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Assessment of Sanitation Services and Practices among Local Community in West B Municipality in Zanzibar Island, United Republic of Tanzania

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ABSTRACT: Good basic sanitation services and practices are essential in maintaining generally accepted standards for personal hygiene and public health. The objective of this paper is to assess the sanitation services and practices among the local community in West B Municipality in Zanzibar Island, United Republic of Tanzania. The study uses a cross-sectional study design. Raosoft online sample calculator was used to determine the sample size while systematic random sampling was applied to select the respondents. Results show that a substantial proportion of the community uses on-site sanitation systems by which excreta and wastewater are collected and stored in containments within the vicinity, requiring emptying when full. Many toilets have security issues as they lack privacy and user comfort. About 28.8% have unlockable doors, 21.2% have fixed clothing curtains and 3.8% are completely open. In the area, Indian-type squat toilets are dominant (78.75%), followed by traditional pit latrines (20%). A slightly large percentage (55%) of households use motorised but the remaining percentage (45%) use non-motorised means of emptying and transportation. The study further found limited or ineffectual use of Personal Protective Equipment (PPE) among the sludge workers, thus risking their health and safety. The conveyed sludge waste is usually taken to a designated treatment plant, disposed of in excavated pits or dumped openly in the forest. This implies that sanitation services and practices in West B are inadequate, leading to disease transmission due to environmental pollution. The study recommends compliance with standards and guidelines, awareness and advocacy, technological innovations, stakeholder involvement and research and development on sanitation services and practices.

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Environmental sanitation practices refer to residents' involvement in the provision, utilization, and maintenance of ecological sanitation facilities and services and adherence to environmental legislation (Daramola, and Olowopoku, 2016). Close to two decades after the United Nations (UN) identified sanitation as among the global development priorities, more than four billion people, mostly in low- and middle-income countries (LMICs), lack access to safely managed sanitation (WHO, 2017). Safe sanitation systems separate human excreta from human contact at all steps of the sanitation service chain carrying excrement from the toilet to its eventual safe use or disposal. Health hazards associated with the sanitation chain may be microbial (the focus of these guidelines), chemical or physical. Good hygiene

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and proper sanitation practices are prerequisites for improving health conditions, economic productivity through a healthy labour force, and quality of life (Shrestha, *et al.,* 2018). Safe sanitation is vital for health, from preventing infection to improving and sustaining mental and social well-being. The lack of safe sanitation systems leads to infectious diseases among them are diarrhoea, Tropical neglected diseases such as soil-transmitted helminth infections, schistosomiasis and trachoma; and Vector-borne diseases such as West Nile Virus or lymphatic filariasis (Daramola, and Olowopoku, 2016; Curtis *et al.,* 2002; van den Berg *et al.,* 2013) causing substantial disease burden globally (Pruss-Ustun *et al.*, 2014); especially in developing countries. Access to, and use of sanitation facilities and services for the safe disposal of human urine and faecal is vital for sanitation practices and avoidance of such diseases. Worldwide the number of populations without access to basic sanitation has increased. Tracing back to the Millennium Development Goals (MDGs), the world did not achieve the sanitation targets to reduce the proportion of the population without access from 51% in 1990 to 25% by 2015 (WHO, 2017). By 2020, over 1.7 billion people did not have basic sanitation services, such as private toilets or latrines (UNICEF, 2013). Poor sanitation is among the serious environmental health risks that affront human dignity and endanger ecological sustainability, particularly water quality and aquatic biodiversity. There are many pollution threats in areas with inappropriate sanitation or improper functioning systems. Such areas are normally characterized by many populations not served with an adequate water supply and sanitation, at the same time, sewage flows directly into streams, rivers, lakes, and wetlands, affecting coastal and marine ecosystems (EPA, 2016). Until today, most of the population who lack sanitation services stays in rural areas; globally, eight out of ten users of unhygienic sanitation facilities and those who defecate live in rural areas (WHO/UNICEF, 2022). The United Nations reaffirmed the importance of sanitation by incorporating it into the Sustainable Development Goals (SDGs). Goal 6 aims "to ensure the availability and sustainable management of water and sanitation for all (WHO\UNICEF, 2022). Despite these efforts, 4.2 billion people use unsafe sanitation services that leave human waste untreated, threatening human and environmental health. At the same time, 673 million people have no toilets, and all practice open defecation (WHO, 2017). Disparities exist in sanitation coverage between the wealthy and developing countries. In many developed countries, 99 % of the population has access to hygienic sanitation, but many African countries lag behind. In 2020, only 27 % of the population was estimated to use safely managed sanitation, and 37 % used basic hygiene (Sengupta *et al.,* 2018). While in developing nations the proportion of the population with access to basic sanitation facilities has improved, in Sub-Sahara Africa, the situation has continued to be the worst in the world. According to Sengupta *et al.,* (WHO, 2017), only 28 % of the population has access to basic sanitation facilities. Studies further reveal that countries with poor sanitation access are in Sub-Saharan Africa. (Mzuza, *et al.,* 2019). The absence of basic sanitation facilities can cause environmental pollution, and an unhealthy environment contaminated by human waste (Batram and Crain, 2010). For example, waste from those practising open defecation and urination without proper sanitation facilities can contaminate the community's land and water. As a result, it may cause disease transmission thus widespread illness and death. Without sanitation facilities, people often have no choice but to live in and drink water from an environment contaminated with waste from infected individuals, thereby putting themselves at risk for future infection.

It is estimated that 2.1 - 2.6 billion people in low and middle-income countries depend on onsite sanitation technology (Practica, 2016; WHO and UNICEF, 2017) which accumulates tons of untreated or poorly treated faecal sludge daily (Odagiri *et al.,* 2021). In most cases, when the containment is full, they haphazardly discharge into the environment including open areas, farming land and water source areas (Edokpayi *et, al.,* 2020; Singh and Sauer, 2020). These poor sanitation practices cause significant health and ecological implications beyond environmental tolerance. Studies show that a truck volume of 5 m^3 of sanitary waste if dumped in the environment, will cause the same effects as 5,000 people performing open defecation (Bassan, *et al.,* 2014). For the sanitation system to be properly managed, safety practices across the whole sanitation chain from the user interface, containment, conveyance, treatment, and final disposal of or reuse are to be accurately observed. Successful intervention in sanitation relies mostly on human behaviour towards sanitation infrastructure and the system (Ngamlagosi and Mutegeki, 2019). In India for example, despite the government striving to increase access to sanitation facilities by constructing toilets at the household level, the rate of open defecation is still high (Coffey *et al.,* 202). To minimize the negative effects of poor sanitation on public health and the environment, the World Health Organisation provides guidelines on safe sanitation practices to communities to reduce hazards associated with poor handling of excrement along the sanitation service chain for both off-site and on-site sanitation. Safe sanitation systems must

separate human excrement from human contact at all steps along the chain (WHO, 2018). The toilet slab and pan should be constructed using durable material that can be easily cleaned, the superstructure should be designed and built in such a way that it prevents intrusion of rainwater, stormwater, animals, rodents or insects, affords privacy and safety for the user, through provision of lockable doors among other things specifically when the toilet is shared (Scout, 2017). Moreover, the toilet should have access to adequate water supplies and sewerage, safeguarding and cleaning the facility. The containment, which involves septic tanks or pits should retain the sludge from the toilet to avoid discharge to the local environment, to prevent faecal sludge hazard. Also, septic tanks and pits are supposed to be well covered to avert overflow, entry of rainwater and accidental plunging especially the children. Conveyance of the sludge waste (which involves emptying and transportation) should be done in a manner that limits exposure of the sludge workers carrying out the process, the community around and anyone who could be exposed to pathogens by any means. Fiscal sludge should be treated to change its physical, biological and chemical composition to be safe and fit for the intended next use or disposal (WHO, 2018). Lastly, the treated sludge should be safely disposed of or used to reduce the risks to the public from residual pathogen risks, e.g., farmers who use sludge as compost for soil improvement (Strande *et al.,* 2014).

In Tanzania, efforts to improve people's health by controlling water and sanitation-related diseases have long started. Since 1973 several campaigns have been implemented to induce behaviour change at the household level. One of the campaigns was the *Mtu ni Afya* which was implemented in 1973 leading to remarkable changes in basic sanitation coverage. Despite this and other sanitation campaigns and efforts, the country faces several sanitation challenges. Only 47 % of its population has access to basic sanitation, and 23.5% has access to basic hygiene facilities (Usma, *et al.,* 2012).

Zanzibar Island, a semi-autonomous part of the United Republic of Tanzania, has also been taking steps to promote sanitation services. A few years ago, the Zanzibar Utilities Regulatory Authority (ZURA) collaborated with the Eastern and Southern Africa Water and Sanitation Regulatory Association (ESAWAS) and conducted a diagnostic study to establish the regulatory mechanism integrating both water and sanitation services to ESAWAS. The scooping study of sewerage management conducted by UN-Habitat in Zanzibar and the review study by ESAWAS countries' sanitation regulatory frameworks identified policies, legal framework, and institutional arrangement for sanitation service; and gaps and obstacles which hinder smooth management and regulation of sanitation in Zanzibar (RGoZ, 2013). Among them are the Zanzibar Environment Policy, Zanzibar Health Policy, Zanzibar Health Policy, Zanzibar Water Policy, Local Government Authority Act, (2014), Zanzibar Environmental Management Act No.3 (2015) (URT, RGoZ and UNDP, 2022). Many studies in the sanitation sector have been conducted in Zanzibar (Thomas, et al., 2013; Hassan and Fweja, 2020; Ali and Kidagye, 2022; Seppala, 2002). However, none of them pays special attention to sanitation services and practices; particularly the management of sludge waste along the sanitation service chain which includes toilet construction, usage, conveyance mechanisms, and hygienic disposal of excreta waste. Therefore, the objective of this paper is to assess sanitation services and practices among the local community in West B Municipality in Zanzibar Island, United Republic of Tanzania, focusing on the management of sludge waste.

MATERIALS AND METHODS

Data were collected from West B municipality (6°16'37.0"S; 31°03'43.0" E) in Zanzibar Island, United Republic of Tanzania. According to the 2022 National Population and Housing Census West B municipality has a population of 344,517 of which 163,539 are males and 180,978 are females. The municipal has 34 administrative councils (Shehia) (2022). The study used an explorative research design to gain insights into sanitation systems and practices in the West B district. Purposive sampling was applied to select the study sites (councils) where 4 councils with more than 3,500 households; Kijitoupele (5,116), Mwanakwerekwe (3,948), Kisauni (3,767) and Mambosasa (3,574) were selected. Raosoft online sample calculator was used to determine the study sample. The calculation considered a confidence level of 90%, a margin of error of 10% and a population size of 16,405. After computation, a sample size of 68 was obtained. This, however, was elevated to 80 to increase the accuracy. After that, systematic random sampling was applied to select the respondents. Household was the unit of analysis. Key informants were chosen purposively. Research methods included household surveys, in-depth interviews and observation. The instruments for data collection involved semi-structured questionnaires, interview guides and observation checklists. A mixed methods approach was used to collect, analyse, and report the data.

Research permits from respective bodies were obtained. During data collection, the principle of

informed and voluntary consent was obtained from all participants and their legal guardian(s). Confidentiality and rights of individuals were considered at all levels. The study gathered the data using in-depth interviews, household surveys and observation. Instruments for data collection included interview guides, questionnaires and a camera. Content analysis was used to analyse qualitative data whereas IBM SPSS version 26 computer programme was used to analyse quantitative data. Results are presented in text, tables, charts, and photos.

RESULTS AND DISCUSSION

The study examined the community practices across the sanitation service chain from the sanitary facilities (toilets) to the disposal. According to WHO (Scout, 2017), the adopted sanitation service chain runs from containment, emptying, transportation, treatment, and finally, disposal or end use of sludge waste. Respondents were mainly heads of households, but in the absence of the head of household, the following person in the chain of command was involved.

Demographic characteristics of the respondents: Information on respondents' demographic characteristics (Table 1). These include age, sex, marital status, education level, household size and occupation. Results show that 26.3% were aged between 21-30 years, 62.5% were aged 31-60 years and the remaining 12.2% were aged above 61 years. Out of 80 respondents, 60 (75%) were females and 20 (25%) were males. Among them 81.2% were married, 10.0% were single and 8.8% were divorced; 28.6% had primary education, 53.8% had a secondary level of education 6.3 had tertiary level of education and 11.3% had no formal education. Many of the households (53.4%) had between 6-10 members. Others had 11 members and above (30%) and 1-5 (16.2%). Most household heads (40.0%) had no formal employment, followed by small-scale business operators (38.7%). Some had salary employment (8.8%), small-scale farming (11.2%), and large-scale business (1.3%).

Table 1: Respondents demographic characteristics (n=80)

Demographic characteristics	Variable	Frequency	Per cent
Age	21 - 30	21	26.3
	31 - 60	50	62.5
	61+	9	12.2
Sex	Male	20	25.0
	Female	60	75.0
Marital status	Married	65	81.2
	Single	8	10.0
	Divorced/separated	7	8.8
Education level	Primary education	23	28.6
	Secondary education	43	53.8
	Tertiary education	5	6.3
	No formal education	9	11.3
Households size	Up to 5	13	16.2
	6-10	43	53.8
	11 and above	24	30.0

Source: Field data (2022)

Community Sanitation Practices: The study examined community sanitation practices along the sanitation service system starting with the sanitary facility (toilet) in use. Various sanitation categories were evaluated based on capture, containment or storage, conveyance, transportation, treatment and dumping or end-use.

User interface: This first component of the sanitation service chain should be secured with privacy for the user to feel comfortable using the toilet, therefore it should be a secured building or room with a roof and lockable door. All toilet superstructures in the study area are made of blocks or stones. Nevertheless, around 7.5% of them had open roofs, thus increasing the risk of rainwater and intrusion of insects and animals. This makes the toilet unsafe and difficult to enter especially during rain. Results further show that only 46.2% of the toilets have lockable doors implying that more than half of the households lack this important aspect. About 28.8% of the households had unlockable doors, 21.2% used only fabric curtains and the remaining 3.8% had neither doors nor curtains. It was noted that toilets are mostly shared by members of the same family but also, between two or more households. This situation is of great concern because it affects the privacy and security of the user. Lack of privacy and safety leads to shame, anxiety, fear, assault, embarrassment, and lack of dignity (ESAWAS, 2019) accordingly affecting individuals'

mental well-being. It was also revealed that 98.8% of the toilet's surface area is made of concrete floors and slabs and smoothened with sand and cement. These designs adhere to the WHO guidelines which require toilets to be made from easy-cleaning materials such as concrete, porcelain, fibre-glass, or stainless steel (Scout, 2017). The remaining toilets (1.2%) have mud surface floors which are difficult to clean or disinfect, inflicting health hazards. All 80 toilet facilities (100%) were discovered to be using on-site sanitation systems, encompassing dry and pour flush toilets. The sludge and wastewater from the toilets are contained or stored in septic tanks, cartridges or pits around the home yard.

Table 2: Toilet categories

Category		Frequency	Per cent
Toilet floor material	Cement.	79	98.75
	Soil/ mud	1	1.25
Toilet roofing design	Roofed/ superstructure	74	92.50
	Open roof /unroofed	6	7.50
Toilet door security	Lockable door	37	46.25
	Unlockable door	23	28.75
	Curtain	17	21.25
	Nothing	3	3.75
Toilet capture	Dry toilet (Traditional pit)	10	20.00
	Pour toilet (Indian squat type)	63	78.75
	Pour toilet (European type)	1	1.25
Toilet maintenance	When need arises	80	100.00
Toilet cleaning (weekly)	Almost every day	70	87.50
	Five days a week	1	1.20
	Four days a week	5	6.30
	Three days a week	3	3.80
	Two days a week	1	1.20

Toilet capture and containment: The toilet capture is connected to containments which are either septic tanks, pits, cartridges or containers that require emptying when full. Containments are supposed to have openings from which sludge waste would be emptied. The openings must be secured by a fitting lid to prevent objects, animals, and humans from falling into. While falling objects may cause contamination, excessive water may instigate overflow of the containment as was observed during the study (figure 1). This becomes risky to all household members specifically to children.

Fig. 1: Septic tank overflow due to rainwater entry

A clean toilet increases user comfort and helps to prevent flies and minimize odour, therefore, water availability is another important aspect of sanitation. Although the area has a piped water supply system, water service is subjected to rationing. Inconsistent water supply has been compromising effective

sanitation, thus risking people's health. It was further informed that toilet cleaning is determined by water availability. When water is unavailable, toilets may not be cleaned. However, mud-floor toilets do not always need water to be cleaned, instead [1] *Chelewa* broom (Fig 2) is used to sweep the surface floor. Some people also use chelewa broom for scrubbing ceramic toilet pans and concrete floors. In this case, water is vital.

Fig. 2: Chelewa broom

Disinfecting the toilet: Effective sanitation involves not only cleaning but also disinfecting the toilet facility. The study discovered that both modern or industrial and conventional disinfectants are used. Around 47.5% were reported to have been using industrial chemicals such as ARO, Dettol, liquid soap, powdered soap, and other chemical reagents. About 36.3% use only water to clean while 11.2% apply traditional or local disinfectants which include ashes and salt. This is mostly done in dry toilets where local disinfectants are applied to prevent flies and minimize odour. In the pit latrine, for example, ash is sprinkled around the toilet hole and left until the next cleaning. The use of conventional disinfectants conforms to WHO guidelines which maintain that where dry latrines are used, an application of ash, soil, lime, and saw-dust should be available within facilities but, they should be safely stored and used. Unlike concrete or cement floors, mud-floored toilets are disinfected by pouring the agents into the capture pit. These toilet designs have high risks of excreta-related pathogens and intrusion of rodents or insects as reported by Scout (2017).

Emptying and transporting/Conveyance: Emptying or removal of sludge waste is normally done when the containment is full. The emptied waste is transported to a designated treatment or disposal area. On-site sanitation technologies such as septic tanks are designed for periodic emptying, but for pit latrines, owners may decide either to empty the pit or cover it up and dig a new one (CAWST, 2016). Nonetheless, in densely populated areas like West B, emptying and conveyance are viable options because there is limited space for frequent shifting of pit location.

Around 45% of the respondents revealed that they empty the containments for safety purposes, particularly to protect children from various health risks including accidents i.e., plunging into septic tanks and pits. About 35% exposed that they do the emptying to prevent overflow of the chambers, thus averting accidents to the entire family from various health risks associated with the sludge waste and wastewater as well as accidents around the homestead.

Transportation is carried out immediately after emptying. Sludge waste must be removed from the area as soon as it is removed from the containment. Commonly, emptying is done when the need arises and there are two common methods used for emptying and transportation: automatic motorized and non-motorized. More than half of the households (55%) implement automatic motorized emptying and the remaining (45%) use manual emptying (kuzamia-*diving into the septic tank or pit and fetching the sludge with a bucket*). WHO guidelines recommend and prioritise motorised emptying over manual emptying wherever possible (Scout, 2017), because it is safer and ensures a high level of sanitation. Many who opt for manual emptying in the study area (71.4%) disclosed that motorised emptying is

challenging due to limited road connectivity which prohibits sanitation service vehicles from reaching the containment. Studies confirm that non-motorized emptying is usually done in unplanned settlement areas where mechanical equipment and trucks cannot reach (CAWST, 2016). The proportion of the population relying on manual emptying is quite significant suggesting that the possibility for faecal contamination in the soils, water, and raw or cooked food is high.

More than half of the respondents reported that the last time emptying was undertaken, they noticed sanitation workers using protective gear. Around 61.15% testified that the workers had clothes, gloves, safety boots and masks; 1.25% observed clothes, safety boots and gloves whereas 1.25% did not see any protective gear being used. Meanwhile, 39% were uncertain whether the workers did or did not use any protective gear. This involved both motorized and manual workers.

Like many other places in Sub-Saharan Africa, limited use of PPE in Urban West B is associated with various factors such as availability, affordability and comfortability. Sanitation workers do have access to all required PPEs. In most cases, only gloves and jackets are available. The workers should protect their heads, eyes, nose and mouth, hands, feet and body (Water Aid, 2020). Failure to do that increases risks of contamination and injuries. Limited use of PPE can also be linked to the climatic condition of Zanzibar. Given the high temperatures and humidity, sanitation workers do not feel comfortable wearing heavy garments which causes them to sweat and feel uncomfortable to work. Moreover, many PPEs are manufactured with low-quality materials and thus do not last longer. Sometimes due to poor access to proper PPEs, workers use inappropriate gear which does not effectively protect them.

Sanitation workers may not use protective gear because they don't have any, but sometimes they don't want to, even if they have one. Workers who don't use protective gear during operation are potentially at risk as they are exposed to pathogens and toxic gases. They are vulnerable to serious health problems such as diarrhoea, rashes on the skin, skin irritation, nausea, anaemia and diseases of the throat, to mention some. Manual workers may also encounter death during sewer diving. Although there is no documentation of manual workers' deaths in the study area, such cases have been reported from other countries. India for example, reported a high death toll resulting from manual emptying of sewers and septic tanks in 2017. The Guardian News Web informed that within one year (2017), at least 300 manual sanitation workers died doing the work in only 13 of 28 India's states (Sclar, *et al.,* 2018).

Table 3: Sanitation service and practices

Practice		Frequency	Per cent
Septic tank accessibility	Easily accessible with an open way	55	68.75
	Not easily accessible due to geographic barriers	25	31.25
Emptying and Transportation	Motorized	45	55.00
	Manual (*kuzamia*)	35	45.00
Protective gear used during emptying	Not sure	29	36.25
	No protection	1	1.25
	Cloths, gloves, safety boots and mask	49	61.15
	Cloths, gloves and safety boots	1	1.25
On-site waste treatment methods	No treatment	29	36.25
	Local/indigenous methods using ash or salt.	13	16.25
	Industrial chemical	38	47.50
Final disposal	Open dumping	2	3.20
	Pit holes	33	41.75
	Designated area (Kibele)	45	55.00
Ruse of the waste	For agriculture purposes/manure	10	12.50
	Not used (disposed)	70	87.50

Some respondents believe sanitation workers lack knowledge of the risks associated with limited use of protective gear, thus proposing awareness creation campaigns to help them make informed decisions. Representing the Zanzibar Utility Regulatory Authority (ZURA) during an interview, key informant number 1 said:

"Mostly, sanitation workers do not comply with the set Standard Operational Procedures; they just do some things to dodge the law and not to prevent themselves or others from the risks. For example, they can be

careful not to litter any waste on their way to the disposal just because they don't want to face the law and not otherwise. They don't have the required knowledge and skills to handle sludge along the sanitation chain (KI 1, 2022).

Another key informant also showed his concern over the limited use of PPEs by sanitation workers and how they risk their lives:

"Generally the use of personal protective gear among the sanitation workers is poor, thus risking their health. Unfortunately, many workers do not have the equipment, and some do not care because they never suffer the imminent danger of not applying the PPE" (KI2, 2022).

This was also confirmed by key informant number 1 during an in-depth interview

"Most of the transportation and excreta-emptying workers do not apply the personnel protective gear (PPE) because they are not accustomed to wearing them or they think it can delay them during working" (KI1,2022).

Treatment and disposal/ reuse: The study established that sludge some of the households treat sludge waste on-site, but others do not. About 47.5% said they use industrial chemicals (could not mention) and 16.3% apply ashes or salt inside the containments. The remaining 36.2% never treat sludge waste. With motorised emptying and transportation, waste is taken to the treatment plant in Kibele. At Kibele, waste is treated before being taken to the final disposal. According to ZURA officials, treated waste can be reused as compost in farms, or safely disposed of in the environment.

A small proportion of the respondents (12.5%) revealed that they take the sludge to their farms to be used as compost manure, but they only take sludge water, not faecal material. A significant proportion (87.5%) attested that they take the waste to the disposal site and are unwilling to use it as manure. The perception of most people is that agricultural products can be contaminated with pathogens, hence affecting their health. Scientific studies have proved that untreated sludge waste has potential adverse effects of toxic inorganic and organic compounds on the environment and living organisms through the food chain following the use of sludge in cropland (Bai *et al.,* 2017). Most respondents do not prefer open dumping, especially for untreated waste. About 37.35% are worried about disease transmission insisting that open dumping encourages the breeding of pathogens and the spread of diseases such as cholera. Others have concerns with environmental pollution, others mentioned ecological pollution and disease transmission. Some are bothered by the smell of the dumped waste, but some are not as shown in Figure 3.

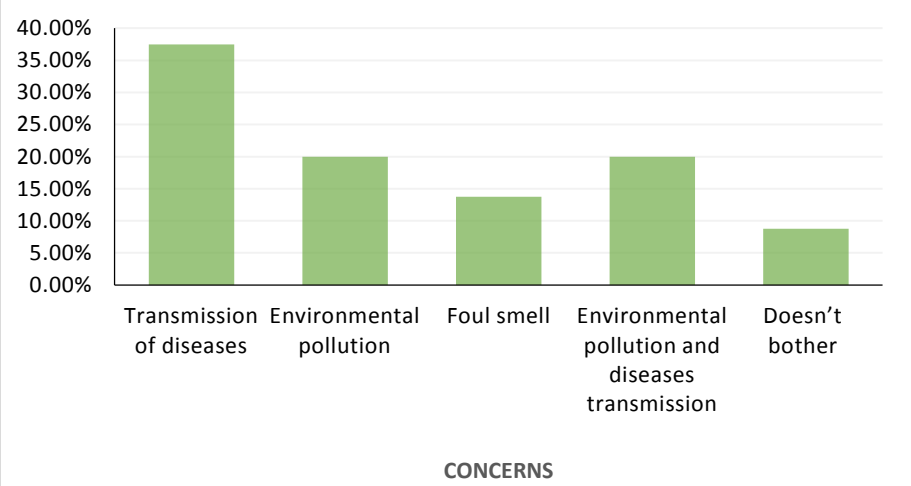

Fig. 3: Concerns for untreated waste open dumping
Sources; Field data (2022)

Recycling is the best way of reducing and reusing sludge waste. However, limited knowledge about recovery, treatment and re-use of sludge prevents waste recycling. A study on Knowledge, Attitudes, and Practices (KAP) on faecal sludge resource recovery and reuse conducted in Dar es Salaam, Tanzania revealed that the knowledge about faecal sludge recovery and reuse is moderately low. Moreover, many people have negative attitudes toward using faecal sludge-derived products, except those not directly consumed, such as biogas or faecal sludge-briquettes (Safi, 2018).

Conclusion: The study noted that the sanitation service chain and practices in West B Municipality in Zanzibar are weak. In some households, toilets lack the necessary features such as roofs, lockable doors and water, thus reducing user comfort, security and general hygiene. Additionally, manual emptying of the toilets and the absence or improper use of protective gear put sanitation workers and the community at high risk of contaminating pathogens, thus contributing to the spreading of diseases. Moreover, the disposal of untreated sludge prompts underground water pollution. On the other hand, using untreated sludge as compost manure can contaminate the produce and affect the consumers. Interventions such as education and awareness creation for safe sanitation practices should be organized. In poor-planned areas, innovative technologies such as dewatered sludge recycling, decentralised thermal treatment and treatment of faecal sludge in situ (i.e., improved pit latrines) should be adopted particularly in poorly planned areas. Meanwhile, local community engagement should be embraced and strengthened to improve sanitation services.

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Data Availability Statement: Data are available upon request from the corresponding author

REFERENCES

Ali, WM; and Kidagye, ES (2022). Determination of Factors that Contribute to the Prevalence of Diarrhoea among Children Under Five Years of Age in Association with the Status of Drinking Water Sources at Bububu, Zanzibar *Tanzania J. Sci.* 48(2): 474-486 DOI: https://dx.doi.org/10.4314/tjs.v48i2.21

Atangana, E; Oberholster, PJ (2023). Assessment of water, sanitation, and hygiene target and theoretical modelling to determine sanitation success in sub-Saharan Africa. *Environ. Develop. Sustaina.*. 25: 13353–13377 https://doi.org/10.1007/s10668-022-02620-z

Bai, Y; Zang, C; Gu, M; Gu, C; Shao, H; Guan, Y; Wang, X; Zhou, X; Shan, Y; Feng, F (2017). Sewage sludge as an initial fertility driver for rapid improvement of mudflat salt soils. *Sci. Total Environ*. 578, 47–55

Bassan, M; Brdjanovic, Dodane, PH; Hooijmans, C (2014). Faecal Sludge Management – Systems Approach for Implementation and Operation. Water Intelligence Online. https://doi.org/10.2166/9781780404738

Bi, Q; Abdalla, FM; Masauni, S; Reyburn, R; Msambazi, M; Deglise, C; von Seidlein, L; Deen, J; Jiddawi, MS; Olson, D; Nemes, I; Taib, JA; Lessler, J; Andemichael, GR; Azman, AS (2018). The Epidemiology of Cholera in Zanzibar: Implications for the Zanzibar Comprehensive Cholera Elimination Plan. *J Infect Dis. 218 (suppl3):* S173-S180. doi: 10.1093/infdis/jiy500

Centre for Affordable Water and Sanitation Technology [CAWST] (2016). Technical Brief: Sanitation System – Emptying and Transporting Fecal Sludge. Creative Commons: Calgary, Canada

Coffey, D; Gupta, A; Hathi, P; Spears, D; Srivastav, N; Vyas, S (2017). Understanding Open Defecation in Rural India: Untouchability, Pollution, and Latrine Pits. *Econ Polit Wkly.* 52(1):59-66

Curtis CF; Malecela, M; Reuben, R; Maxwell CA. (2002). Use of floating layers of polystyrene beads to control populations of the filaria vector Culex quinquefasciatus. Ann Trop Med Parasitol. Suppl 2: S97-104

Daramola, O and Olowoporoku, O (2016). Environmental Sanitation Practices in Osogbo, Nigeria: An Assessment of Residents' Sprucing-Up of Their Living Environment. *Economic and Environmental Studies* 16 (4): 699-716

Eastern and Southern Africa Water and Sanitation Regulators Association [ESAWAS] (2019). Review of ESAWAS Countries' Sanitation Regulatory Frameworks Detailed Gap Analysis Report, April 2019

.

Edokpayi, JN; Enitan AM; Adeeyo, AO; Durowoju, O.S; Jegede, AO; Odiyo, JO (2020). Recent trends and national policies for water provision and wastewater treatment in South Africa. In: *Water Conservation and Wastewater Treatment in BRICS Nations. Elsevier*, pp. 187–211. doi:10.1016/B978-0-12-818339-7.00009-6

.

Environmental Protection Agency (2016). National Rivers and Streams Assessment 2008–2009. https://www.epa.gov/sites/production/files/2016-03/do

Hassan, J; and Fweja, LWT (2020) Food Hygienic Practices and Safety Measures among Street Food Vendors in Zanzibar Urban District *eFood*.. 1(4); 332–338 *DOI: https://doi.org/10.2991/efood.k.200619.001*

Mzuza, MK; Zhang, W; Kapute, F; and Wei, X (2019). The impact of land use and land cover changes on the Nkula Dam in the Middle Shire River Catchment, Malawi. In A. Pepe and Q. Zhao (Eds.), Geospatial analyses and Earth observation (Chapter 3). https://doi.org/10.5772/intechopen.86452

Ngamlagosi, F and Mutegeki, M (2019). *Regulation Strategy and Framework For Inclusive Urban Sanitation Service Provision Incorporating Non-Sewered Sanitation Services*. East and Southern Africa Water and Sanitation Regulators Association (ESAWAS)

Odagiri, M; Thomas, A; Listyasari, M; Mills, F; Bain, RES; Muhammad, Z; Slaymaker, T; Mardikanto, A; Gultom, A; Indiyani, A; Rangkuti, H; Willetts, J (2021). Safely Managed On-Site Sanitation: A National Assessment of Sanitation Services and Potential Fecal Exposure in Indonesia. *Int J Environ Res Public Health*. 3; 18(15):8204. doi: 10.3390/ijerph18158204

Practica Foundation (2016). Integrated Fecal Sludge Management (FSM) chains *Assessment, design and setup of faecal sludge management chains in towns and cities in developing countries* in https://www.practica.org/wp-content/uploads/Integrated-FSM-chains.pdf

Prüss-Ustün, A; Bartram, J; Clasen, T; Colford, JM; Cumming, O; Curtis, V; Bonjour, S; Dangour, AD; De France, J; Fewtrell, L; Freeman, MC; Gordon, B; Hunter, PR; Johnston, RB; Mathers, C; Mäusezahl, D; Medlicott, K; Neira, M; Stocks, M; Wolf, J; Cairncross, S (2014). The burden of disease from inadequate water, sanitation and hygiene in low- and middle-income settings: a retrospective analysis of data from 145 countries. *Trop Med Int Health*. 19(8):894-905

Revolutionary Government of Zanzibar [RGoZ] (2013). Zanzibar Utility Regulatory Authority Act. No 7. Zanzibar

Safi, M (2018). Man scavenging death toll of Indian sewer cleaners revealed. The Guardian web of the year

.

Sclar, GD; Penakalapati, G; Caruso, B; Rehfuess, EA; Garn, JV; Alexander, K (2018). Exploring the Relationship between Sanitation and Mental and Social Well-being: A Systematic Review and Qualitative Synthesis. Social Science and Medicine.

.

Scout, S (20-17). India: The Problem of Open Defecation - World Food Prize Michigan Youth Institute. (2017). https://www.canr.msu.edu/news/india-the-problem-of-open-defecation

Sengupta, S; Verma, R; Kazm, S (2018). Bottom to the Fore: Rural sanitation in Sub-Saharan Africa, Centre for Science and Environment, New Delhi

Seppala, OT (2002). Effective water and sanitation policy reform implementation: need for systemic approach and stakeholder participation. *Water Policy 4 (2002) 367–388*

Shrestha, MV; Manandhar, N; and Joshi, SK (2018). Study on Knowledge and Practices of Water, Sanitation and Hygiene among Secondary School Students. 0657(3). https://doi.org/10.3126/jcmsn.v14i3.21158

Singh, S; Sauer, J; (2020). Practical experience testing aspects of market development for city-wide inclusive sanitation. WL39,313–326.doi:10.3362/1756-3488.19-00009.

Strande, L; Ronteltap, M; Brdjanovic, D (2014). Faecal Sludge Management: Systems Approach for Implementation and Operation. IWA Publishing, UK

The United Republic of Tanzania [URT] (2022). Ministry of Finance and Planning, Tanzania National Bureau of Statistics and President's Office - Finance and Planning, Office of the Chief Government Statistician, Zanzibar. The 2022 Population and Housing Census

The United Republic of Tanzania [URT]; Revolutionary Government of Zanzibar [RGoZ]; United Nations Development Programme [UNDP] (2022). Policy and Institutional Review Zanzibar, Tanzania. The Biodiversity Finance Initiative https://www.biofin.org/sites/default/files/content/knowledge_products/Biofin%20PIR%20-%20Final.pdf

Thomas, J; Holbro, N; Young, D. (2013) A review of sanitation and hygiene in Tanzania. Research report. London School of Hygiene and Tropical Medicine

United Nations Children's Fund [UNICEF] (2013). Progress on Sanitation and Drinking Water: WHO Press World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland.

United Republic of Tanzania [URT] (2020). Guidelines for onsite Sanitation and Faecal Sludge Management for Water and Sanitation Authorities. Energy And Water Utilities Regulatory Authority (EWURA)

Usman, K; Khan, S; Ghulam, S; Khan, S; Khan, M; Anwar M; Khalil, S (2012). Sewage Sludge: An Important Biological Resource for Sustainable Agriculture and Its Environmental Implications *American Journal of Plant Sciences*. 3, 1708-1721 http://dx.doi.org/10.4236/ajps.2012.312209

van den Berg, H; Kelly LA; Lindsay SW (2013). Malaria and lymphatic filariasis: The case for integrated vector management. Lancet Infect Dis. 13: 89–94.

Water Aid (2020). Assessing the usability of personal protective equipment for sanitation workers in tropical countries (Working paper) https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/assessing-the-usability-of-personal-protective-equipment-for-sanitation-workers-in-tropical-countries.pdf

World Bank [WB] (2018). Reaching for the SDGs The Untapped Potential of Tanzania's Water Supply, Sanitation, and Hygiene Sector.

World Health Organization [WHO] (2017). 2017 annual report WHO/UNICEF joint monitoring programme for water supply, sanitation and hygiene. In *the 2017 annual report WHO/UNICEF joint monitoring programme for water supply, sanitation and hygiene* (pp. 20-20).

World Health Organization [WHO] (2017). Launch version July 12 Main report Progress on Drinking Water, Sanitation and Hygiene.

World Health Organization [WHO] (2018). Guidelines on sanitation and health. Geneva: WHO CC BY-NC-SA 3.0 IGO.

World Health Organization and the United Nations Children's Fund [WHO and UNICEF] (2017). Progress on drinking water, sanitation and hygiene: 2017 update and SDG baselines, 2017. Geneva, Switzerland.

World Health Organization/United Nations Children's Fund [WHO/UNICEF] (2022). Progress on household drinking water, sanitation and hygiene 2000-2020: Five years into the SDGs. In *Joint Water Supply, and Sanitation Monitoring Programme.*