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Household water access and COVID-19 in Karoi town, Zimbabwe

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A B S T R A C T

Water is a crucial resource in the fight against coronavirus disease (COVID-19), which was first discovered in late 2019 in Wuhan, China, and which has since become a pandemic. Thus, clean water unavailability constitutes a risk to people's wellbeing as the chances of contracting the disease is high without it. The World Health Organisation (WHO) prescribed hygiene as a critical measure to control the spread of this highly transmissible disease. As frequent washing of hands and observing general rules of hygiene could mitigate the spread of the disease, access to clean and adequate water supply is one of the fundamental ways of stopping the pandemic. There has, therefore, been a high demand for water across the world in a bid to address the problem. Specifically, the general lockdown and the need to frequently wash hands coupled with the obsolete water infrastructure in Zimbabwe have worsened water access problems for the citizenry. This study, therefore, assessed water access in Karoi town in Zimbabwe. Adopting a household water access conceptual framework, the study investigated six residential areas where a sample of 150 household heads were randomly selected and interviewed. Data on water access were obtained from the respondents using interview schedules. In-depth information on the subject was also obtained from four key informants working at Karoi Town Council (KTC) and Zimbabwe Water Authority (ZINWA). The results showed that households had knowledge on the importance of water availability and hygiene in relation to COVID-19 prevention, leading to an intensified high demand for water and consequently water shortage in the area. The study recommends that KTC and ZINWA need to improve on its water infrastructure and enhance the subsidization of improved water access during the COVID-19 and post-COVID-19 pandemic.

Introduction

The outbreak of coronavirus disease (COVID-19) in late 2019 in Wuhan, China, and which has since become a pandemic calls for a behaviour change [37]. The most important hygiene practice in stemming the spread of COVID-19 is handwashing with soap and clean water. This practice agrees well with the third and sixth Sustainable Development Goals (SDGs), which

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emphasise on good health and clean water, respectively [12]. The World Health Organization (WHO) [45], therefore, recommends handwashing as a basic behavioural practice in the fight against the pandemic. The pandemic has imposed massive health and economic burdens on communities globally and with its attendant negative impact on the water sector. While the full extent of the impacts of the pandemic on the water sector is still emerging, its effect on household water use has, however, been felt because the demand for water has increased considerably. Available data indicate that residential water demand increased during the lockdowns [13]. Thus, access to clean and reliable water is vital for achieving the handwashing practice. This implies that water supply authorities across the globe need to ensure that quality water supply is a priority. Whereas water access is not the main issue in developed countries, it is a mammoth task amongst households in developing countries like Zimbabwe.

Several countries in the South, most especially in Africa, enacted some policies to ensure households have access to enough water for the purpose of curtailing the pandemic. For instance, the Ghanaian government implemented a free water policy to improve water access at the height of the COVID-19 pandemic [4,5]. Nonetheless, the policy has resulted in huge water bills for the government of Ghana, which spends over 40 million United States dollars on the item every month [38]. In Brazil and Chile, water supply authorities were directed by the governments to implement a three months tariff relief for low-income households and a postponement of tariff adjustment [11]. Furthermore, the governments of the two countries made provisions to freely supply water tanks to informal settlements [11]. In Burkina Faso, the government provided subsidies for water consumers and removed penalties for defaulting in water bills payments in all urban areas [27]. While Chad made temporary payments for all household water bills [46], the Democratic Republic of Congo provided 2-month, free water for poor households and hospitals [22]. In Ethiopia, the city of Adama made special provisions to directly supply water to those who needed assistance [9]. In Gabon, the government paid water bills for vulnerable households through a solidarity fund [8]. The same scenario obtained in Mauritania where the government paid water and electricity bills for poor households in both rural and urban communities in 2020 [46]. In Namibia, the government ensured that water points were kept open and people were exempted from using water cards throughout the lockdown period. Thus, Namibia Water (NamWater) and all local authorities provided subsidies for all Namibians [16].

At the advent of the pandemic, all government initiatives in Africa and elsewhere were meant to improve water access and alleviate people's conditions. It is, however, noteworthy that there is no consensus in literature on what constitutes water access [14,18,30,43]. As such, various stakeholders define the term in different ways leading to a controversy in the conceptualisation of the concept. Like in other literature, water access is defined in this paper in terms of the indicators of access rather than adopting a simple and unilinear definition of the concept. Literature has shown that water access is measured by 8 main criteria including water availability, source, quantity, supply and demand, distance to water source or time spent reaching the location and getting back home from there [14,18,30,43]. Firstly, the term water access is measured by water availability and reliability of the source. Secondly, accessibility is a function of the type of water source. Here, access to water is determined by whether households obtain water from improved or unimproved sources. If most households obtain water from improved sources, it implies water is accessible and the opposite is true if most households fetch water from unimproved sources. Thirdly, the quantity and affordability of water supplied from an improved source are other crucial variables in the measurement of water access. The quantity of water (in litres) from an improved source, and available for and used by each household member per day determines water accessibility. This is referred to as the basic water requirement [43]. It is the amount of water consumed per capita per day within a household. According to World Health Organisation (WHO), a person is entitled to 50 l of water from an improved source daily [41]. In terms of daily usage, Dhanaseela and Ono [15] suggest that an individual household member needs 5 l of water for drinking, 10 l for food preparation, 15 l for bathing and 20 l for general sanitation of their environment, and all at an affordable cost. This means that a household should not exceed 5 percent of its monthly income on water services. Water access is also based on the proportion of people who receive an adequate amount of safe drinking water from improved sources daily [30]. In this context, access to water is based on supply and demands. On the one hand, the supply side relates to water institutions or organisations, which makes water available to consumers. Thus, water access is made available by the institutions that provide or supply water to consumers. On the other hand, water demand has to do with the consumer of water supplied by designated institutions. As such, water access is viewed on the scope or coverage of supply. Here, the emphasis is on the availability of water supply infrastructure in an area rather than the actual use of the available infrastructure. From the point of view of the consumer, therefore, water access entails the satisfaction derived from the actual use of water supplied from a source. Water access is also measured by the distance in metres or time in hours travelled or spent to collect water from a water point [20,23]. World Health Organisation (2020) prescribes a water source to be within 1000 m or within a 30 min walking time to and from the water point back to individuals' homes. Besides distance and time, water access is also defined by how user friendly or secure is the water source [3]. Thus, a water point must be friendly to and safe for those accessing it like children, old and disabled household members.

The quantity of water obtained from a source is also a proxy measure of water access [30]. A household has access to water if it obtains water from a source that supplies enough quantities in addition to an acceptable quality for domestic use. While a minimum of 25–50 l of water per individual per day is permissible, WHO [45] recommends that a household member need to use 50–100 l of water per day to meet water-related, domestic needs. A measure of water access in terms of quantity considers optimal water access when a household member can draw a minimum of 25 l of water daily from a water point located within 1000 m from the homestead [30]. Water affordability is measured in terms of the water affordability index which is a statistical measure derived from comparing the household's monthly income to the portion

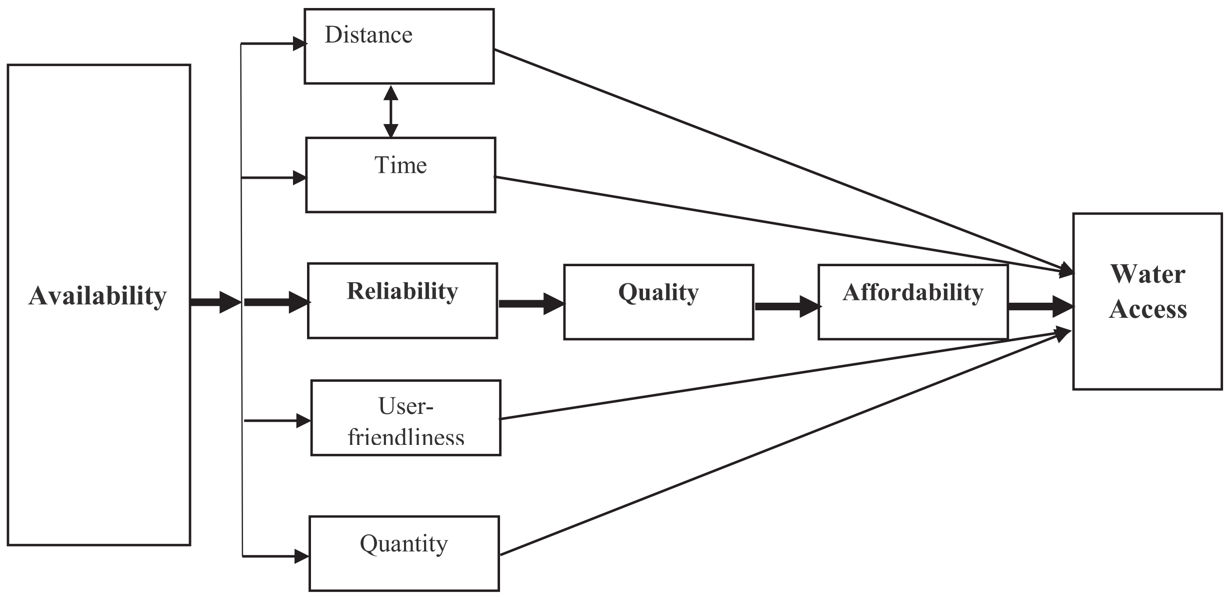

Fig. 1. Households water access conceptual framework. (**Source**: Authors, 2021).

of the income spent on the water [18,30]. Based on Warner et al. [48], water is inaccessible to a household, which spends more than 5 percent of its monthly income on water.

Like many towns in Zimbabwe, the enforcement of lockdown in Karoi town was strict at the height of COVID-19 pandemic. All non-essential movements were barred [29] while curfew was enforced from 6 pm to 6 am. Business hours were cut from 8 am to 3 pm [44] and all public loitering was prohibited [29]. The entire Hurungwe District was put under indefinite localised COVID-19 lockdown after a surge in positive and death cases [44]. Non-essential travellers were denied access into or out of Karoi town and Magunje. There were 24 h police roadblocks at three points along Chinhoyi-Karoi highway. These roadblocks were strictly manned by both uniformed and non-uniformed forces, which denied private taxis entry. Considering the need to improve water access during the COVID-19 pandemic, this paper analysed 8 water access indicators in Karoi town, Zimbabwe.

Conceptual framework

This study draws its analysis from the water access conceptual framework (Fig. 1). The framework comprises eight variables emanating from the notion that water access may have been wrongly conceptualised and that the concept has no agreed definition [21,30]. Rather than dwell on defining water access, this paper focuses more on the measurement of the concept. Based on the proposed conceptual framework, water access is a function of eight crucial variables (see, Fig. 1). Thus, the first two foundational variables are availability and reliability. All things considered, there should always be enough water for household consumption at any given time [19]. Nonetheless, Thomas et al [40]. and Rafa et al [33]. argue that water should be available not only at the household level but in all places where people converge like health and education institutions. As such, the Zimbabwe National Water Policy stipulates that water for domestic use should be available in significant amounts of at least 25 l per day per individual [35]. Also, water access is a function of distance or walking time from a household to a water source [30,33]. Based on WHO [41] report, water is accessible if it is located within 1 km from the user's place of residence and it takes 30 min for the user to access the water and return home. However, it is noteworthy that water accessibility is contextual; the optimum distance to water sources varies across nations as well as the yardsticks set by different institutions. For instance, while WHO [41] pegs 1000 m as the optimum distance to a water source, African Development Bank (ADB) and ZINWA set 500 m as the ideal distance to a water source. In another vein, water quality is of fundamental importance in understanding household water access. Water is of high quality if it is safe and free from biological, physical and chemical pollutants [2]. In terms of affordability, a water bill should not exceed 5 percent of the household's monthly income ([32]; Warner et al. [48], suggesting that the amount budgeted for water by individual households must not impact too much on other crucial, monthly expenses. Water affordability is expressed as an index that compares household monthly income with the amount spent on water expressed as a percentage [17]. This implies that the households must not be compelled to make a compromise between water and other basic needs like food and health [30].

Adequate, clean and safe drinking water supply must be available for households and should be accessible for all their members. Thus, water accessibility connotes the supply of sufficient quantities of water and the reliability of the services provided by any water agency. Whereas reliability connotes continuity of service provision for the current and future house-

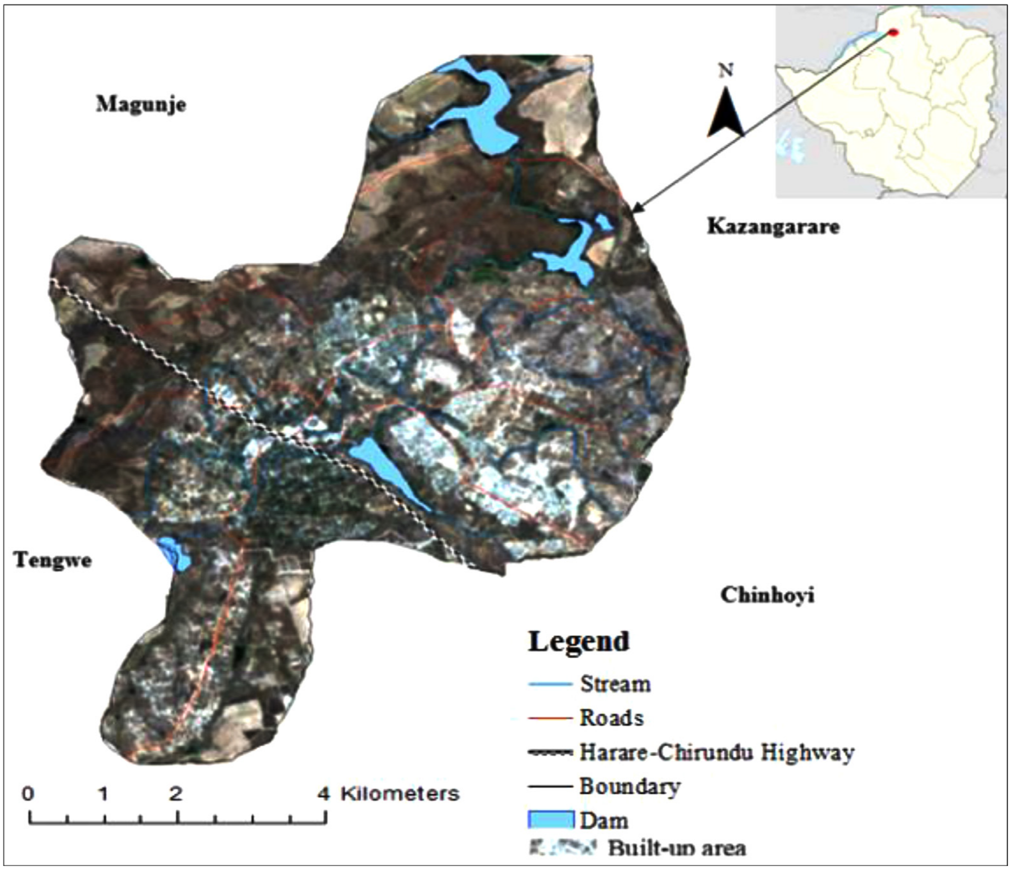

Fig. 2. Map of the study area (**Source**: Authors, 2021).

holds, accessibility implies a reliable supply of water on a continuous basis and which is within the reach of every household member's demand.

Methodology

Study area

Karoi Town Council (KTC) is a local authority in Mashonaland West Province in Zimbabwe (Fig. 2). The local authority is located along the Harare-Chirundu highway and 88 and 200 km northwest of Chinhoyi and Harare, respectively. The town is surrounded by Kazangarare rural area, Tengwe Business Centre and Magunje growth point.

Data collection

Socio-demographic data were collected through a household survey and key informant interviews. The interview schedule was chosen because the area is one of the hotspots in the Hurungwe District of Zimbabwe. Whereas a GPS was used to collect data on household location, data on the amount of water received per day, cost of water and other related issues were obtained using a household interview schedule. The interview schedule was partitioned into four main sections. While section one captured data on demographic variables (age, gender and household size), section two elicited data on water consumption before and during COVID-19 pandemic. Section three focused on precautionary measures and issues related to contracting the disease while fetching water at public water sources. The last section addressed measures meant to combat water shortages. Respondents were requested to indicate the volumes of water, which they consumed per day before and during the COVID-19 pandemic, and which is measured in terms of a 20 l water container. Interview schedule was the most appropriate data collection tool because some of the respondents were non-literate. Besides, the use of other forms of data collection tools like questionnaires was not feasible because of the need to prevent the transmission of COVID-19 virus through surface contact with objects. Also, the use of electronic questionnaires was not feasible because most household

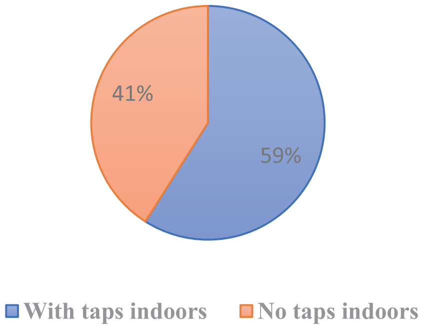

Fig. 3. Distribution of households with and without indoor water sources. (**Source**: Fieldwork, 2021).

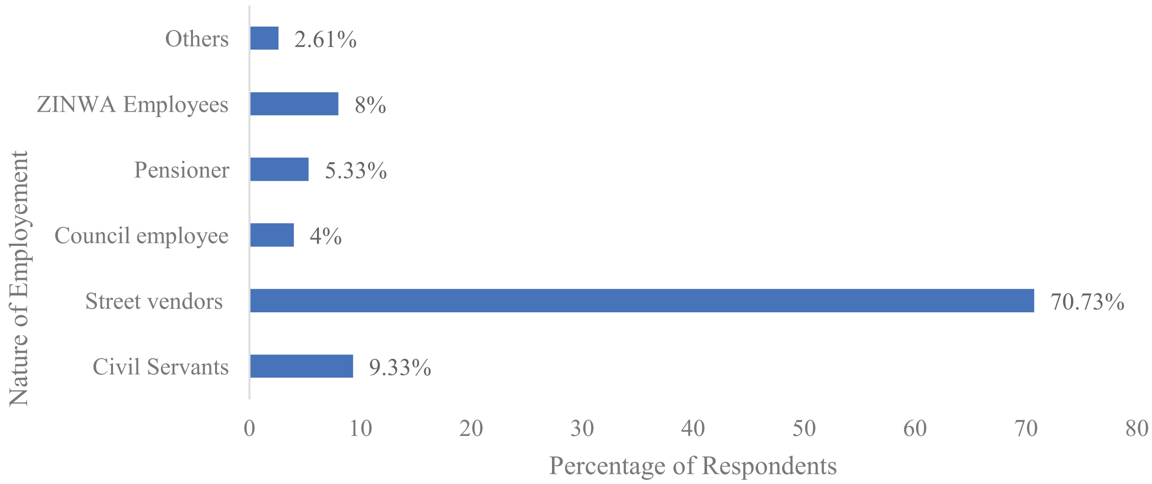

Fig. 4. Distribution of HH by employment. (Source, Fieldwork, 2021).

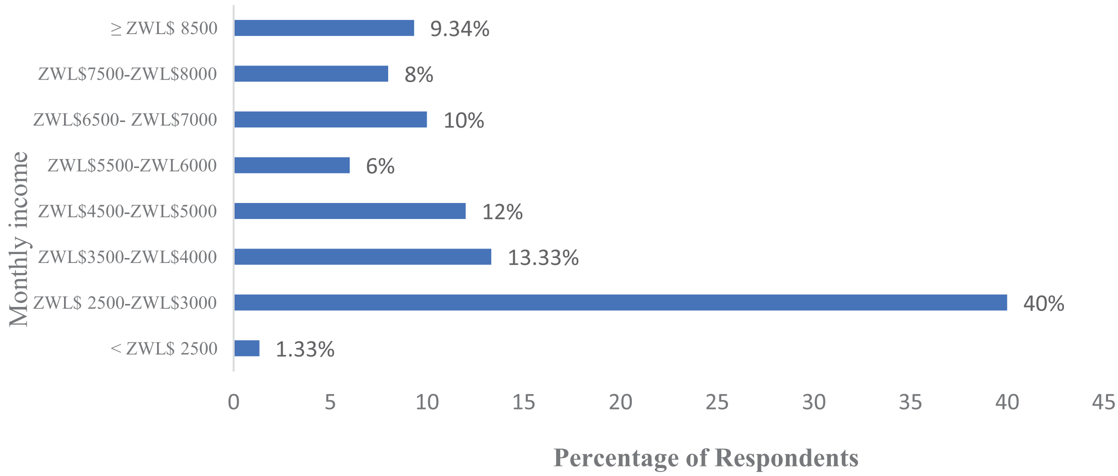

Fig. 5. Distribution of household heads by monthly income. (**Source**: Field survey, 2021).

heads (HHs) did not have access to computers and the Internet. Thus, the two research assistants who conducted the survey observed social distancing during data collection activities. Data was also collected from Google Earth. A snapshot from Google Earth for KTC was taken and stored in ArcGIS 8.2 software. The snapshot was georeferenced and subset into a small area to reduce the size of the image for easy processing and analysis in GIS software. The subset was done using the KTC shapefile as shown in Figs. 1–5.

Table 1
Sampling procedure and sample size.

Residential area	Target sample (HH)	Sample $n = \frac{N}{1+N(e)^2}$	Standardized sample	Actual sample used
Chikangwe	2649	348	35	50
Garikayi	643	246	25	10
Chiedza	2228	339	34	50
Flamboyant	489	220	22	10
Kubatana	1124	295	30	10
Westview	361	190	19	20
Total	7494	1638	165	**150**

Sample size

A sample of 150 HHS instead of 165 was randomly selected from the six residential areas of Chikangwe (50), Garikayi (10), Chiedza (50), Flamboyant (10), Kubatana (10) and Westview (20). While the ideal sample size for this study was 1638 HHs, only 150 HHs were involved in this study. This was because 1638 HHs were too many as against the limited resources including the time available for data collection. To address this challenge, the actual sample size derived using the Taro Yamane formula:

$$n = \frac{N}{1 + N(e)^2}$$

where, n = the sample size required [1];

N = the entire population; and
e = allowable error

The sample size was standardised by dividing the actual sample size for each residential area by 10 (Table 1). Thus, column 4 in Table 1 shows the standardised HHs sample size for the 6 residential areas. However, some 15 HHs in Garikayi, 12 in Flamboyant and 20 in Kubatana were inaccessible because the gates were either locked or research assistants were denied consent to interview HHs. This could be explained on the ground that most people were afraid of contracting COVID-19 and were not willing to allow visitors to interact with them. Some 35, 34 and 19 HHs were supposed to be selected and interviewed in Chikangwe, Chiedza and Westview, respectively. Nonetheless, while 50 households were eventually interviewed in Chikangwe, 50 were interviewed in Chiedza and 20 in Westview because the people in the three residential areas were willing to interact with the researchers. The residents' willingness to talk to researchers may have been because of their curiosity about issues developing in relation to the pandemic or they misconstrued the researchers as some representatives of a donor agency that was planning to drill boreholes. Overall, the actual sample size and interviewed was 150 HHs (see, Table 1). Three key informants from KTC, one from Karoi Hospital and two from Zimbabwe National Water supply Authority (ZINWA) were interviewed. Officials of KTC and ZINWA responsible for water supply were interviewed on water access issues before and during the advent of COVID-19 pandemic in the town. The official of Karoi Hospital was interviewed to collect information on compliance issues in line with the World Health Organisation (WHO) COVID-19 protocols.

Data analysis

Socio-demographic data analysis was done using Statistical Package for Social Sciences (SPSS) version 25. Both descriptive and inferential statistics were used to summarize the data and draw conclusions on water access and COVID-19 related issues in the study area, respectively. Also, simple spatial analysis using buffer zone was conducted to determine the distance of a household from water sources.

Results and discussion

Results show that the average age of respondents was 36.1 years with a standard deviation of 15.5. Those whose age ranged from 20–29 years constituted 28 percent of the HHs while 35 percent comprised those in the 30–39 years age group (Table 2). While HHs whose age fell within 40–49 years age bracket comprised 13 percent of the respondents, those within 50–59 years constituted 17 percent of the total sample size. HHs who were aged 60 years and above constituted only 7 percent of the respondents.

The results show that while 59% of the respondents had indoor taps (Fig. 3), they opined that that taps were always dry. An informal discussion with a key informant from the KTC indicated that there was water problem in the town, culminating in the installation of water tanks as a backup water source. The key informant said:

Yes, I can confirm that there is water crisis, but the problem is not ours as a council but ZINWA's, which is responsible for supplying the town with water. The authority has failed to refurbish pipes that were laid during the colonial era and in response, we had to install water tanks as a backup.

Table 2
Distribution of household heads by age (n = 150).

Age Group	Frequency	Percentage	Descriptive statistics
20-29	42	28	
30-39	53	35	
40-49	20	13	
50-59	25	17	
60+	10	7	M = 36.1
Total	150	100	SD = 15.5

Source: Field Survey, August-September 2021.

Table 3
Distribution of households by the amount of water (Litres/Day) used before and after March 2020.

Household Size	Before March 2020	After March 2020 (%) change
1–3 members	60	85 + 41.6 %
4–6 members	80	100 + 25%
7–9 members	100	120 + 20%
10 + members	130	150 + 15.4%

Source: Field survey, August -September 2021.

Reacting to the current water challenge in the study area, the key informant from ZINWA remarked thus: The current water challenges are a result of the damage that occurred to the electricity cable at Karoi Dam. We replaced the damaged electricity cable, but the replaced cable got stolen a day after its installation, leaving Blockley Dam as the sole raw water source for the town. As you may be aware, Blockley Dam cannot meet the requirements of the town because its location is subject to load shedding, leading to depressed water supplies to the town. ZINWA technical team is on the ground working on the restoration of supplies from Karoi Dam. The authority appeals to residents to bear with ZINWA as it works on the restoration of supplies from Karoi Dam and to use the backup water sources sparingly.

The two standpoints provided by the respondents show that there is a misunderstanding between KTC and ZINWA on the supply of potable water to residents. Given the viewpoint of the key informant from KTC, ZINWA refused to cede water supply responsibility to KTC in accordance with the Urban Council Act (Chapter 29, 13), which outlined that all local authorities are empowered to run their water and sewage systems. Buttressing this point, one key informant from KTC opined that "[t]he responsibility to supply water should revert to the council as it is ready and capable to provide the service. I, therefore, urge the government to finalise the takeover of the function by the Council".

As shown in Fig. 4, data on respondents' employment status reveal that the majority (70.73%) of the HHs were informally employed, working as street vendors. However, approximately 29.3 percent of the respondents were formally employed as government workers (9.33%), Zimbabwe National Water Supply Authority (ZINWA) (8%), pensioners (5.33%), Karoi Town Council employees (4%) and other employees (2.61%), which include those employed by Zimbabwe Electricity Supply Authority (ZESA) among others.

The monthly income of respondents is shown in Fig. 5. The mean income was ZWL$ 5285.71 with a standard deviation of ZWL$1067.73. The standard deviation value indicates that there is a high variation in employee income. While HHs in low-income brackets earned less than the minimum wages of ZWL$2500 per month, those in the high-income brackets earned above the minimum wage. Findings reveal that a majority (40%) of the HHs had a monthly income of between ZWL$2500 to ZWL$3000. While, 13.33% of the HH earned between ZWL$3500 and ZWL$4000, 6% and 12% of them had a monthly income of ZWL$4500 to ZWL$5000 and ZWL$5500 to ZWL$6000, respectively. Results also show that 10% of the HH earned between ZWL$6500 and ZWL$7000. While the least percentage (1.33%) earned less than ZWL$2500, about 9% of them earned above ZWL$8500. All things considered; the low-income group are more likely to feel the impact of water price than the high-income group category.

The HHs revealed that there was a change in some activities and behaviour due to COVID-19. The distribution of household size and amount of water consumed in litres before and after March 2020 are shown in Table 3. The results show that households with 1–3 members constituting 41.6 percent of the respondents had the highest volume of water (in litres) consumed after March 2020. It is noteworthy that while on the aggregate large households consume more water, economies of scale generally obtain in large than in small households. Accordingly, small households tend to consume relatively more water per capita than large households [6,7]. This is explained on the ground that water is efficiently utilised in large than in small households because resources are somewhat carefully shared among members. It is noteworthy to emphasise that an increase in income levels is often accompanied by an improvements in living standards, which might suggest an addition to the number of water consuming household appliances or infrastructures like washing machines and swimming pools, which have the propensity to increase the amount of water consumed by fewer but affluent consumers [34,42].

Table 4
Reasons for increase in water consumption.

Statement	Yes (%)	No (%)
(i) Water consumption increased due to cooking and bathing	58%	42%
(ii) Handwashing contributed to increased water consumption	65%	35%
(iii) COVID-19 related lockdowns contributed to high water consumption	75%	25%
(iv) More water was used for general cleanliness than before COVID-19	81%	19%

Source: Field survey, August -September 2021.

Table 5
Water Tariffs structure.

Volume	Old	New	Location
I < 15 m^3	ZWL$1443	ZWL$1795	High
Ii > 20 m^3	ZWL$2777	ZWL$2928	Medium
Iii > 33 m^3	ZWL$5259	ZWL$5376	Low
iv	ZWL$17798	ZWL$19580	Commercial

Source: ZINWA Marketing Department, 2021.

Water consumption and payment

While households with 4–6 members witnessed 25 percent increase in water consumed within the same period, the households with 7–9 members experienced a 20 percent increase in the amount of water consumed after March 2020. Also, households with 10 members and above witnessed a 15.4 percent increase in the amount of water consumed after March 2020. An interview with the HHs revealed that the increase in water use is a result of the high frequency of handwashing in line with COVID-19 prevention measures. Most (90%) households reported an increase in the amount of water for washing dishes, clothes and flushing toilets during the period from March 2020 up to 15 September 2021 when the survey was conducted. Some (25%) households revealed that the increment recorded in water use between March 2020 and 15 September was a result of the need to wash fruits, bathing and frequently washing hands as a COVID-19 precautionary measure.

An independent sample t-test conducted indicated that there was a statistically significant difference ($t = 65.34$, $p \leq 0.00$) between the volumes of water (m^3) consumed per household before and after March 2020. This implies that water consumption increased after March 2020 because households probably adhered to COVID-19 health protocols, which required more water for personal hygiene. The results of this study bear semblance with the finding of Sempewo et al [37]. in Uganda, which indicates that the amount of water consumed by households increased due to improved hygiene practices. It must, however, be pointed out that access to clean and affordable water is not a problem that stemmed from the COVID-19 pandemic; rising water prices, shortages and dry taps among other water supply challenges were some of the issues earlier identified by Gondo and Kolawole [18] prior to the pandemic.

The results showed that while 58 percent of the HHs agreed that water consumption increased because of cooking and bathing, 42 percent suggested otherwise. The majority (75%) of the HHs agreed that COVID-19 related lockdowns were the main contributors to high water use. The results showed that 81 percent of the respondents thought that a significant amount of water was needed for the general cleanliness of the environment as compared to the period before COVID-19.

Water tariffs

In order to understand how households access water in the study area during the COVID-19 pandemic in terms of cost, water tariffs structure in the study area were perused and key informants were interviewed. The findings are shown in Table 5. The table indicates that old water tariffs were reviewed leading to some increments in the new structure[1].

The authority revealed that whereas the old price for a 15 m^3 of water was ZWL $1 443 for a high-density suburb, the new tariff is now pegged at ZWL$1 795 for the same volume of water. While the old tariff for medium density suburbs was ZWL$2 777, the new charge has been increased to ZWL$2 928 and a volume of water greater than 33 m^3 was pegged at ZWL$5 259 for low density suburbs but has now been increased to ZWL$5 376. Also, the old tariff for commercial areas was ZWL$1 7798 and has been increased to ZWL$19 580 in the new tariffs. A key informant at ZINWA had this to say:

"We had envisaged increasing the tariffs by 25 percent on 1 March 2021 and we had already communicated this to our clients but after further consultations with various stakeholders and taking into consideration that most of our clients are from rural service centres, growth points, small towns and they are mainly from the informal sector, we said that it was prudent for us to give our clients time to recover from the lockdown. That is why we came to this conclusion. For now, we have set aside the tariff increase until such a time when our clients have gone back to work."

[1] ZWL$1 = US$0.004545

Table 6
Water tariff structure for 3 selected countries in Southern Africa.

Botswana		South Africa		Zambia	
Block	Tariff (BWP)	Block	Tariff (ZAR)	Block	Tariff (ZK)
i. Min	P0.00	0–6	R9.10 kl	0–6	ZK4.47
ii. > 0–5	P3.92	6–10 kl	R9.66 kl	6–30	ZK5.92
iii.> 5–15	P 11.65	10–15 kl	R16.49 kl	30–60	ZK7.92
iv.> 15–25	P20.18	15–20 kl	R23.99 kl	60+	ZK9.87
v.> 25–40	P31.36	20–30 kl	R32.95 kl		
vi.> 40	P39.20	30–40 kl	R36.51 kl		

Source: Water Utilities Corporation, 2015; [31]).

Table 7
Main sources of water.

Source of Water	Frequency
• Tank	55
• Shallow well	36
• Borehole	21
• Tap (Communal)	18
• Stream	5
• Dam	4

Source Fieldwork, August -September 2021.

However, one respondent during an informal interview opined that even the so-called old water bills were high and that most households could not afford it and that water availability was unreliable. The respondent said: “The bills are too high and yet water supplies have been unreliable over the years with no signs of improvements or effort to address them”.

A comparison of the water tariffs for three randomly selected countries in southern Africa over the same period shows the minimum charge for a consumer whose consumption falls within block 2 was BWP 3.92, ZAR9.10 and ZK4.47 for Botswana, South Africa and Zambia, respectively (Table 6). This translate to US$0.34 (Botswana), US$0.60 (South Africa) and US$0.26 (Zambia) per cubic litre consumed. Findings also show that a consumer who consume more than 40 m^3 is charged BWP39.20 (US$3.42) per m^3 in Botswana. Also, the tariffs are ZAR40.62 (US$ 2.66) for an equivalent volume water consumed in South Africa. In Zambia, a consumer would pay ZK7.16 (US$0.41) for the same volume of water. In the context of Karoi town, the minimum amount paid is ZWL$1795 (≈ US$8.16), ZWL$2928 (≈ US$13.31) and ZWL$5376 (≈ US$24.44) for high, medium and low-density residential areas, respectively. Comparatively, potable water is expensive in Zimbabwe than in other southern African countries. It is noteworthy that while water from indoor taps is not always available, households are expected to pay monthly bills (see [18]).

A household head (HH) comments on the issue thus:

> We have become milking cows for ZINWA because it bills us exorbitantly even if we do not get any water from the tap for the whole month”. It is unfortunate that it has become normal for us to go for weeks without water and still receive huge monthly water bills.

Water sources and spatial distribution

Understanding spatial distribution of water sources is very crucial during a pandemic such as COVID-19 as water plays a vital role in curbing the spread of the disease. The findings revealed that there were six sources of water in the study area. The sources comprised taps, tanks, shallow wells, boreholes, dams and streams (Table 7) Fig. 3. shows the spatial distribution of the six sources of water. As at the time of data collection, findings showed that there were 21 boreholes out of which only five were functional and the rest were in a state of disrepair. However, 40 percent of the households had water tanks with a carrying capacity ranging from 2000 to 10,000 l. There were also more than 18 communal taps. However, only 8 of them were functional. Only 2 of the 4 streams within the study area were flowing while the other 2 were not but had some pools of water. Field observation showed that there were 12 pools of water located approximately 1 km from each other across the two streams which were not flowing. An observation of the spatial distribution of HHs indicated that areas close to the roads and electricity lines were densely populated than those away from such infrastructures. Thus, the Chikangwe, Garikayi and Chiedza residential areas were densely populated implying a high demand for more water sources. In-depth probing revealed that Chikangwe, Garikayi and Chiedza had 14 boreholes and three dams.

Findings show that there were 55 water tanks and 36 shallows wells, which were dug on waterlogged areas. Five households in the study area also obtained water from streams. Analysis also shows that there were 5 dams in the study area.

The mapping of survey data is important in visualising and identifying areas where there are water access challenges as well as evaluating the success of the water provisions measures adopted in the fight against COVID-19. The proximity to a

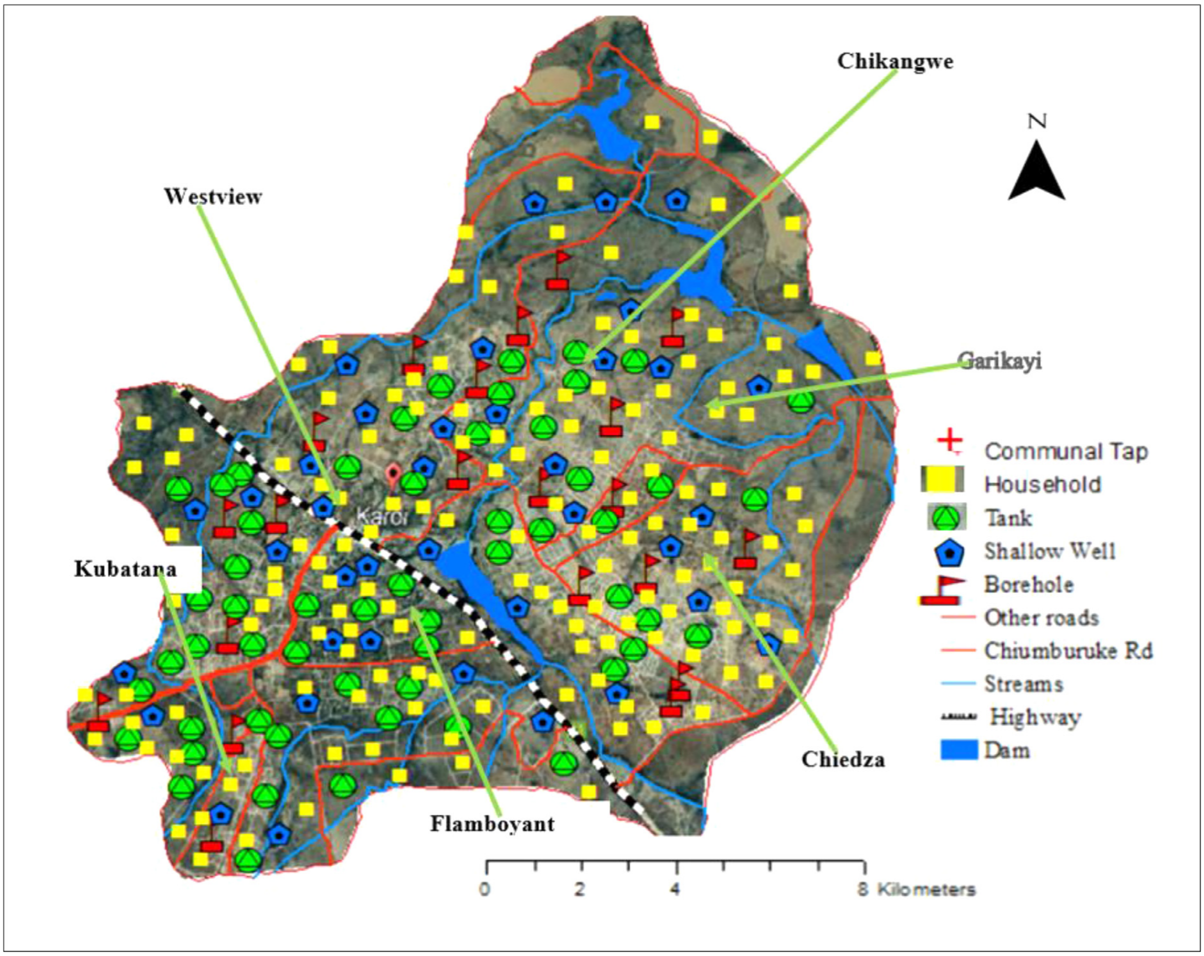

Fig. 6. Spatial distribution of water sources (**Source:** Fieldwork 2021).

source of water is one of the approaches used to measure access to water [18,43]. ZINWA set 500 m as the furthest distance that a household in an urban environment should cover to fetch water. Although ZINWA has set 500 m from a water point as the maximum distance that a household in an urban setup should travel to access water, the World Health Organisation [47] stipulates less than one kilometre as the benchmark.

While there were 36 shallow wells within the study site, only 24 percent of the households were within the range of 500 m or less to the water points and most (76%) of them were outside the 500 m radius (Fig. 4). Findings show that there were 21 boreholes and 35 percent of the households were within 500 m or less (Fig. 5) and the majority (65%) of them were located more than 500 m away from the boreholes.

Literature has shown that distance to a water point plays a key role in determining water access [10,20,23,28]. This is because distance influences the time taken to make a return trip on water fetching unless one uses other means of transportation. Using GIS technology, the paper assessed how faraway a household is from four water sources which are tap, tank, borehole and streams (see, Figs. 3–6). This was done to determine the maximum distance a household travels to access water. The mean distance of a tank from a household was 300 m with a standard deviation of 209 m and the average time to make a return trip to water sources was 45 min with a standard deviation of 36 min. The findings revealed that there were 55 water tanks in the study area and 62.7 percent of the households were within 500 m from the tanks and 37.3 percent were more than 500 m away from the water points (Fig. 7). In this regard, households far from improved water sources opted to travel a shorter distance to those water sources providing unimproved water such as streams and dams which might expose people to water-borne diseases.

The findings revealed that about 35 percent of the households were within 500 m from the communal taps. This implies that 65 percent of the households were outside the ZINWA recommended distance from a water point. In order to determine water access during COVID-19, Table 6 gives a summary of the water access status of the 6 main sources of water in the study area. The findings in Table 9 give a summary of each of the water sources cross-tabulated with 8 water access indicators. Results indicate that 62.7 percent of the respondents were within 500 m from a water tank and the travel time

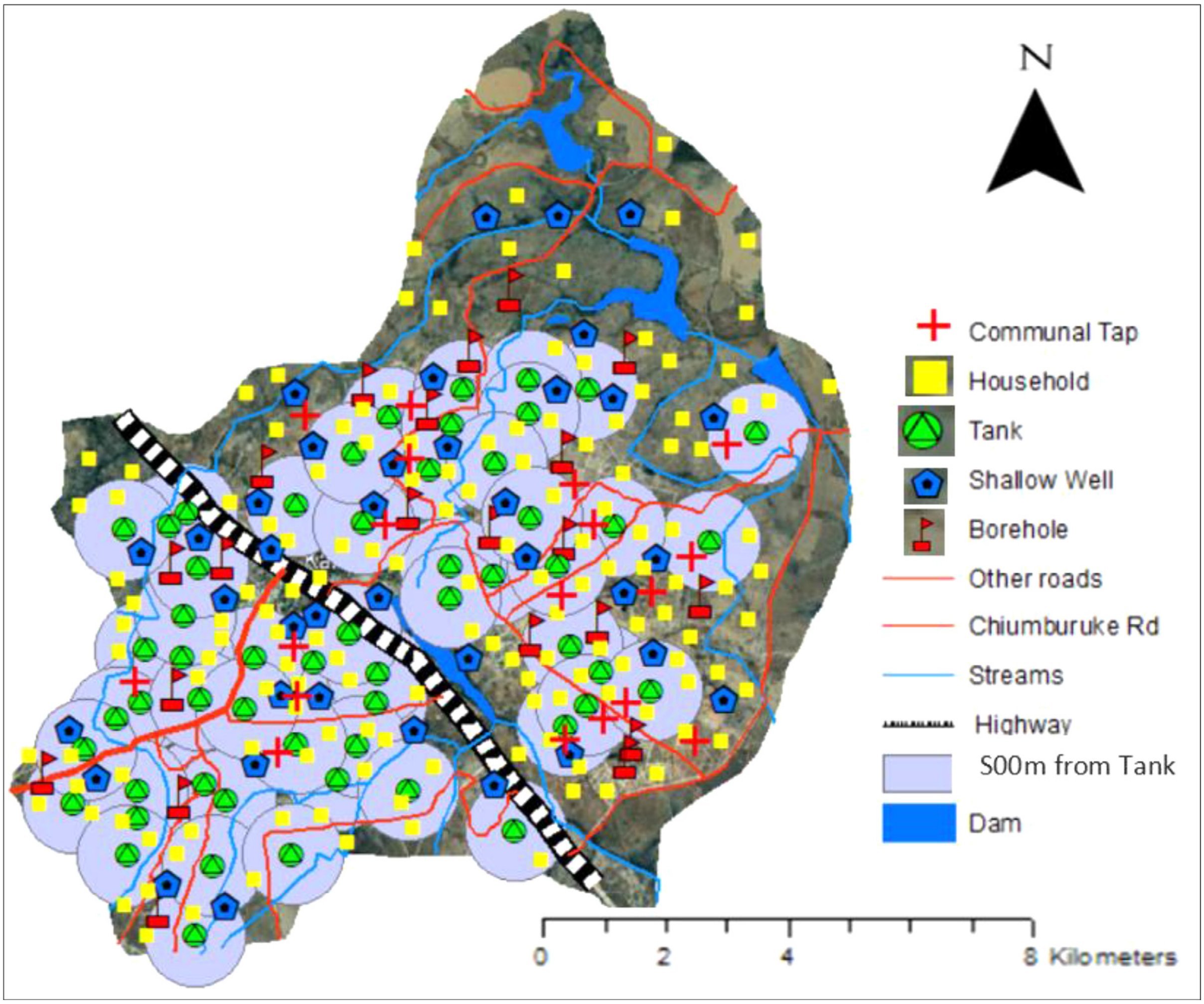

Fig. 7. Households within 500 m from a tank. Source: Fieldwork (2021).

to and from the tank is ≤ 30 min. Also, water from a tank was always available (AA), reliable (R) and user friendly (UF). Besides a tank ability to provide enough water for each household, the water was affordable (A) and of good quality (GQ). Findings also reveal that while 35 percent of the households were within 500 m or less from a tap, only 33.3 percent of them were within a similar distance from a tap. While travelling to and from a dam takes ≥ 45 min, it takes only less than 30 min to fetch water from a tap. Travelling less than 30 min to access water, the respondents indicated that water from a dam was reliable while tap water was unreliable.

In terms of boreholes, water was sometimes available (SA) and only 35 percent of the HHs were within the recommended 500 m distance and the travel time to fetch water from it was less than 30 min. In the respondents' viewpoints, boreholes were an unreliable source of water even though they are user-friendly. According to the respondents, borehole water was not enough and was of poor quality even though affordable. Only 23.3 percent HHs, which relied on streams as a source of water, were within 500 m and they took ≥ 45 min as return time to obtain water from the source. Water from streams was neither reliable nor user-friendly.

Based on Majuru et al [24]. findings, water supply reliability denotes that water is available within a known schedule even if it is not a continuous 24 h supply. A reliable source of water is crucial during COVID -19 pandemic Table 5. shows the level of water reliability in the study area.

Findings reveal that while 10 percent of the respondents indicated that water taps were dry for less than I day, the majority (60%) indicated that taps were dry for more than 2 to 5 days per week. The results also show that 30 percent of the respondents could not access water through taps for more than a week. Based on the information obtained from HHs, water supply interruptions mostly occur every season even though the frequency is high in dry than wet seasons. An interview with one key informant revealed that leaking taps and pipes were the problems encountered in water supply and, therefore, were the main factors affecting constant water supply to the households. However, information from other key

Table 8
Households within and outside 500 m from water sources (%).

Source of Water	Frequency	≤ 500 m	> 500 m
i. Tank	55	62.7%	37.3
ii. Shallow well	36	24%	76%
iii. Borehole	21	35%	65%
iv. Tap (Communal)	18	33.3%	66.7%
v. Stream	5	23.3%	76.7%
vi. Dam	4	6.7%	93.3%

Source**:** Field survey, August -September 2021.

informants underscored erratic power supply as the main cause of erratic water supply; power outages are closely associated with unstable water flow. However, the majority (85%) of the HHs refuted the claim from the key informants saying that electricity would be available on many occasions and yet there would be no water in the taps. This variance in opinions may perhaps be contextual and based on individual personal experiences. Most households would resort to accessing non-potable water from unimproved sources (such as streams, dams and shallow wells) when the taps are dry.

Causes of water supply challenges

Analysis of the household interview schedules revealed that there were several reasons causing water supply disruptions. The findings showed that water was not accessible especially to low income households due to high cost. According to the HHs, the cost of water per month for a household with an average of six members was ZWL$5000 per month and the households especially those in low-income areas found this amount too high. Another challenge observed was the low water pressure. This has resulted in people queuing for longer times at the communal tap and borehole water points thereby exposing them to the risk of contracting COVID-19 since most of the time people do not observe health protocols and are exposed to non-sanitized surfaces such as borehole handles and water tap faucets. A respondent interviewed at a borehole water point said that "[m]en and women stand in a queue to collect water from the borehole and in most cases, they do not observe the social distance as recommended by health officials". The interviewee also revealed that '[a]s people pump water from the borehole, they also do not sanitize the borehole handle before and after the next user. This is a risky practice during this time of a pandemic'. Observation by the researchers during data collection indeed showed that no serious COVID-19 protocols were observed at the borehole. About 25 percent of the HHs indicated that theft of water metres and tap faucets affected the smooth supply of water in the study area. Old and dilapidated water pipes, which could no longer sustain high water pressure matched with the demand of the growing population as compared to when the pipe networks were installed created an additional challenge to water access in the study area. Other challenges were closely linked with water disruptions arising from illegal connections, water leakages and cutting of underground pipes by people engaged in urban farming as well as vandalism. Respondents also claimed that the water levels at the main sources of water supply had been very low for the last two years despite a rise in the amount of rainfall received in the area. Mangirazi [25] believes the low water level in the Karoi dam for the past two years is because of the following reason:

"Karoi council has continued to allocate residential stands on waterways and wetlands which is a cause to worry about. While most dams in the country are spilling, Karoi Dam is failing to attract meaningful water because all waterways and wetlands are now residential places. Karoi Town Council needs to come up with a housing policy that protects and safeguards our environmental sustainability".

While the explanation by Mangirazi [25] is valid, other meteorological variables like rise in temperature may also explain the reason why the dam is failing to fill up despite high rainfall. There is also a possibility that the rise in temperature in the area result in high evaporation of water from the dam, thus making the water level to consistently remain low. The geology of the base of the dam may also explain the scenario. The dam might be having a porous rock with poor water retention capability. Thus, most of the water collected in the dam is lost via throughflow and hence the dam remains almost empty despite high rainfall.

Access to a reliable supply of clean water is a vital human need and of global concern as well. Based on WHO [45] report, handwashing with soap and water is a critical defence against the spread of COVID-19. Thus, a reliable supply of clean water for household use is crucial not only for handwashing but also for keeping the entire home environment clean. Despite the important role of clean water in coping with a pandemic, two billion people struggle to access a clean and reliable supply of water close to their homes [26,39]. The mean distance to a borehole was 250 m with a standard deviation of 154.1 m. Considering ZINWA standardised 500 m distance from a water point, the results revealed that only 31 percent of the households were within the service coverage of the boreholes (Fig. 9). This implies that the majority (69%) of the households were outside the ZINWA recommended distance from water sources. It is noteworthy that households far from the boreholes used other sources of water (Fig. 8, Tables 4, 8, 10 and 11).

The average distance from a household to a stream was 500 m with a standard deviation of 322.3 m. The findings reveal that there were 5 main streams and most (76.7%) of the households were in a distance of more than 500m and only 23.3

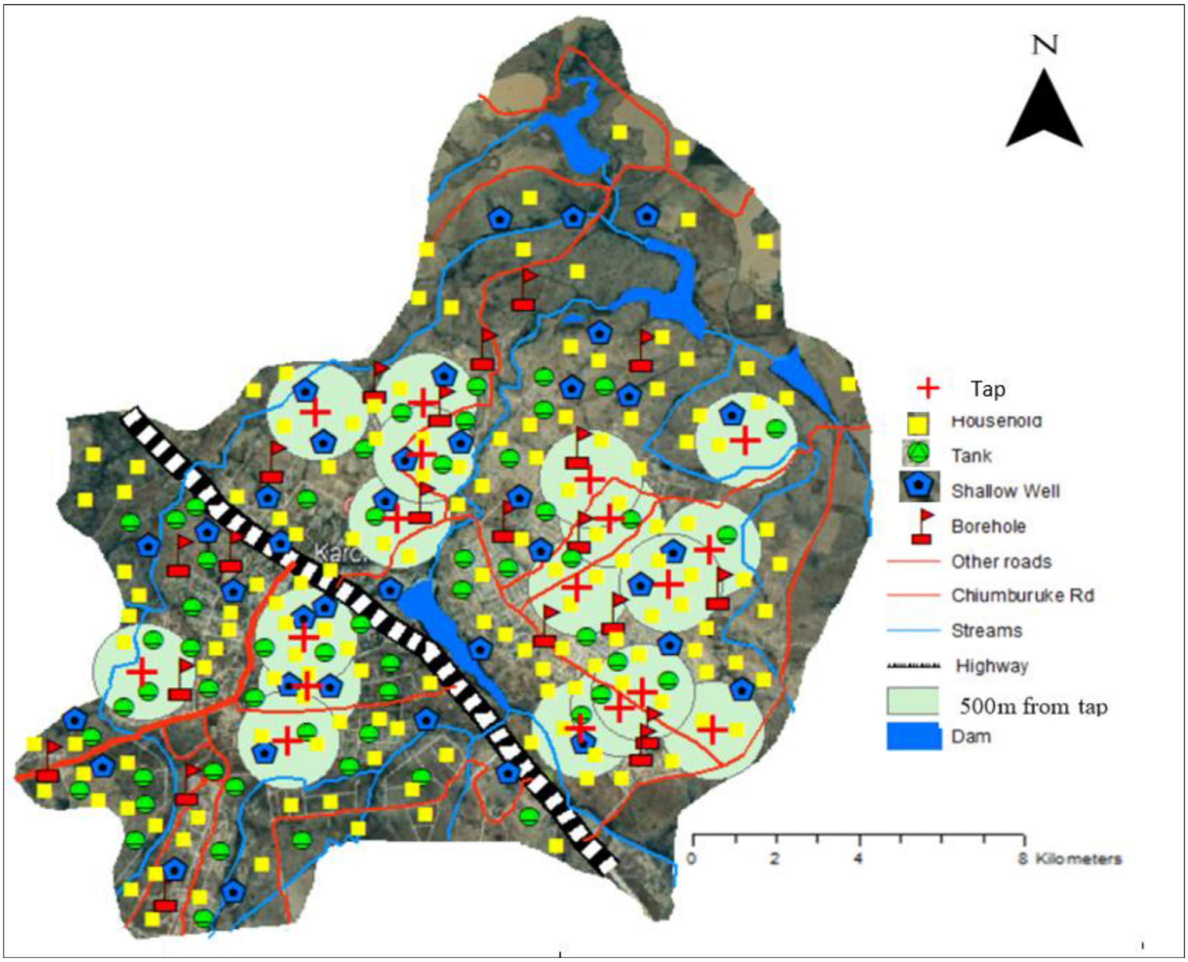

Fig. 8. Households within 500 m from a tap. (**Source**: Fieldwork, 2021).

Table 9
Water Access situation in the study area.

Source	Availability	Percent Households (< 500 m).	Time	Reliability	User Friendly	Quantity	Quality	Affordability
Tank	AA	62.7%	≤ 30 min	R	UF	E	GQ	A
Tap	SA	33.3%	≤ 30 min	UR	UF	NE	P	NA
Borehole	SA	35.0%	≤ 30 min	UR	UF	NE	P	A
Streams	SA	23.3%	⩾ 45 min	UR	NUF	E	P	A
Shallow Wells	SA	10.0%	⩾ 45 min	UR	UF	E	GQ	A
Dam/Reservoirs	AA	35.0%	⩾ 45 min	R	NUF	E	P	A
AA = Always available			E = Enough		UF = User friendly			A = Affordable
SA = Sometimes available			NE = Note enough		NUF = Not user friendly			UR = Unreliable
GQ = Good quality			NA - Not Affordable		P = Poor			R = Reliable

Source: Field survey, August-September 2021.

Table 10
Water supply reliability.

Duration with no water	Respondents (%)
i.< 1 day	10%
ii > 2-3 days	60%
iii ≥ 7 days	30%

Source, Field survey, 2021.

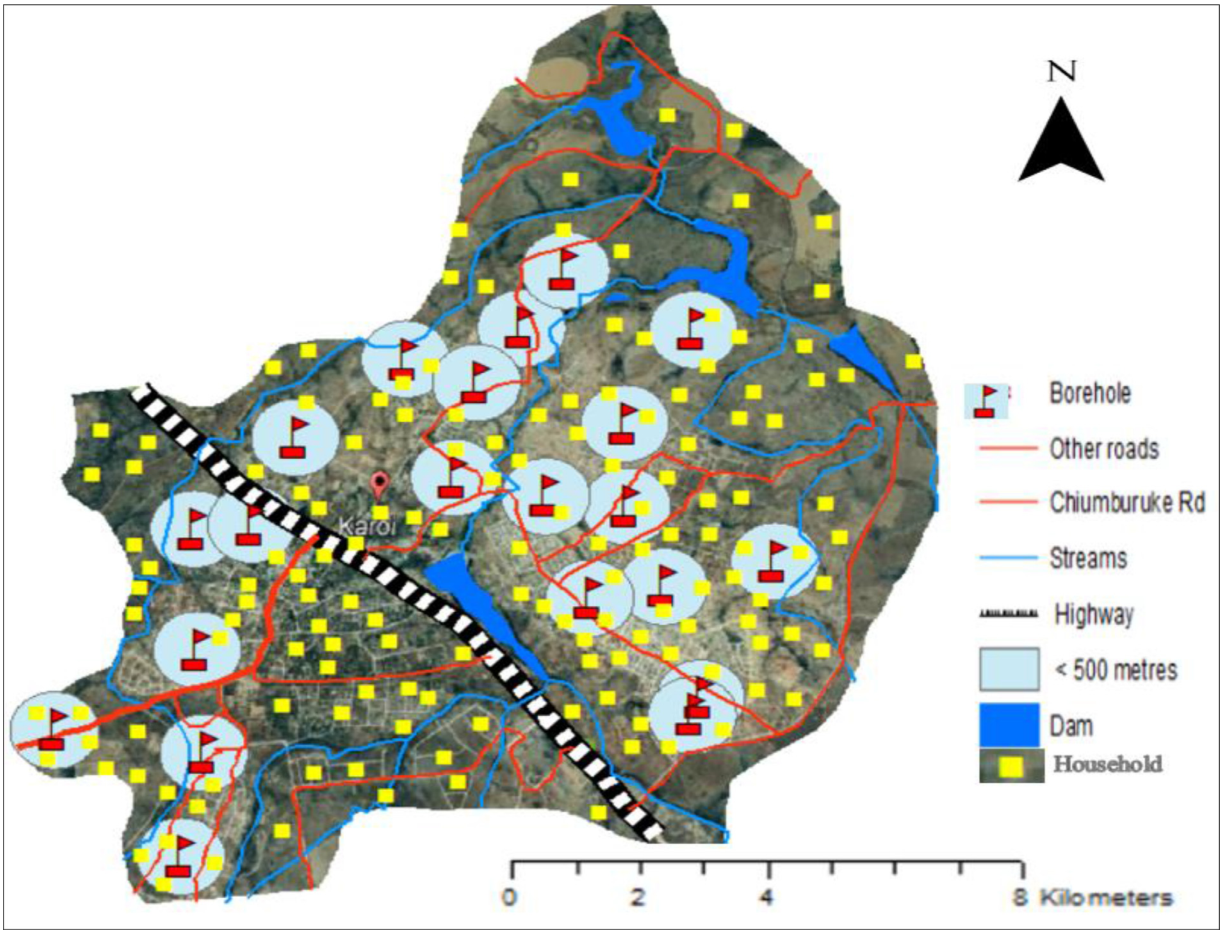

Fig. 9. Households within 500 m from a borehole. (Source: Fieldwork, 2021).

Table 11
Causes and solutions of water challenges in the study area.

Cause	Suggested solution
• High water cost	• Government and business entities to fund subsidies
• Low water pressure	• install new infrastructure to increase pressure
• Old and dilapidated pipes	• Install new pipes
• Illegal connections	• Constant inspections by KTC and ZINWA officials
• Water leakages	• Households to promptly report any water leakages
• Cutting of underground pipes	• Demarcation of underground pipes and banning farming activities close to water lines
• Vandalism	• Arrests of culprits
• Low rainfall	• Households to use water sparingly
• High seepage	• Water authorities should promptly repair all leakages
• Population increase	• Improve living conditions in rural and growth points
• Power outage	• ZINWA to invest in solar energy
• Loss of skilled manpower	• Increase remunerations of ZINWA officers
• Lack of political will	• Good leadership is required

(Source: Fieldwork, 2021).

percent of them were within 500 m or less from streams (Fig. 10). The majority (93.3%) of the dams in the area were within a distance greater than 500 m from households and only 6.7 percent of them were within 500 m radius or less.

Water points are not evenly distributed in the location, which, therefore, warranted that households had to cover varying distances in search of water. The distance a household is from a water point (such as a borehole, tank and water tap) is very critical because these were the main form of improved water sources where households in the study area obtained potable water. The findings revealed that most households without indoor water sources had to visit boreholes, especially during the dry season when water levels in most other water points decline. Distance influences the time taken to access water and the quantities drawn since there are no water distribution systems. To circumvent the impact of distance and increase

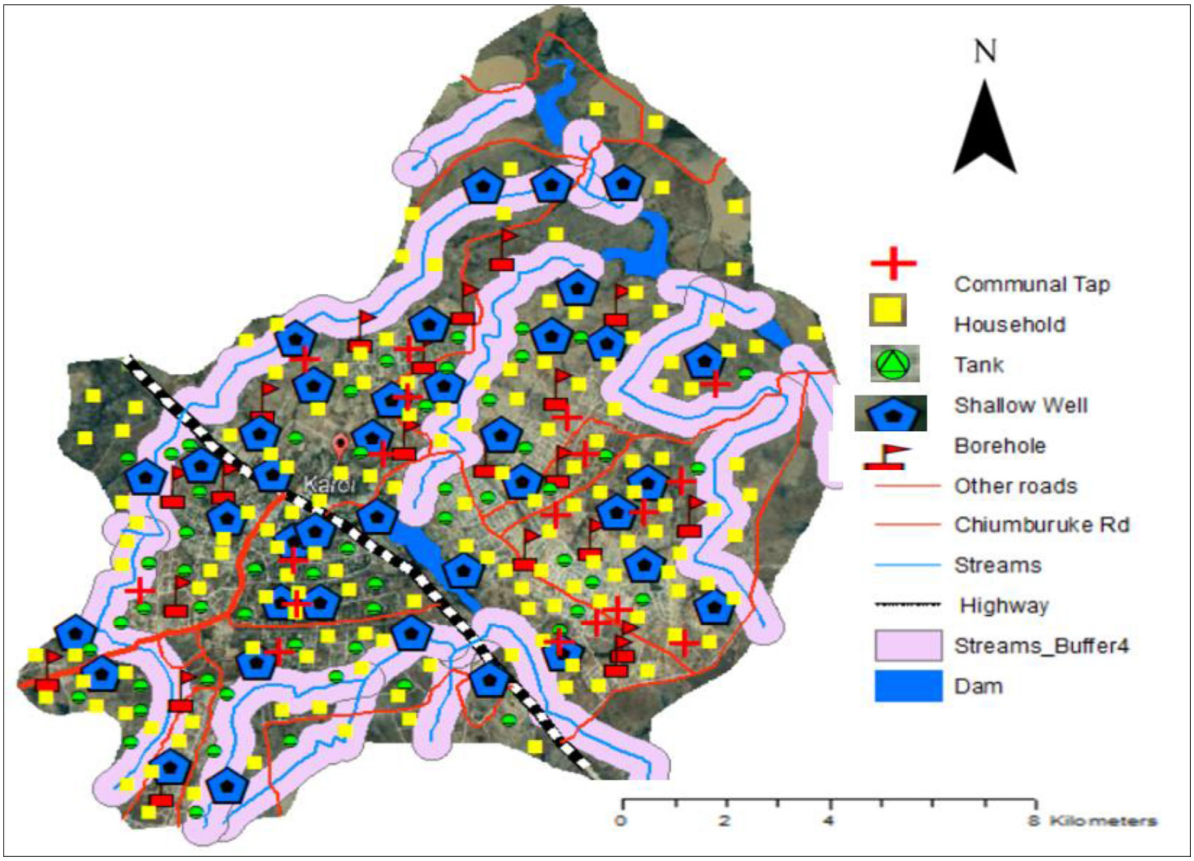

Fig. 10. Households within 500 m from streams (Source: Fieldwork, 2021).

water quantities drawn at once from far-away sources, households might resort to the use of animal-drawn carts or vehicles. This underscores the need for investing in water distribution infrastructure to ease access.

Frequency of turning a tap on and handwashing

Analysing the frequency of handwashing as well as the number of times a water tap is turned on in a day are important variables in understanding water usage in a household. The information on these variables is crucial to enable water supply authorities like ZINWA and KTC to plan on water accessibility during the COVID-19 pandemic and other similar situations. The number of times per day, which household members opened taps and engaged in handwashing with soap was analysed. The results showed that there was an increase in both the frequency of turning on taps and handwashing sessions. The higher the occurrence of turning on of taps and washing of hands would, therefore, imply that households water bills would increase during COVID-19 pandemic. Given the scenario, most households resorted to collecting water from unimproved water sources such as streams, dams, among others. The results obtained in the research were similar to the findings of a study conducted by Sayeed et al [36]. in Bangladesh, which showed that handwashing and frequency of turning on water taps increased during the COVID-19 pandemic than they had before the disease outbreak.

Conclusion and recommendations

The paper employed water access conceptual framework to analyse how residents accessed water during COVID-19 in Karoi town in Zimbabwe. The results indicated that 62.7 percent of the households obtained water from installed tanks during the start of COVID-19 as a measure to promote hygiene in the area. Water tanks were situated in such a way that the majority (62.7%) of the households were situated in less than 500 m radius and took less than 30 min as travel time to and from the source of water. Findings also revealed that the way people interacted with each other without observing health protocols at water sources had a high propensity of exposing them to the risk of contracting COVID-19. This was mainly due to long queues witnessed at water points and lack of stringent regulations on all health protocols associated with curbing the spread of the disease. Most of the households also opined that water price was too high. The study recommends an increase in the volume of storage in the high densities areas by constructing more water storage facilities (such as tanks) to enhance water harvesting during the raining season. Also, there is a need to increase alternative sources of water through the rehabilitation of broken-down boreholes, and drilling of more boreholes, among others. Water supply authorities and the government would do well to ensure that water supply workers are regarded as critical service providers whose remunerations need improvement, accordingly. In another vein, ZINWA needs to cede potable water supply responsibility to KTC and allow the organization to concentrate on raw water development as stipulated in the Urban Council Act (Chapter 29, 13) and ZINWA Act (1998) as it applies in other towns and cities in Zimbabwe. Given that the sample size of the study was relatively small, further research with a broader scope is suggested. It is also recommended that a future research designed to examine the possibility of amalgamating KTC and ZINWA resources be implemented in Zimbabwe. The COVID-19 pandemic underscores the critical role of water in preventing diseases and reinforces the notion that adequate water is vital for public health [4]. This would imply that the local council water policy and actions might need a review with a view to addressing water needs and preparing for future public emergencies. Also, it is imperative for the government to ensure a moratorium dispensation on water disconnections as well as enact a law that compels local authority to install indoor water supply systems in every household in the study area and elsewhere in Zimbabwe. It is, of course, a mere platitude to emphasise that enough funding is needed for providing and maintaining water infrastructure in Zimbabwe. Doing so would partly enhance the realisation of WHO recommendation on good hygiene among household and community members.

Declaration of Competing Interest

No conflict of interest.

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