J Soc Sci, 29(1): 73-79 (2011)
PRINT: ISSN 0971-8923 ONLINE: ISSN 2456-6756
DOI: 10.31901/24566756.2011/29.01.10

Access to Potable Drinking Water in the Wonderfonteinspruit Catchment

T. Marara[1], L. G. Palamuleni[1] and E. E. Ebenso[2]

[1]Department of Geography and Environmental Sciences, [2]Department of Chemistry P/Bag 2046, North West University, Mmabatho, South Africa, 2735

KEYWORDS Settlement Types. Water Sources. Water Management. Water Quality. Potable

ABSTRACT The Wonderfonteinspruit catchment has been extensively studied from various academic angles due to the pollution from mining activities. Though extensive, the existing research on the catchment has neglected the plight of informal settlements next to the river, which lack adequate potable drinking water. This study was aimed at identifying the water sources and uses for the informal and formal settlements, investigating the challenges in accessing potable drinking water, the health risks thereof and establishing community perceptions. Questionnaires were administered to residents from systematically selected four settlements in the catchment to determine their water sources and uses, issues of water quality and community perception, health risks and awareness. Results indicate various challenges of water access and quality across different settlement types. The study developed new measures of community perceptions regarding water management namely; the drinking water suitability index, and the municipality effectiveness index. These indices are useful in assessing the effectiveness in the implementation of institutional set-up for water resources management in the area and also because community perceptions are useful reflectors of water resource management goals.

INTRODUCTION

Water supply has a direct impact on the economic development of any country. This is because it has to support food production, manufacturing and various other water dependent societal supplies. The availability of water has a direct impact on the self-sufficiency of any economy and access to clean water is universally accepted as a precondition for economic and social development (Molden and Merrey 2002; Gilbert et al. 1997). One of the UN Millennium development goals is to reduce by half the proportion of people without sustainable access to safe drinking water by 2015. Water scarcity and quality problems involve complex, technological, societal, cultural, economical and political dimensions. Globally, 1.1 billion people lack access to safe drinking water and approximately 2 to 4 million deaths a year are attributed to unsafe drinking water. In particular, only 22-34 percent of the population in sub-Saharan Africa has access to adequate safe water. Poverty stricken communities in developing countries in Africa face the problem of lack of access to potable water supplies. In these countries, there is a heavy reliance on river, stream, well and pond water sources to meet their daily water needs (Nevondo and Cloete 1999).

By 1994, the South African government had committed to ensuring provision of at least 25*l*/capita/day of clean water. However, this placed unsustainable demand on financial resources of local government. This is due to the dilemma characteristic of providing basic services to informal communities that are unable to pay for the maintenance costs of those services, yet local government budgets rely on such funds. Thus, Nevondo and Cloete (1999) indicated that efforts to ensure access to potable water supply by rural residents in South Africa have been fraught with financial and human resource constraints, making it unlikely that high quality water will be made available to the bulk of rural residents in the near future.

The Wonderfonteinspruit catchment (hereafter referred to as WFS) harbours significant thousands of informal settlers who have migrated in pursuit of better economic opportunities like mining, small-scale agriculture and other related economic opportunities. These informal settlements are located next to the WFS River and there has been speculation that, since they lack potable drinking water (piped water), they rely on the WFS for their domestic consumption and personal hygiene. From studies done in the catchment (Coetzee 1998; Winde 2000, 2002, 2004), there is sufficient evidence that the WFS is contaminated with above – average radionuclide concentrations posing health risks to those who use the water for drinking. Ingestion of drinking water containing significant amounts of trace and heavy metals is a topical issue and the effects thereof are well documented. The effects vary from edema, gastrointestinal, muscular, reproductive, neurological and genetic malfunctions amongst many others.

Nonetheless, humans are increasingly becoming aware of the complexity of the nature of delicate balance that exists within the global ecosystem (Ahmet et al. 2006). Peoples' perceptions indicate the resources management goals as well as their willingness to participate in related programmes. It is the peoples' growing environmental conscientiousness as well as the health risks arising from heavy metal contaminated drinking water that this study seeks to identify the drinking water sources and uses, the various community perceptions regarding issues of water supply and quality, the problems and the health risks arising thereof.

METHODOLOGY

Figure 1 shows the WFS, which lies between the upper North west and Gauteng provinces in South Africa. The main river, Wonder fonteinspruit runs 90km through several townships including Krugersdop, Westonaria, Oberholzer and Potchefstroom. Four settlements were systematically selected to be representative of the whole catchment in the upper and lower sections; namely Kagiso, Khutsong, Bekkersdal and Carletonville. These settlements were each further sub divided into formal and informal settlements. Following systematic sampling technique, 160 semi- structured questionnaires were administered to households in the catchment. In each town, 40 questionnaires were administered with 20 in the informal and 20 in the formal settlements. Furthermore, municipality authorities were interviewed using semi-structured questionnaires to determine the level of implementation of water resources management, and the challenges thereof. Information from questionnaires and interviews was gathered, captured, transformed and analyzed using Statistical Package for Social Scientists (SPSS) package version PASW (Predictive Analytics Software) 18.0. Frequency tables were drawn and further cross tabulations used to describe and estimate the relationships between the variables.

RESULTS

Figure 2 shows that 98 to 100 percent of the respondents in Khutsong, Kagiso and Bekkersdal and approximately 47 percent of the respondents in Carletonville use tap water as their main source of water.

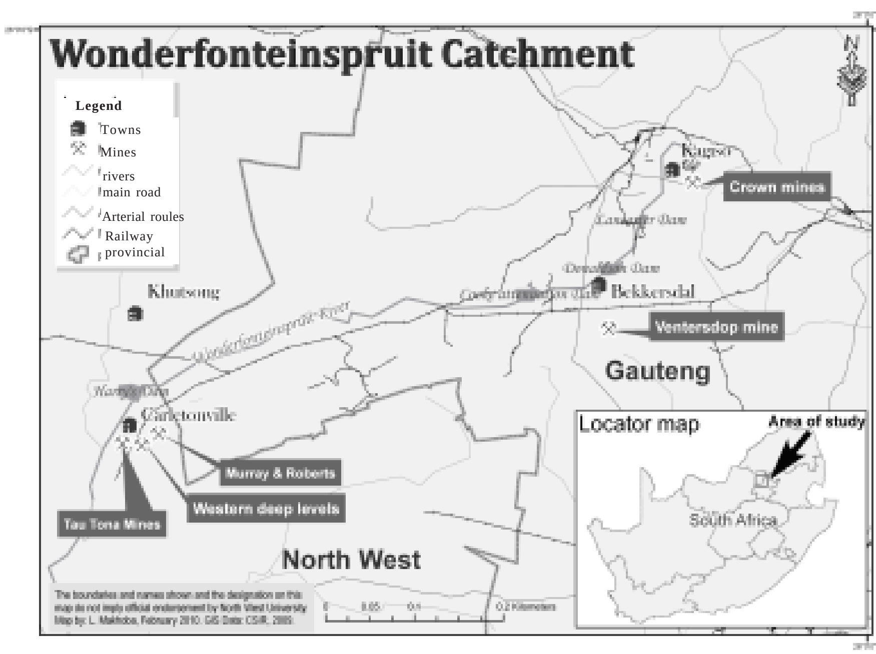

Fig. 1. The WFS catchment, South Africa

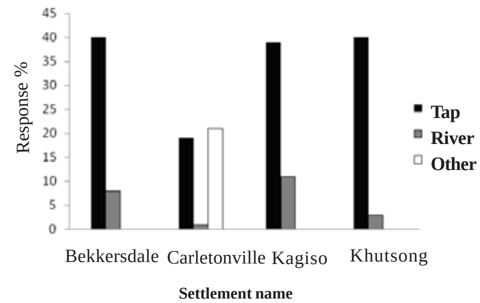

Fig. 2. The main water sources in the WFS catchment

From observations and informal interviews, most of the residents in informal communities do not have access to tap water in their yards except for some sections in Carletonville and Bekkersdal which have Jojo (high capacity metric tanks) and communal standpipes respec-tively. These findings are similar to the study results from Bloemfontein (Pretorius and De Villiers 2002) where a majority of respondents from informal settlements indicated that they had access to water and yet none of them had water delivered to their dwellings. In contrast, 14 percent of the respon-dents stated that the river was their main source of water for domestic consumption. The highest proportion of river use was reported from Kagiso (6.9 percent), Bekkersdal (5 percent) and Khutsong (1.9 percent).

Domestic uses for tap water vary from drinking, cooking, bathing and laundry. The uses for tap water vary across settlements with accessibility. For example, 98.8 percent of the respondents in the formal settlements use tap water for all their domestic consumption purposes including drinking, cooking, bathing and laundry compared to 71.3 percent in the informal settlements. The study revealed that 26.3 percent of the respondents from informal settlements do not have tap water available to them for use or they have inadequate supplies (1.7 percent). As such, tap water is only used for drinking and cooking. This may be due to the formal settlements having access to tap water compared to the socio-economically disadvan-taged informal settlements that have to manage the little they have and augment with alternative sources.

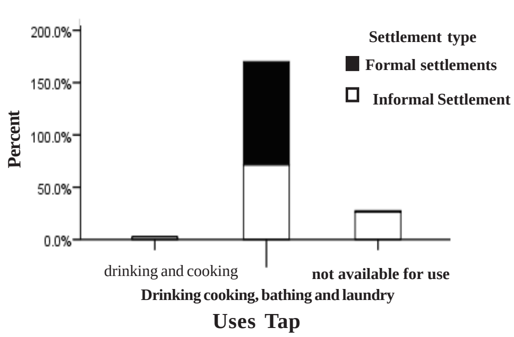

Fig. 3. Different domestic uses for tap water in WFS catchment by settlement type

The distribution of respondents based on the use of the Wonderfonteinspruit River as their source of water as shown in Figure 3 indicate that 20 percent of the informal residents use that water for other purposes (ritual, recreational, watering livestock and gardens). The results indicated that 4 percent of the respondents use river water is their main source of domestic water supply while

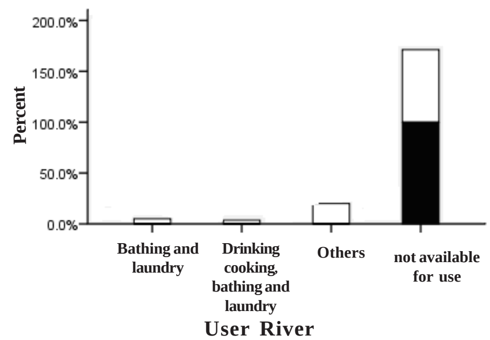

Fig. 4. Domestic uses of the WES

From Table 1 the highest occurrence of water shortage is in informal settlements with 72 percent compared to 28 percent in formal settlements. This is attributed to lack of tap water and communal water points within the informal settlements especially Khutsong and Kagiso. In addition, in Carletonville contribution to water shortage arise from the delay by municipalities in filling the Jojo tanks. It is also important to note that during the time of the survey, the Merafong municipality was having a crisis in Khutsong formal settlement where residents had gone without water for weeks and water had to be delivered by water trucks. Formal settlements experience water shortages but theseverity is less relative to informal settlements. During the water shortages, communities augment their water with a number of alternatives as illustrated in Figure 5.

Table 1: Cross tabulation of water shortages relative to settlement type

			Settlement type		Total
			Informal settlements	*Formal settlements*	
Water shortages	Yes	Count	59	23	82
		% within Water shortages	72.0%	28.0%	100.0%
		% within Settlement type	73.8%	28.8%	51.3%
		% of Total	36.9%	14.4%	51.3%
	No	Count	21	57	78
		% within Water shortages	26.9%	73.1%	100.0%
		% within Settlement type	26.3%	71.3%	48.8%
		% of Total	13.1%	35.6%	48.8%
	Total	Count	80	80	160
		% within Water shortages	50.0%	50.0%	100.0%
		% within Settlement type	100.0%	100.0%	100.0%
		% of Total	50.0%	50.0%	100.0%

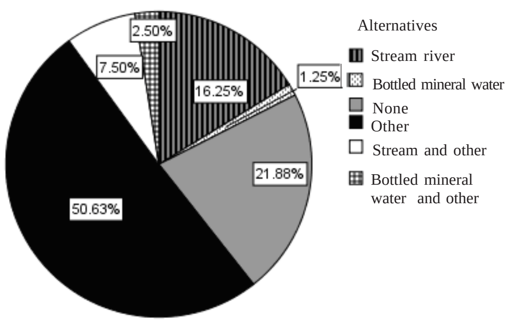

Fig. 5. Alternative sources of water in the WFS

The most common alternative is the river which recorded 16.5 percent and additional 7.5 percent of the residents supplement river water with other alternatives. A significant 50.63 percent have no alternatives at all, while 21 percent resort to other alternatives like buying from trucks and waiting for water to be pumped in the case of formal settlements. It is interesting to note that except for the river, all the other alternatives require some form of payment. Alternatives vary with type of settlement. All the people who use the river as their alternative are from informal settlements (23.8 percent). This may be attributed to the disregard of these informal settlements are by municipalities since their dwellings are considered to be illegal, thus they lack piped water systems.12.5 percent of residents with no alternatives are formal residents, the possible explanation for that is the characteristic less frequent water shortages and short-lived. On the contrary, informal residents who do not have alternatives it is because they cannot afford to pay (Fig. 6).

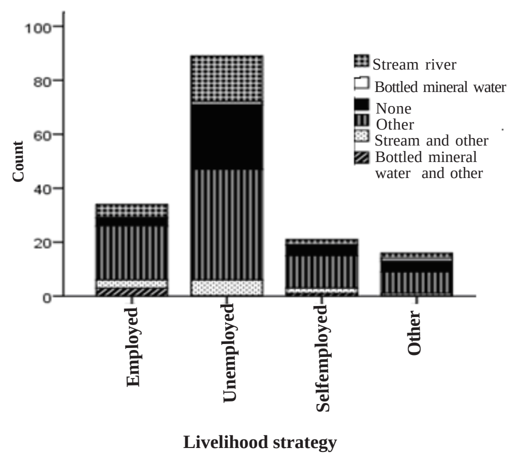

Fig. 6. Alternative water sources by livelihood strategy

In order to assess the economic characteristics of respondents, questions were asked regarding the respondents' occupation. It was however not based on how much they get from their occupation but on the assumption that some sort of activity brings income to the household and enables them to afford potable water. It should be mentioned that the employment category (especially in the informal settlement) is not "white collar" job but rather unskilled and semi-skilled employment which include activities such as laborers in the mines, vendors and hawkers. As such, livelihood strategy to some extent also determines the alternative water source. The results indicated that the highest proportion of river use (10.6 percent) constituted unemployed residents; the same applies to those who had no alternatives, the unemployed constituting 15 percent. This could be accounted for by the inability to pay for the expensive alternatives by these unemployed residents.

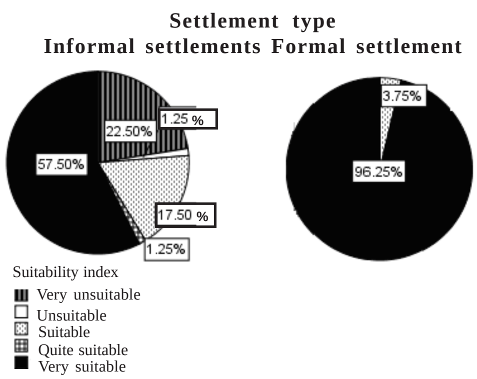

Fig. 7. Suitability Index for domestic water use by settlement

To determine the community perception on suitability of water for domestic consumption for all the domestic uses of water, residents were asked if they thought the water was suitable for, drinking, cooking, bathing and laundry. A suitability index ranging from 0 to 4 (very unsuitable to very suitable) based on the composite responses was devised. Figure 7 presents the suitability index for domestic water use by settlement. Results show that the suitability index varies with settlement type. At least 98.75 percent in the formal settlements perceived that the water was very suitable for all the domestic uses compared to 61.25 percent in informal settlements. This could be attributed to the formal settlements having access to municipal water that they assume is clean and the bulk of the informal settlements which access tap water from the formal settlements. Only 17.5 percent in informal settlements perceive the water to be unsuitable since they have to use water from the river for all domestic purposes. The respondents comprise of residents from Khutsong and Carletonville. Of much interest to note were the responses from some residents (9 percent) in the informal settlement who indicated that the river water they were using was suitable for all domestic purposes because they had been using it for a while with no visible health effects.

An effectiveness index is a quantitative measure of perception regarding the sufficiency and adequacy of municipal intervention methods during periods of water scarcity and events of poor water quality. This is a functional tool for determining municipal programmes on water demand management as well as integrated water resources management. In addition, 60 percent of the respondents perceive the intervention as very effective and this constituted 41.9 percent who had no problems of water shortages and 53.1 percent who had no problems of water quality (Table 2). In contrast, 36.2 percent felt that municipal efforts were ineffective, and they largely comprised those with problems of water shortages 30.6 percent as well as water quality 22.5 percent.

Table 2: Effectiveness index – water shortage and water quality

Variable	*Response*	*Effectiveness Index*		
		Ineffective (%)	*Effective (%)*	*Very effective (%)*
Water shortage	Yes	30.6	2.5	18.1
	No	5.6	1.3	41.9
Water quality	Yes	22.5	1.3	6.9
	No	13.8	2.5	53.1

To further explore if there existed a relationship between perception on effectiveness of municipal efforts and the existence of water quality problems, a statistical analysis was done using Pearson's Chi-square test. Results from the Pearson's Chi-squared test identified an association between the perception on effectiveness of municipal intervention and the existence of water quality problems. Another association was also found between effectiveness of municipal intervention and the occurrences of water shortages. From these results it can be concluded that, communities' perception on effectiveness is determined by availability of water as well as the quality of the water. Wherein for example the more available the water the higher the perception on effectiveness.

DISCUSSION

The results from the study reiterate the notion that local authorities are still struggling to manage their water resources (DWAF 1998). The informal settlements have been marginalized in terms of priority lists, of service provision. Hence, they lack a piped water systems as well as communal water outlets. Although informal settlements have become an inescapable part of South Africa (Ashton and Bhagwan 2001), they continue to be affected by a form of discrimination with disregard to water and sanitation provision. The informal settlements are thus forced to resort to the use of river water as an alternative.

The use of river water for domestic consumption purposes, in particular the WFS, has grave repercussions for the health of these informal residents. The WFS catchment is at the centre of numerous environmental reports regarding acid mine drainage contamination of the stream. The research findings indicate that, there are above average concentrations of radionuclide and heavy metals in the WFS (Winde 2000, 2002; Winde and Van der Walt 2004 and Coetzee 2006). Winde (2000) reported on the 30x enrichment factors of Uranium that pose a double threat from its radiological and chemical toxicity especially through ingestion.

Research in the area of human health has shown that the main threats to human health from heavy metals are associated with exposure to lead, cadmium, mercury and arsenic Järup (2003). A continuum of effects, varying from shortness of breath to different types of cancers may occur, in the event of ingestion of drinking water containing significant amounts of trace metals (Cantor 1997; Calderon 2000; Xia and Liu 2004; Dogan et al. 2005). In a local study, a significant correlation was observed between Uranium concentrations in groundwater samples and heamatological abnormalities amongst residents of the respective area (Toens et al. 1998). This condemns especially the informal residents who rely on river water for their drinking purpose at risk of contracting the above mentioned conditions.

CONCLUSION

Informal settlements struggle to access adequate potable water. Findings revealed that there is significant use of river water from the WFS for domestic consumption, either as an alternative or a main water source .This implies serious health problems for the Wonderfonteinspruit informal communities. Due to these problems of water shortages and poor water quality, communities have lost confidence in the local government, which might deter them from getting involved in water resources management programmes. These findings not only provide a baseline for a long term epidemiological survey to assess health impacts arising from mining activities in the catchment but also suggest policy implications in the area of water resources management, service delivery and waste management in particular the operational aspect of the water institution.

ACKNOWLEDGEMENTS

The authors would like to thank the North West University Institute of Research, the Department of Geography and Environmental Sciences and the NRF for the financial support of this research study.

NOTES

The informal settlements in this study refer to dense settlements comprising communities housed in self-constructed shelters under conditions of informal or traditional land tenure (Opperman 2008). The informal settlements in the scope of the study are those that lie in the selected towns and are in close proximity to the river.

Jojo Tanks: These are communal water tanks placed by the municipality for the benefit of informal settlements to access water which can be refilled from time to time

REFERENCES

Ahmet D, Fevzi YA, Tuna L, Nedim O 2006. Heavy metals in water, sediment and tissues of Leuciscus cephalus from a stream in southwestern Turkey. *Chemosphere*, 63: 1451–1458.

Ashton PJ, Bhagwan JN 2001. Appropriate management of urban runoff in South Africa; integrated report. *Report No.TT155/01*. Pretoria: Water research Commission.

Calderon RS, Barwick MS, Levy DA, Gunther F, Craun M, Beach JM Rebecca L 2000. Surveillance for waterborne-disease outbreaks. United States, 1997-1998 *Surveillance Summaries,* 49(4): 1-36.

Cantor KP 1997. Drinking Water and Cancer. *Cancer Causes Control,* 8: 292–308

Coetzee H 2006. An assessment of Sources, Pathways, Mechanisms and Risks of Current and Potential future pollution of Water and Sediments in Gold mining areas of the Wonderfonteinspruit catchment report to the water research commission compiled by, Council for Geoscience, *WRC REPORT No.1214/1/06*.

Dogan M, Dogan AU, Celebi C, Baris YI 2005. Geogenic arsenic and a survey of skin lesions in the Emet region of Kutahya, Turkey. *Indoor Built Environment*, 14: 533–536.

DWAF (Department of Water Affairs and Forestry) 1998. Development of a strategy for managing water quality effects from dense settlements: Draft Document Pretoria

Gilbert L, Selokow TA, Walker E 1997. *Society, Health and Disease. An introductory Reader for Health Professionals.* Pretoria: Sigma Press.

Järup L 2003. Hazards of heavy metal contamination. *British Medical Bulletin*, 68: 167-182.

Molden D, Merrey D 2002. Managing Water from Farmers' Fields to River Basins: Implications of Scale. In: A Turton, A Henwood (Eds.): *Hydropolitics in the Developing World. A Southern African Perspective.* Pretoria: AWIRU, University of Pretoria, pp. 141-155.

Nevondo TS, Cloete TE 1999. Bacterial and chemical quality of water supply in the Dertig village settlement. *Water SA,* 25(2): 215-220.

Opperman I 2008. *The Remediation of Surface Water Contamination in the Wonderfonteinspruit.* Master of Science Thesis, University of South Africa (UNISA) Johannesburg South Africa.

Toens PD, Stadler W, Wullschlege NJ 1998. The association of groundwater chemistry and geology with typical lymphocytes (as biological indicator) in the Poffadder area, North Western Cape, South Africa. *WRC report 839/1/98.*

Winde F 2000. Fluviale Prozesse and Uratransport-Beispiele ausder Wismutregion ostthuringens and Goldbergbaugebieten Sudaafrikas. In: H Baumhauer, B Schutt (Eds.): *Geomorphologie und Umweltgeschichte. Jahrestagung des Abeitskreisess Geomorphologie in trier* (Germany), (4-8)10 /2000. Tagungsband, 41-42. Wismut Germany

Winde F, De Villiers AB 2002. Uranium contamination of streams by tailings dams – case studies in the Witwatersrand gold mining area (South Africa). In: BJ Merkel, B Planer-Friedrich, C Wolkersdorfer (Eds.): *Uranium in the Aquatic Environment.* Berlin, Heidelberg, Springer Berlin, pp. 889-897.

Winde F, Van der Walt JI 2004. The significance of groundwater-stream interactions and fluctuating stream chemistry on waterborne uranium contamination of streams-a case study from a gold mining site in South Africa. *Journal of Hydrology*, 287(1-4): 178-196.

Xia Y, Liu J 2004. An overview of chronic arsenism via drinking water in PR China. *Toxicology*, 198: 25–29.