River catchment dynamics and access to clean water in rural South Africa

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Abstract

Context: This paper explores evidence-based indicators of the National Water Policy Review (NWPR, 2013) among households in the Mthatha River catchment of the Oliver Regina (OR) Tambo District Municipality, one of the rural areas of South Africa.

Data source & Method: A total number of 420 households were surveyed in the upper, township/peri-township, lower and coastal regions of the Mthatha River catchment. Descriptive and logistic regression analyses were conducted on the data collected from households.

Findings: Approximately 68% of the total households surveyed reported that they have access to the required minimum of 25 litres/person/day, but only 30% had access to piped water either in the house or from public taps. Logistic regression showed that access to clean piped water was influenced by lack of water infrastructure, proximity to urban regions, daily flow of pipe-borne water, household size and distance to public taps.

Conclusion: The promotion of point-of-use technologies are recommended to ensure equitable clean water access

Keywords: domestic water; household technology; water security; rural community

Introduction

Water is an essential component that is required in all social and economic activities. Most people in Africa have witnessed water shortage or insecurity periodically or permanently (Dugunmaro 2007). According to Hope (2006), many of the most marginalised in the distribution of safe water are rural Africans, with the highest percentage of income poverty and also suffering from regular and extreme food deficits associated with seasonal and inter-annual climatic variability. The impact of water insecurity is enormous. When the provision and availability of water become inadequate, people are forced to use insufficient and contaminated water, resulting in water-related diseases. Satterthwaite (2003) states that inadequacies in the provision of piped water, sanitation and drainage result in problems with insect-borne diseases such as malaria and others related to lack of water and use of poor-quality water. While there are arguments regarding the magnitude of resource allocation towards pro-poor clean and piped water access for the rural poor in global market-driven systems, governments have no choice but to spend on what can be termed preventable diseases during an outbreak of waterborne diseases. Lack of access to safe water remains the third most significant risk factor of poor health in developing countries (Haller, Hutton & Bartram 2007).

Since the inception of democratic rule in 1994, the South African government has developed four different policy documents to ensure equitable distribution of water resources among its citizenry. The policy documents are the White Paper on Water Supply and Sanitation (1994), the White Paper on a National Water Policy for South Africa (1997), the White Paper on Basic Household Sanitation (2001) and the Strategic Framework for Water Services (2003). However, all these documents have been interpreted in many forms without achieving targets of equitable and efficient water distribution. Hence, government's National Water Policy Review (NWPR, 2013) made some critical declarations for equitable water distribution as follows:

A basic water supply serves as the provision of a basic water supply facility, the sustainable operation of the facility (available for at least 350 days per year and not interrupted for more than 48 consecutive hours per incident) and the communication of good water-use, hygiene and related practices; A basic water supply facility is defined as the infrastructure necessary to supply potable water to a formal connection at a boundary at a stand; and

The provision of an adequate supply of safe water to all households to meet their domestic and productive requirements; with a minimum of 25 litres per person per day provided free of charge to all indigent households, a maximum distance of 200 metres from dwelling and with a flow rate of not less than 10 litres a minute.

Four years after gazetting the updated National Water Policy Review (NWPR, 2013), access to clean water by rural households, which is the foremost point, is yet to be achieved. Since the enactment of the policy, few studies have investigated the successful implementation and the pathway to achieving it. Van Koppen and Schreiner (2013) state that correction of documented flaws of integrated water resource management by adopting developmental water management as the water resource management approach was good enough to bring about equitable distribution of water, most especially in rural areas. Kemerink et al. (2013) question the viability of water users' associations as the feasible vehicle for representation for inclusive water access in rural South Africa. Rivett et al. (2013) state that water quality in rural areas of South Africa is influenced by the failure of rural municipalities to report the required information and by non-regulatory compliance. However, as much as these studies have advanced frameworks and institutional changes necessary for water distribution, they did not include post-enactment analysis to show whether the NWPR (2013) and attendant changes achieved the intended goal of equitable water distribution in rural South Africa and the influencing factors. This study aimed to fill that gap. The study on which this paper was based set out to investigate access to clean water at the daily minimum of 25 litres per person among the rural households in the Mthatha River catchment. The paper presents major sources of water, access to the daily minimum of 25 litres/person, access to clean piped water, distance to public tap water and the reasons for non-access to clean water sources in four different regions of the catchment. It hopes to highlight constraints to clean water access as stipulated in the policy document and required adjustments for achieving Sustainable Development Goal 6 in South Africa.

Water insecurity cannot be measured by only examining physical water reserves or inflows/outflows and abstraction/recharge balances, as it is the qualitative, socio-economic and political factors that in fact have the greatest impact on water scarcity in most places (Cohen & Sullivan 2010). Vörösmarty, Green, Salisbury and Lammers (2000) state that socio-economic impacts are likely to become increasingly important as the effects of climate change on water resources become more severe. Sullivan (2002) suggests that the measurement of water insecurity (scarcity) should go beyond the availability of the physical resource itself and examine how water is used, managed and shared. Hunter, MacDonald and Carter (2010) point out the disparity of water distribution between wealthy nations and poorer ones. In wealthier nations, high-quality water is universally available, with large amounts of money spent to assure reliable household supplies, whereas in poorer countries, access to water is generally delivered through communally managed public water points in rural regions and unreliable distribution systems in towns and cities.

Water security has been defined as the reliable availability of an acceptable quantity and quality of water for health, livelihoods and production, coupled with an acceptable level of water-related risks (Grey & Sadoff 2007). Going by the benchmark of average annual total actual renewable water resources per person, South Africa is recognised as a water-scarce country. Using this definition, South Africa is the 29th driest country out of 193 countries, with an estimated 1 110 m^3 of water per person in 2005 (Development Bank of Southern Africa 2010). While abundance of water sources/water security does not directly translate into economic growth and development, as we have seen in countries such as Bangladeshi and the DRC, compared to Singapore, which was once a water-scare country (DBSA 2010), efficient water source management could be very important to improve the current status of water sources and sustainable water security in South Africa.

As one of the signatories to the Sustainable Development Goals, in South Africa, with its mix of both developed and developing regions, about 1 million people in the metros and 17.1 million in rural municipalities have no access to any form of water supply infrastructure (StatsSA 2016). The consumer units that received a free basic service, however, grew rapidly until 2013, before starting to decline from 44% in 2013 to 36.7% in 2015 (StatsSA 2016).

The reality is that many water supply interventions in developing countries do not last. In a study by Rietveld, Haarhoff and Jagals (2009) it was found that in some villages in South Africa, a country with supposedly improved water supplies, several issues of water mismanagement such as insufficient water (wells having dried up or incapable of meeting the demand), broken water pumps, lack of money to buy diesel for the pump and no personnel to operate the pump (when the operator was ill, for example) were common factors pointing to the unreliability of water supply interventions.

There have been spirited efforts to enhance domestic rainwater harvesting to alleviate rural water access in South Africa. Kahinda, Taigbenu and Boroto (2015) report that the South African government has committed itself to providing financial assistance to poor households for the capital cost of rainwater storage tanks and related works in the rural areas to meet the Sustainable Development Goal. The authors argue that beyond the cost of installation, maintenance and proper use of the domestic rainwater harvesting system to ensure its sustainability, there is a risk of waterborne diseases, hence the need for other sources of technology to reduce these concerns. However, Sobsey, Stauber, Casanova, Brown and Elliot (2008) suggest that the beneficial effects of improving household drinking water quality at the point of use (POU) to reduce diarrheal disease risks had been previously underestimated.

The increase in the global population with its attendant basic domestic water needs, both in quantity and in quality, has put more pressure on water resources. Cohen (2003) states that poor countries face higher risks of water insecurity than richer countries because the population of poor countries is expected to grow faster than that of the richer countries because of higher birth rates in poor countries. Other factors, such as low-cost household technologies, as opposed to centralised systems, offer means of addressing water and sanitation needs in a more integrated and sustainable manner (Sobsey *et al.* 2008). In their study on water and sanitation issues in the developing world, Montgomery and Elimelech (2007) found that some of the obstacles that must be overcome to improve water and sanitation services are lack of investment in infrastructure, lack of political will and difficulty in maintaining services.

This study on the dynamics of access to clean water was underpinned by sustainability theory. The concept of sustainability became prominent after the published report titled "Our common future" by the World Commission on Environment and Development (1987). The report defined sustainability as "development which meets the needs of current generations without compromising the ability of future generations to meet their own needs (WCED, 1987:34)". The term 'sustainability' integrates social, environmental and economic responsibilities.

Several dimensions of project sustainability have been considered depending on the nature of the sector or project. For this study on access to clean drinkable water by rural people, we aligned with dimensions outlined by Macharia, Mbassana and Odour (2015) as technical, institutional, social and environmental dimensions of sustainability theory. These dimensions are briefly explained below.

- Technical sustainability: This refers to the reliable and correct functioning of the technology and, for water supplies, the delivery of enough water of an acceptable quality. Equity aspects relate to the technology meeting the demands of all user groups.
- Institutional sustainability: To keep systems operational, accessible and widely used, communities need institutions. Institutions have cultural characteristics, agreed-upon and valued procedures and rules for operation and varying capacities for management and accountability.
- Social sustainability: Users will only sustain services that satisfy their expectations. This means services that they can easily access, that are in accordance with their socio-cultural preferences and practices, and that they consider worth the cost they incur to obtain them. It also includes looking at how fairly the burdens and benefits from the services are shared across different socio-economic, gender and ethnic groups that manage and control the services. This is necessary to deal with multiple threats to water resources ranging from over-extraction to contamination of water sources through industrialisation and waste disposal, which threaten reliable and safe drinking water supplies.

The theory of sustainability highlights three aspects as common elements in its definition, namely the limits of available resources, the interdependence of human activities both in present and future generations and issues of equity in the distribution of a benefit (goods or services). The concept has also been extended to incorporate institutional or management sustainability, which brings in the theory of the community management model (Macharia *et al.* 2015).

Data and methods

The description of the study area

This study was conducted in the King Sabata Dalinyebo and Nyandeni local municipalities of the OR Tambo District Municipality, which are the two local municipalities in the Mthatha River catchment (Figure 1). The district is predominantly rural, with low levels of education and high migration by men (Eastern Cape Socio Economic Consultative Council, 2017). Domestic and irrigation water for the inhabitants of the catchment region is sourced from the Mthatha River. The Mthatha River catchment is roughly 100 km long and 50 km wide and covers an area of approximately 5 520 km^2. The 250-km long Mthatha

River, with its two large tributaries, winds its way to the sea north of Coffee Bay (Mankosi village).

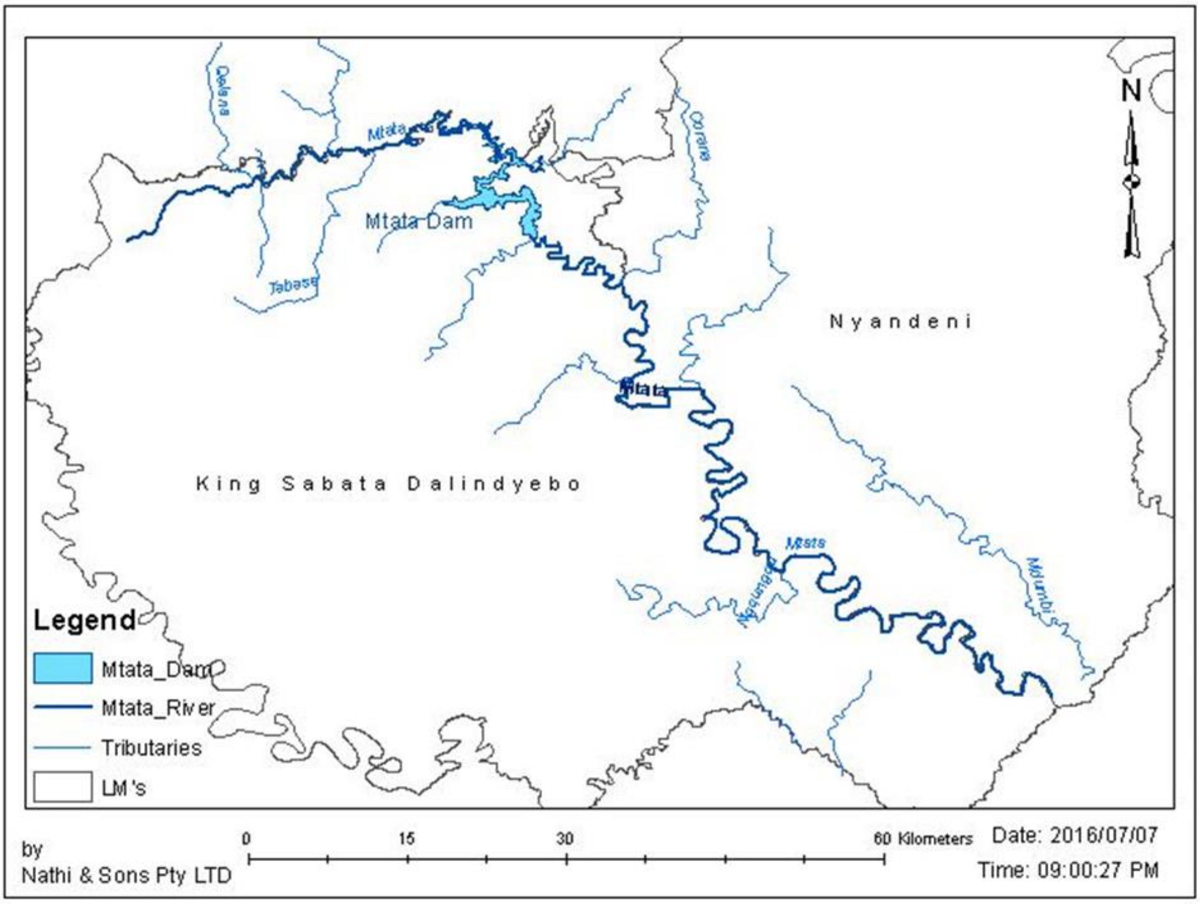

Figure 1: Map showing the Mthatha River flow through the two local municipalities

Major water storage reservoirs in the Mthatha catchment are the Mthatha Dam and the Corana Dam on the Corana tributary of the Mthatha River. The Mthatha Dam has a catchment region of 886 km and can store up to 254 million m^3 of water, while yielding approximately 14.5 million m^3 of water a year. The Mthatha Dam supplies Mthatha town and the surrounding regions with domestic water and acts as balancing water storage, supplying the small dams at the First and Second falls downstream of Mthatha town (River health program, 2008).

Data-collection procedure

This study had a quantitative research design and a multi-stage data-collection procedure was employed during the survey. The catchment was divided into four regions in relation to the source of the Mthatha River. These are the upper region, the township/peri-township region, the lower region and the coastal region. Ten communities/villages were randomly selected in each of the regions. A total of 420 households were interviewed in the whole catchment. One hundred households in each region were systematically selected based on their willingness to participate. However, at the end of the survey, there were regions that had more than a hundred households. The household heads who were able to give details of water access and security were interviewed on the issues of access to the daily minimum of 25 litres of water per person in the households, clean piped water in the house, distance to the public taps (200-metre distance or more), the frequency of flowing piped water (350 days' supply of water enshrined in the policy or otherwise) and source of water supply to the households' domestic needs in each community. The interviews also explored other water security variables with the objective of developing a dichotomous model for those households that were able to get the required daily minimum of 25 litres and those households that did not, with various explanatory variables responsible for this. It is expected that the villages surrounding Mthatha Dam will benefit from government water supply from the dam.

Data-analysis methods

The analysis of the data was done using SPSS version 20. Descriptive statistics in the form of percentages and pie-charts are presented on a regional basis to illustrate water access, water security, availability, functional water infrastructure and other domestic water situations in different regions of the Mthatha River catchment. Inferential analysis through the use of logistic modelling was deployed to explore the determinants of access to water in the catchment. This model is similar to the one employed in the study by Macharia *et al.* (2015) on determinants of clean water access in Kenya. However, our choice of the binary option of logistic regression instead of ordered logistic regression used by Macharia *et al.* (2015) was motivated by the nature of the dependent variables considered, which had two categories. The implicit and empirical representations of the binary logistic model are expressed below:

Mathematical expression of binary logistic model based on the cumulative logistic probability function specified as:

$$P_i = f(Z_i) = f(\alpha + \beta_i \chi_i) = \frac{1}{1+e^{-z_i}} = \frac{1}{1+e(\alpha + \beta_i \chi_i)}$$

Hence, the empirical function of binary logistic model employed in this paper is explicitly written as:

$$Log \frac{P_i}{1-P_i} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 ... + \beta_{13} X_{13} + \varepsilon_0$$

Where Log Pi is the logarithm of probability that a household had access to 25 litres/day/person and Log $1-P_i$ is the logarithm of probability of certain households not accessing 25 litres/day/person, which is the dependent variable; α is the constant; β_{1-13} are the estimate parameters; while X_{1-13} are the independent (explanatory) variables and α_0 is the error term. Table 1 below illustrates the variables used in the logistic regression analysis.

Table 1: Variables used in the logistic modelling

Dependent variable	Access to daily minimum 25 litres/person/day. Dummy variable 1 for access, 0 for otherwise
X_1	Household size (number)
X_2	Daily access to water: Dummy variable 1 for access, 2 otherwise.
X_3	Piped water in the house: dummy variable 1 for yes, 2 otherwise
X_4	Distance to public tap: within 200 meters 1, otherwise 2
X_5	Dam as water source
X_6	River as water source
X_7	Spring (spring water) as water source
X_8	Municipality Truck as water source
X_9	Water harvesting as source of water
X_{10}	Upper region of the catchment
X_{11}	township/peri-township region of the catchment
X_{12}	Lower region
X_{13}	Coastal region.

Results

The first part of the results on rural water security is the locational characterisation of the households' water issues. This is captured by descriptive statistics in table 2 and figure 2 on topical issues: a) daily access to drinking water, b) access to clean piped water, c) distance to public tap, d) frequency of running tap water and reasons, e) other sources of water and f) access to the daily minimum of 25 litres/person. All these are issues presented for each of the four different regions of the Mthatha River catchment. The second part of the results presentation is inferential analysis on the determinants of access to the required daily minimum of 25 litres/person in the Mthatha catchment through logistic regression modelling. This is presented in Table 3.

Table 2: Essential indicators of access to water by households in Mthatha river catchment

		Upper region (%)	Township/peri-Township region (%)	Lower region (%)	Coastal region (%)
Drinking water access (both safe and unsafe)	Have access	73.5	76	79.6	69.5
	No access	26.5	24	20.4	30.5
Piped clean water	Piped water in house	73.5	88	3.3	3.9
	No piped water in house	26.5	12	96.7	96.1
Distance to public tap	100 metres	28.6	12	30.1	31.3
	101 to 200 metres	14.3	4	26.9	17.2
	201 to 300 metres	7.1	2	9.7	13.3
	Far away	17.3	7	16.1	10.9
	No public tap	1	-	15.1	27.3
Frequency of tap flowing	All days	66.3	76	1.1	2.3
	4 days	10.2	9	2.2	0.8
	3 days	6.1	3	1.1	-
	1 day	2	3	-	0.8
	No tap	15.3	9	95.7	96.1
Reasons for tap not flowing regularly	Can't pay water bill	8.1	2	7.5	0.8
	No water infrastructure	24.5	7	89.2	96.1
	Non-functioning infrastructure	4.1	12	1.1	1.6
	Functioning infrastructure	63.3	79	2.2	1.6
Major Sources of water	Dam	27.6	4	--	2.3
	River	10.2	1	51.6	74.2
	Spring water	12.2	1	36.5	18.8
	Municipality truck	2	53	2.2	0.8
	Rainwater harvesting	-	6	--	--

Daily access to drinking water from both safe and unsafe sources

Table 2 illustrates the distribution of households that had daily access to drinking water (not from safe sources) in each of the regions. In the upper region of the Mthatha River catchment, 74% of the households surveyed had daily access to drinkable water, while 76% in the township/peri-township region, approximately 80% in the lower region and about 70% in the coastal region had access to drinkable water daily. However, there are more households in the coastal region (30.5%) that were without daily access to drinkable water compared to other regions.

Access to clean piped water

Households' access to clean water through pipes in their homes is presented in Table 2. The figures show that 88% of the households surveyed in the township/peri-township region had clean piped water in their homes. This was followed by 73.5% of the interviewed households in the upper region. However, the majority of households in the lower and coastal regions lacked access to clean piped water in their homes (96.7% and 96.1% respectively). Juxtaposing the results, we assumed that while the majority of the households in the lower and coastal regions responded affirmatively to having access to daily drinking water, lack of access to clean piped water in their homes could suggest compromised sources of drinkable water.

Furthermore, the results illustrated in Table 2 show the availability of public taps and their distances from homes in each region. While the result shows that the majority of the households surveyed had clean piped water in their homes, it further shows that 42.6% of households surveyed in the upper region of the catchment had public water within the required 200-metre radius. Approximately 16% of the households surveyed in the township/peri-township region had a public tap water source within the required 200-metre radius. However, less than 5% of the households surveyed in the lower and coastal regions (see Table 2) had access to clean piped water in their homes. The results in Table 2 further shows that approximately 57% in the lower region and 48.5% of the coastal region of the households interviewed had public water taps in the recommended 200-metre vicinity. Approximately 15% of the households surveyed in the lower region did not have public water at all, while 27.3% of the respondents in the coastal region had no public water at all in their region. This revealed that approximately half of the interviewed households in the lower and coastal regions were exposed to unclean sources of water and were at risk of waterborne diseases.

Frequency of tap flowing and the determinants

One specific goal of the NWPR (2013) is to achieve an average of three days of running tap water per week. From Table 2, the distribution of the average tap flow frequency in the catchment and the proximate reasons. The result shows that approximately 83% of the interviewed households in the upper region received water above three days/week. As expected, 88% of households received water more than three days per week in the township/peri-township region. However, 3.3% of the surveyed households got water from a tap three days/week in the lower region, while 3.1% of households in the coastal region received water from their tap on average three days/week. Furthermore, more than 95% of the surveyed households in both the lower and the coastal regions lacked access to piped water. The result further shows that functioning infrastructure had been responsible for the high rate of running tap water in the upper and township/peri-township regions (63.3% and 79% respectively). However, lack of water infrastructure (89.2%) and inability to pay the water bond (7.5%) were the reasons attributed to low rates of running tap water in the lower region. Figure 5 also indicates that the lack of access to three days/week of running tap water was largely due to lack of water infrastructure (96.1%).

Other sources of water

The results on other sources of water apart from piped water in all the regions of the Mthatha River catchment are indicated in Table 2. The analysis shows that approximately 28% of the households surveyed in the upper region relied mainly on dams as water source in the absence of tap water, followed by spring water (10%). However, households in the township/peri-township region relied mainly on municipality trucks (53%) for water supply, followed by rainfall water harvesting (6%). In the lower and coastal regions, 51% and 74% of the households relied on rivers as the main source of water respectively.

Minimum daily required 25 litres/person

The responses from the interviewed households on access to the minimum daily required 25 litres/person are illustrated in Figure 2. Comparatively, 76% of the surveyed households in the township/peri-township region, 74% in the upper region, 61% in the lower region and 52% in the coastal section believed they had enough water to satisfy the daily requirement of 25 litres/person. However, as illustrated in the figure 2, with the exception of those who lived in the township or close to an urban region, most of the sources of water were not clean sources.

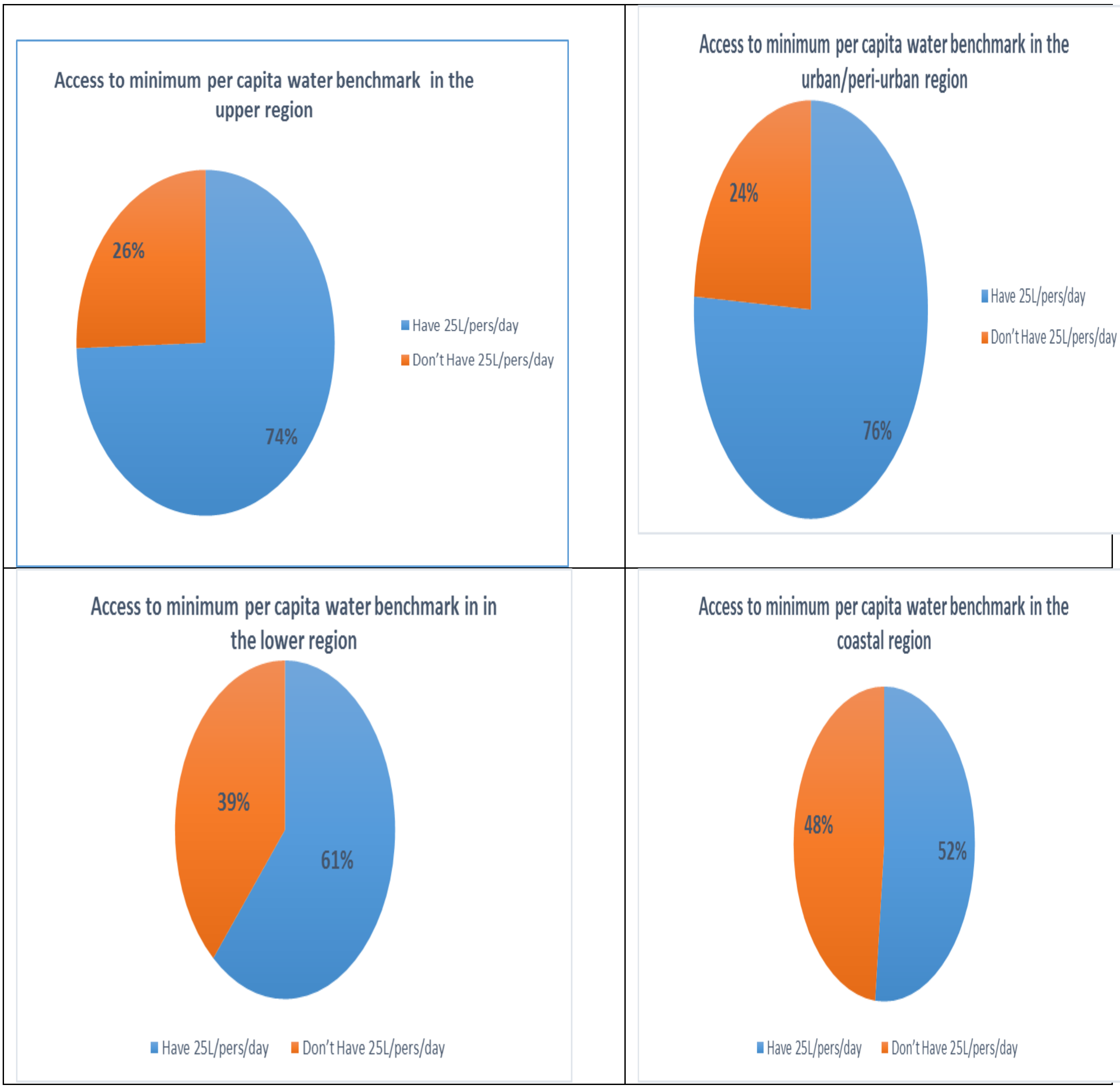

Figure 2: Access to the minimum daily 25 litres/person in the Mthatha catchment

The determinants of accessing the minimum daily required water (25 litres/person/day)

The results of the inferential analysis through the binary logistic regression model are illustrated in Table 3. The logistic model was estimated through the maximum likelihood procedure with SPSS version 20. The model's iteration was completed at -2log likelihood of 497.24 and a chi-square of 45.75 significant at 1%. The overall accuracy of the logistic model was 68.7%. The coefficients are expressed in the logarithm of the probability of whether the measured determinants have an effect on the households having access to the required daily minimum of 25 litres/person envisaged in the NWPR (2013). In interpreting the impact of other sources of water on securing the minimum of 25 litres per day, in-house piped water was used as reference point in the logistic modelling. Similarly, to determine the effect of the region, township/peri-township was used as the reference point. The Wald statistic shows the contribution of each of the factors in determining access to the minimum daily 25 litres/person by the households.

Information from the Wald statistic illustrated in Table 3 shows that among other determinants, distance to the public tap [6.033], household size [4.005] and region (upper region [2.906] and coastal [2.323] had major influences on access to the required daily minimum water amount in the Mthatha catchment of the OR Tambo District Municipality. However, there was a mixed impact of other sources of water. While water sources such as dams, rivers and getting water from municipality trucks had negative impacts on the probability of households in the Mthatha River catchment securing the minimum required water per day, other sources such as spring and rainwater harvesting showed a positive impact. It was also deduced from the study that the regions (locations) had a positive impact on securing the minimum required water per day.

In examining the coefficients, the results of the logistic model show that daily access to water [-0.367] was significant. This indicates that there is the likelihood that households with no access to water daily are water-insecure (do not have access to the required minimum water). Although lack of clean piped water in the house has the probability to increase water insecurity in the Mthatha River catchment, it was not significant, as the coefficient [-0.311] shows that it has less impact compared with the effect of the household size [-0.006].

The surveyed households with a large household size in the Mthatha River catchment were likely to not have access to the minimum of 25 litres/person daily. The result from the modelling showed that household size is a significant determinant of minimum clean water access. The results of the logistic modelling further reveal that the households that travelled more than 200 metres to get clean water in the catchment had the likelihood to be water-insecure. As stated earlier, the distance to an available public tap was the most important and significant determinant of water security in the Mthatha River catchment.

On the impact of other sources of water on minimum water security (Table 3), the coefficients (in brackets) clearly show that surveyed households that depended on dams [-0.038], the river [-0.228] and water from municipality trucks [-0.483] as sources of water were likely to be water-insecure, with the most impact associated with sourcing water from the municipality truck, although they were not statistically significant. Similarly, spring water [0.323] and rainwater harvesting [0.432] had positive impacts. The implication of this is that the surveyed households that depended on spring water and rainwater harvesting were likely to be more water-secure in the catchment. Furthermore, the results in Table 3 show that all the other regions (upper, lower and coastal regions) in relation to township/peri-township had a positive link to water security. From this information, we deduced that the problem of water insecurity is not solely because of the location of these regions in the catchment, but also because of the provision of equitable water infrastructure and effective water management systems.

The Exp (β) scores in Table 3 provide information on the impact of all the determinants of water access (security) in the Mthatha River catchment, most importantly, those factors that had a positive likelihood to improve water security. The Exp (β) score for spring water was 1.482. This implies that increasing the surveyed households' access to spring water by one unit had the probability of improving water security by 38%. Similarly, the Exp (β) for rainwater harvesting through the logistic modelling was 1.541. This implies that increasing water harvesting innovation by one unit has the probability to increase the water security situation in the Mthatha River catchment by 54%. The location factor (upper, lower and coastal) shows impacts of 126% (upper region), 54% (lower region) and 57% (coastal region) improvement in water security in these regions if water infrastructure and management can be provided in these regions.

Table *3*: The determinants of access to the required minimum of 25 litres/person/day domestic water

Variable	β	Standard error	Wald	difference	significance	Exp (β)
Daily water access	-0.367	0.217	2.856	1	0.091*	0.693
Pipe in house	-0.311	.405	.591	1	0.442	0.733
Household size	-0.063	.031	4.005	1	0.045**	0.939
Distance to public tap	-0.630	.256	6.033	1	0.014**	.533
Dam as water source	-0.038	.999	.001	1	0.969	.962
River as water source	-0.228	1.044	.048	1	0.827	.796
Spring water (Spring)	0.323	1.051	.095	1	0.758	1.382
Municipality truck	-0.483	1.045	.214	1	0.644	.617
Rain water harvesting	0.432	.998	.188	1	0.665	1.541
Upper region	0.819	.480	2.906	1	0.088*	2.268

Lower region	0.368	.578	.405	1	0.525	1.445
Coastal region	0.452	.297	2.323	1	0.127	1.572
Constant	2.449	1.459	2.817	1	0.093*	11.577

Discussion

The information generated through both descriptive and inferential analysis indicated significant knowledge of water security and challenges in ensuring the practicality of implementation of developmental water access suggested in South Africa's National Water policy. While the majority of the households surveyed said they had daily access to water, further analysis showed that the majority of them did not have access to clean water from a tap. The implication of this is, while there may be water satisfaction in terms of quantity, water quality is compromised, further suggesting the vulnerability of people to waterborne diseases. A similar study by Satterthwaite (2003) found that poor-quality water or inadequacies in providing piped water could lead to the outbreak of waterborne diseases such yellow fever and insect-borne diseases such as malaria.

The results also explicitly show that efficient distribution of clean water is skewed towards the township/peri-township region or the regions close to the urban centre where the headquarters of the local government is located. Our findings on inefficient water management to the detriment of poor and rural people are supported by a prior study by Rietveld et al. (2009), which reported that the issues of water management were paramount to clean water access in rural South Africa. The findings underscore the need for more frequent and coordinated community-based evaluation of the requirements and the efficiency of water management bodies. A similar study by Zhang (2012) in rural China found that a community-level access to water approach helped to reduced adult illness by 11%.

The target of minimum three days per week of running tap water was duly achieved in the urban regions of the Mthatha River catchment. However, the experience was not the same for the surveyed households in the rural communities. The main reason for this was lack of water infrastructure. It is instructive to note that less than 10% of the people surveyed suggested water bond/bill payment was responsible for non-access to clean tap water. This study found that South African provision for rural water infrastructure is lagging behind the provision of infrastructure as enshrined in the National Water policy. The assertion that developing nations will need to make large investments in water management and infrastructure at all levels to ensure water security cannot be overemphasised. Apart from large investment, Grey and Sadoff (2007) suggest that greater attention must be paid to institutional development, environmental change and equitable sharing of benefits and costs. However, Jiménez and Pérez-Foguet (2010) in their study on challenges of water provision in Tanzania concluded that national policies and plans needed to change from an infrastructure to a service-delivery approach to ensure rural water security.

The inferential analysis showed that the household size of the interviewed respondents indicated significant negative effects on their access to the daily minimum required water security status in the Mthatha River catchment. In other words, any planning towards accessing minimum water security in rural South Africa must incorporate household demography in order not to overstretch water resources and infrastructure. Mberu and Ezeh (2017) highlight the importance role of population factor in achieving key development goals and intervention in African countries.

Furthermore, the fact that the majority of the surveyed households in the hinterland of the catchment had a low profile of household assets and depended on river water for their daily water does not only suggest the need for alternative sources for clean water, but also points to the fact that households in rural areas are exposed to waterborne diseases with attendant indirect costs of treating avoidable diseases. In a similar study, Omer, Bezruchka, Longhi, Kelly, Brown and Hagopian (2014) found that equitable redistribution of wealth and assets positively influences population health in Sudan. Sobsey et al. (2008) state that lack of access to safe water contributes significantly to the global burden of disease and death resulting from infectious diarrhoea and other enteric illnesses, as well as their sequelae and indirect health effects. Gamper-Rabindran, Khan and Timmins (2010) state that piped water intervention in Brazil helped in the reduction of infant mortality.

Conclusion

This paper explored the current situation of the daily minimum of 25 litres/person enshrined in the NWPR (2013) and highlighted the dynamics and the determinants of water security in the Mthatha River catchment. Both descriptive statistics and inferential analysis were conducted to illustrate the locational indicators of access to clean water in the four regions of the catchment and the logistic model was fitted to understand factors influencing access to the minimum required water by households in the Mthatha River catchment. The information generated through the analyses showed that there is a need to revisit the area factors, institutions and investment strategies embedded in the NWPR (2013) to ensure the envisaged water rights among South Africans, especially in rural areas.

First, dichotomous access to clean water between the urban and rural communities exists in the Mthatha catchment. This study found that lack of access to clean water among the households in the hinterland was not only because they lived in rural communities, but also because of a perception of rurality, which is sometimes viewed as people without choices and means. Hence, the provision of clean water should be seen as mainstreaming equity among rural communities. Second, most of the households without clean piped water in their homes had to walk distances more than the recommended 200 metres before getting clean water. The situation is sometimes aggravated in communities where there are dry public taps where the households have to keep on checking daily, resulting in time wastage and weariness. Third, the information generated through the analyses emphasises once again the need for more investment in the provision of water in the rural Eastern Cape. Many economic models of financing investment on water infrastructure have posited that people must be ready to pay more to improve their access to clean water. Without demeaning the efforts of national government regarding clean water access in South Africa to achieve its target of a daily minimum of 25 litres/person, most especially in rural communities, efforts in terms of water as service provision and efficient water management need to be improved. Finally, there seems to be uncoordinated community-based water management networks, as some of the water infrastructure systems are being vandalised by land miners, exposing the community to dire water security situations. We observed that only a bottom-up approach, according to which local community organisations are empowered to take ownership and monitor water infrastructure will be appropriate to improve water security in the regions of the Mthatha catchment.

Recommendation

The intention of the NWPR (2013) to improve access to daily clean water in South Africa has not been realised, particularly in rural communities. The assessment of the situation through the river catchment has further stressed the need for a coordinated approach to solve this vital development goal in a country with severe socio-economic problems such as South Africa. From various insights in this paper, we make the following policy and intervention recommendations.

First, water Acts or policy intervention towards providing clean water, especially among the rural poor, must consider equity not equality. Equity is usually understood as the degree of equality in the living conditions of people, particularly regarding income and wealth. The meaning of equity encapsulates ethical concepts and statistical dispersion, and encompasses both relative and absolute poverty. This will emphasise the notion of community-/village-based water provision by considering the best form of water investment and infrastructure provision.

Second, as the analysis showed that more than half of the people in the Mthatha River catchment depend on other sources such as rivers, spring water and rainwater harvesting, we recommend promotion of POU water filtration technologies such as ceramic and bio-sand household water filters and other ready-to-use household technologies towards the provision of clean water for rural people. These technologies should improve household water quality and in the process reduce waterborne diseases and death.

Third, many policy interventions have been planned through the top-bottom approach with no significant success. We recommend a community/village approach that lays emphasis on household size and population growth for the provision of clean water through available water resources for the people in the Mthatha River catchment.

Finally, the situation on the ground suggests the need for a hybrid consortium between private philanthropic individuals to tackle the issue of clean water provision and attainment of the daily minimum of 25 litres/person in the Mthatha River catchment. Most importantly, the provision of POU technologies in the villages that do not have piped water with no likelihood of getting it soon will be an effective solution.

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