The Role of Community-Based Initiatives in Enhancing Water Quality and Livelihoods in Rural Tanzania: A Case Study of Mvomero District

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Abstract

This study investigates the impact of community initiatives on water quality and household livelihoods in Mvomero District, Tanzania. With a focus on the FuatiliaMaji project. The study explores how these initiatives influence both water quality and the socio-economic well-being of households. Using a cross-sectional research design, data were collected from 130 households through structured questionnaires. The analysis revealed that community-based monitoring, water conservation efforts, and the protection of water sources positively contribute to improved water quality. Moreover, these initiatives were found to enhance household income, health, and overall livelihood, although challenges related to water cost and time spent fetching water persist. The study highlights the importance of affordable water solutions and strengthened community participation in water governance to foster sustainable water management practices. The findings suggest that increasing investments in water infrastructure, scaling up community-based monitoring systems, and reducing the economic and time burdens of water collection are crucial for improving both water quality and household livelihoods in the region.

NG Journal of Social Development

Vol. 15 Issue 1 (2024)
ISSN(p) 0189-5958
ISSN (e) 2814-1105
Home page
https://www.ajol.info/index.php/ngjsd

ARTICLE INFO:
Keyword
Water Quality, Community Initiatives, Community-Based Monitoring, Citizen Science

Article History
Received: 30th September 2024
Accepted: 7th November 2024

DOI:*https://dx.doi.org/10.4314/ngjsd.v15i1.1*

1. Introduction

Water is an essential element of the ecosystem, crucial for sustaining life and facilitating numerous biological, chemical, and physical processes within both living and non-living systems (Eludoyin & Olanrewaju, 2021). It plays a critical role in supporting life on Earth by connecting the land, oceans, and atmosphere into a unified system, forming the backbone of environmental stability (Mishra & Dubey, 2015). Water's ability to dissolve a wide variety of substances, both natural and synthetic, has earned it the title of the "universal solvent," emphasizing its indispensable role in life on Earth (Balasubramanian, 2015). The human body, composed largely of water, relies on this resource to maintain vital biological processes, underscoring its fundamental importance for survival (Bidaisee, 2018; Kilic, 2020; Utouh et al., 2024).

Despite the vast amount of water available on Earth—approximately 1.386 billion cubic kilometers, with the majority residing in the oceans—only a small fraction is accessible and suitable for human consumption (Balasubramanian, 2015; Mishra & Dubey, 2015). In Africa, often perceived as water-rich due to its numerous river basins and sizable lakes, over 300 million people still lack access to safe drinking water, with rural areas disproportionately affected. Women and children in these areas bear the burden of fetching water, sometimes walking long distances to reach the nearest source (Eludoyin & Olanrewaju, 2021). The Food and Agriculture Organization (FAO) estimates that addressing water access issues in Sub-Saharan Africa could yield significant benefits, including health improvements and time savings worth up to USD 3.1 billion (2000 dollars). However, water access challenges persist, especially in rural regions, exacerbating the already existing inequalities in access to basic services.

In Tanzania, despite considerable efforts to prioritize household water supply, many communities still face restricted access to clean water due to inadequate water resource management, particularly in rural areas (Mosha, 2024; Lufingo, 2019). While some areas successfully utilize surface water for gravity-fed supply systems, others rely on expensive pumping systems, which are often beyond the financial reach of low-income households (Alavaisha et al., 2019). Water quality further complicates this issue, as even groundwater—though often regarded as safer—can contain harmful pollutants, and the lack of effective regulation and management only worsens the situation (Ngowi & Saria, 2022). These issues significantly hinder efforts to achieve sustainable development and national goals (Utouh & Kitole, 2024), which are focused on improving livelihoods and enhancing the well-being of rural communities.

Community-based initiatives play a critical role in addressing water quality and accessibility challenges. However, despite the existence of these efforts, many Tanzanian communities still face the ongoing problems of water contamination and scarcity, which contribute to significant public health risks. Waterborne diseases such as cholera, hepatitis, and diarrhea remain widespread, particularly among low-income populations, further exacerbating the country's challenges in meeting its development goals (Eludoyin & Olanrewaju, 2021). While community-driven efforts to improve water quality are numerous, they have yet to fully mitigate the health impacts associated with poor water quality. The persistence of waterborne diseases underscores the need for a more in-depth understanding of the effectiveness of these initiatives. This study, therefore, aims to assess the impact of community-driven solutions on water quality in Mvomero District, exploring the types of activities being implemented and their influence on local livelihoods, with the goal of

informing future interventions and contributing to the achievement of Tanzania's sustainable development objectives.

2. Theoretical Foundation

This study draws upon three theories: Participatory Research Theory, Social Learning Theory, and Empowerment Theory, to explore the impact of community initiatives on solving water quality issues in the Mvomero District, Tanzania. Participatory Research Theory emphasizes the active involvement of community members in the research process, treating them as co-researchers rather than mere subjects. According to Evans and Potochnik (2023), participatory research integrates public participation in roles that go beyond the traditional use of human subjects in research. This theory supports the principles of community-based monitoring (CBM) and citizen science, which advocate for incorporating local knowledge and expertise into scientific inquiry (Kidd et al., 2024). This approach is particularly relevant to community initiatives aimed at addressing water quality issues, as it underscores the importance of local engagement and collective action. Evans and Potochnik (2023) and Kidd et al. (2024) distinguish between two strands of participatory research: one focused on social change and the other on knowledge gathering. This study aligns with both strands, recognizing that community-driven initiatives can simultaneously enhance knowledge and promote meaningful social progress.

Moreover, Social Learning Theory, developed by Albert Bandura, posits that individuals learn through observation, imitation, and modeling. This process is influenced by factors such as attention, motivation, attitudes, and emotions (Cherry, 2022). The theory explains how the interaction of environmental and cognitive elements shapes learning and behavior (Overskeid, 2018). Bandura's theory extends beyond behaviorism, which attributes learning solely to conditioning, and cognitive theory, which emphasizes psychological influences like attention and memory (Zhou and Brown, 2015). In the context of community initiatives, Social Learning Theory helps explain how community members acquire and share practices that improve water quality, thereby fostering collective learning and behavior change.

In addition to these theories, Empowerment Theory focuses on enabling individuals and communities to gain control over their lives and environments. This theory is particularly applicable to CBM as it highlights the importance of community participation, capacity building, and local leadership in environmental management (Kidd et al., 2024). According to Shuhaimu et al. (2023), empowerment involves sharing power, enhancing competence, fostering independence, and creating an impact. The key components of empowerment include active participation, critical reflection, and awareness of broader political and economic structures (Khany and Tazik, 2016; Shuhaimu et al., 2023). This study incorporates Empowerment Theory to analyze how community initiatives not only address water quality challenges but also strengthen local capacities and encourage sustainable resource management. These theoretical perspectives collectively provide a comprehensive framework for understanding how community-driven initiatives contribute to water quality improvements and the empowerment of local populations.

2.1 Empirical literature review

Sesabo (2023) examined the impact of water accessibility and sanitation-related diseases on livelihoods in Tanzania. The study utilized probit regression and ordinary least squares models, drawing from the 2017/18 Household Budget Survey data, within a non-experimental research framework. The findings revealed that factors such as urban household location, age, household

size, education level, water cost, and employment status significantly influence water accessibility. Moreover, secondary and higher education levels, along with water costs, were found to affect household sanitation status. The study further highlighted that both water accessibility and sanitation-related diseases have a significant impact on household livelihoods. In conclusion, neglecting the urban-rural gap in water access will continue to exacerbate the welfare of rural populations. The study recommends that water accessibility improvement initiatives should be paired with health promotion programs, particularly in rural areas where water access is limited, and income levels are low.

Utouh et al. (2024) investigated the role of water accessibility in predicting household participation in water conservation practices in Singida Municipality, Tanzania. Employing a quantitative approach with a cross-sectional survey design, primary data were gathered from 391 households. The study assessed various aspects of water accessibility, including physical access, economic feasibility, and cultural acceptability, in relation to the frequency of household participation in water conservation practices (WCPs). Structural Equation Modeling (SEM) revealed a significant positive correlation between water accessibility and WCP participation ($Z = 7.34$, $p < 0.01$). The authors concluded that enhancing water service delivery is essential to increasing participation in conservation efforts. They recommended that policymakers and water sector stakeholders prioritize providing equitable access to clean and safe water to foster greater community involvement in water resource conservation.

Ngowi and Saria (2022) conducted an assessment of water quality from the Great Ruaha River and related water sources used for domestic purposes in the Pawaga Division. By collecting triplicate samples from 16 sites, the study analyzed physicochemical and bacteriological parameters of the water. The results indicated that the water supplied by the Pawaga Water Supply system was unsafe, necessitating treatment to remove microbial, physical, and chemical contaminants before it could be deemed safe for domestic use. The study recommended that the government enhance water management strategies and implement interventions to improve water quality. Key measures include increasing monitoring of wastewater disposal and identifying sources of water pollution.

Eludoyin and Olanrewaju (2021) conducted a review on water supply and quality issues across Sub-Saharan Africa. They noted that water insecurity, exacerbated by climate change, poor infrastructure, insufficient funding, and ineffective governance, remains a major challenge for the region. The authors emphasized the need for innovation, education, infrastructure development, and political commitment to improve access to safe water. They proposed strengthening the governance of water resources, improving water management practices, addressing urgent water needs, and bolstering financial support for sustainable water solutions as crucial steps for improving water quality and availability in the region.

Alavaisha et al. (2019) assessed water quality across various irrigation schemes, using a case study of wetland agriculture in Kilombero Valley, Tanzania. The study measured physicochemical water parameters and collected macroinvertebrate data from different irrigation sites. Results showed that turbidity, temperature, nitrate-N, and ammonium-N concentrations were significantly higher at downstream sites compared to upstream sites. Macroinvertebrate diversity and richness were also greater upstream, with more sensitive species declining in abundance downstream. A positive correlation was found between the physicochemical parameters and macroinvertebrate indices, suggesting that water quality deteriorates downstream of irrigation sites. The study emphasizes the impact of agricultural activities on water quality and biodiversity.

Mwangi and Muchiri (2020) investigated the relationship between water accessibility and agricultural productivity in rural Kenya. The study employed a mixed-methods approach, combining both qualitative and quantitative data gathered from 250 households in the region. Results indicated that limited water access significantly reduced agricultural yields, leading to food insecurity and increased poverty. Households with better access to irrigation and water sources experienced higher productivity and resilience against drought. The study calls for more investment in water infrastructure to enhance agricultural production and alleviate rural poverty.

Juma and Nguvumali (2023) explored the socio-economic impacts of improved water supply in rural Tanzania. Their research, which employed a quasi-experimental design, found that communities with better access to clean water had improved health outcomes and reduced time spent collecting water, leading to increased economic activity. Households in these communities experienced higher productivity in both domestic and small-scale agricultural tasks. The study advocates for policies that prioritize water infrastructure as a driver of broader socio-economic development in rural regions.

Bwire and Kaaya (2021) conducted a study on the impact of water supply on educational outcomes in Uganda. By analyzing survey data from 300 households in rural areas, the study revealed that lack of access to clean water contributed to high absenteeism in schools, particularly among female students. The study found that when water access was improved, school attendance rates, especially among girls, increased significantly. The authors recommend integrating water access into education development policies to promote gender equality and educational outcomes.

Ngoma et al. (2018) analyzed the effectiveness of community-based water management initiatives in Zambia. The study found that community participation in water management not only improved the sustainability of water resources but also increased local ownership of water infrastructure. The study highlighted that local knowledge and involvement in decision-making are key to ensuring the long-term success of water management systems. The research suggests scaling up community-based approaches to enhance water security and community resilience.

This body of literature underscores the multifaceted relationship between water accessibility, health, socio-economic outcomes, and environmental sustainability. It highlights the critical need for improved water infrastructure, policy interventions, and community participation in addressing water challenges in Tanzania and Sub-Saharan Africa. The studies emphasize that integrated water management strategies, alongside investments in education, health, and infrastructure, are essential to achieving sustainable water access and improving the quality of life in the region.

Conceptual Framework

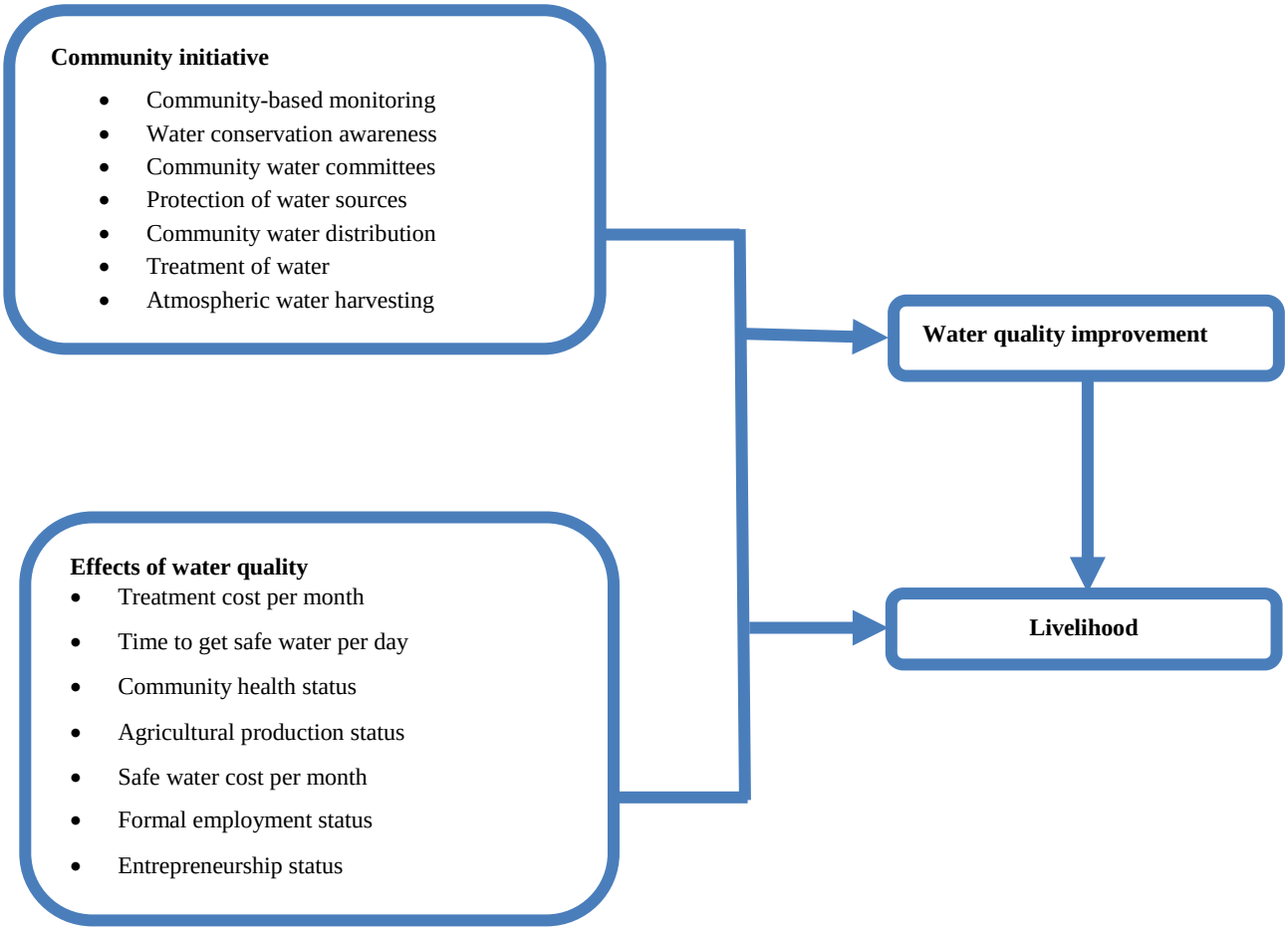

Figure 1: Conceptual framework
Source: Authors design (2024)

3. Methodology

This study employed a cross-sectional research design to examine the impact of community initiatives on solving water quality issues in Mvomero District, Tanzania. A cross-sectional design was chosen because it allows for the collection of data at a single point in time, providing a snapshot of the community's involvement in the FuatiliaMaji project and its effects on water quality. This approach is particularly useful for understanding the current status of water-related challenges and the role of community initiatives, without requiring longitudinal data. By focusing on a specific point in time, the design enabled the researcher to analyze the impact of ongoing initiatives and identify key factors influencing water quality in the district.

The population for this study consisted of all individuals and groups involved in the FuatiliaMaji project in Mvomero District. To ensure a representative sample, the study used structured questionnaires to collect primary data from participants. The questionnaires were designed to capture information on the project's implementation, community participation, and perceived improvements in water quality. Using the Yamane formula for sample size determination, the

estimated sample size for the study was 130 respondents. This sample size was considered sufficient to provide reliable and valid results while ensuring that the study's findings were representative of the broader population involved in the community initiative.

4.1 Analytical modeling

The study employs two primary models to analyze the impact of community initiatives on water quality and household livelihoods in Mvomero District, Tanzania. These models are the Probit Model for analyzing water quality and the Multiple Linear Regression (MLR) Model for assessing the impact of water-related factors on household livelihoods.

Probit Model for Water Quality

To investigate the factors influencing water quality, the study employs a Probit regression model. The Probit model is suitable because the dependent variable in this case, water quality, is binary (safe or unsafe water), and the independent variables are continuous and categorical factors such as community-based monitoring, water conservation awareness, and water source protection. The Probit model estimates the probability that an event occurs based on the predictors. These probabilities are constrained between 0 and 1, which is important when dealing with binary data. The cumulative distribution function (CDF) of the normal distribution ensures that the predicted probabilities always lie within this valid range, which is not guaranteed with linear regression (Dimoso and Andrew, 2021).

The Probit model can be specified as follows:

$$P(Y_i = 1) = \Phi\ (\beta_0 + \beta_1 D_{1i} + \cdots + \beta_k D_k) + \varepsilon_i$$

Whereas $P(Y_i = 1)$ is the probability of having safe water for household i, Φ is the cumulative distribution function (CDF) of the standard normal distribution, β_0 is the intercept term, β_1 to β_k are the coefficients representing the impact of each independent variable on the probability of safe water, Community-based monitoring, Water conservation awareness, and Community-based monitoring are the independent variables that influence water quality. The dependent variable Y_i takes the value of 1 if water quality is safe, and 0 if it is unsafe. Generally, the Probit model is well-suited for this study due to its ability to handle binary dependent variables, provide meaningful probability estimates, and model non-linear relationships between the predictors and the outcome. These advantages make the Probit model an ideal tool for understanding the impact of community-based initiatives on water quality in Mvomero District, Tanzania.

Multiple Linear Regression (MLR) Model for Household Livelihood

The Multiple Linear Regression (MLR) model was used in this study to analyze the impact of various factors on household livelihood, as it allows for examining the relationship between a continuous dependent variable and multiple independent variables. MLR is ideal for assessing how factors such as water quality, time spent fetching water, and water costs collectively influence livelihoods (Kitole and Sesabo, 2024). Its strengths include simplicity and interpretability, as it provides clear insights into the magnitude and direction of relationships between predictors and the dependent variable, while also allowing for statistical tests to assess significance and model fit. This makes MLR a powerful tool for understanding complex interactions and making predictions about household outcomes.

The MLR equation is specified as:

$$I_i = \alpha_1 + \alpha_2 X_{1i} + \cdots + \alpha_k X_k + v_i$$

5. Results

5.1 Description of respondents' characteristics

The descriptive statistics presented in Table 1 provide an overview of key variables related to the study. The average income of the 130 respondents is 554,252.2 Tanzanian Shillings (TZS), with a standard deviation of 135,029.9 TZS, indicating moderate variation in income levels within the sample. The minimum income reported is 250,000 TZS, while the maximum is 1,255,000 TZS, reflecting a wide range of income levels among the participants. In terms of medical treatment costs, the mean expenditure is 46,300.62 TZS, with a standard deviation of 14,982.14 TZS, suggesting some variation in how much individuals spend on medical care. The minimum medical cost is 20,000 TZS, and the maximum is 70,000 TZS.

Table 1: Descriptive statistics

Variable	Observation	Mean	Std. Dev.	Min	Max
Income	130	554,252.2	135,029.9	250,000	1,255,000
Medical treatment costs (TZS)	130	46,300.62	14,982.14	20,000	70,000
Time (Hours)	130	33.16385	21.00944	0.5	75
Safe Water cost (TZS)	130	37,074.62	6,247.846	26,000	51,000

Source: Field data (2024)

Regarding time spent on water-related activities, the average time is 33.16 hours, with a standard deviation of 21.01 hours, which indicates considerable variation in how much time respondents dedicate to these activities. The minimum time reported is only 0.5 hours, while the maximum is 75 hours, showing that some individuals may spend a significant amount of time fetching or managing water. Lastly, the cost of safe water is reported at a mean of 37,074.62 TZS, with a standard deviation of 6,247.85 TZS, reflecting some variation in water prices across the sample. The cost ranges from 26,000 TZS to 51,000 TZS, indicating differences in the affordability of safe water for households within the study area.

5.2 Impact of community initiatives on water quality

The implementation of community-based monitoring significantly increases water quality among communities in Mvomero District. The results show that community-based monitoring is positively associated with improved water quality, with an increase of approximately 40.27% in the likelihood of better water quality. This suggests that when local communities actively monitor the water sources and track quality, they are more likely to observe improvements in water conditions. The statistical significance of this relationship indicates that community involvement in monitoring plays a crucial role in ensuring the quality of water available to households.

In addition, raising awareness about water conservation practices has a positive impact on water quality, with an increase of about 40.93% in the likelihood of improved water quality. This indicates that when communities are educated about the importance of conserving water and using it sustainably, they are more likely to engage in behaviors that protect and enhance water quality. This finding emphasizes the role of education and awareness in fostering a culture of conservation that directly benefits water resources.

Table 2: Impact of community initiative on water quality

Water Quality	Coef.	Std. Err.	P>z	dy/dx	Std. Err.	P>z
Community-based monitoring	1.0833	0.5171	0.036	0.4027	0.1629	0.013
Water conservation awareness	1.1007	0.5501	0.045	0.4093	0.1773	0.021
Community water committees	1.1954	0.5567	0.032	0.4444	0.1776	0.012
Protection of water sources	1.3306	0.5483	0.015	0.4920	0.1701	0.004
Treatment of water	1.2671	0.5908	0.032	0.4701	0.1887	0.013
Atmospheric water harvesting	2.3579	0.6696	0.000	0.7222	0.1487	0.000
Constant	-0.7647	0.4653	0.100	-1.64	0.100	-1.6767

Source: Field data, (2024)

The formation of community water committees also has a significant and positive effect on water quality. The presence of these committees increases the likelihood of improved water quality by about 44.44%. This suggests that when local communities organize themselves into committees to manage water resources, they can more effectively oversee and implement water quality initiatives, ensuring better monitoring, maintenance, and sustainable use of water resources. Community-driven management is shown to be a critical factor in improving local water quality.

Protecting water sources, treating water, and harvesting atmospheric water all have substantial positive impacts on water quality as well. Protection of water sources increases the likelihood of improved water quality by 49.20%, indicating that safeguarding natural water sources from contamination is a key factor in maintaining clean water. Water treatment efforts contribute to a 47.01% increase in water quality, demonstrating the importance of ensuring that water is treated before it reaches households. Furthermore, atmospheric water harvesting shows the most significant effect, with a 72.22% increase in the likelihood of improved water quality. This highlights the potential of alternative water sourcing methods, such as atmospheric water harvesting, to significantly improve the availability and quality of water in the district. Together, these initiatives underscore the importance of comprehensive, community-led efforts to manage water quality.

5.3 Impact of community initiatives towards solving water quality problems on livelihood (income)

The regression results presented in Table 4 show the impacts of various water quality initiatives on household livelihood, particularly focusing on income and other key factors. The implementation of community-based monitoring has a positive and significant effect on household income, with a coefficient of 0.1421 ($p = 0.003$). This indicates that households involved in community-based monitoring of water quality experience an increase in income, with the effect being statistically significant. The positive coefficient suggests that these initiatives may lead to improved local water conditions, which could enhance economic opportunities or reduce the costs associated with water-related issues.

Similarly, water conservation awareness and the establishment of community water committees both have positive impacts on household livelihood. Water conservation awareness shows a coefficient of 0.1122 ($p = 0.009$), meaning that increased awareness about water conservation is linked to higher household income. Likewise, the formation of community water committees has

a coefficient of 0.0911 (p = 0.010), further supporting the idea that organized local efforts to manage water resources can have a direct and positive effect on household economic well-being. The protection of water sources also shows a positive effect with a coefficient of 0.2091 (p = 0.046), indicating that safeguarding water resources is associated with an increase in household income, possibly by ensuring consistent and safe water access.

Table 4: Effects of Water Quality Initiatives on household livelihood

Income	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Medical	-0.0973	0.0213	-2.04	0.014	-0.0695	0.2540
Community-based monitoring	0.1421	0.0216	2.014	0.003	0.0029	1.0107
Water conservation awareness	0.1122	0.0316	2.648	0.009	0.0071	1.0449
Community water committees	0.0911	0.0144	3.16	0.010	0.0016	0.9033
Protection of water sources	0.2091	0.2144	2.06	0.046	0.0144	1.8810
Treatment of water	0.0710	0.0149	0.075	0.075	0.0084	1.4101
Atmospheric water harvesting	0.1632	0.3654	0.218	0.318	0.0102	1.9033
Time to fetch water	-0.1721	0.0392	-4.38	0.000	-0.249	-0.0944
water cost	-0.7660	0.0470	-16.3	0.000	-0.8591	-0.6729
Health status	0.0494	0.0203	2.43	0.016	0.0092	0.0897
Employment	0.0477	0.0171	2.78	0.006	0.0137	0.0817
entrepreneur	0.0467	0.0163	2.86	0.005	0.0144	0.0791
_cons	0.9676	0.0190	5.75	0.000	0.9298	1.0053

Source: Field data, (2024)

On the other hand, factors like time spent fetching water and water cost have negative and significant effects on household livelihood. The time spent fetching water is negatively related to income, with a coefficient of -0.1721 (p = 0.000), suggesting that the more time a household spends on water collection, the lower their income may be. Similarly, the cost of water has a significant negative effect on household income, with a coefficient of -0.7660 (p = 0.000), indicating that higher water costs are associated with lower household income, as families may need to allocate more of their resources to water access, limiting their ability to invest in other areas.

Additionally, health status, employment, and entrepreneurship are positively associated with household income. Better health status is linked to an increase in income (0.0494, p = 0.016), implying that households in better health are likely to have higher incomes, potentially due to fewer medical costs and more productivity. Both employment (0.0477, p = 0.006) and entrepreneurship (0.0467, p = 0.005) also have significant positive effects on income, demonstrating that having stable employment or engaging in entrepreneurial activities increases the likelihood of higher household income. These findings underscore the broader socio-economic benefits of water quality initiatives and the importance of improving water access and related community efforts in enhancing household livelihoods.

Analysis of Covariance (ANCOVA)

The results from the Analysis of Covariance (ANCOVA) presented in Table 5 show that the model explaining the impact of various factors on water quality and household livelihood is highly significant. The F-statistic for the model is 504.75, with 6 degrees of freedom for the model and 123 degrees of freedom for the residuals. This high F-statistic (p = 0.0000) indicates that the model

as a whole is statistically significant, meaning that the factors included in the model significantly explain the variation in the dependent variable, which in this case, appears to be related to water quality and its impact on household livelihood.

Table 5: Analysis of Covariance (ANCOVA)

Source	SS	df	MS	Number of observations	=	130
				F (6,123)	=	504.75
Model	7.47496484	6	1.24582747	Prob > F	=	0.0000
Residual	0.303586796	123	0.002468185	R-squared	=	0.9610
				Adj R-squared	=	0.9591
Total	7.77855163	129	0.06029885	Root MSE	=	0.04968

Source: Field data, (2024)

The R-squared value of 0.9610 indicates that 96.1% of the total variation in the dependent variable is explained by the independent variables included in the model. This suggests a very strong fit of the model to the data. The adjusted R-squared value of 0.9591 is also very high, showing that even after adjusting for the number of predictors in the model, the relationship remains robust. The low Root Mean Square Error (RMSE) of 0.04968 further reinforces the model's precision, suggesting that the predictions made by the model are close to the observed data. Together, these statistics demonstrate that the ANCOVA model provides a very good fit for explaining the impact of the various factors on household livelihood and water quality in the study area.

Multicollinearity test

The results from the multicollinearity test, presented in Table 6, show the variance inflation factor (VIF) values for the variables included in the model. The VIF measures how much the variance of a regression coefficient is inflated due to collinearity with other predictors. Generally, a VIF value greater than 10 suggests problematic multicollinearity, whereas values below 10 indicate that multicollinearity is not a concern. The VIF values for all the variables in this study are well below the threshold of 10, indicating that there is no significant multicollinearity among the predictors. For instance, the VIF for "Safe water cost" is 1.03, "Time" is 1.01, and "Medical treatment cost" is 0.98. The highest VIF value is for "Entrepreneurship," which is 1.12, still well below the critical value of 10. The mean VIF is 1.023, which further supports the conclusion that multicollinearity is not an issue in this model. Therefore, the results of the analysis can be interpreted without concern for inflated standard errors or unreliable coefficient estimates due to multicollinearity.

Table 6: Multicollinearity test

Variable	VIF	1/VIF
Safe water cost	1.03	0.970874
Time	1.01	0.990099
Medical treatment cost	0.98	1.020408
Entrepreneurship	1.12	0.892857
Formal employment status	1.01	0.990099
Community health status	0.99	1.010101
Mean VIF	**1.023**	

Source: Field data, (2024)

The results from the Breusch-Pagan / Cook-Weisberg test for heteroskedasticity, as presented in Table 7, indicate that there is no evidence of heteroskedasticity in the model. The null hypothesis (Ho) for this test is that the variance of the errors is constant, meaning that the data does not exhibit heteroskedasticity. The test statistic chi2(1) is 0.53, with a p-value of 0.4663. Since the p-value is much greater than the typical significance level of 0.05, we fail to reject the null hypothesis of constant variance. This suggests that the residuals (errors) in the model are homoskedastic, meaning the variance is constant across all levels of the independent variables. Therefore, we can conclude that heteroskedasticity is not a problem in this model, and the results can be interpreted reliably without concerns about varying error variance.

Table 7: Heteroscedasticity test

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of Income
chi2 (1) = 0.53
Prob > chi2 = 0.4663

Source: Field data, (2024)

6. Discussion

The findings from this study shed light on the significant role that community initiatives play in improving water quality and, consequently, household livelihoods in Mvomero District, Tanzania. The positive impact of community-based monitoring on water quality, as observed in this study, is consistent with previous research that highlights the importance of local involvement in environmental management. For instance, Kidd et al. (2024) emphasized that community-based monitoring programs can significantly enhance the effectiveness of environmental monitoring efforts, improving the sustainability of natural resources and ultimately contributing to the welfare of the community. By involving local populations in water quality monitoring, communities in Mvomero District can better manage their water resources, reduce contamination, and ensure access to safe water, leading to improved health and economic outcomes for households. This aligns with Bidaisee (2018), who argued that clean water is crucial for the health and socio-economic development of communities, and Mosha (2024), who pointed out the need for active community participation in water governance to mitigate water-related challenges in Tanzania.

Similarly, the implementation of water conservation awareness and the formation of community water committees also positively impacted water quality. These findings are supported by Alavaisha et al. (2019), who found that public awareness and community-based initiatives are essential for the sustainable management of water resources, particularly in areas where water scarcity is a concern. The study by Utouh et al. (2024) further supports the notion that community-driven efforts, such as water conservation awareness campaigns and the establishment of local committees, can significantly improve participation in water resource conservation. These initiatives help reduce the environmental impact of water usage and promote better water management practices, thus improving both water quality and the livelihoods of the community members. In Mvomero District, these actions may have led to more sustainable water use practices, reducing the strain on local water resources and improving access to clean water for households.

In contrast, factors such as time spent fetching water and water costs had a negative impact on household livelihood. Longer hours spent collecting water are a well-documented barrier to

economic development, as households face reduced productivity and higher opportunity costs. This aligns with Sesabo (2023), who found that water accessibility significantly influences the livelihoods of households, particularly in rural areas like Mvomero District. The high cost of water further exacerbates the financial burden on households, as families are forced to allocate a significant portion of their income to water-related expenses, limiting their ability to invest in other essential needs, such as education or healthcare. Dinka (2018) underscores the critical relationship between water costs and economic stability, suggesting that addressing water affordability could significantly improve the socio-economic conditions of rural communities.

Finally, the analysis of health status, employment, and entrepreneurship indicates that improvements in these areas contribute positively to household income, reinforcing the broader socio-economic benefits of water quality initiatives. The findings align with Eludoyin and Olanrewaju (2021), who highlighted the link between water access and improved health outcomes, which in turn supports economic activities. As communities gain access to clean and safe water, they experience fewer waterborne diseases, leading to better health and higher productivity. Furthermore, the increased participation in local economic activities, such as employment and entrepreneurship, is a key factor in improving household income, as noted by Khany and Tazik (2016), who emphasized the importance of empowerment and socio-economic engagement in improving livelihoods. These improvements are critical in Mvomero District, where water quality initiatives may have created a more conducive environment for economic development and enhanced community well-being.

Therefore, the results of this study underscore the importance of community initiatives in improving water quality and enhancing household livelihoods. By implementing effective community-based monitoring, increasing water conservation awareness, and establishing water committees, Mvomero District has made significant strides in addressing water-related challenges. However, challenges such as high-water costs and the time required to fetch water continue to hinder economic development. It is crucial for policy makers to consider these factors in future water management strategies to ensure the sustainability of water resources and improve the socio-economic conditions of rural communities in Tanzania.

7. Conclusion

This study aimed to assess the impact of community initiatives on water quality and household livelihoods in Mvomero District, Tanzania. The findings demonstrate that community-based initiatives, such as monitoring, water conservation awareness, and the establishment of water committees, play a significant role in improving water quality. These initiatives have not only contributed to safer water but also positively influenced household income, health, and overall well-being. The study supports the argument that community involvement in water management is crucial for sustainable resource utilization and improving public health, which is consistent with previous research in similar settings.

Additionally, the study revealed that factors such as water cost and the time spent fetching water continue to pose challenges for households, especially in rural areas. While community initiatives have led to improvements in water quality, the economic burden of water expenses and the significant time investment for water collection remain barriers to enhancing livelihoods. The negative effects of these challenges underline the need for more affordable and accessible water solutions to alleviate the economic pressures faced by households.

Based on the findings of this study, it is recommended that efforts to improve water accessibility and quality in Mvomero District focus on reducing the economic burden of water costs. Providing affordable water solutions and enhancing the infrastructure for water distribution would significantly ease the financial strain on households, especially in rural areas. Addressing the cost of water would not only improve household welfare but also contribute to increased time for income-generating activities, reducing the overall burden on families.

Additionally, community-based initiatives such as water conservation awareness, water source protection, and the establishment of water committees should be scaled up. These initiatives have proven effective in improving water quality and fostering local ownership of water resources. Strengthening these community-driven programs would further enhance water management practices, encouraging more sustainable use of water resources and improving local governance structures.

Furthermore, it is essential to invest in improving water infrastructure, including the treatment of water and the establishment of clean water facilities. This would ensure that households have access to safe water, thus reducing the prevalence of waterborne diseases and contributing to overall health improvements. Building local capacity for water treatment and monitoring would also help ensure the long-term sustainability of water quality improvements.

Finally, reducing the time spent on water collection should be prioritized. This can be achieved by improving the proximity of water sources to households and investing in more efficient water collection systems. Minimizing the time spent on fetching water would enable households to focus more on productive activities, education, and healthcare, ultimately improving their livelihoods and contributing to the overall development of the community.

Competing Interests

Authors have no conflict of interest to declare.

Funding Sources

Authors did not receive any fund to undertake this study.

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