

Factors Affecting Water User Associations' Performance in Managing Water Resources in Ruvu Catchment, Pangani Basin, Tanzania

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Abstract

This study evaluates factors influencing Water User Associations (WUAs) in managing water resources within Tanzania's Ruvu Catchment, Pangani Basin, and identifies key determinants of their performance. Employing a quantitative approach and case study design, data were collected from 91 WUA leaders, members, staff, and stakeholders through purposive sampling using questionnaires. Data analysis, conducted with IBM SPSS V27, included descriptive and inferential statistics presented in tables. Results indicate that financial constraints significantly hinder WUA operations, particularly for MIWALENI Spring WUA. Limited access to training and capacity-building programs weakens effectiveness. Governance practices favor decentralized and hybrid models, encouraging participatory decision-making; however, community involvement remains moderate due to training and technical resource limitations. Infrastructure deficiencies and lack of technical expertise further impact performance. The study underscores the need for comprehensive capacity-building and institutional support to enhance WUA effectiveness. To address financial constraints, sustainable funding mechanisms, including water tariffs, donor grants, and public-private partnerships, are recommended. Additionally, regular technical and governance training programs should be implemented to bridge knowledge gaps and empower WUA members. These measures can contribute to more effective and sustainable water resource management in similar catchment areas.

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1. Introduction

Water is a fundamental resource for life, underpinning societal advancement and economic stability. It supports critical sectors such as agriculture, energy, industry, and public health. Despite covering 70% of the Earth's surface, only 3% of the planet's water is freshwater, and a large portion of this is inaccessible (Mwakalila, 2023). This limited availability necessitates effective management strategies to ensure sustainability and equitable distribution (GWP, 2017). Historically, civilizations such as those along the Nile and Indus rivers thrived due to their access to freshwater for drinking, agriculture, and trade (Keys & Falkenmark, 2018). Today, challenges like water scarcity, pollution, and declining water quality call for comprehensive management approaches to ensure the sustainable utilization of water resources (Masifia & Sena, 2017; Dungumaro & Madulu, 2003).

In Tanzania, abundant water resources are increasingly threatened by human activities, climate change, and population growth (Mwakalila & Mwila, 2023). The Pangani Basin, nourished by Mount Kilimanjaro, is a crucial water source that supports the livelihoods of approximately 80% of the population engaged in agriculture (PBWB Hydrological Report, 2020; Barrow, 2016). However, rapid demographic changes, urbanization, and economic development have intensified water demand, leading to conflicts, pollution, sedimentation, and illegal water extraction (Wilkinson, 2023; Franks et al., 2004). Water User Associations (WUAs) were established within the Integrated Water Resources Management (IWRM) framework to empower local communities to manage water resources (Aboagye & Namara, 2019; Aarnoudse et al., 2018). Despite these efforts, WUAs in the Ruvu Catchment face challenges such as poor governance, limited community engagement, and ineffective management (Richards, 2019; Lalika et al., 2015).

WUAs are designed as community-driven entities that integrate technical, financial, and human capacities to manage water resources effectively (Chepyegon & Kamiya, 2018). Acting as intermediaries between government authorities and water users, WUAs are tasked with promoting equitable water distribution, resolving conflicts, and protecting water sources (Grafton & Hussey, 2011; Cleaver & Franks, 2005). In the Pangani Basin, 24 WUAs, including JUWAMARA, JUWAHIMO, and JUWAMAMI, aim to address water scarcity and pollution through collaborative management (Kayunze, 2008; Chikozho, 2018). However, financial constraints, weak governance, low awareness among water users, and fragile institutional support hinder their effectiveness (Muginya, 2013; Hussain et al., 2022).

A key issue in the Ruvu Catchment is managing diverse water demands, including irrigation, domestic supply, and hydropower generation, while combating environmental degradation (Nobert, 2020; González & Agha, 2023). Encroachment on protected areas, unregulated water abstraction, and poor agricultural practices exacerbate the strain on water resources (Anderson & Cavendish, 2014). Although WUAs strive to address these challenges, their efforts are often constrained by inadequate institutional frameworks (Lalika et al., 2015; Kassam et al., 2023). Research indicates that both formal and informal institutions significantly influence the effectiveness of water resource policies (Keys & Falkenmark, 2018). However, the relationship between these frameworks and WUA performance in the Ruvu Catchment remains underexplored (Giné & Pérez-Foguet, 2008).

This study aims to fill this gap by examining the factors that influence WUA effectiveness in managing water resources in the Ruvu Catchment. The research evaluates the institutional, technical, and social dynamics affecting WUA performance, offering practical recommendations to improve water governance (Lema, 2023; Masifia & Sena, 2017).

Additionally, the study explores how WUAs can integrate traditional water management practices with modern governance frameworks to address emerging challenges such as climate change and increasing water demand. Understanding these dynamics is essential for aligning local water management efforts with broader national and global sustainable development goals (Richards, 2019; Wilkinson, 2023).

The findings of this study will enhance WUA performance, promoting sustainable water resource management in the Ruvu Catchment. By identifying the key factors influencing their effectiveness, this research provides valuable insights for policymakers and stakeholders to strengthen WUA capacity. Such improvements are critical not only for safeguarding livelihoods in the Pangani Basin but also for preserving Tanzania's water resources amid mounting pressures from population growth, urbanization, and environmental degradation.

Methodology

This study employed a quantitative research approach grounded in the positivism research philosophy to investigate factors influencing the performance of Water User Associations (WUAs) in the Ruvu Catchment, Pangani Basin, Tanzania. The research adopted a case study design, focusing on three key WUAs: Rau, Himo, and Miwaleni. They are known for their significant role in managing water resources amidst rising conflicts and environmental challenges. These were appropriate for examining complex social phenomena within their natural settings, providing context-specific insights into challenges such as water conflicts and source degradation. The Ruvu Catchment study area was selected due to its dynamic water management challenges, including seasonal rivers, water shortages, and disputes between upstream and downstream users. Its significance is further highlighted by its role in hydroelectric power production and government interventions through the Pangani Basin Water Board. Purposive sampling was used to select 91 respondents, including WUA leaders, members, and stakeholders, from a population of 133, ensuring data was collected from individuals with relevant expertise.

Data was gathered through semi-structured questionnaires, enabling the capture of quantitative data, and analyzed using descriptive statistics to identify trends, patterns, and relationships among variables. A pilot test was conducted to ensure data validity, and the instruments were refined based on feedback from knowledgeable participants. Reliability was assessed using Cronbach's Alpha, with coefficients above 0.7 confirming internal consistency. Ethical considerations, such as informed consent, confidentiality, and institutional permissions, were adhered to throughout the study. Data analysis involved cleaning, summarizing, and organizing the findings into tables, highlighting key challenges, performance levels, and actionable recommendations for enhancing WUA effectiveness in water resource management.

Results

This objective aims to identify the key factors influencing the performance of Water User Associations (WUAs) in managing water resources in the Ruvu Catchment. It focuses on understanding the roles of governance, financial resources, technical capacity, community involvement, and environmental conditions in shaping WUA effectiveness. Data from 77 respondents across three associations, RAU WUA, HIMO WUA, and MIWALENI Spring WUA, were assessed in various domains, including leadership, governance, resources, training, and stakeholder engagement. The goal is to pinpoint challenges and improvement opportunities, helping enhance WUA performance and ensure sustainable water resource management for local communities and ecosystems.

Factors Influencing WUA Performance and Awareness

This section explores the key factors influencing the performance of Water User Associations (WUAs), focusing on training and capacity-building initiatives, financial support, community involvement, and governance. It also assesses the awareness of these factors among members, leaders, and stakeholders. The analysis reveals that financial support is overwhelmingly recognized as the most influential factor affecting the performance of Water User Associations (WUAs), with 87.0% of all respondents agreeing. The importance of financial resources was slightly more pronounced among MIWALENI Spring WUA members (91.3%), compared to HIMO WUA (88.9%) and RAU WUA (81.5%). This highlights a consistent concern about funding across all groups yet suggests that MIWALENI WUA may face unique financial challenges (Table 1).

Table 1: Factors Influencing WUA Performance and Awareness

Question	RAU WUA (27 Responded)	HIMO WUA (27 Responded)	MIWALENI Spring WUA (23 Responded)	Total (77 Responded)
Training and capacity-building initiatives	18 (66.7%)	20 (74.1%)	16 (69.6%)	54 (70.1%)
Availability of financial support	22 (81.5%)	24 (88.9%)	21 (91.3%)	67 (87.0%)
Community involvement	15 (55.6%)	17 (63.0%)	14 (60.9%)	46 (59.7%)
d) Government policies	14 (51.9%)	12 (44.4%)	13 (56.5%)	39 (50.6%)

Training and capacity-building initiatives were also significant, with 70.1% overall agreement. HIMO WUA (74.1%) slightly outpaced the other associations in emphasizing this factor. Similarly, community involvement scored 59.7% overall, with slight variations across groups, showing HIMO WUA (63.0%) placing the most emphasis on community integration, followed by MIWALENI (60.9%) and RAU (55.6%). Fewer respondents (50.6% overall) identified this as a key factor regarding governance and policy. RAU (51.9%) and MIWALENI (56.5%) members prioritized it slightly more than HIMO (44.4%).

Governance, Decision-Making, and Leadership

This section examines the governance structures, decision-making processes, membership composition, and leadership dynamics within the WUAs. By understanding how these factors shape organizational effectiveness, the section aims to identify areas where improved governance and leadership practices can enhance WUA performance and community engagement. In governance structures, decentralized and hybrid models were dominant, each accounting for 39.0% of responses across all WUAs. RAU WUA leaned slightly more toward decentralization (44.4%), while HIMO (40.7%) and MIWALENI (43.5%) exhibited a stronger preference for hybrid structures. The centralized model was the least favoured, with only 11.7% of all respondents acknowledging its use.

For decision-making, consensus-based processes were the most common (55.8%), suggesting an emphasis on participatory governance. This preference was more evident in HIMO WUA

(59.3%) compared to MIWALENI (56.5%) and RAU (51.9%). The majority voting, the second most common method (31.2%), was more prevalent in RAU (33.3%) than in MIWALENI (30.4%) or HIMO (29.6%). Executive decisions by leaders were rare, accounting for only 10.4% overall, indicating a general preference for collective input. Membership composition was dominated by farmers (61.0%) and local community members (59.7%). Farmers were more heavily represented in RAU (66.7%) compared to HIMO (55.6%) and MIWALENI (60.9%), whereas community members were more prevalent in HIMO (66.7%) than in RAU (59.3%) or MIWALENI (52.2%). Government representatives and NGOs had minor participation, reflecting a limited role in governance.

Table 2: Governance, Decision-Making, and Leadership

Question	RAU WUA (27 Responded)	HIMO WUA (27 Responded)	MIWALENI Spring WUA (23 Responded)	Total (77 Responded)
Centralized	3 (11.1%)	4 (14.8%)	2 (8.7%)	9 (11.7%)
Decentralized	12 (44.4%)	10 (37.0%)	8 (34.8%)	30 (39.0%)
Hybrid	9 (33.3%)	11 (40.7%)	10 (43.5%)	30 (39.0%)
None of the above	3 (11.1%)	2 (7.4%)	3 (13.0%)	8 (10.4%)
Consensus-based	14 (51.9%)	16 (59.3%)	13 (56.5%)	43 (55.8%)
Majority vote	9 (33.3%)	8 (29.6%)	7 (30.4%)	24 (31.2%)
Executive decisions by leaders	3 (11.1%)	2 (7.4%)	3 (13.0%)	8 (10.4%)
Other (Specify)	1 (3.7%)	1 (3.7%)	0 (0.0%)	2 (2.6%)
Farmers	18 (66.7%)	15 (55.6%)	14 (60.9%)	47 (61.0%)
Local community members	16 (59.3%)	18 (66.7%)	12 (52.2%)	46 (59.7%)
Government representatives	4 (14.8%)	5 (18.5%)	6 (26.1%)	15 (19.5%)
NGOs or external stakeholders	5 (18.5%)	6 (22.2%)	5 (21.7%)	16 (20.8%)

Capacity Building, Financial Resources, and Barriers to Participation

This section focuses on capacity-building efforts, financial resources, and barriers to participation within the WUAs. It identifies the availability and effectiveness of training programs, financial management strategies, and access to critical resources. Additionally, it highlights barriers such as lack of information, transportation issues, and financial constraints that hinder WUA's performance. The aim is to provide actionable understandings for enhancing resource management and training programs to address these challenges. The findings indicate significant gaps in capacity building and training. Only 35.1% of respondents received extensive training, with MIWALENI WUA reporting the highest access (43.5%) compared to RAU (33.3%) and HIMO (29.6%). Meanwhile, 39.0% received some training, with HIMO (44.4%) slightly ahead of the other associations. The need for training remains evident, with 19.5% indicating they had yet to receive any but required it. Financial resources were identified

as the most lacking, with 74.0% of respondents highlighting this gap, particularly among MIWALENI members (82.6%). Technical equipment was the second most cited deficiency (49%), with HIMO (55.6%) reporting a slightly higher need than RAU (44.4%) or MIWALENI (47.8%). Information access (40%) and human expertise (61%) were additional challenges, with MIWALENI (69.6%) showing the greatest need for skilled personnel.

Table 3: Capacity Building, Financial Resources, and Barriers to Participation

Question	RAU WUA (27 Responded)	HIMO WUA (27 Responded)	MIWALENI Spring WUA (23 Responded)	Total (77 Responded)
Yes, extensive training	9 (33.3%)	8 (29.6%)	10 (43.5%)	27 (35.1%)
Yes, some training	11 (40.7%)	12 (44.4%)	7 (30.4%)	30 (39.0%)
No, but we need it	5 (18.5%)	5 (18.5%)	5 (21.7%)	15 (19.5%)
No, we do not require it	2 (7.4%)	2 (7.4%)	1 (4.3%)	5 (6.5%)
Financial resources	18 (66.7%)	20 (74.1%)	19 (82.6%)	74 (74%)
Technical equipment and tools	12 (44.4%)	15 (55.6%)	11 (47.8%)	49 (49%)
Information and data access	9 (33.3%)	12 (44.4%)	10 (43.5%)	40 (40%)
Human resources/expertise	14 (51.9%)	17 (63.0%)	16 (69.6%)	61 (61%)
Lack of time	10 (37.0%)	11 (40.7%)	9 (39.1%)	39% (39)
Lack of information	8 (29.6%)	10 (37.0%)	7 (30.4%)	32% (32)
Transportation issues	5 (18.5%)	4 (14.8%)	5 (21.7%)	18% (18)

Barriers to participation included lack of time (39.0%), lack of information (32.0%), and transportation issues (18.0%). RAU WUA (37.0%) and HIMO WUA (40.7%) reported similar time constraints, while MIWALENI WUA (39.1%) experienced slightly less impact. Transportation challenges were minimal but present, with MIWALENI showing the highest concern (21.7%). This data underscores the critical role of financial resources, training, and participatory governance in driving WUA performance. Associations such as MIWALENI face heightened financial and technical challenges but show relative strengths in capacity-building efforts. Governance and decision-making favor inclusivity, yet there is room to strengthen support for underrepresented groups, such as government and NGO stakeholders, to ensure balanced decision-making. Addressing barriers like training access and financial constraints will be essential to enhancing the sustainability and effectiveness of WUAs in managing water resources.

Stakeholder's perceptions on key factors influencing the performance of WUAs in managing water resources

The first specific objective of this research was to identify the key factors influencing the performance of Water User Associations (WUAs) in managing water resources in the Ruvu Catchment. The data was collected from 14 stakeholders representing various groups, including the Pangani Basin Water Board (PBWB), Local Government Authorities (LGAs) leaders (WEOs, VEOs, Village Chairpersons), the National Resource Council (NRC), and other stakeholders. The findings provide insight into both the challenges faced by WUAs and the strategies employed to overcome operational difficulties. The table reveals that the most critical

challenge faced by WUAs is insufficient funding and resources, as cited by 92.86% of stakeholders. This issue underscores the need for sustainable financial mechanisms to support WUAs' operations. Additionally, more technical expertise (85.71%) is needed, reflecting the need for capacity-building initiatives. Infrastructure inadequacies (71.43%) and user conflicts (57.14%) further highlight operational and social challenges in water resource management within the Ruvu Catchment.

Table 4: Primary Difficulties Faced by WUAs in Managing Water Resources

	Frequency	Percentage (%)
Lack of technical expertise	12	85.71%
Insufficient funding and resources	13	92.86%
Conflicts among water users	8	57.14%
Inadequate infrastructure	10	71.43%

Tactics Used by WUAs to Address Operational Difficulties

The findings (Table 5) indicate that collaboration with government agencies for technical support (85.71%) is a widely adopted strategy, reflecting the importance of partnerships in addressing expertise and resource gaps. Additionally, community training programs (71.43%) play a significant role in raising awareness and building local capacities for water management. Increasing water tariffs (64.29%) is employed to boost revenue, although it might require careful balancing to ensure affordability. Interestingly, most stakeholders (92.86%) endorsed implementing a combination of all these strategies.

Table 5: Tactics Used by WUAs to Address Operational Difficulties

	Frequency	Percentage (%)
Increase water tariffs	9	64.29%
Community training programs	10	71.43%
Collaborating with government agencies	12	85.71%
All of the above	13	92.86%

These findings emphasize the multifaceted challenges and proactive measures WUAs take to manage water resources. Lack of resources and technical expertise emerge as dominant challenges, while collaboration, training, and revenue generation are crucial strategies to enhance WUA performance. Stakeholders' feedback highlights the need for continued support from government entities and capacity-building programs to strengthen WUAs' role in sustainable water resource management.

Discussions

This study's findings offer important insights into the elements affecting the performance of Water User Associations (WUAs) in the Ruvu Catchment. The availability of financial resources proved to be the most significant element influencing the performance of WUA, with a persistent emphasis on inadequate funding throughout the associations. This is consistent with the findings of Kayunze (2008), who highlighted the necessity for strong financial mechanisms to support WUA operations in Tanzania. The findings emphasize that training and capacity-building initiatives are crucial for enabling WUAs to manage water resources efficiently. These findings align with the work of Franks et al. (2004), which emphasized the

necessity of enhancing water management organizations to tackle resource limitations and guarantee fair distribution. Furthermore, it was observed that community involvement and participatory governance are crucial yet often overlooked elements, indicating that promoting local ownership and active engagement may help close the gaps in management effectiveness.

The governance structures within the WUAs indicate an apparent inclination towards decentralized and hybrid models, fostering participatory decision-making and inclusivity. This aligns with the principles of New Institutional Economic Theory, highlighting the importance of local governance and institutional structures in facilitating efficient resource management. Nonetheless, obstacles like insufficient technical skills and participation barriers—such as limited information and time constraints, highlight the necessity for improved stakeholder involvement. Nobert (2020) emphasized the importance of raising public awareness and enhancing enforcement mechanisms to tackle environmental degradation and resource mismanagement. The study's findings regarding capacity-building gaps and stakeholder dynamics indicate that tackling these challenges could greatly enhance WUA performance, supporting the conclusions drawn by Chepyegon and Kamiya (2018) about the necessity of incorporating community-driven strategies and sustainable technologies in water management.

The results enhance the existing body of work by highlighting the connections among governance, financial backing, and community involvement in managing sustainable water resources. The findings align with previous studies regarding capacity building and financial sustainability. However, they provide a more detailed view by emphasizing particular WUAs' unique challenges, including MIWALENI's increased financial and technical limitations. This study enhances the conversation on water management by highlighting the significance of customized interventions considering local conditions. Moreover, the results reinforce the idea that working with government bodies and NGOs is crucial for tackling resource deficiencies, as highlighted by Franks et al. (2004) and Kayunze (2008). By tackling these challenges, WUAs in the Ruvu Catchment can improve their ability to manage water resources sustainably, securing lasting ecological and socio-economic advantages for the region.

Conclusions

The study identifies key factors influencing the performance of Water User Associations (WUAs) in managing water resources in the Ruvu Catchment. The study concludes that the performance of Water User Associations (WUAs) in managing water resources in the Ruvu Catchment is primarily influenced by financial, governance, technical, and capacity-building factors. Financial constraints emerge as the most critical issue, limiting WUAs' ability to access necessary resources and sustain operations. This financial insufficiency, particularly notable in associations like the MIWALENI Spring WUA, hampers infrastructure development and the provision of essential training programs. Governance practices play a significant role in WUA performance, with decentralized and hybrid governance structures fostering more effective decision-making and community involvement. However, the varying structures across associations highlight a need for adaptive approaches tailored to specific contexts. Additionally, technical expertise and infrastructure gaps further constrain WUAs' capacity to manage water resources efficiently, while limited training opportunities and barriers to participation reduce the effectiveness of community engagement efforts.

The findings reveal that inclusive governance models and participatory community involvement are crucial for sustainable water resource management. However, participation still needs to be improved due to challenges such as insufficient technical support, limited awareness, and time constraints among stakeholders. This aligns with institutional economic theories that emphasize the role of local governance and institutional frameworks in resource

management. The study enhances the understanding of WUA dynamics by highlighting the interconnectedness of governance, financial sustainability, and capacity-building. It also underscores the importance of addressing local challenges, such as the increased limitations faced by specific associations like MIWALENI, to improve the overall performance of WUAs in managing water resources sustainably. These findings contribute to the broader community-driven water resource management discourse, offering insights into the structural and operational elements that influence WUA effectiveness.

To address WUAs' challenges, the study recommends implementing sustainable funding mechanisms, such as water tariffs, donor grants, and public-private partnerships, to alleviate financial constraints. Regular technical and governance training should be prioritized to bridge knowledge gaps and empower WUA members. Promoting inclusive and transparent governance practices is essential for fostering trust and community ownership. Strengthening partnerships with technical agencies and introducing conflict resolution mechanisms can further enhance WUA's effectiveness. For further research, studies should examine adaptive measures WUAs can employ to address climate change challenges, particularly in water-scarce regions. Investigating innovative funding solutions, such as blended financing models and their scalability, can provide critical insights into long-term sustainability.

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