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Assessing accessibility and availability of portable water supply in selected communities of Lepelle-Nkumpi local municipality, Limpopo province of South Africa

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ABSTRACT

In this study, we assessed the accessibility and availability of portable water supply in selected communities of the Lepelle-Nkumpi Local Municipality. A systematic random sampling method was used to select 49 households from Mashite village and 77 households from Lebowakgomo Zone F. A Global Positioning System (GPS) was used to collect absolute locations of available water taps and the reservoir in the Mashite village whereas for Lebowakgomo Zone F municipal household taps data were recorded. Data were statistically analysed and the Pearson Chi-Square test was used to test the relationship between the reuse of onsite greywater at Mashite rural area and Lebowakgomo township area. The results showed that the majority of households (38%) in Mashite village obtained their water from the rivers whereas all respondents in Lebowakgomo Zone F had access to tap water. Further, ninety-four percent (94%) of respondents in Mashite village travel less than 1 km to a water source, while 6% travel between 1 and 3 kms. Proximity to standard water pipes in Mashite village was beyond the recommended 200 m distance. Thirty-five percent (35%) of the respondents in Mashite village and 77% respondents in Lebowakgomo Zone F, respectively, indicated that the available water met their water needs although the quantity of water used per month differed between the two areas. Most of the respondents (56%) in Mashite village used 250 L of water per month while 61% use more than 6000 L in Lebowakgomo Zone F. It is, therefore, recommended that local municipalities should provide rural communities with water taps that are in close proximity of 200 m to households as recommended by the Department of Provincial and Local Government (DPLG). However, even though the DPLG recommends the proximity level of 200 m, this is still questionable as some households still struggle to have enough running water as these taps are sometimes vandalised, not functional or even situated in elevated areas were it becomes impossible for water to ascend uphill due to the pressure of the water. In addition, it is further recommend that local authorities provide household taps that are functional. Moreover, the service delivery should be improved, and water provision infrastructure maintained regularly.

1. Introduction

Water accessibility and availability is a constraint and remains a worldwide challenge in developing countries due to water scarcity (Carden et al., 2007; Chaggu, 2011; Adewumi et al., 2012). Prosperity for South Africa and other countries depends upon water management and utilization of many resources, with water playing a pivotal role in the socio-economic development of the country, more particularly in the agricultural sector. The development of any country depends on accessibility and availability of adequate water resource.

The United Nations General Assembly recognized the rights of humans to water and sanitation (Meier et al., 2013; Brown et al., 2016). In the South African context, the Department of Provincial and Local Government (DPLG) urges local municipalities to devote their allocated

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budgets towards providing obligatory infrastructure to cater for almost 25 L of drinkable water per person per day, which is supplied within 200 m of a household and with a minimum flow of 10 L per minute (Department of Provincial and Local Government DPLG, 2007). Although the rights of people to access safe drinking water still remains a major problem in many countries, this concept is still under-developed. Notwithstanding the need for a mutual understandings and clarifications regarding its meaning (Brown et al., 2016), universally, the ever-escalating discussions surrounding water scarcity notion contribute to new plans and viewpoints on public policies in the water supply sector. In most of the developing countries, the availability of infrastructure for provisions of water is not always adequate to ensure sufficient access (Adewumi et al., 2012; Aleixo et al., 2019). Shaheed et al. (2014) has highlighted the variances in water supply facilities over time, and in space, in terms of availability, safety and accessibility. Guardiola et al. (2010) and Majuru et al. (2012) have asserted circumstances where the supply of piped water to communities is erratic and non-drinkable. It is, therefore, important to reduce the varied nature of disparities not only in development, however, also in the manner that services are being distributed. Disasters such as drought, flooding and unavailability of the technological know-how in the treatment and management of greywater also contribute to the lack of social and economic development of the water sector in developing countries (Department of Water Affairs and Forestry, DWAF, 2004). Analyses of this calibre are becoming more beneficial and receiving international attention given their inclusion in the Sustainable Development Goals (SDGs). Goal number 6 specifically focuses on ensuring the availability and sustainable management of water and sanitation for all by the year 2030 (Department of Water Affairs and Forestry, DWAF, 2004).

South Africa is one of the water scarce countries, with an average annual rainfall of approximately 500 mm (Adewumi et al., 2010; Berger, 2004). Much of this rainfall is seasonal and is far below the world's annual average of 860 mm (Department of Water Affairs and Forestry, DWAF, 2004; South African Weather Service SAWS, 2014). The rainfall patterns are highly variable, with extreme levels of evaporation, due to the hot climate, and increasing challenges of water scarcity. A growing economy and social development give rise to the increasing demands for water in South Africa. The country is regarded as the thirtieth driest country in the world and has less water per person than countries widely considered as being much drier, such as Namibia and Botswana (NWRS,

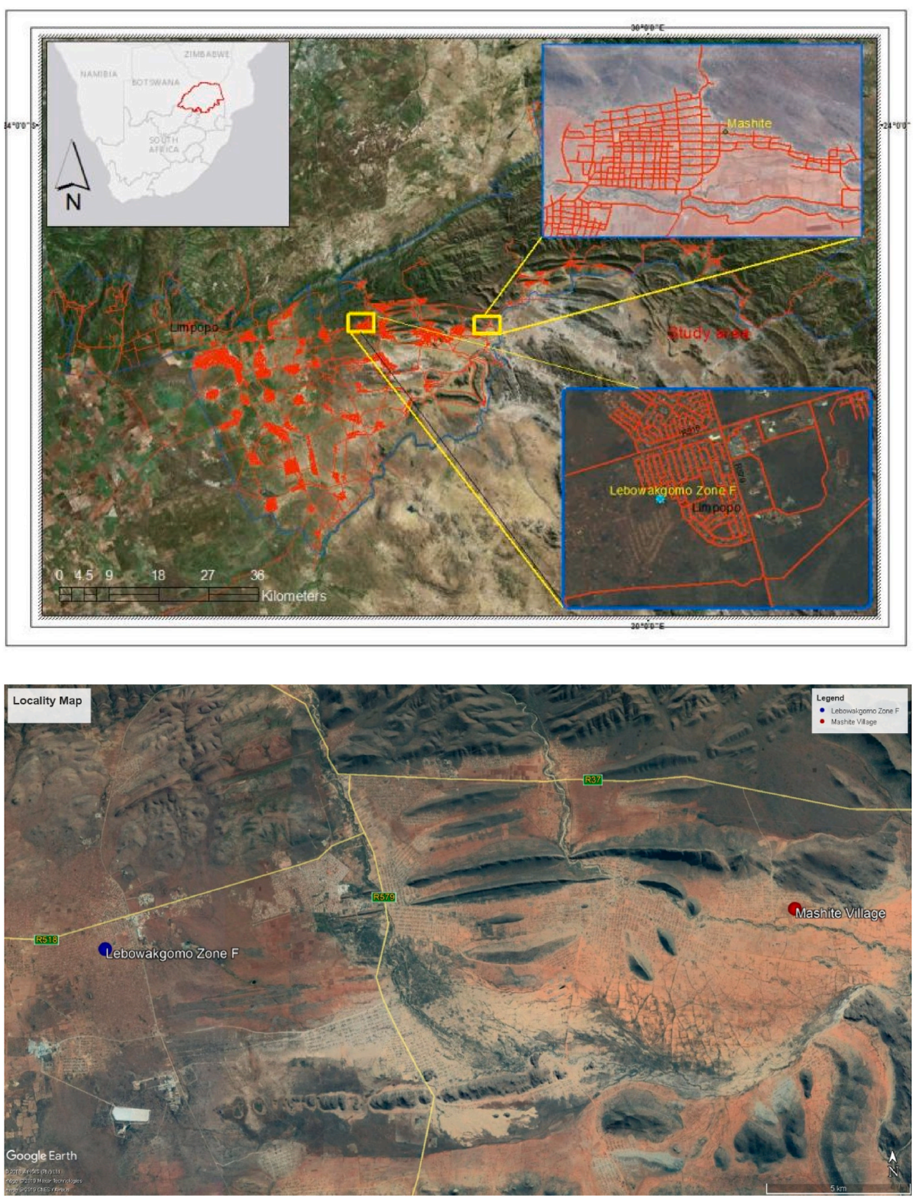

Fig. 1. Study area maps.

2013). According to Adewumi et al. (2010), many communities in South Africa struggle to access reliable and adequate quantities of potable water for diverse water requirements, such as drinking and cooking. It has been reported by Department of Water Affairs and Forestry, DWAF (2004) that residents of Lepelle-Nkumpi local municipality and other rural villages of South Africa have not yet received communal taps that are at a distance of 200 m from households. The current free basic potable water provision in South Africa is 6000 L per household (Berger, 2004). Due to the poor service level, residents queue for long periods at access water points which may have erratic or irregular supply. The residents also travel long distances carrying water home. The difficulty of getting water from stand-pipes forces people to resort to any available surface water like rivers (Adewumi et al., 2010) even if it means the water source is shared with their livestock. The scarcity of clean, fresh water in South Africa, is a reality. This is, among other reasons, due to growth in population and increased economic activities as well as inadequate water supply systems. Thus, in this study we assessed the accessibility and availability of water supply in selected communities of the Lepelle-Nkumpi Local Municipality, South Africa.

2. Study area

The research was conducted in Lepelle-Nkumpi Local Municipality which is one of the 5 local municipalities in the Capricorn District Municipality, Limpopo Province of South Africa (Fig. 1). It is geographically located at the latitude 24° 17′ 56.76″ South and longitude 29° 31′ 58.8″ East. Lepelle-Nkumpi local municipality is located 55 km South of Polokwane city. It is predominantly rural with a population of 230 350 people, with an aerial coverage of 3454.78 km^2, which is 20.4% of the district's total land area (Statistics South Africa StatsSA, 2013). It is divided into 29 wards, which comprise a total of 93 settlements. Among the 93 settlements, only Lebowakgomo is urban. About 95% of its land falls under the jurisdiction of Traditional Authorities. All sittings of the Provincial Legislature take place at Lebowakgomo old Parliament for the former homeland and it is one of the Capricorn District Municipality growth points (Statistics South Africa StatsSA, 2013). The municipality is situated on an elevated plateau with an altitude ranging between 1200 m and 1500 m above sea level. The climate of Lepelle-Nkumpi local municipality can be described as subtropical with an average temperature of 23°, humid summers and a cooler, dry and sunny winter season lasting from June to September. The dry season begins from April and extends to October, approaching the beginning of a hot, humid wet season. The annual average precipitation is 489 mm, which indicates the aridity of the region (South African Weather Service SAWS, 2012). The municipality receives most of the rainfall in summer as compared to winter, while it experiences no rainfall in spring (South African Weather Service SAWS, 2012).

3. Materials and methods

3.1. Sampling technique

Purposive random sampling was used to select two settlements for sampling namely: Mashite village which is a rural settlement and Lebowakgomo Zone F, which is an urban settlement. This is because water use characteristics are likely to differ in rural and urban settlements. Consequently, a comparison of the access to water between these two settlements are useful in understanding access to the resource and service delivery dynamics. Households in Mashite do not have running water unlike Lebowakgomo Zone F, which has been identified as a potential growth point with improved service delivery.

3.2. Data collection

Data was collected using both primary and secondary data collection techniques, field observation, point collection and pilot study. Primary data was collected by a means of a questionnaire. The questionnaire consisted of both open and close ended questions. It consisted with a total of 26 questions of which 16 were close-ended and 10 were-open ended. The questionnaires were self-administered to 126 households with 49 in Mashite village and 77 for Lebowakgomo Zone F. Only the household head or any older member of the family in each household was required to complete the questionnaire. The questionnaire focused on the socio-economic characteristics, accessibility and availability of water supply, the coping mechanisms of water scarcity and perception of greywater reuse at Lepelle-Nkumpi Local Municipality. The tribal councillor at Mashite village was interviewed on the strategies which were used to minimise water wastage and its conservation. Open ended questions on whether the community was sensitized on water conservation by organising awareness campaigns and public participation events were also asked. For instance, questions included community perspectives on water scarcity, the situation of water scarcity in this area, how the community is affected, whether they use greywater and how they conserve water as well as the effectiveness and challenges of the adopted strategies.

Secondary data such as the number of households in Lepelle-Nkumpi Local Municipality was acquired from the municipality's Integrated Development Plan (IDP, 2014). Furthermore, greywater reuse literature was obtained from research reports, journal articles, the internet, and books. Provincial boundaries were obtained from South African National Space Agency (SANSA, 2014) and the municipal demarcation downloaded from http://www.demarcation.org.za Accessed May 14, 2014.

Observation was the most important method of identifying areas where the water is conserved or not con served. It took three days to observe the physical condition of water conservation or wastage. Photographs on water conservation facilities such as water storage tanks, and water wastage such as burst pipes, leaking taps etc. were taken by the researcher in order to show the status of water conservation in Lepelle-Nkumpi Local Municipality (Fig. 2).

A GPS was used to collect absolute location of available water taps and the reservoir in the Mashite village. Slope information was obtained from the 90 m spatial resolution Digital Elevation Model (DEM) (SANSA, 2014), using Geographic Information System (GIS) software package ArcGIS 10.1. All collected points were added into an excel sheet before they were mapped in the GIS software. The polygon rivers data and the SPOT 5 building count were used as restricted areas to suitable locations (SANSA, 2014). The thematic maps were developed for each of the parameters. All the maps were georeferenced to the Universal Transverse Mercator (UTM) coordinate system.

3.3. Data analysis

The data collected using questionnaires was gathered from two types of questions: the first type was close ended questions dealing with the socio-economic characteristics of the communities, accessibility and availability of water supply as well as the coping mechanism for water scarcity. The responses were analysed using descriptive statistics in statistical software to obtain the inter-relationship of responses to different questions in average and graphical forms. Descriptive statistics in the form of frequencies and means were computed to describe the characteristics of the collected data. The descriptive statistics were also used to ascertain the households' coping mechanisms during water scarcity, to assess the accessibility and availability of water supply and lastly to ascertain the perceptions on greywater reuse by the two communities of the study area. These responses were compared for similarities or differences using Pearson Chi-square test method (Equation (1)).

$$X^2 = \sum \frac{(0-e)^2}{e} \tag{1}$$

Fig. 2. Water storage facilities (A) and access points (B–D) common in the area under study.

where O = Observed frequency, E = Expected frequency, $\sum$ = Summation and X^2 = Chi Square value.

3.4. Suitability criteria (Multi-criteria evaluation and GIS)

Multi-criteria evaluation in GIS was used; this is a GIS evaluation analysis which helps with the allocation of land to suit a specific objective on the basis of a variety of attributes that the selected areas should possess. The suitability criteria (Multi-criteria evaluation in GIS) was used to analyse factors based on the following: criteria accessibility/suitability and restriction criteria. The suitability analysis was decided based on the municipal and provincial by-laws principles and engaging with the municipal planning department for both the factor and restriction criteria.

The factor criterion enhances or detracts from the suitability of a specific alternative for the activity under consideration e.g. distance to water taps (near = most suitable; far = least suitable). The second one was the restriction criteria, which serve to limit the alternatives under consideration such as an element or a feature that represents limitations or restrictions and area that is not preferred in any way or considered unsuitable e.g. protected area, water body etc. The following formula was used:

$$S = \Sigma\, w_i x_i \Pi r_j \quad (2)$$

where Σ = sum of weighted factors; S =Suitability to the objective being considered, W_i = Weight assigned to factor; X_i = Criterion score of factors i and r_j = Constraints.

3.4.1. Factor criteria (accessibility and suitability)

GIS has proven practical throughout the world and effective when used for determining suitable lands for a built environment (SANSA, 2014). The suitability restriction criteria were taken into account when determining the accessibility and suitability of the factor criteria in developing the Mashite water accessibility model. In terms of the distance to the nearest water taps from the household (point layer with taps) proximity analysis was performed were accessible was 20 m buffer zone to the water source and less accessible was 50 m to the water source (Table 1).

Table 1
Proximity analysis.

Restriction Criteria	Minimum Buffer Distance (m) Accessible	Maximum Buffer Distance (m) Less accessible	Analysis Buffer Distance (m) Tolerable
SPOT Building Count_2006_2012	20	50	50
Street National	100	300	200
NFEPA Rivers	30	200	100

3.4.2. Restriction criteria for suitability

An initial list of key variables was compiled and discussed with key stakeholders at the Lepelle-Nkumpi Local Municipality Planning Department to determine key siting criteria for identifying the restrictions and the restricted buffer zones, rivers, wetlands, critical biodiversity area, ecological support area and streets. The restriction criteria were grouped into three categories: accessible, less accessible and tolerable.

Water taps accessibility was analysed by measuring the proximity of water taps to houses using the SPOT 5 building count data sets (SANSA, 2014). Proximity analysis was done by buffering the GPS points (water taps) at a distance of 20 m and overlay the data together with the household data to evaluate water accessibility. The 20 m overlay was most preferred to be accessible by the community and municipality. The closer the spot building counts to the buffers, the more accessible and the further they are, the least accessible to the taps.

4. Results

4.1. Demographic characteristics

The respondents were household headed male and female in the study area. Out of 49 households sampled in Mashite, majority (76%) were female, while 24% were male. In Lebowakgomo Zone F, the majority of the respondents (70%) were also female while 30% were male

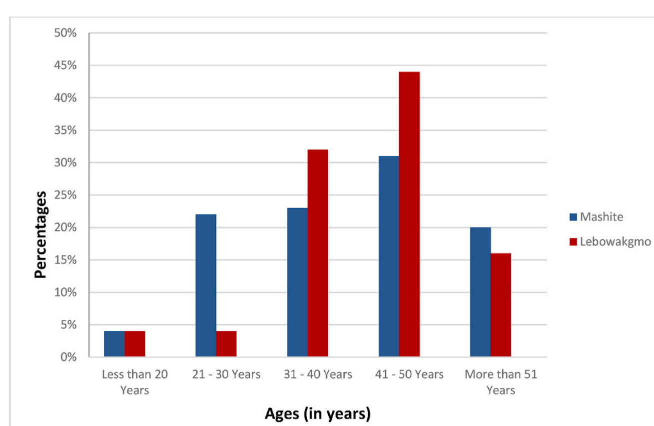

Fig. 3. The age of the respondents from the two communities.

(Fig. 3). The reason why most of the respondents were female might be because most of the women are at home, carrying out household chores than men. Another reason could be that most of the household heads were female. Furthermore, the data was collected during the day, where most men were likely to be at work at the time of conducting the study.

The age of the respondents was grouped into five categories as indicated in Fig. 3. In Mashite village, most of the respondents (31%) were between 41 and 50 years of age followed by 23% of the respondents aged between 31 and 40 years. The percentage falling under the '21–30 years age' category was 22%, followed by the group in the 'more than 51 years' category (20%). The remaining respondents were younger than 20 years and constituted only 4%. Respondents' results on age distribution in Lebowakgomo Zone F had a similar sequence for 41–50 years, and for 31–40 years, 21–30 years and less than 20 years as in Mashite village. However, the percentages of groups were different, with the exception of the less than 20 years which had the similar percentages (4%) for both areas. The 21–30 years age group also had 4% of the responses. Forty-four percent (44%) of the respondents in Lebowakgomo Zone F were 41–50 years old, followed by 32% (between 31 and 40 years old). Only 16% of the respondents were older than 50 years (Fig. 3). The reason Mashite village ranked higher in the age group between 21 and 30 years than Lebowakgomo might be because most of the Lebowakgomo youth were in tertiary institutions or that those who had finished tertiary education are working in towns as compared to Mashite where most of them have families and their own houses.

4.2. Sources of water

In reference to water sources, the majority of the households in Mashite get their water from rivers whereas from Lebowakgomo Zone F all (100%) the respondents get their water from the taps.

The majority of households (38%) in Mashite get water from the river, 31% harvest rain water, 15% obtain water from the dams, 6% get water from the taps and lastly 10% of the respondents uses other methods of acquiring water such as buying water from other households where they pay R2 for 20 L and R20 for a 210 L tank, while others installed their own borehole taps (Fig. 4). Households that depend on social grants are likely to suffer the most due to their lower levels of income (Motoboli, 2011). Similar studies have been done in Thabazimbi local municipality where the community sometimes spend about a month without water. The community is forced to spend R1.50 to get a 25 L bucket of water and many people are not working and those who cannot afford to pay for water resort to using water from the wells, fountains or rivers. According to the Human Development Report HDR (1997) and Motoboli (2011), inadequate water supplies are the cause and effect of unemployment.

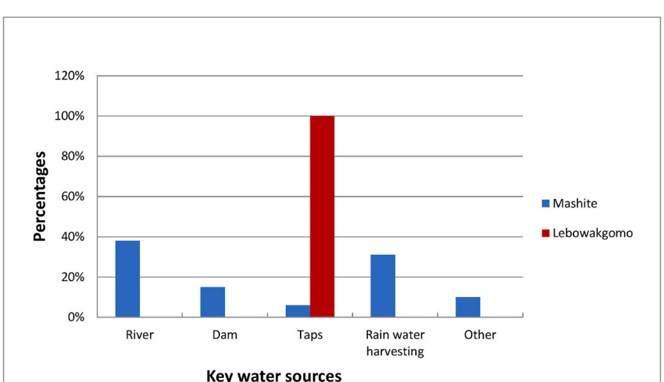

Fig. 4. Key water sources for the two communities.

4.3. Availability of water

The communities, when asked whether water is always available, their responses were as following: in Lebowakgomo Zone F all respondents (100%) said yes, whereas, in Mashite village, 73% of the respondents said yes and 27% of the respondents said no (Fig. 5).

4.4. Water sufficiency

Water sufficiency is the availability of water resources to meet the demands of water usage. Fig. 6 shows if the available water was adequate/enough for the people's needs or not.

Thirty-five percent (35%) of Mashite village respondents indicated that the water was enough for their needs, while 65% stated it is not. The majority of the respondents mentioned that they queue long lines for water and they only take home three 20 L containers (60 L) and by the time they go back the water is no longer available. Seventy-seven percent (77%) of Lebowakgomo respondents indicated that the water was enough, while 23% declared it was not (Fig. 6). The majority of the respondents further mentioned that water is sometimes less or not enough in the morning while others reported that water is sometimes less or not sufficient in the evening.

4.5. Pearson Chi-Square

A Pearson Chi-Square test was conducted to assess whether townships and rural areas have an impact on water sufficiency for the respondents needs. The Pearson Chi-Square value for the association between region and water sufficiency was obtained as 66.779 with 1 degree of freedom and significance probability less than 0.001, indicating a very highly significant result. Based on this data analysis there would appear to be an association between region and water sufficiency. Thus, it can be concluded that people in rural areas lack sufficient water as compared to those in townships. This might be because in townships people pay for water services unlike rural areas where water is free. In most cases, better service delivery is offered to urban communities (exclusive of informal settlements) as compared to rural areas.

4.6. Distance from the water sources

When the respondents in Mashite were asked how far the water sources are from their homes, 94% of them said less than 1 km, while 6% of them said between 1 km and 3 km. The majority of the respondents said that the nearest water source was found at a corner house which is less than 1 km from their houses while others said the next street which is also less than 1 km. In contrast, Lebowakgomo respondents mentioned that they do not travel to the water sources as they have taps indoors. According to the RDP standard of South Africa, a water source (communal tap) has to be 200 m or less to a household (Republic of South Africa. RSA, 1997). This implies that the majority of the

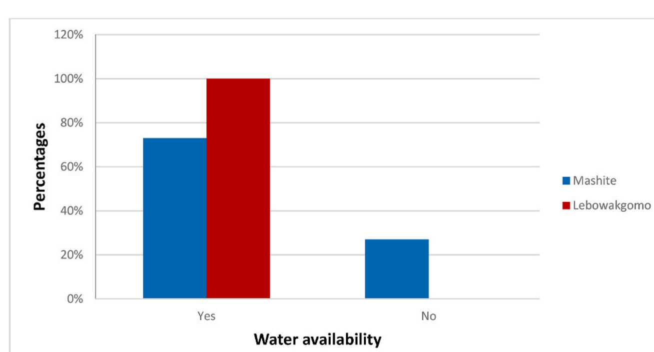

Fig. 5. Availability of water in study areas.

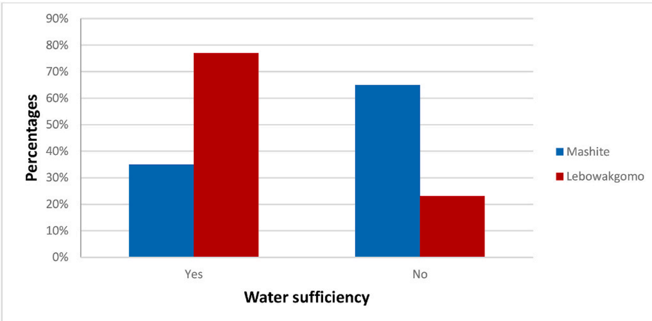

Fig. 6. Sufficiency of water for respondents' needs.

communities in Mashite travel long distances to access water.

Proximity analysis was done at a distance of 50 m–100 m, 100 m–150 m, and 150 m–200 m. The data was overlaid together with the houses data to evaluate water tap accessibility. The red buffer zone is 50 m–100 m which indicates that houses in these buffer zones are closer to standpipes when compared to green and blue buffer zone areas. The green buffer zone is 100 m–150 m which indicates moderate accessibility and the blue buffer zone 150 m–200 m indicates low accessibility to standpipes (Fig. 7).

From Fig. 8, households with poor water accessibility are in the blue buffer zone. This shows that the availability of piped water does not adequately meet the needs of the most poor and vulnerable. This is specifically true for those in the blue buffer zone as they are shown to be far away from water sources. Fig. 8 also shows that standpipes are not evenly distributed. According to World Health Organization WHO (2006), rural areas in Africa are the ones mostly with limited sources of water. Not only is there poor access to readily accessible drinking water, even when water is available it is not enough. This mostly affects the individuals travelling more distance to the source of water.

5. Discussion

According to the Water Service Act, 1997 (Act 108 of 1997; Binns et al., 2001) availability of water is the right of access to basic water supply. The Mashite community emphasised they wanted the water taps to be erected inside their yards and not in the street. According to the municipality, the decision to erect the taps on the street was part of phase 1 of a larger water project (Adewumi et al., 2010). Their plan was that stand-pipes would be followed by the erection of the water taps in the yards as well as providing for water metres. The supply of water from the street taps/standpipes is not done on a daily basis (Adewumi et al., 2010). According to the respondents, there are streets that have numerous taps as compared to other streets in the same area. Furthermore, some of those taps have been vandalised and were not in operation. Respondents in Lebowakgomo said that they do not have standpipes (Adewumi et al., 2012; Berger, 2004).

The availability of water from standpipes varied across Mashite village. Some sections had stopped drawing water from the taps, whereas some sections received standpipe water after every two days per month while in other sections running standpipe water was available during the day only (Adewumi et al., 2012; Berger, 2004). The new stands do not receive standpipe water at all because the water is unable to flow to these sections due to the weak water pressure from the main supply. The quantity of water supply to the villagers is below the RDP standard. The villagers often stand in long queues to fetch water from the taps. The flow rate is at 25 L of water per 20 min. This is contrary to the RDP standard which is 10 L of water per minute (200 L per 20 min). The scramble for water supply at Mashite village is still visible and it is a common feature (Burrows et al., 1991). Sometimes water taps run dry while people are still in the queue. This is a physical water scarcity since there is not enough water to meet all demands (NWRS, 2013). The expectation of the villagers is that, water should be available on a daily basis. Villagers fetching water from the river do not drink it; they use it for washing clothes, bathing, cleaning, and irrigation (Berger, 2004).

The quantity of water used depends on the number of people in the household. According to the World Health Organisation (2006), the minimum quantity of water needed for survival is 25 L per person per day, which, per month, is 750 L per person. The quantity of water used by respondents from the study area varied, and it ranged between 250 L and 8001 L, per month per household. Most of the respondents (56%) in Mashite village use 250 L of water per month, which is 8.3 L per day per household, far less than the recommended quantity by World Health Organization WHO (2006). Twenty-one percent (21%) of the respondents would use 1500 L per month (50 L per day per household), 16% of respondents used 500 L per household per month (16 L per household per day), and the remaining 7% of respondents used 840 L of water per household per month (28 L per household per day). In

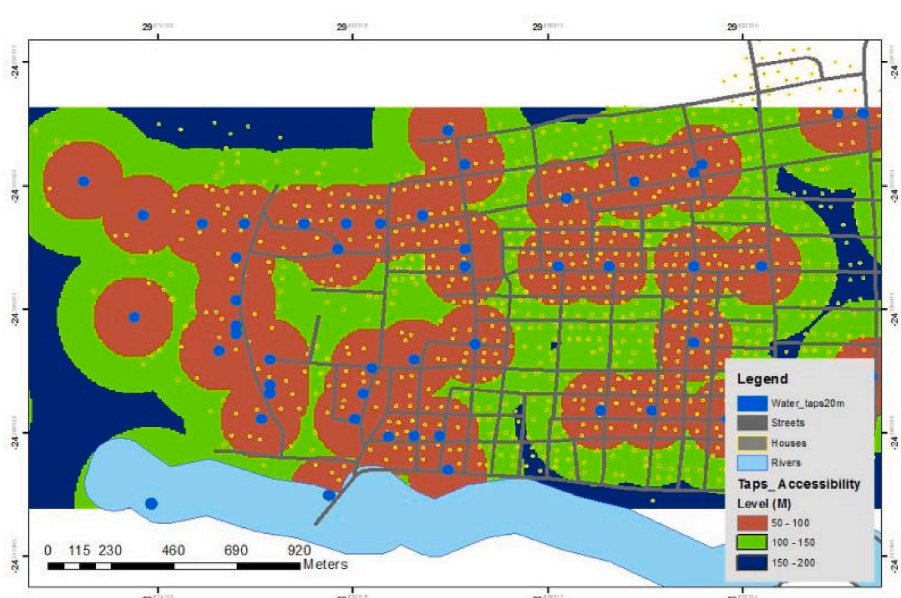

Fig. 7. The distance from households to the nearest water tap.

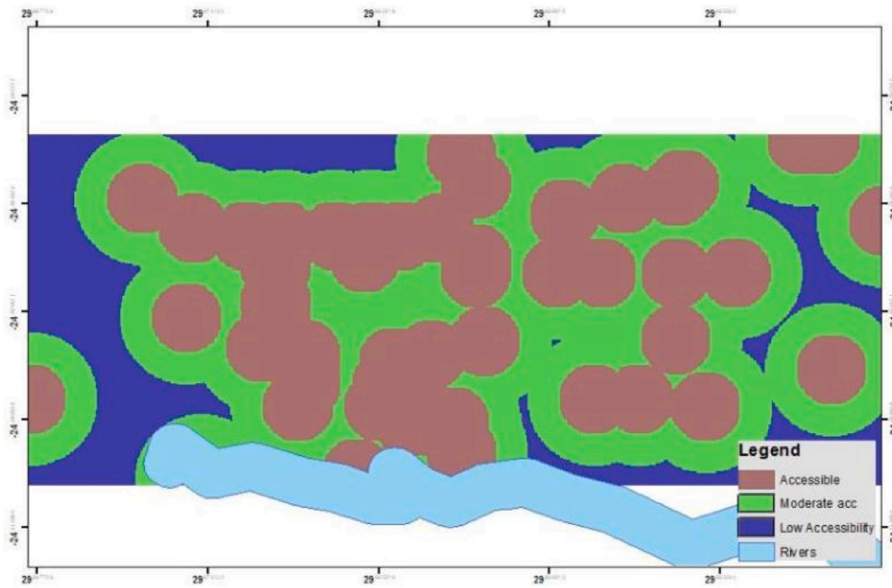

Fig. 8. Households with poor access to water.

Lebowakgomo Zone F, all respondents have indoors taps; their water usage was higher than Mashite village. Sixty-one percent (61%) of respondents used between 5900 and 6000 L per household per month. Thirty-two percent (32%) of the respondents used between 6001 L and 8000 L per month per household, while the remaining 7% used more than 8001 L per month per household. The respondents who used more than 8001 L of water per month have hair salons and carwash businesses. Respondent in Lebowakgomo Zone F meet and exceed the recommended amount of water per person per day. The results suggest that households with improved water access consume more water than the minimum standard for the Free Basic Water in South Africa. The Free Basic Water states that 6000 L per household of 8 people per month or 200 L per household per day which is 25 L per person per day (Moller, 2008). Households with unimproved water access consume less than the minimum standard.

6. Conclusions

The findings indicate that access to water varies significantly between the two communities. In Mashite village there was a serious water accessibility and availability problem when compared to Lebowakgomo Zone F where water was regularly accessible and available. In Mashite village water was found to be insufficient, standpipes were leaking as compared to Lebowakgomo Zone F with indoor tap water supply. The communities need water authorities in the local municipality to encourage public participation and awareness campaigns. Therefore, there is a need for the government to install metre taps at Mashite area and provide them with the 6000 L water for basic needs. Meter taps should also be within a 200 m proximity to households. This will reduce the amount of time and distance individuals (particularly women, the elderly, disabled and children) have to travel to access water, which is a basic need. Moreover, the water supply infrastructures should be adequate and well maintained. According to the Constitution of South Africa, Section 27 sub-section 1b states that every citizen has the right of access to sufficient water. Sub-section 2 further expresses that, reasonable measures and legislative means have to be taken by a State to achieving this right within its available resources.

Author statement

All authors confirm contribution on the manuscript and do approve its publication.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

Adewumi, J.R., Ilemobade, A.A., Van Zyl, J.E., 2010. Decision support for the planning of integrated wastewater reuse projects in South Africa. Water Sci. Technol. Water Supply 10 (2), 251–267.

Adewumi, J.R., Ilemobade, A.A., Van Zyl, J.E., 2012. Minimising risk in wastewater reuse: proposed operational principles and guidelines for South Africa. J Water Reuse Desalination 2 (4), 227–238.

Aleixo, B., Pena, J.L., Heller, L., Rezende, S., 2019. Infrastructure is a necessary but insufficient condition to eliminate inequalities in access to water: research of a rural community intervention in Northeast Brazil. Sci. Total Environ. 652, 1445–1455.

Brown, C., Neves-Silva, P., Heller, L., 2016. The human right to water and sanitation: a new perspective for public policies. Ciencia Saude Coletiva J. 21 (3), 661–670. https://doi.org/10.1590/1413-81232015213.20142015.

Binns, J.A., Illgner, P.M., Nel, E.L., 2001. Water shortage, deforestation and development: South Africa's working for water programme. Land Degrad. Dev. 12 (4), 341–355.

Berger, D., 2004. South Africa Yearbook, 5. Pretoria Yearbook A, pp. 1–30. https://www.gcis.gov.za/content/resource-centre/sa-info/yearbook/2004-05. (Accessed 19 November 2019).

Burrows, W.D., Schmidt, M.O., Carnevale, R.M., Schaub, S.A., 1991. No potable reuse: development of health criteria and technologies for shower water recycle. Water Sci. Technol. 24 (9), 81–88.

Carden, K., Armitage, N., Sichone, O., Winter, K., 2007. The use and disposal of greywater in the non-sewered areas of South Africa: paper 2 – greywater management options. Water S. Afr. 33 (4), 433–441.

Chaggu, E.O., 2011. Greywater reuse and recycling potential: the case of Mwanza city. Ardhi university. Tanzania. Open Environ. Eng. J. 4, 78–88.

Department of Provincial and Local Government (DPLG), 2007. The Municipal Infrastructure Grant (MIG), from Program to Project to Sustainable Services. http://www.cogta.gov.za/mig/docs/3.pdf. (Accessed 18 November 2019).

Department of Water Affairs and Forestry, (DWAF), 2004. *Water Supply and Sanitation* White Paper. DWAF, Pretoria.

Guardiola, J., González-Gómez, F., Grajales, Á.L., 2010. Is access to water as good as the data claim? Case study of Yucatan. Int. J. Dev. 26 (2), 219–233. https://doi.org/10.1080/07900621003655692.

Human Development Report (HDR), 1997. Poverty from a Human Development Perspective. Oxford University Press, New York, pp. 1–20. Published for United Nations Development Programme.
Lepelle-Nkumpi Local Municipality Integrated Development Plan (IDP), 2014. Limpopo, South Africa. www.lepelle-nkumpi.gov.za. (Accessed 19 January 2014).
Majuru, B., Jagals, P., Hunter, P.R., 2012. Assessing rural small community water supply in Limpopo, South Africa: water service benchmarks and reliability. Sci. Total Environ. 435–436, 479–486. https://doi.org/10.1016/j.scitotenv.2012.07.024.
Meier, B., Mason, K., Georgia Lyn, A., Urooj, Q., Bartram, J., 2013. Implementing an evolving human right through water and sanitation policy. Water Pol. 15 (1), 116. https://doi.org/10.2166/wp.2012.198.
Moller, M., 2008. Free basic water-a sustainable instrument for a sustainable future in South Africa. IIED) 20 (1), 67–87.
Motoboli, M.J., 2011. The Impact of Improved Water Access for Both Domestic and Productive Uses on Human Development: the Case of Letsoalo Sekororo in Limpopo Province, South Africa. MSc dissertation. University of Limpopo (Turfloop campus).
Republic of South Africa. (RSA), 1997. Water Services Act, 108 of 1997. Government Printer, Pretoria. South Africa.
Shaheed, A., Orgill, J., Ratana, C., Montgomery, M.A., Jeuland, M.A., Brown, J., 2014. Water quality risks of 'improved' water sources: evidence from Cambodia. Trop. Med. Int. Health 19 (2), 186–194. https://doi.org/10.1111/tmi.12229.
Statistics South Africa (StatsSA), 2013. General Household Survey. Statistical Release. Pretoria, South Africa.
South African Weather Service (SAWS), 2012. South African Rainfall Data. http://www.weathersa.co.za/. (Accessed 18 January 2014).
South African Weather Service (SAWS), 2014. South African Rainfall Data. http://www.weathersa.co.za/. (Accessed 20 January 2014).
World Health Organization (WHO), 2006. Guidelines for the Safe Use of Wastewater, Excreta and Greywater. http://www.WHO.org. (Accessed 17 April 2013).