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ASSESSING THE ROLE OF INFRASTRUCTURE AND PUBLIC HEALTH INTERVENTIONS IN IMPROVING SANITATION FACILITY USAGE IN FLOOD-PRONE AREAS OF TSHOLOTSHO DISTRICT

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Article Info

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Abstract

This paper examines the significant WASH-related difficulties in Africa that claim many lives. Sanitation-related infections are the second leading causes of infant mortality in Africa after pneumonia and malaria. The study aims to explore the factors determining sanitation facility use in Tsholotsho District, Zimbabwe. A quantitative approach was used to collect data from 218 respondents in four wards through questionnaires. Access to treated water, age, household income, and distance from the nearest water source were identified as the significant factors that influenced the selection of a sanitation facility. The study recommends the need for more initiatives aimed at solving rural WASH challenges in Africa, especially ending open defecation.

Introduction

Water, sanitation, and hygiene (WASH) are crucial components of public health, particularly in developing countries where access to these services may be limited (Jenkins & Sugden, 2006). Inadequate WASH conditions can lead to the transmission of various diseases such as diarrhea, cholera, and typhoid (Prüss-Ustün et al., 2014). Flood-prone areas are particularly vulnerable to the negative impacts of poor WASH conditions, as floods can contaminate water sources, damage sanitation facilities, and compromise hygiene practices (Dreibelbis et al., 2013). In Zimbabwe, Tsholotsho District has been identified as a flood-prone area, with frequent flooding events leading to widespread damage to infrastructure and public health (Manyena et al., 2013). Therefore, assessing the role of infrastructure and public health interventions in improving sanitation facility usage in flood-prone areas of Tsholotsho District is critical for the development of effective strategies to enhance WASH conditions and mitigate flood hazards.

Several studies have indicated that inadequate infrastructure and lack of access to sanitation facilities are key determinants of poor sanitation practices (Hutton et al., 2014; Antwi-Agyei et al., 2015). In flood-prone areas, the functionality of sanitation facilities is often compromised due to the destruction of infrastructure, causing a decline in sanitation facility usage (Bain et al., 2014). Additionally, public health interventions aimed at promoting sanitation facility usage, such as hygiene education and community-led total sanitation (CLTS), have been shown to be effective in improving WASH conditions in some contexts (Kar & Chambers, 2008; Crocker et al., 2016). However, the effectiveness of these interventions in flood-prone areas remains understudied.

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In order to address this research gap, the present study aims to assess the role of infrastructure and public health interventions in improving sanitation facility usage in flood-prone areas of Tsholotsho District. Specifically, a multivariate probit model will be employed to analyze the factors influencing sanitation facility usage, taking into account the potential interactions between infrastructure, public health interventions, and other socioeconomic and demographic variables. The multivariate probit model has been widely used in similar WASH studies, as it allows for the simultaneous estimation of multiple discrete choice outcomes, and accounts for potential correlations between these outcomes (Cameron & Trivedi, 2009; Hirai et al., 2016).

By assessing the role of infrastructure and public health interventions in improving sanitation facility usage in the flood-prone areas of Tsholotsho District, this study will contribute to the growing body of literature on WASH and flood hazards in developing countries. Furthermore, the findings of this study will have important policy implications for the design and implementation of infrastructure and public health interventions aimed at enhancing sanitation facility usage in flood-prone areas. Ultimately, this research will contribute to the global efforts towards achieving the United Nations' Sustainable Development Goal 6, which calls for universal access to clean water and sanitation by 2030 (UN, 2015).

Materials and Methods

Tsholotsho District is among the seven (7) districts in Matabeleland North province of Zimbabwe (Pawaringira, 2018). Tsholotsho District lies to the north-western part of Bulawayo which is the second largest city in Zimbabwe after Harare. Tsholotsho district covers seven thousand, eight hundred and forty-four square per kilometre (7 844km^2).Tsholotsho district has a population of one hundred and fifteen thousand, one hundred and nineteen (115 119) people with a population density of sixteen (16) persons/km^2 per square kilometre. Tsholotsho District is prone to flash floods which can be attributed to poor drainage and the fact that the land is fairly flat (Dube and Munsaka, 2018). Wards such as Sipepa, Jimila, Mbiriya, and Patalika are highly prone to flash floods. Sipepa and Jimila wards are along Gwayi River and are mostly affected by floods when the river overflows into the flood plain.

A quantitative approach was used in this study, with a focus on flood prone wards in Tsholotsho District that is ward five (5), ward six (6), ward seven (7) and ward eight (8). The four (4) wards were purposively selected as they are more prone to flooding and they have been affected during the previous flood incidences.

Target population for this study was four thousand, four hundred and six (4 406) household heads for the wards that are most prone to flooding. The household heads were targeted since they are responsible for the well-being of their families and they are key in all community WASH programs.

Table1: Sample Size

Ward	**Total number of households**	**Sample size**
5	1026	49
6	1400	79
7	860	45
7	1120	66
Total	**4406**	**239**

The Rao soft sample calculator is principally a software that largely computes or produces the sample size of a research (Rahman, Shiddike and Mohammad, 2020). The process of estimating a sample size for a survey, study can be baffling and infuriating, therefore, the Rao soft sample size calculator gave both sample size and confidence interval calculation to minimize the obstructions faced during study (Schoonenboom and Johnson, 2017) (Dopp *et al.*, 2019). This software puts into consideration the margin of error, the confidence level and response distribution (Bailey and Gammage, 2020). Using the Rao soft calculator, confidence level of ninety-five percent (95%), confidence interval of five percent (5%) and population proportion of fifty percent (50%)

are accepted (Gunbayi, 2020). This study used the Rao soft software package to determine the sample size from the study population. A questionnaire was used to collect data after being pilot tested in ward 13. The quantitative data gathered using Questionnaire survey was analysed using Statistical Package for Social Sciences (SPSS Version 2.2) whereby the researcher pruned the data to check on trends, similarities, differences, and recurrences.

Results and Discussions

The targeted Questionnaire respondents were two hundred and thirty-nine (239) household heads and two hundred and eighteen (218) household heads responded to the questionnaire translating to a response rate of ninety-one point two percent (91.2%). In all the four (4) wards which were targeted, female respondents were the majority comprising of fifty-five point nine percent (55.9%) whilst forty-four point one percent (44.1%) were males with no respondents who were under transgender.

in all the four (4) wards combined, the age group of sixty (60+) plus years had the highest number of the respondents with twenty-two point one percent (22.1%) whilst nineteen (19) years had the least number of respondents with two point three percent (2.3%). Generally the majority of the respondents were forty-one (41) years and above with a combined total of fifty-nine percent (59%) of the total respondents. The male respondents between the ages of thirty-one (31) to forty (40) years had the highest percentage of twenty-six percent (26%) whilst the male respondents between the age of twenty (20) and thirty (30) years had the least number of six point three percent (6.3%) and there were no male respondents who were nineteen (19) years. The female respondents' age group that had the highest number of respondents was twenty (20) to thirty (30) years with twenty-six point one percent (26.1%) and the one (1) with the least was of those nineteen (19) years with two point three percent (2.3%).

The level of education in terms of the sex of the respondents showed that the majority of males totalling fifty point five percent (50.5%) had attained primary education with a considerable number of fourteen point seven percent (14.7%) who never went to school. However, the females who attained secondary education had the highest percentage of forty-one-point seven percent (41.7%) with a considerable twenty percent (20%) that never went to school. The picture painted by these percentages were an affirmation on the levels of education in the district.

The household size according to the sex of the respondents was an average of two point two (2.2) people per each household of the ninety-seven (97) households which were male headed. For female headed households, the average household size was one point eight, eight (1.88) persons per each household of one hundred and twenty-two (122) female headed households. This also clearly reveals that more households in Tsholotsho are headed by females. In a patriarchal society like Tsholotsho, a household headed by a female faces so many difficulties which include compromised economic power and its participation in community programs is also hindered as postulated by Azad *et al.*, (2019).

Out of all the respondents in all the four wards, fifty three percent (53%) of them indicated that they had owned and used a pit latrine. A significant number of respondents summing to thirty three percent (33%) still practiced open defecation and this is a cause for concern. In all the four wards, diarrhea was the most common illness experienced during flood episodes as confirmed by forty four point five percent (44.5%) respondents. Ringworms and stomach problems were also common illnesses faced during flood episodes in all the four wards with twenty two point nine percent (22.9%) and seventeen point nine percent (17.9%) respondents confirming the respectively. Trachoma was the least experienced illness with zero point five percent (0.5%) respondents having experienced it or one of their family members having experienced it. There were less respondents who revealed that Cholera, Typhoid and Dysentery are also experienced during flood episodes.

Table 2: Common illnesses experienced after floods in Tsholotsho

Ward	illnesses that are common after the flood								Total
	cholera	diarrhoea	Typhoid	Dysentery	ringworms	trachoma	stomach problems	other	
5	4.3%	30.4%		15.2%	21.7%	2.2%	26.1%		100.0%
6		35.3%	13.2%	5.9%	38.2%		7.4%		100.0%
7	6.7%	73.3%	2.2%		11.1%		6.7%		100.0%
8		44.1%			15.3%		32.2%	8.5%	100.0%
Total	2.3%	44.5%	4.6%	5.0%	22.9%	0.5%	17.9%	2.3%	100.0%

Whenever the respondents experience health problems during the floods, the majority of the respondents that is ninety five point four percent (95.4%) indicated that they get help from the clinics. A total of sixty nine percent (69%) respondents revealed that the clinics are easily accessible to them whilst thirty one percent (31%) indicating that the clinics were inaccessible to them. Due to economic challenges affecting the health sector in Zimbabwe, even if the clinics are accessible but there is shortage of drugs and medicines which limit the services that the people can get. Only three point seven percent (3.7%) of the respondents sought help from the spiritual leaders whilst zero point five percent (0.5%) percent a piece consulted traditional healers and some not seeking any help.

The sanitation situation is bad as mostly in wards seven (7) and eight (8), where community members do not have toilets according to the key informant interviews. Approximately sixty percent (60%) of community households in the study area did not have toilets and still practice open defecation. The district sanitation coverage remains low at below thirty five percent (35%) as according to the Zimbabwe Vulnerability Assessment Committee Report of 2022. Since most communities rely on open water sources, during the rainfall season, the feaces are washed into these open water sources causing a health hazard. This attributed to the costs of building a toilet and as well as attitude and perceptions of community members which influence their priorities. In ward six (6) most households do have toilets and this is as a result of functional community health clubs that embark on awareness campaigns to have open defecation free communities. Only one village was declared Open Defecation Free in ward six (6).

Table 3: sanitation facilities for the households in Tsholotsho

Name of Ward		Which sanitation facility do you have				Total
		pit latrine	flush toilet	open space	other	
Name of Ward	5	17.4%	21.7%	60.9%		100.0%
	6	67.6%	4.4%	27.9%		100.0%
	7	24.4%	11.1%	55.6%	8.9%	100.0%
	8	88.1%			11.9%	100.0%
Total		53.7%	8.3%	33.0%	5.0%	100.0%

Multivariate probit model for determinants of sanitation facility

To determine sanitation facility usage in Tsholotsho District, this section presents the analysis of findings based on the results of the Multivariate probit model.

Table 4: A multivariate probit model for determinants of sanitation facility usage in Tsholotsho District.

	Open space			Pit latrine			Flush toilet		
Open space	Coefficient	Std. Err	P-value	Coefficient	Std. Err	P-value	Coefficient	Std. Err	P-value
Gender	0.122	0.194	0.531	-0.105	0.187	0.576	0.174	0.186	0.349
Treat water	0.208	0.200	0.298	0.348	0.201	0.083*	0.211	0.195	0.279
Age	-0.007	0.005	0.206	0.001	0.005	0.864	-0.011	0.005	0.039**
Distance to nearest water source	-0.089	0.066	0.173	-0.213	0.065	0.001***	-0.029	0.064	0.654
Level education	-0.059	0.111	0.598	-0.118	0.108	0.276	-0.009	0.109	0.937
Rural District Council	-0.117	0.191	0.540	0.039	0.192	0.840	-0.328	0.180	0.068**
District Development Fund	0.069	0.112	0.540	-0.130	0.109	0.235	0.065	0.106	0.536
Source of income	0.432	0.188	0.022**	0.177	0.184	0.338	0.146	0.184	0.429
Accessibility to health facilities	0.054	0.210	0.798	0.146	0.204	0.472	0.180	0.203	0.374
Constants	0.267	0.683	0.695	0.519	0.682	0.447	0.387	0.669	0.564
/atrho21	0.831	0.131	0.000***						
/atrho31	0.971	0.136	0.000***						
/atrho32	0.705	0.122	0.000***						
rho21	0.681	0.070	0.000***						
rho31	0.749	0.060	0.000***						
rho32	0.608	0.077	0.000***						
Likelihood ratio test rho21 = rho31 = rho32			0.000***						
Prob > chi2 =			0.0000						
chi2(3) =	121.1								
Log likelihood =	-351.61322								

As depicted in Table 4, the likelihood ratio test of the independence of the error terms in the various sanitation equations was rejected (Chi2 (3) = 162.570; P > 0.000). The study thus adopted the alternative concept of interconnection among the many drivers of the adoption of sanitation facilities. The results so supported the application of the Multivariate Probit concept.

The coefficient of treated water is positive and statistically significant in influencing the choice of pit latrine type of sanitation facility in Tsholotsho District of Zimbabwe. This implies that the likelihood of using pit latrine decreases with household's access to treated water. This could be attributed to the fact that the access

to treated water discourages the household's continued use of pit latrine and consequently switch to other improved method of sanitation such flush toilet. This is in consonance with the studies of (Morella et al. (2008); Günther & Fink (2011) who opined that flush toilet offers greater health advantages than other modern sanitation innovations. Additionally, studies have indicated that flush toilets, as opposed to renovated pit latrines, can lower child mortality and significantly lower the likelihood that children under the age of five would contract diarrheal infections Günther & Fink (2010; 2011).

The coefficient of age is negative and statistically significant in influencing the choice of flush toilet type of sanitation facility in Tsholotsho District of Zimbabwe. This implies that the likelihood of aged household head using flush toilet reduces in the study area. This implication could be traceable to the fact that aged household head prefers their traditional method of open defecation or latrine as compared to their younger counterparts (children and youth) who prefer modern facility such as flush toilet. This corresponds to the study Joshi & Amadi, (2013) who posited that infection rates were significantly associated with older children between 8–10 years old.

Furthermore, the coefficient of distance to the nearest water source is also negative and statistically significant in prompting the choice of pit latrine type of sanitation facility over flush toilet which requires water. This means that the more the distance to the nearest water source, the less likely the household to choose or use flush toilet. The households with their private source of water are likely to use the flush toilet compared to the pit latrine. This in tandem with the studies by WHO and Unicef (2019), which revealed that in developing countries, communities travel long distances in search of water and most of them still rely on boreholes that have low pumping capacity. The study further noted that these communities still practice open defecation as only a few household have put latrines or practice cat system.

Source of income for households has a positive coefficient which is statistically significant in the choice of open space as a sanitation facility. With most of the households in Tsholotsho District depending on farming as their source of income, open defecation is still rife as farmers do not have other sanitation options during hours they are working on their fields. Since it was noted that there was a higher number of households who were unemployed and depended on remittances with a meagre income as postulated by Thebe and Maviza (2019), they cannot afford to construct a pit latrine or flush toilet hence the choice of open space as a sanitation facility. Statistically this mean that the lower the income the higher the chances of the household to choose open space as their sanitation facility.

Integrating DRR in the WASH sector

Although the focus of DRR differs at different stages of the WASH emergency management cycle, the general approach (mitigation and preparedness) is largely the same for each stage (UNICEF, 2020). DRR coverage in Zimbabwe is limited due to lack of time and resources during the emergency phase. For ease of use, the emphasis is on essential services that enable users to access enough clean water to survive (UNICEF, 2020). DRR protection is limited to essential elements to ensure a safe location for emergency systems, or an adequate supply and secure storage of water treatment chemicals however in Zimbabwe this remains a pipe dream for many rural communities. During emergencies such as floods that affected Tsholotsho District during the 2016 to 2017 rainfall season, the timeframe considered was a narrow range from hours to weeks thus integration with other sectors and cross-cutting issues was also more limited (Mavhura, 2020). During the recovery period, some stabilization occurs and boundaries are extended, while the elements covered by the exemption remain important. The services covered extend to less important but essential services such disposal of solid wastes whose presence may pose a risk to public health. DRR measures are broader, target higher levels of resilience, and are more integrated with other sectors (Kitagawa, 2020). The development phase contains elements of the discharge and recovery phases, but in an expanded form. All the WASH services are covered, including non-mandatory services, waste disposal where the presence of solid waste does not raise significant public health or safety concerns (Ashu and Van Niekerk, 2019). DRR measures are comprehensive and aim at high resilience of the particularly important WASH services. DRR need to be integrated in all phases of WASH development that is from planning to delivery of WASH services. It is critical to integrate DRR in capacity development of communities, in the co-ordination of communities as well as formulation and implementation of normative frameworks.

In order to improve rural water supply, Zimbabwe has embarked on the following on a number of initiatives. In the late 90s, Zimbabwe initiated a deliberate program to rehabilitate boreholes and wells and updating of Rural Water Supply (RWS) mapping and needs (Nicholson, 2020). The obligation and asset stewardship of RWS in Zimbabwe was placed in hands of Rural District Councils which had to build their sector capability on the other hand encouraging backing from communities and the private sector (Cole *et al.,* 2021). To address rural sanitation and hygiene challenges, Zimbabwe is yet to create a specific budget line for Rural Sanitation and Hygiene (RSH) in national and local budgets (Demberere *et al.,* 2014). No efforts have been made to develop latrine options that the communities can afford to improve sanitation and hygiene services, and there is no clear policy on emptying and replacement of latrines. There is also lack of interest and development of private sector capability for them to engage in latrine building and nurture latrine management. However through development partners there have been efforts to start a nation-wide sanitation behaviour transformation package to eradicate the menace of open defecation (Jain *et al.,* 2019).

Conclusion

The key findings on the determinants of sanitation facility usage in Tsholotsho District show that access to treated water, age of the respondents, distance to the nearest water source and the sources of income for the households are the most influencing factors. These factors were found to be statistically significant in influencing the choice and use of a certain sanitation facility. These factors influence the perceptions and attitudes around the selection of a sanitation facility. A significant number of households still practised open defecation and these are critical in addressing WASH issues. The findings revealed that there are few households with access and used flush toilet. Diarrhoea was discovered to be the most common illness experienced during flood incidences open defecation has a long bearing on the levels of diarrhoea cases in the District. There are some illnesses that were experienced besides diarrhoea and these included Typhoid, Cholera, Dysentery, Ringworms, Trachoma, and stomach problems. The fact that the findings reveal that there is low sanitation coverage in Tsholotsho District is a cause for concern in addressing WASH challenges in the

face of increased frequency of floods due to Climate Change. Reliance on open water sources is a problem that should be tackled if there is sincerity in reducing exposure to health hazards that may result.

The water and sanitation sector is essential to the survival and functioning of society, and it is essential that this sector continues to function in all circumstances (Vörösmarty *et al.*, 2018). Poor WASH services can cause a hazard, and a WASH hazard can further degrade these WASH services and increase disaster risk (Rivero, Morais and De Sousa Pereira, 2020). Therefore, disaster risk should be considered when establishing or developing WASH services, whether during emergency, response, and early recovery or development phases. It is also important that existing or new WASH services do not introduce or amplify new vulnerabilities or threats (Prakongsri and Santiboon, 2020). Other hazards can directly disrupt WASH facilities levels and increase risk to WASH related hazards, for example, earthquakes can burst water pipes, contaminate water supplies, and increase the risk of faecal-oral infections (Kusumawardhana and Nur Auliya, 2020). Improper WASH service can lead to disaster thus communities that use faecal-contaminated river water from upstream communities are at risk of outbreaks of oral faecal infections such as typhoid fever, diarrhoea, fever and/or cholera (World Health Organization, 2020). Poor construction of structures or clogging with soil and solid waste can lead to community flooding as the water generated by heavy rains cannot be drained. A disaster can easily disrupt or degrade the WASH service, creating conditions that lead to subsequent or secondary disasters (Abrams *et al.*, 2021). Communities displaced by floods and living in cramped and unsanitary conditions may be at risk of epidemics of cholera, spotted fever and other infectious diseases. The diagrammatic presentation below is an illustration of how DRR can be infused in WASH so as to increase the coping capacity of communities and ultimately reduce WASH disaster risk.

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