo, 2010; Chen et al., 2020).

This spatial variation in turbidity is illustrated in Figure 11, shows higher turbidity concentrations in inlet areas and lower values toward the outlet. Similar

processes have been observed in other Tanzanian lakes, where poor catchment management and surface runoff during rainfall events accelerate sediment inflows (Banasik et al., 2021; Juško et al., 2022).

The level of microbial contamination in the form of total and fecal coliform was high for all of the inlet and raw lake water samples, the spatial distribution of total coliform is shown in Figures 12.

Total coliform levels ranged from 66 to 95 CFU/100ml and fecal coliform levels ranged from 11 to 28 CFU/100 ml. These results are greater than the Tanzania Bureau of Standards and World Health Organization maximum allowable limits of 0 CFU/100ml for drinking water. Statistical analyses of the data using one-way ANOVA resulted in statistical significance of 0.05 between total coliform sample locations ($F(3,6) = 16.677$; $p = 0.003$); however, there were not statistical significant differences in fecal coliform levels between sample locations ($F(3,6) = 2.757$; $p = 0.134$). Additionally, no coliform was detected in the treated water which provides strong evidence that the treatment process removed the potential health risks associated with microbial contamination.

The spatial distribution of fecal coliform is shown in Figures 13. Field observations reinforce this evidence: at several points along the shoreline, humans and livestock collected water from the same access points (Figure 14), creating direct pathways for fecal input into the lake.

Results indicated consistent alkalinity throughout the sampling locations (pH 9.11-9.29), although within the acceptable range of TBS limits (5.5 – 9.5), the results exceeded the World Health Organization's (WHO) maximum limit for pH (8.5). The higher-than-normal pH readings indicate a significant geologic influence on the pH of the water, specifically, the release of dissolved carbonate and bicarbonate ions from volcanic bedrock into the surface waters. This phenomenon has also been observed in other areas where the local bedrock is comprised of volcanic

material (Pecoraino et al., 2015). A pH reading of 7.61 was obtained for treated water samples which indicates an appropriate reduction of pH through the treatment process.

Although this study did not directly identify contamination sources, the results are consistent with

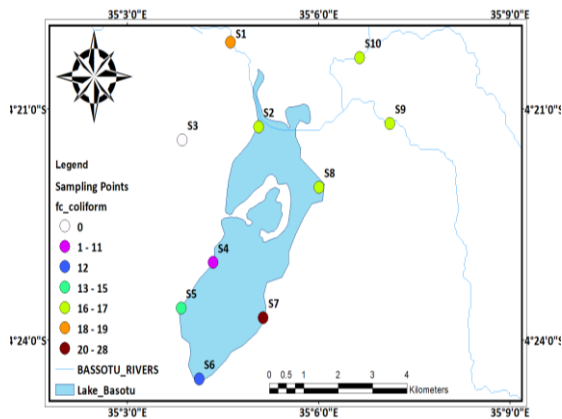


Figure 13: Spatial distribution of fecal coliform counts (CFU/100 mL) in Lake Bassotu

data from the region. For example, Gwimbi et al. (2019) reported that very high levels of *E. coli* found in unprotected water sources in Lesotho were due to both poor sanitation and the presence of livestock, while in Tanzania, at least 80 percent of the potential pathways of disease transmission can be attributed to waterhole use by humans, livestock and wildlife (Linuma et al., 2024); Moshi et al. (2022a) also identified a relationship between heavy rainfall, resulting in increased runoff and poor sanitation, and the levels of coliforms in Lake Tanganyika. These collective studies illustrate an evident risk-action gap; although households have identified their drinking water as unsafe they do so without subsequently treating the water.

4. Conclusion and Recommendations

While water usage is largely dictated by a desire for clean drinking water and accessible water sources; the lack of alternative infrastructure has allowed the use of Lake Bassotu's water to be driven by perceptions of

safety and availability rather than quality. Although there is a strong level of awareness about the pollution risks associated with using lake water for drinking purposes; both the levels of water treatment and community involvement in pollution reduction are very low. This reflects an awareness-action gap. Turbidity, pH (alkaline) and microbiological contamination were all identified through laboratory testing, indicating the potential environmental impacts of unsustainable land use and inadequate law enforcement. Behavioral factors that are driving community participation and action include risk perception and positive attitude towards sustainability, while supportive norms and ability are less influential. Framed under the RANAS behavioral model, these findings show that risk perceptions and attitudes alone are insufficient to drive change without reinforcement from norms, ability, and self-regulation.

Therefore, in order to protect Lake Bassotu for future generations, there is need for a collaborative effort from policy makers, scientists, and local stakeholders to create an action plan for protecting Lake Bassotu's watershed. Policy makers need to enforce a stricter 60-meter buffer zone to limit agricultural activities on the shoreline, and monitor all agricultural activities in the watershed. In addition to enforcing policies, the local community needs to take responsibility for managing their waste, educating farmers about sustainable agriculture practices, and promoting sustainable livelihoods through agroforestry and rainwater harvesting to help alleviate the pressure being put on the lake. Also, there is need for further researches (such as conducting baseline



Figure 14: Water access point showing contamination risk.

bathymetric surveys of the lake, performing seasonal water quality testing, and conducting ecological assessments of sedimentation and biodiversity within the lake) to be conducted so as to understand the long term trends regarding the health of Lake Bassotu.

Collectively, these studies and initiatives would significantly reduce the pollution levels in Lake Bassotu; would eliminate the knowledge gap between the communities that rely on Lake Bassotu and the actions needed to protect the lake; and would increase the water security and resilience for the communities that rely on Lake Bassotu.

Acknowledgements

The authors sincerely thank the residents of Bassotu, Mulbadaw, and Diling'a villages for their cooperation during data collection. We also acknowledge the Water Institute for your administrative and institutional support and for allowing us to carry out this research. Our gratitude goes to WaterAid Tanzania for funding that enabled this study.

Conflict of Interest

The authors declare no conflict of interest related to this research.

Funding

The research is funded by WaterAid under The BASIN project which is funded by [CLARE Programme](https://clareprogramme.org/project/behavioural-adaptation-for-water-security-and-inclusion-basin/) <https://clareprogramme.org/project/behavioural-adaptation-for-water-security-and-inclusion-basin/> a UK-Canada framework research programme on Climate Adaptation and Resilience, aiming to enable socially inclusive and sustainable action to build resilience to climate change and natural hazards. Grant No. is 110005 – 002.

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