The assessment of community participation on the management of water supply project in Tanzania: A case of Kwimba District in Mwanza region

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Abstract

The researcher focused on factors affecting the sustainability of water supply projects in Tanzania, specifically in Sumve, Bungulwa and Bupama wards of Kwimba District. The study assessed community participation on the management of Rural Water Supply (RWS) projects, examined the awareness and willingness of community members to contribute to the maintenance costs and analysed capacity of community members in managing Rural Water Supply projects. The study surveyed 30 water points and selected a total of 160 individuals for interview using non-probability sampling techniques. The findings revealed that there was not enough community involvement in water supply projects. Hence, there was the possibility of a declining of water supply project because of low community involvement. However, the people from the visited communities were ready to contribute their resources in terms of money and other resources for maintenance of water supply projects. The challenge was on the approach that was used to collect funds from the community members for maintenance works. In which, it was noted sometimes they were told to contribute for the maintenance costs when need arose and sometimes they were not told to do so even if there were broken water points. Hence some water points were not working because they were not repaired. The study recommends that in order to get the well-established Rural Water Supply project the local community participation must be given the first priority in order to encourage their willingness to contribute towards the maintenance costs.

Keywords: Community participation, water management, water supply projects, Mwanza

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Introduction

Water scarcity is both a natural and a man-made phenomenon (Kwandu 2020; Mekonnen and Gokcekus 2020; Verma et al. 2021). There is enough freshwater on the planet for billions of people but it is distributed unevenly and too much of it is wasted, polluted and unsustainably managed (Jazi 2021; Laud et al. 2020; Shan et al. 2020). The number of innovations has been made in order to help the communities to access safe and clean water for their consumption. The use of water is grown at more than twice the rate of population increase in the world (Peters et al. 2021; Pokhrel et al. 2021). With a growing population, stable and abundant water supplies are becoming increasingly debated in the societies (Briske et al. 2020; Rafa et al. 2020).

Water is a fundamental resource to life and in sustaining the environment and plays a central role in the social and economic development (Balacco et al. 2020; Falkenmark 2020; Mohsin et al. 2021). It touches all spheres of life including domestic, agriculture, livestock, fisheries, wildlife, industry, energy, recreation and other social and economic activities (Duan and Chen 2020; May et al. 2021; Ngxumeshe et al. 2020). Water is vital for sustainable socio-economic development as a strategic primary input playing a pivotal role in poverty alleviation through enhancing food security, domestic hygienic security, hydropower, industrial development, mining, navigation, and the environment for sustenance of ecosystems (Mahlknecht et al. 2020; Mgulo and Kamazima 2022; Nepal et al. 2021).

Diarrhoea caused by inadequate sanitation, improper hand hygiene and drinking water kills an estimated 842,000 people every year globally, or approximately 2,300 people per day (WHO 2019). The proportion of people without sustainable access to safe drinking water in developing countries remains high. The rate of access to improved water sources has little increased from 49% in 1990 to 60% in 2020 (Bjornlund et al. 2020). 82% of those who lack access to improved water live in rural areas, while 18% live in urban areas (Nadimpalli et al. 2020; Sewell et al. 2019).

The management situation of water supply is comparatively important for the human being survival (Li et al. 2021; Singh et al. 2020; Smol et al. 2020). Despite the fact that water is most important for the human being survival still there is low sustainability of water projects in Africa (Luo et al. 2020; Molekoa et al. 2021). Africa has the lowest total water supply coverage of any region in the world (Hiran and Henten 2020; Thomas et al. 2020). Currently, 800 million

people are estimated to live in sub-Sahara Africa of which about 300 million people do not have access to safe water; a situation which exerts a heavy toll on the health and economic progress of sub-Sahara Africa countries (Uhagile 2021).

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Water supply and sanitation in Tanzania has for a long time been characterized by decreasing access to improved water sources, intermittent water supply and generally low quality of supply service (Beard and Mitlin 2021; Kanganja 2020; Lyimo and Gindo, 2022). Out of 52 African countries, Tanzania is ranked number seven with shortage of clean water for domestic use, in which 43% of population lacks basic access to safe drinking water. The leading countries are Ethiopia with about 60% of population lacks clean water, Democratic Republic of the Congo (about 57%), Papua New Guinea (about 51%), Republic of Chad (about 51%), Uganda (about 50%), and Mozambique (about 45%). The ranking was based on an assessment of access to water, water demands, and the reliance on external supplies of water.

Since 2006, the government of Tanzania adopted the policy of "integrated water resources management" in order to improve development of both urban and rural water supply (Atenaka 2019). The policy shifted the responsibility of water provision and sanitation services from the local governments to community members themselves; a strategy called community-owned water supply organization in rural areas (Cord et al. 2022; Rugeiyamu et al. 2021; Theodory 2022). The policy and strategy aimed at increasing the accessibility of water in the vicinity of the community members especially in the rural areas where the majority of them live (Islam et al. 2021; Mgulo and Kamazima, 2022). The policy and strategy have been backed by a significant increase of the budget starting in 2006, when the water sector was included among the priority sectors of the National Strategy for Growth and Reduction of Poverty (Adair et al. 2011; Uhagile 2021).

Although, the Tanzania government has been allocating substantial budgets for rural water supply, the major challenge remains to be on the sustainability of those projects. It has been noted in many rural areas that, water infrastructures have been wearing out without replacement which leads to interrupted supply of water services (Atenaka 2019; Komakech et al. 2020; Mgulo and Kamazima 2022).

Community participation in management of water projects is important because it ensures sustainability by preventing destruction of the project infrastructures (Ibrahim et al. 2020; Nizkorodov 2021; Tantoh et al. 2020). Although community members are the beneficiaries of such water projects but they cannot adequately preserve the projects if they are not encouraged to participate in the management (Dewi et al. 2021; Nizkorodov 2021; O'Donnell et al. 2020).

Water supply projects in the community without people's participation in the management cannot last longer to gain value for money (Joshi 2020; Tantoh and McKay 2020; Walker et al. 2021). Nevertheless, proper sustainability of the water supply system decreases the shortage of water in the community, which leads to the prevention of an outbreak of water-borne diseases such as typhoid and cholera (Omotoso and Ibitoye 2021; Rafa et al. 2020; Zohra et al. 2021). However, it increases the economic production and development because the community will not spend much time searching for water in long distance places.

In Tanzania, the rate at which rural areas are supplied with water varies from one place to another, but most rural areas in Tanzania face a similar challenge on sustainability of the water services supplied (Christopher and Beal 2022; Komakech et al. 2020; Nkiaka et al. 2021). This study examined participation of community members in management of water supply projects in rural wards of Kimba district, which is one of the eight districts of Mwanza region. The study was conducted in three rural wards of Kwimba district that are Sumve, Bungulwa and Bupama. At the time this study was conducted, there were efforts undertaken of supplying piped water in the rural areas of Kwimba District yet there were numbers of dysfunctional water points in those rural areas.

Statistics showed that available water points were 42, 27 and 21 in Sumve, Bungulwa and Bupama wards respectively while non-function water points were 14, 10 and 14 for those wards respectively (Khan and Khan 2021). It was through this rate of dysfunctional water points this study was conducted trying to address the question of sustainability of water supply in rural wards of Kwimba;

amidst national water supply policy and strategy that insists on community participation in rural water supply management to increase their sustainability. Therefore, the study aimed at discovering whether the new water supply project would be sustainable or not and this was through examining the extent to which community members were involved in the management of water supply project. The study also involved examining community awareness and willingness to contribute towards maintenance costs.

Literature review

Water management in Tanzania

Water supply and management is governed by much legislation, but the most important ones are water resource management Act of 2009 and the water and sanitation Act of 2009 (Tanzania 2009). Other legislation related to the water sector, includes: The Energy and Water Utilities Regulatory Authority Act Cap. 414, Local Government Authorities (LGA) (Urban) Act No. 7 (1987). Local Government Authorities (District) Act No. 8 (1987) and the Environmental Management Act No. 20 of 2004 (Mgulo and Kamazima 2022).

The key principles in which water supply and sanitation Act operates, show that; the major focus is on decentralization of the managerial functions of water management from top levels to local levels where primary beneficiaries reside. This decentralization is meant not only to give local community members the rights of ownership over water services, but it also give them responsibilities of making sure operational and maintenance costs are covered by community members themselves (Engdaw 2021; Hanson 2022; Pradana 2021). In this light therefore, contributing for water services is a legal and accredited action that has been legally endorsed by legal frameworks governing the supply and management of water services in rural Tanzania (Bhushan and Gopalakrishnan 2021; Herschan et al. 2022; Vila-Guilera et al. 2022). There are also Community Owned Water Supply Organizations (COWSO) in rural areas (Fundi 2021; Zingari and Forzano 2021).

Community participation on the management of water supply projects

A study by Alam (2022) concerning water supply in rural communities of Gujranwala division in Punjab Province, Pakistan reported reasonable levels of

consumer satisfaction in terms of the quality and quantity of water supply. The study concluded that water supply in the rural areas was performing better because communities were encouraged to participate in all phases of the project; from project design to implementation and maintenance. The study concluded that fully community participation in the RWS project helps to achieve substantial improvements in availability and accessibility of water in rural communities.

To some extent, culture and tradition contributed to the hindrances of water management which reduces the protection and sustainability of water projects. In many parts of developing countries women participation in water management project in Ethiopia has received little attention due to the cultural norms of African societies do not allow women to speak before the public meeting (Addisie et al. 2021; Mamo 2022). Meanwhile, women are the ones who mostly engaged in fetching water. Such non-participation of women in the water planning meeting leads to a lack of proper management of the water projects. The involvement of women in the management of community properties is necessary to ensure inclusion of both male and female interests in the properties such as water schemes.

The Maroons community in Nepal has been using strong community rules and regulations to monitor conservation of freshwater ecosystems (Campbell et al. 2021; Thapa 2020). This has been through zoning, unwritten rules, and arbitration by the Maroon Council. They concluded that, the Maroon freshwater ecosystem management has helped to ensure sustainability of water supply for domestic and agricultural activities. They suggested that the rural communities should be given aquatic ecological knowledge, encouraging their local traditional methods of water ecosystem. This can help to keep water supply project sustainable in the rural areas.

Supporting communities in managing their water resources means supporting communities to make choices and to reach a common understanding on the necessary arrangements for sharing and allocating water supply related maintenance costs (Ostad-Ali-Askari and Shayannejad 2021; Rugland 2021). In carrying out a water project, community members need to have full understanding regarding project planning, designing and evaluation in order for them to gain the full ownership of the project (Hickson and Owen 2022; Mansell et al. 2020; Prescott et al. 2021).

Sustainability and managerial challenges in RWS projects

According to Schultes, et al. (2022) provision of safe drinking water in rural areas in Ghana is a major challenge because there is no established institutional arrangements that ensure available drinking water facilities are maintained, and managed in an efficient, equitable, and sustainable ways.

The private sector does not usually have sufficient incentives to invest in rural water supplies due to the high costs of infrastructure development in areas with low population density and the high transaction costs of collecting fees for drinking water in such areas (Anh et al. 2022; Thomson 2021). If the awareness of the value of safe drinking water is limited and if people can easily resort to unsafe water sources, people will be obviously vulnerable. This being the fact, private safe drinking water supply projects have not been carried out in the rural areas. The study added that if drinking water projects are provided by the government, the projects tend to collapse in a short period because of lack of fund and motivation by the government officer to manage rural water facilities in a sustainable way (Thomson 2021).

Tonya (2015) conducted a study in Bahi and Chamwino Districts of Dodoma, Tanzania. It was a cross-section study that examined sustainability of RWS project. The study was conducted on 24 water projects in which 136 respondents were interviewed. Some of the surveyed projects were noted to be nonfunctional schemes. In Chamwino 30.4% of the schemes were not functioning while in Bahi 10.3% of the surveyed schemes were not functioning. This indicated that there were some communities that did not have access to safe water supply. The study added that there were very limited involvements of community members, the beneficiaries, in the decision making concerning appropriate technology that can be adopted in RWS project. The study established a very strong negative correlation coefficient (r = -91.99%) between the technology used and sustainability of the project. The study concluded that RWS projects were facing sustainability challenges because of technical challenges caused by the chosen water supply technologies.

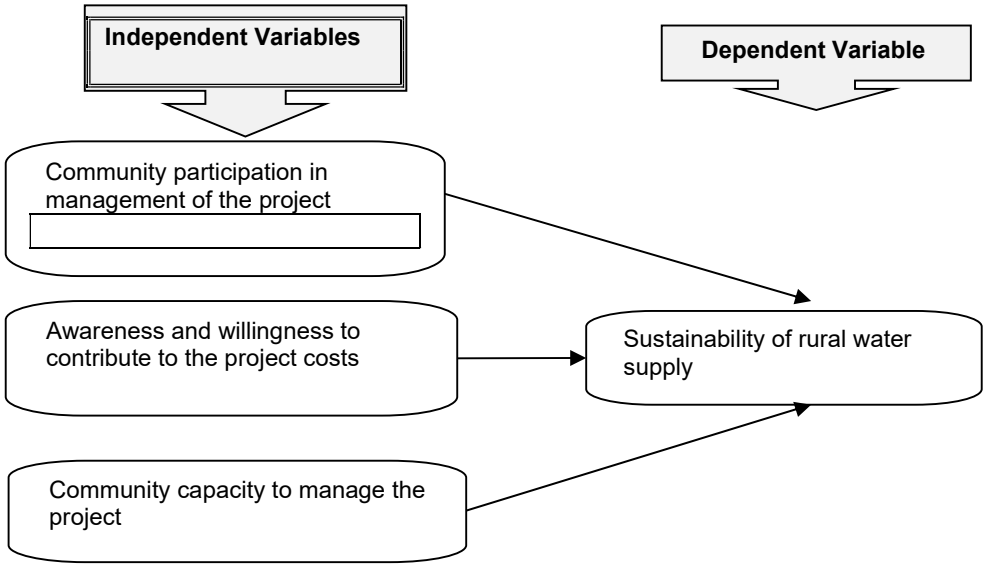
Conceptual framework

Sustainability of rural water supply is influenced by several factors, but for the sake of this study, three factors have been conceptualized and linked to that sustainability which includes community participation, community awareness

and willingness to contribute to the water management fund and the community capacity in managing water supply project (Abdullah et al. 2021; Ahmed et al. 2020; Elahi et al. 2022; Valcourt et al. 2020). Community participation has a crucial role to play in ensuring the sustainability of rural projects because it helps to enhance a sense of ownership over the projects and hence commitment to the projects (Angmor, et al. 2016; Okal 2020; Radosavljević et al. 2020; Ruggiero 2021). If rural communities are actively involved in the water project from the planning phases to the evaluation, they can have a clear understanding about the project and as they participate in making some decisions, they usually tend to own the project and have possessive feelings, which is very important for sustainability (Cachelin and Nicolosi 2022; Muhamad Khair 2020; Uhagile 2021).

The awareness and willingness of community members to contribute to the maintenance funds of the public projects, is a key to sustainability of the projects (Adeniran et al. 2021; Zuniga-Teran et al. 2020). When rural community members are not aware and/or willing to contribute to the management funds of the public water supply projects, the sustainability of those projects is likely to be questionable, because even minor repairs of water infrastructures become impossible which eventually results in failure of the project (Lakmeeharan et al. 2020; Millington and Scheba 2021). Community capacity to management the water supply project entails issues like knowledge and skills on plumbing together with other knowledge/skills related to plumbing such as iron smelting, available in the project area (Enqvist et al. 2022; Tantoh and McKay 2020; Walker et al. 2021). When this skills/knowledge is available in the rural areas, it makes possible for effective maintenance of the water infrastructures to take place, whenever any breakdown is identified. Schematic diagram (Figure 1) shows how the sustainability of rural water supply is related to other variables.

Figure 1: Conceptual framework of the study



Source: Field Survey (2020)

Methodology

Research approach and design

The study used both qualitative and quantitative approaches in collecting and analyzing data. The qualitative approach helps to subjectively assess attitudes, opinions and behaviours of community members towards the maintenance of water supply projects. The quantitative part assisted in quantifying the extent they had participated in the management and their capacity managing water supply projects. Furthermore, descriptive survey design was applied in which cross-sectional data were collected from the mentioned three wards of Kwimba District.

Sampling design and sample size

A Multistage-purposive sampling technique was used in drawing a sample from the three wards. The first stage was selection of wards to which the study was

conducted; three wards were selected purposively, these were Sumve, Bungulwa and Bupama. The second stage was selection of five functioning and five non-functioning water points in each of the mentioned wards. A total of 30 water points were selected. The third stage was a selection of five households located nearby each of the sampled water points; whereby a head (bread winner) of each selected household was recruited to the study. However, the study selected three ward executive officers (one from each ward) and seven water management officials from Kimba District Council. In this regard, a sample size of 160 respondents was included in the study

Table 1: Sample size of the study

	Categories	Frequency	Percentage %
	Heads of the households	150	93.75
	Ward executive officers (WEOs)	3	1.88
	Water management officials	7	4.38
		160	100.00

Source: Field Survey (2020)

Data collection

Data was collected through face-to-face interviews and questionnaires. All respondents were given similar copies of questionnaire to feel. They were both closed and open ended questions. The closed question had Likert scale response mode that ranged from strongly disagree to strongly agree. Interviews contained unstructured questionnaires. The first two heads of households to be selected from each chosen water point, the WEOs and water management officials were subjected to both questionnaires and interviews.

Data analysis

Descriptive statistics like simple counts, frequencies and percentage and mean calculations were applied to understand and interpret the respondents' views given in form of quantitative data. This was achieved through Statistical Package for Social Science (SPSS Version 26). Content analysis that applied application of pattern matching was used to recognize strong explanation from the respondents' opinions in the collected qualitative data associated with the central theme of the study.

Demographic profile of respondents

Number of male (74.38%) representatives was three-fold of that of female (25.62%) representatives. This was due to the fact that the study selected heads of the households in the visited communities; the position which is dominated by men in majority of Tanzanian communities. As highlighted by some studies previously conducted, on African culture men are mostly the decision makers at all levels of socio-economics. Men play a big role in leading, establishing and maintaining household and community projects (Hiran & Henten, 2020; Wenda & Fon, 2021). Concerning age group distributions, the majority (51.24%) were at 46 years and above. Followed with those aged from 36 to 45 who were about 35.63%, and the respondents with age of 26 to 35 were 10% while the lowest group was who of the age between 15 to 25 who represented 3.13% of the respondents. With these statistics it can be accepted that the greater number of respondents were mature enough to take family and community responsibilities. They had experience in delivery of public services (i.e. water resources and water projects sustainability issues) within their communities. Therefore, the information they provided concerning study topic was relevant and reliable.

Table 2: Demographic profile of respondents

Variable	Proxies	Frequency (F)	Percentage (%)
Gender	Male	119	74.38
	Female	41	25.62
	Total	**160**	**100.00**
Age groups	18-25	5	3.13
	26-35	16	10.00
	36-45	57	35.63
	46 and above	82	51.24
	Total	**160**	**100.00**
Level of education	Informal education	12	7.64
	Primary	68	43.31
	Ordinary secondary	44	28.03
	Advance secondary	18	11.47
	Tertiary education	15	9.55
	Total	**157**	**100.00**
Main occupation	Agriculture (farming and keeping)	89	55.63
	Business person	34	21.25
	Employees in private sector	24	15.00
	Government employees	13	8.12
	Total	**158**	**100.00**

Source: Field Survey (2020)

In the education qualification, the majority of respondents had the primary level of education, namely 43.31%, those with ordinary and advanced secondary education were 28.03% and 11.47% respectively. Meanwhile respondents with tertiary level of education (university degrees) represented 9.55%. The respondents which have the informal education were about 7.64%. It was revealed that 66.63% of the respondents depend on the agricultural activities (subsidiary farming and keeping) as the main occupation. This finding depict the real life of rural areas where the majority of people depend on the agricultural activities for their daily bread. On the other hand, 21.5% were doing businesses as their main job, 15% and 8.12% were employees in the private sectors and government sector respectively.

Findings

Community participation in management of water supply project

Any development project is characterized by the different phases that range from planning to maintenance phases. In carrying out public projects, especially in rural areas, the inclusion of community members in all those phases is of vital importance for sustainability of the project. Therefore, the study assessed the involvement of community member in different phases of carrying out water supply project. They were to indicate whether community members were involved by voting 'yes' or they were not involved by voting 'no'. The findings were summarized in table 3.

Table 3: Community participation in management of water supply project

Variables	Yes	No	Total
Community members are involved in water resource management planning	34(21.52%)	124(78.48%)	158(100%)
Community members are involved in designing water supply projects	23(14.74%)	133(85.26%)	156(100%)
Community members are involved in implementation of water supply projects	67(41.87%)	93(58.13%)	160(100%)
Community members are involved in monitoring of water supply projects	46(30.06%)	117(69.94%)	153 (100%)
Community members set rules and regulations for water resource management in the area	21(13.13%)	139(86.87%)	160(100%)
Weighted frequency and percentage	**38(24.26%)**	**121(75.74%)**	**157(100%)**
Interpretation of YES-Votes 81% - 100%= very high level of participation 61% - 80% = high level of participation 41% - 60% = moderate level participation 21% - 40% = low level of participation 0% -20% = very low level of participation			

Source: Field Survey (2020)

The findings from the field indicated that 78.4% of the respondents indicated that community members were not involved in water resource management planning. 85.26% of respondents denied community involvement in the designing water supply projects; 58.13% of the respondents negated community involvement in implementation of water supply projects; 69.94% of the respondents' involvement of community in monitoring implemented water supply project; and involvement of community members in setting rules and regulations for water resource management within the community received 86.87% of denial votes. In general, there was low level of community participation in the management of water supply project (weighted percentage of yes-votes was 24.6%).

In the interview phase of data collection, one of the selected WEOs mentioned that:

> "In my ward community members have been contributing their resources including human resources, financial resources and materials to support maintenance of the water supply. However, their contributions have never been enough; therefore, we have also been using funds from the local government collections for water project maintenance".

Awareness and willingness to contribute to RWS project maintenance costs

The study assessed the awareness and willingness of the community members in contributing to the water supply project maintenance costs in the rural areas. Data were collected from selected heads of households and WEOs. The findings were presented in the table 4 in which it was revealed that 19.05% and 34.69% of community members had very good awareness and good awareness respectively. On the other hand, 21.09% had little awareness and 25.17% mentioned they were not aware that communities were responsible for public water supply management costs. The data showed that half of the community members had awareness and half of them had none. With these results it can be said that there was moderate awareness among community members that public water supply management costs were supposed to be incurred by community members.

Variable	Measurement	Responses Frequency	
			Percent%
Communities are responsible for public water supply management costs.	Definitely YES (very good awareness)	28	19.05
	Probably YES (good awareness)	51	34.69
	Probably NO (little awareness)	31	21.09
	Definitely NO (no awareness)	37	25.17
	Total	**147**	**100.00**
You are willing to contribute for maintenance cost of waters supply schemes	Definitely YES (very high willingness)	33	22.15
	Probably YES (high willingness)	79	53.02
	Probably NO (little willingness)	25	16.78
	Definitely NO (no willingness)	12	8.05
	Total	**149**	**100.00**

Table 4 Awareness and willingness to contribute to water supply project cost

Source: Field Survey (2020)

Table 4 further indicated that about three quarters (22.15% + 53.02%) of the surveyed community members were willing to contribute to the maintenance cost of water supply schemes. Few of the surveyed community members (16.78% + 8.05%) were unwilling to contribute to the maintenance cost of water supply schemes. These showed that the community members could contribute to the maintenance cost of non-function water points if they were well encouraged and to fill the sense of ownership of the project.

Approaches used to collect community contributions for maintenance costs of RWS

The study collected information concerning approaches that have been used to collect community contributions for maintenance costs of rural water supply projects. Data for this matter was collected from surveyed head of the households and WEOs. Three methods were identified as presented in the Table

5. The approaches that were reported to be very rarely used in collecting contributions from the community members for water system maintenance costs were "daily water use fee from the water point" and "household monthly contributions". The approach that was popularly used to collect maintenance funds was mentioned to be "when need for maintenance arises". However, this was applied sometimes; meaning that there was a time when there is the need of maintaining water supply schemes but community members were not contributing for the maintenance costs. The study found out that there was no proper approach for collecting community contributions for maintenance of water supply projects.

Table 5: Methods used to collect community contributions for maintenance costs of RWS

Variables	Very rarely used	Rarely used	Sometimes used	Always used	Total
Daily water use fee	107(71.33%)	24(16%)	19(12.67%)	0(0%)	150(100%)
Household monthly contributions	83(54.25%)	45(29.41%)	23(15.03%)	2(1.31%)	153(100%)
When need for maintenance arise	17(11.26%)	41(27.15%)	54(35.76%)	39(25.83%)	151(100%)

Source: Field Survey (2020)

Rural community capacity in managing water supply projects

The study analysed the capacity of the rural community to manage RWS projects. They were asked to vote whether community members had enough skills to supervise operations of rural water supply and whether they could contribute enough funds for maintenance of a rural water supply project if they would be encouraged to do so. The findings, as presented in the Table 6,

revealed that community members accepted there were enough skilled people in their communities who could sustainably supervise operations of RWS projects. This was accepted by 40% and 28.13% of the surveyed community members who voted the capacity was "very high" and "high" respectively. However, 14.75(22%) of the respondents voted definitely NO (very little capacity with technical skills in regard to water system repair and maintenance.

Further, the findings indicated that respondents indicated that community member were able to contribute enough funds for maintenance of rural water supply projects if they would be encouraged. 30.19% showed that community members had "very high capacity" on this matter and 45.28% pointed out that community members had "high capacity" to manage the project.

Table 6: Rural community capacity to manage water supply project

Variable	**Measurement**	**Responses**	
		Frequecy	**%**
If they are encourages, community members have enough skills to supervise operations of RWS projects for their sustainability.	Definitely YES (very high capacity)	64	40.00
	Probably YES (high capacity)	45	28.13
	Probably NO (little capacity s)	29	18.13
	Definitely NO (very little capacity)	22	14.75
	Total	160	100.00
If they are encourages, communities can contribute enough funds for maintenance of RWS project.	Definitely YES (very high capacity)	48	30.19
	Probably YES (high capacity)	72	45.28
	Probably NO (little capacity s)	35	22.01
	Definitely NO (very little capacity)	4	2.52
	Total	159	100.00

Source: Field Survey (2020)

Discussion, conclusion and recommendations

Community participation in management of water supply project

The study found out that low participation of community members in management of public water service projects in the rural areas. This is different from what was expected to occur in the introduction of decentralization approach of water management in the country (Dobbin and Lubell 2021; Tantoh and McKay 2020; Walker et al. 2021). The aim of water management decentralization was to have a managerial strategy, which includes the involvement of local government, community members and nongovernment organizations (NGOs) in the planning and implementation of water projects. The study argued that Kwimba local government has failed to make better use of local community resources in management of rural community water supply projects.

According to previous studies for instance in Africa the new constructed water supply systems were at the danger of poor maintenance and that the systems would face detrimental operation challenges in the near future (Hovden et al. 2020; Huang et al. 2022; Otter et al. 2020; Sweya and Wilkinson 2021). One of the significant factors that affect sustainability of the rural water supply projects was lack of full community participation in establishment and operation of the projects (Sweya and Wilkinson 2021).

It is clear that community participation in water supply projects provides members of the community with the opportunity to influence the decision-making process. Participation broadens social development ideals by participating fully in the decision-making process, ordinary people experience fulfillment, which contributes to a heightened sense of community and a strengthening of community needs. As such, to promote public participation in the public projects within rural areas is vital for the sustainability of the project (Dilay et al. 2020; Henderson et al. 2020; Sweya et al. 2021).

Awareness and willingness to contribute to water supply project costs

For sustainable rural water supply project, the community should be sensitized to be at the forefront in contributing towards the maintenance cost. The study found out that community members have good awareness that they were responsible for maintenance cost of water projects in their communities. They

were willing to contribute for the maintenance cost (Dery et al. 2020; Tantoh and McKay 2020; Walker et al. 2021). This shows that the presence of dysfunctional water points in the visited communities was on the modality used to collect contributions from the community members. This is because community members, as the main beneficiaries of the projects, were aware and willing to contribute towards the maintenance cost. It was found out that community members were told to contribute for the maintenance when the need arose. This means that there were no reserved resources for emergence repairs (Alim et al. 2020; Dery et al. 2020; Tsani et al. 2020).

It was also reported that maintenance funds were partly collected from the local government authority but it was taking time for the local government to approve the funds for maintenance of the water projects in the rural areas. Therefore, there was a need of establishing mechanisms or approaches that would ensure community members are firmly committed in continue contributing for the maintenance of such projects (Kessy 2020; Komakech et al. 2020; Mdee and Mushi 2021). Capital contributions should not wait for specific maintenance need this is because the income of rural people is unpredictable since the majority of them depend on the subsidiary agricultural activities that depend on climatic conditions. For example, the operation of rural water supply schemes in Malawi has always not reached the level of full cost recovery, due to socio-economic conditions pertaining to the rural areas; but proper management that involve community members in water management committees can help to ensure communities contribute funds enough to carry out both short term and long term maintenance (Oduor and Murei 2020; Truslove et al. 2020).

Community capacity to manage RWS project

Following low level of involvement in the planning, design, and implementation of RWS projects; the community members and their community organizations lack the capacity to provide the necessary expertise for taking up promptly maintenance and repairs of the broken water schemes. These reduced communities' supervision of the water supply facilities and rendered them dependent on the local government for the maintenance cost of the dysfunctional water points. Therefore, there should be mechanisms to ensure all stakeholders, including community members, are fully involved in making social and economic decisions affecting RWS projects (Hui et al. 2020; Kostiukevych et al. 2020; Tantoh and McKay 2020).

Conclusion

The study concluded that water supply projects in rural areas of Kwimba District were not sustainable due to the low level of community involvement in the establishment phases that affect their participation in maintenance of the projects. Hence, there is the possibility of a decline in water supply in rural areas of Kwimba in the near future due to inadequate maintenance. Nevertheless, it was still early to rescue the working water points from collapse as well as to restore non-function water points because communities were willing to contribute towards the maintenance of water supply projects. Therefore, community member can keep and sustain the community water project if they are empowered to do so.

Proper mechanisms are needed to collect maintenance funds from the households. These could be either collection of water user fees at the water points when a user is fetching water or implementation of monthly water contribution fees for each household. One of these two approaches can be effective in the management of maintenance compared to an approach that has been used that involves collection of maintenance funds when needs arise. The water user fees at the water point and monthly contribution fees should be small enough to encourage households to continue using clean water supplied in the community. Furthermore, the low level of community participation in the entire process of implementing rural water supply projects does not create the enabling environment for taking up community-oriented management of RWS projects and in fact was the hindrance to the sustainability of rural water supply sector.

Implications and recommendations

The involvement of the community members in all phases of water project establishment is essential to ensuring sustainability of the projects. In the studied rural wards there were several dysfunctional water points. This might be caused by a lack of proper maintenance efforts from the rural communities since they were not effectively involved in the project establishment phases. The participation of community members in all phases of water supply construction projects makes communities feel responsible for the maintenance of the project. However, if community members participate rightly from the beginning of the projects they can develop the capacity to manage the operation and the

maintenance of the project.

The findings highlight that, in order to improve rural water supply services in Tanzania, within the affordability and community based, community members must participate fully in the process of identifying and selecting (from among options) the appropriate and affordable water supply scheme, then there is a great chance to enhance project ownership and hence its sustainability. Therefore, the implementation should balance between providing for the water supply needs of the community and the need to strengthen or build the capacity of community organizations to execute necessary maintenance required. The local government authorities as an intermediary in their communications with communities, in management of RWS projects, should involve NGOs and Community Civil Organizations (CCOs). The NGOs as well as CCOs should be a major focus of mobilization and education campaigns to rural communities.

References

Abdullah, W., Zainudin, W., Ishak, W., Sulong, F., & Zia-Ul-Haq, H. (2021). Public participation of renewable energy (PPRED) model in Malaysia: An instrument development. *International Journal of Renewable Energy Development,* 10(1), 119-137.

Adair, S. K., Pearson, B. R., Monast, J., & Vengosh, A. (2011). Considering shale gas extraction in North Carolina: lessons from other states. *Duke Envtl. L. & Pol'y F.*, 22, 257.

Addisie, M. B., Gelaye, T. Y., & Teshome, W. M. (2021). Households' reluctance to collect potable water from improved sources, Ethiopia. *AQUA—Water Infrastructure, Ecosystems and Society,* 70(6), 868-878.

Adeniran, A., Daniell, K. A., & Pittock, J. (2021). Water infrastructure development in Nigeria: Trend, size, and purpose. *Water,* 13(17), 2416.

Ahmed, M. F., Mokhtar, M. B., & Alam, L. (2020). Factors influencing people's willingness to participate in sustainable water resources management in Malaysia. *Journal of Hydrology: Regional Studies*, 31, 100737.

Alam, M. M., Hasan, A. K., Kader, M. A., Uddin, M. R., Chowhan, R. R., & Sarker, U. K. (2022). The Response of Lentil (Lens culinaris Medik.) to Variety and Water Management under Old Brahmaputra Floodplain Soil of Bangladesh. *Journal of the Bangladesh Agricultural University*, 20(1), 27-39

Alim, M. A., Rahman, A., Tao, Z., Samali, B., Khan, M. M., & Shirin, S. (2020). Suitability of roof harvested rainwater for potential potable water production: A scoping review. *Journal of Cleaner Production*, 248, 119226.

Angmor, E. N., Tettey, C., & Amoah, T. (2016). Management of community water projects: Assessing the challenges of indigenous arrangements.

Anh, N. T., Dung, N. H., & Thu, D. T. (2022). Privatization in Rural Water Supply and Customer Satisfaction: An Empirical Case Study in Vietnam. *Sustainability,* 14(9), 5537.

Atenaka, K. L. (2019). Community Participation in Water Supply Projects in+ Tumbi Ward; Kibaha Town District Council (Doctoral dissertation, The Open University of Tanzania).

Balacco, G., Totaro, V., Iacobellis, V., Manni, A., Spagnoletta, M., & Piccinni, A. F. (2020). Influence of COVID-19 spread on water drinking demand: The case of Puglia Region (Southern Italy). *Sustainability,* 12(15), 5919.

Beard, V. A., & Mitlin, D. (2021). Water access in global South cities: The challenges of intermittency and affordability. *World Development,* 147, 105625.

Bhushan, C., & Gopalakrishnan, T. (2021). Environmental Laws and Climate Action: A case for enacting a framework climate legislation in India. Paper presented at the International Forum for Environment, Sustainability and Technology, New Delhi 2021 International Forum for Environment, Sustainability and Technology (iFOREST).

Bjornlund, H., van Rooyen, A., Pittock, J., Parry, K., Moyo, M., Mdemu, M., & de Sousa, W. (2020). Institutional innovation and smart water management technologies in small-scale irrigation schemes in southern Africa. *Water International,* 45(6), 621-650.

Briske, D. D., Coppock, D. L., Illius, A. W., & Fuhlendorf, S. D. (2020). Strategies for global rangeland stewardship: Assessment through the lens of the equilibrium–non-equilibrium debate. *Journal of Applied Ecology*, 57(6), 1056-1067.

Cachelin, A., & Nicolosi, E. (2022). Investigating critical community engaged pedagogies for transformative environmental justice education. *Environmental Education Research,* 28(4), 491-507.

Campbell, D., Moulton, A. A., Barker, D., Malcolm, T., Scott, L., Spence, A., . . . Wallace, T. (2021). Wild Food Harvest, Food Security, and Biodiversity Conservation in Jamaica: A Case Study of the Millbank Farming Region. *Frontiers in Sustainable Food Systems,* 150.

Christopher, W. G., & Beal, C. D. (2022). Developing a best-practice model for water and wastewater services in informal urban settlements in Tanzania. International *Journal of Water Resources Development*, 38(3), 403-425.

Cord, C., Javernick-Will, A., Buhungiro, E., Harvey, A., & Linden, K. (2022). Institutional influences on local government support for professionalized maintenance of water supply infrastructure in rural Uganda: A qualitative analysis. *PLOS Water,* 1(2), e0000003.

Dery, F., Bisung, E., Dickin, S., & Dyer, M. (2020). Understanding empowerment in water, sanitation, and hygiene (WASH): a scoping review. *Journal of Water, Sanitation and Hygiene for Development,* 10(1), 5-15.

Dewi, M. K., Manochin, M., & Belal, A. (2021). Towards a conceptual framework of beneficiary accountability by NGOs: An Indonesian case study. *Critical Perspectives on Accounting,* 80, 102130.

Dilay, A., Diduck, A. P., & Patel, K. (2020). Environmental justice in India: a case study of environmental impact assessment, community engagement and public interest litigation. *Impact Assessment and Project Appraisal*, 38(1), 16-27.

Dobbin, K. B., & Lubell, M. (2021). Collaborative governance and environmental justice: Disadvantaged community representation in California sustainable groundwater management. *Policy Studies Journal,* 49(2), 562-590.

Duan, C., & Chen, B. (2020). Driving factors of water-energy nexus in China. *Applied Energy,* 257, 113984.

Elahi, E., Khalid, Z., & Zhang, Z. (2022). Understanding farmers' intention and willingness to install renewable energy technology: A solution to reduce the environmental emissions of agriculture. *Applied Energy,* 309, 118459.

Engdaw, B. D. (2021). Decentralization and Good Governance Handbook of Research on Nurturing Industrial Economy for Africa's Development (281-304): IGI Global.

Enqvist, J., Ziervogel, G., Metelerkamp, L., van Breda, J., Dondi, N., Lusithi, T., . . . Myeza, S. (2022). Informality and water justice: community perspectives on water issues in Cape Town's low-income neighbourhoods. *International Journal of Water Resources Development*, 38(1), 108-129.

Falkenmark, M. (2020). Water resilience and human life support-global outlook for the next half century. International *Journal of Water Resources Development,* 36(2-3), 377-396.

Fundi, S. (2021). Participatory water sector governance in tanzania: usefulness of critical system thinking. *Loyola Journal of Social Sciences,* 35(2).

Hanson, A. H. (2022). Decentralization Planning and the Politicians (104-126): Routledge.

Henderson, F., Steiner, A., Farmer, J., & Whittam, G. (2020). Challenges of community engagement in a rural area: The impact of flood protection and policy. *Journal of Rural Studies,* 73, 225-233.

Herschan, J., Pond, K., & Malcolm, R.(2022). Regulatory-Driven Risk Assessment to Improve Drinking-Water Quality: A Case Study of Private Water Supplies in England and Wales. Available at SSRN 4126894.

Hickson, R. J., & Owen, T. L. (2022). Project management for mining: handbook for delivering project success: *Society for Mining, Metallurgy & Exploration*.

Hiran, K. K., & Henten, A. (2020). An integrated TOE–DoI framework for cloud computing adoption in the higher education sector: case study of Sub-Saharan Africa, Ethiopia. *International Journal of System Assurance Engineering and Management,* 11(2), 441-449.

Hovden, L., Paasche, T., Nyanza, E. C., & Bastien, S. (2020). Water scarcity and water quality: identifying potential unintended harms and mitigation strategies in the implementation of the biosand filter in rural Tanzania. *Qualitative Health Research,* 30(11), 1647-1661.

Huang, W., Chen, X., Fan, Y., & Li, Y. (2022). Management of Drinking Water Source in Rural Communities under Climate Change. *Journal of Environmental Informatics,* 39(2).

Hui, I., Ulibarri, N., & Cain, B. (2020). Patterns of participation and representation in a regional water collaboration. *Policy Studies Journal,* 48(3), 754-781.

Ibrahim, A., Bartsch, K., & Sharifi, E. (2020). Green infrastructure needs green governance: Lessons from Australia's largest integrated stormwater management project, the River Torrens Linear Park. *Journal of Cleaner Production,* 261, 121202.

Islam, S., Mondal, P. K., Ojong, N., Bodrud-Doza, M., Siddique, M., Bakar, A., . . . Mamun, M. A. (2021). Water, sanitation, hygiene and waste disposal practices as COVID-19 response strategy: insights from Bangladesh. *Environment, Development and Sustainability,* 23(8), 11953-11974.

Jazi, H. H. (2021). Integrated water resources management: A tool for sustainable development. *Future Engineering Journal,* 2(1), 1.

Joshi, D. (2020). Misunderstanding gender in water: Addressing or reproducing exclusion Gender, water and development (135-153): Routledge.

Kanganja, M. N. (2020). INVEStigating Solutions For Resolving The Challenges Of Sanitation And Water Supply In Peri-Urban Areas of Lusaka. Cavendish University.

Kessy, A. T. (2020). Transparency in local government finance and service delivery: The case of Mwanza City and Moshi District Councils in Tanzania. Inkanyiso: *Journal of Humanities and Social Sciences,* 12(2), 194-211.

Komakech, H. C., Kwezi, L., & Ali, M. (2020). Why prepaid technologies are not a panacea for inclusive and sustainable rural water services in Tanzania? *Water Policy,* 22(5), 925-942.

Kostiukevych, R., Mishchuk, H., Zhidebekkyzy, A., Nakonieczny, J., & Akimov, O. (2020). The impact of European integration processes on the investment potential and institutional maturity of rural communities. *Economics & Sociology,* 13(3), 46-63.

Kwandu, C. (2020). Effects of peri-urban water scarcity on adaptive capacity of primary school pupils to covid-19 at kalikiliki community school. University of zambia.

Lakmeeharan, K., Manji, Q., Nyairo, R., & Poeltner, H. (2020). Solving Africa's infrastructure paradox. *McKinsey & Company,* 6.

Laud, R., Kretinin, A., & Betts, S. C. (2020). An integrated model for large-scale social entrepreneurship: Addressing global water supply problems. *Global Journal of Entrepreneurship,* 4(1), 42.

Li, X., Yu, X., Wu, K., Feng, Z., Liu, Y., & Li, X. (2021). Land-use zoning management to protecting the Regional Key Ecosystem Services: A case study in the city belt along the Chaobai River, China. *Science of the Total Environment,* 762, 143167.

Luo, P., Sun, Y., Wang, S., Wang, S., Lyu, J., Zhou, M., . . . Nover, D. (2020). Historical assessment and future sustainability challenges of Egyptian water resources management. *Journal of Cleaner Production,* 263, 121154.

Lyimo, B. J., & Gindo, g. (2022). Water supply and sanitation services towards customer satisfaction.

Mahlknecht, J., González-Bravo, R., & Loge, F. J. (2020). Water-energy-food security: A Nexus perspective of the current situation in Latin America and the Caribbean. *Energy,* 194, 116824.

Mamo, A. A. (2022). Socio-Economic Characterization of Community in Watershed Management: Case of Abaya-Chamo Sub-Basin Project Districts of Southern Ethiopia.

Mansell, P., Philbin, S. P., & Broyd, T. (2020). Development of a new business model to measure organizational and project-level SDG impact—Case study of a water utility company. *Sustainability,* 12(16), 6413.

May, L., Aura, C. M., Becker, V., Briddon, C., Carvalho, L., Dobel, A., . . . McGowan, S. (2021). Getting into hot water: Water quality in tropical lakes in relation to their utilisation. Paper presented at the IOP Conference Series: Earth and Environmental Science.

Mdee, A., & Mushi, A. (2021). Untangling blame and responsibility for service delivery and local governance performance: testing a grounded social accountability approach in Tanzania. *Local Government Studies,* 47(6), 993-1013.

Mekonnen, Y. A., & Gokcekus, H. (2020). Causes and Effects of Drought in Northern Parts of Ethiopia.

Mgulo, R., & Kamazima, S. R. (2022). Community Participation and Non-Governmental Organizations-Funded Rural Water Projects' Sustainability: A Case of Chamwino District, Dodoma Region, Tanzania. *European Journal of Medical and Health Sciences,* 4(2), 51-56.

Millington, N., & Scheba, S. (2021). Day zero and the infrastructures of climate change: Water governance, inequality, and infrastructural politics in Cape Town's water crisis. *International Journal of Urban and Regional Research,* 45(1), 116-132.

Mohsin, M., Zhu, Q., Naseem, S., Sarfraz, M., & Ivascu, L. (2021). Mining industry impact on environmental sustainability, economic growth, social interaction, and public health: an application of semi-quantitative mathematical approach. *Processes,* 9(6), 972.

Molekoa, M. D., Avtar, R., Kumar, P., Thu Minh, H. V., Dasgupta, R., Johnson, B. A., . . . Yunus, A. P. (2021). Spatio-temporal analysis of surface water quality in Mokopane area, Limpopo, South Africa. *Water,* 13(2), 220.

Muhamad Khair, N. K., Lee, K. E., & Mokhtar, M. (2020). Sustainable city and community empowerment through the implementation of community-based monitoring: a conceptual approach. *Sustainability,* 12(22), 9583.

Nadimpalli, M. L., Marks, S. J., Montealegre, M. C., Gilman, R. H., Pajuelo, M. J., Saito, M., . . . Swarthout, J. (2020). Urban informal settlements as hotspots of antimicrobial resistance and the need to curb environmental transmission. *Nature Microbiology,* 5(6), 787-795.

Nepal, S., Neupane, N., Belbase, D., Pandey, V. P., & Mukherji, A. (2021). Achieving water security in Nepal through unravelling the water-energy-agriculture nexus. *International Journal of Water Resources Development,* 37(1), 67-93.

Ngxumeshe, A. M., Ratsaka, M., Mtileni, B., & Nephawe, K. (2020). Sustainable Application of Livestock Water Footprints in Different Beef Production Systems of South Africa. *Sustainability*, 12(23), 9921.

Nizkorodov, E. (2021). Evaluating risk allocation and project impacts of sustainability-oriented water public–private partnerships in Southern California: A comparative case analysis. *World Development,* 140, 105232.

Nkiaka, E., Bryant, R. G., Okumah, M., & Gomo, F. F. (2021). Water security in sub-Saharan Africa: Understanding the status of sustainable development goal 6. *Wiley Interdisciplinary Reviews: Water,* 8(6), e1552.

O'Donnell, E., Thorne, C., Ahilan, S., Arthur, S., Birkinshaw, S., Butler, D., . . . Glenis, V. (2020). The blue-green path to urban flood resilience. *Blue-Green Systems,* 2(1), 28-45.

Oduor, J. O., & Murei, L. C. (2020). Community Participation in Monitoring and Evaluation and Sustainability of Rural Piped Water Supply Projects: A Case of Siaya County, Kenya.

Okal, H. A., Ngetich, F. K., & Okeyo, J. M. (2020). Spatio-temporal characterisation of droughts using selected indices in Upper Tana River watershed, Kenya. *Scientific African,* 7, e00275.

Omotoso, T., & Ibitoye, O. (2021). Catchment scale assessment of pollution threats to water quality in relation to prevalence of water-borne diseases in some communities in Omu-Aran, Nigeria. *ITEGAM-JETIA,* 7(30), 69-74.

Ostad-Ali-Askari, K., & Shayannejad, M. (2021). Quantity and quality modelling of groundwater to manage water resources in Isfahan-Borkhar Aquifer. *Environment, Development and Sustainability,* 23(11), 15943-15959.

Otter, P., Sattler, W., Grischek, T., Jaskolski, M., Mey, E., Ulmer, N., . . . Goldmaier, A. (2020). Economic evaluation of water supply systems operated with solar-driven electro-chlorination in rural regions in Nepal, Egypt and Tanzania. *Water Research,* 187, 116384.

Peters, G., Li, M., & Lenzen, M. (2021). The need to decelerate fast fashion in a hot climate-A global sustainability perspective on the garment industry. *Journal of cleaner production,* 295, 126390.

Pokhrel, Y., Felfelani, F., Satoh, Y., Boulange, J., Burek, P., Gädeke, A., . . . Gudmundsson, L. (2021). Global terrestrial water storage and drought severity under climate change. *Nature Climate Change*, 11(3), 226-233.

Pradana, A. W. (2021). Decentralization Practice in Developing Countries: Lessons for Indonesia. *Journal of Governance,* 6(2), 319-339.

Prescott, M. F., Dobbie, M. F., & Ramirez-Lovering, D. (2021). Green infrastructure for sanitation in settlements in the global south: A narrative review of socio-technical systems. *Sustainability,* 13(4), 2071.

Radosavljević, U., Đorđević, A., Živković, J., Lalović, K., & Đukanović, Z. (2020). Educational projects for linking place branding and urban planning in Serbia. *European Planning Studies,* 28(7), 1431-1451.

Rafa, N., Uddin, S. M. N., & Staddon, C. (2020). Exploring challenges in safe water availability and accessibility in preventing COVID-19 in refugee settlements. *Water International,* 45(7-8), 710-715.

Rugeiyamu, R., Shayo, A., Kashonda, E., & Mohamed, B. (2021). Role of Local Government Authorities (LGAs) in Promoting Local Economic Development and Service Delivery to Local Community in Tanzania. *Local Administration Journal,* 14(2), 103-122.

Ruggiero, S., Busch, H., Hansen, T., & Isakovic, A. (2021). Context and agency in urban community energy initiatives: an analysis of six case studies from the Baltic Sea Region. *Energy Policy,* 148, 111956.

Rugland, E. (2021). Integrating Land and Water: Tools, Practices, Processes, and Evaluation Criteria: Working paper. Cambridge, MA: Lincoln Institute of Land Policy. https://www ….

Schultes, O. L., Sikder, M., Agyapong, E. A., Sodipo, M. O., Naumova, E. N., Kosinski, K. C., & Kulinkina, A. V. (2022). Longitudinal borehole functionality in 15 rural Ghanaian towns from three groundwater quality clusters. *BMC Research Notes,* 15(1), 1-6.

Sewell, S., Desai, S., Mutsaa, E., & Lottering, R. (2019). A comparative study of community perceptions regarding the role of roads as a poverty alleviation strategy in rural areas. *Journal of Rural Studies,* 71, 73-84.

Shan, V., Singh, S., & Haritash, A. (2020). Water Crisis in the Asian countries: status and future trends. *Resilience, Response, and Risk in Water Systems,* 173-194.

Singh, J., Yadav, P., Pal, A. K., & Mishra, V. (2020). Water pollutants: Origin and status Sensors in water pollutants monitoring: Role of material (5-20): Springer.

Smol, M., Adam, C., & Preisner, M. (2020). Circular economy model framework in the European water and wastewater sector. *Journal of Material Cycles and Waste Management,* 22(3), 682-697.

Sweya, L. N., & Wilkinson, S. (2021). Tool development to measure the resilience of water supply systems in Tanzania: Economic dimension. Jàmbá: *Journal of Disaster Risk Studies,* 13(1).

Sweya, L. N., Wilkinson, S., & Kassenga, G. (2021). A social resilience measurement tool for Tanzania's water supply systems. *International Journal of Disaster Risk Reduction,* 65, 102558.

Tantoh, H. B., & McKay, T. J. (2020). Rural self-empowerment: The case of small water supply management in Northwest, Cameroon. *GeoJournal,* 85(1), 159-171.

Tantoh, H. B., Simatele, M. D., & Ebhuoma, E. E. (2020). Shifting the paradigm in community-based water resource management in North-West Cameroon: A search for an alternative management approach. *Community Development*, 51(2), 172-191.

Tanzania, U. R. o. (2009). The water resources management act: Government Printer Dar es Salaam.

Thapa, V. (2020). A Dying Holy River: An Examination of Urban Contamination in the Bagmati River Basin. Dartmouth College.

Theodory, T. F. (2022). Emerging and persistent challenges on water resources governance in rural Tanzania: The Mgeta subcatchment of the Upper Ruvu Basin. *Norsk Geografisk Tidsskrift-Norwegian Journal of Geography, 1*-15.

Thomas, M. L., Channon, A. A., Bain, R. E., Nyamai, M., & Wright, J. A. (2020). Household-reported availability of drinking water in Africa: A systematic review. *Water,* 12(9), 2603.

Thomson, P. (2021). Remote monitoring of rural water systems: A pathway to improved performance and sustainability? Wiley Interdisciplinary Reviews: *Water,* 8(2), e1502.

Tonya, E. (2015). Assessing the Implications of Technology on Sustainability of Rural Water Supply in Dodoma, Tanzania. Tanzania; the open university of Tanzania.

Truslove, J. P., Coulson, A. B., Nhlema, M., Mbalame, E., & Kalin, R. M. (2020). Reflecting SDG 6.1 in rural water supply tariffs: Considering 'affordability'versus 'operations and maintenance costs' in Malawi. *Sustainability,* 12(2), 744.

Tsani, S., Koundouri, P., & Akinsete, E. (2020). Resource management and sustainable development: A review of the European water policies in accordance with the United Nations' Sustainable Development Goals. *Environmental Science & Policy,* 114, 570-579.

Uhagile, F. B. (2021). Assessment of tap water scarcity and alternative water sources used at household level: a case of Lukobe ward, Morogoro municipality, Tanzania (Doctoral dissertation, Sokoine University of Agriculture).

Valcourt, N., Walters, J., Javernick-Will, A., Linden, K., & Hailegiorgis, B. (2020). Understanding rural water services as a complex system: An assessment of key factors as potential leverage points for improved service sustainability. *Sustainability,* 12(3), 1243.

Verma, A. K., Dash, A. K., Bhunia, P., & Dash, R. R. (2021). Removal of surfactants in greywater using low-cost natural adsorbents: A review. *Surfaces and Interfaces,* 27, 101532.

Vila-Guilera, J., Dasgupta, R., Parikh, P., Ciric, L., & Lakhanpaul, M. (2022). Barriers to the Delivery and Uptake of Water Sanitation and Hygiene (WASH) Promotion and Infant Diarrhea Prevention Services: A Case Study in Rural Tribal Banswara, Rajasthan. *Indian Pediatrics, 59(1),* 38-42.

Walker, D. W., Smigaj, M., & Tani, M. (2021). The benefits and negative impacts of citizen science applications to water as experienced by participants and communities. Wiley Interdisciplinary Reviews: *Water, 8(1),* e1488.

Wenda, B. D. S., & Fon, D. E. (2021). Evaluating Women's Empowerment in Rural Cameroon through the Abbreviated–Women's Empowerment in Agriculture Index. *European Journal of Humanities and Social Sciences,* 1(3), 45-51.

WHO. (2019). State of the World's Hand Hygiene: UNICEF and WHO Programme Division/WASH 3 United Nations Plaza New York, NY 10017 USA www.unicef.org/wash.

Zingari, G. N., & Forzano, E. (2021). Shaping waters. Visible and invisible infrastructures in the everyday management of water resources in central Tanzania. *Responsible Director,* 88.

Zohra, T., Ikram, A., Salman, M., Amir, A., Saeed, A., Ashraf, Z., & Ahad, A. (2021). Wastewater based environmental surveillance of toxigenic Vibrio cholerae in Pakistan. *Plos One,* 16(9), e0257414.

Zuniga-Teran, A. A., Staddon, C., de Vito, L., Gerlak, A. K., Ward, S., Schoeman, Y., Booth, G. (2020). Challenges of mainstreaming green infrastructure in built environment professions. *Journal of Environmental Planning and Management,* 63(4), 710-732.