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Water Quality Assessment of Various Sources in Rural Areas in the Lowveld Region of Swaziland

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Abstract: This study assesses water quality levels of sources used by rural communities in the lowveld region of Swaziland. The water quality assessments are based on household perceptions about water quality and laboratory water quality analyses which were carried out on selected water quality parameters. A total of 180 household heads were interviewed and in addition water samples from 13 locations were analysed. The parameters considered were physical factors including pH, colour, taste and odour. Results of pH tests indicated that 23.1% of the water sources were acidic, 7.7% were neutral and 69.2% were alkaline. Water collected from the unprotected wells tested acidic, had a pH of 5.96, implying that it is corrosive and might present health risks to humans and livestock. Sources with highly alkaline water were the borehole, spring, hot spring standpipes, and rivers. Survey findings show that colour, taste, smell and turbidity are the quality parameters mostly used by rural households to determine water suitability for domestic use. Most ground water sources were found to have saline water due to low ground water recharge in the area. Water quality remains a sustainable development challenge in the rural areas of Swaziland.

Key words: Domestic water, Swaziland, turbidity, water quality

INTRODUCTION

Pollution of water sources in rural areas remains a challenge in many developing countries (Mwendera, 2006; Zhu *et al*., 2004; Sadeghi *et al*., 2007; Traichaiyaporn and Chitmanat, 2008). Ground water sources found in rural areas include rivers, springs, deep wells, shallow wells and boreholes. Despite all the efforts made to develop rural water supplies, many African countries are finding it difficult to achieve the Millennium Development Goal of reducing by half the number of people without access to clean water by 2050. Water pollution in Southern Africa is attributable to poor management of the resource and lack of enforcement of national water pollution legislation (SADC/IUCN/ SARDC, 1996). As a result, drinking water in rural areas is not always free from objectionable taste, odour, turbidity and other known pollutants (Machena, 1997; De Zuane, 1990; Gray, 1994). In Swaziland, the Water Act of 2003 is the legal framework for utilising and managing water resources. Also, in Swaziland, the Draft National Water Policy of 2001 states that all people are entitled to a minimum of 30 L of safe and clean water/capita/ day from sources not exceeding 200 metres from homesteads (Government of Swaziland, 2009). The aim of this study was to assess water quality levels of various sources used by households in rural communal areas of Swaziland using Siphofaneni Inkhundla (administrative area) as a case study.

MATERIALS AND METHODS

Primary data for this study were collected using two approaches. A household survey was conducted between November 2010 and January 2011, also a laboratory analysis of water samples from the main sources of domestic water in the area was undertaken. The target population was all the households in four chiefdoms in Siphofaneni inkhundla (administrative area), namely Mkhweli chiefdom (268), Vikizijula (188), Maphilingo (594) and Madlenya (745). A list of households in the four chiefdoms was obtained from the Rural Development Area office at Siphofaneni. Using a survey research design a total of 180 household heads (i.e., 10% of the target population) were interviewed and this was complemented by guided direct observation. Names of repetion the household heads were captured on excel spreadsheet and those for inclusion in the sample were obtained according to the random numbers generated by Excel formula. Stratified sampling was the method

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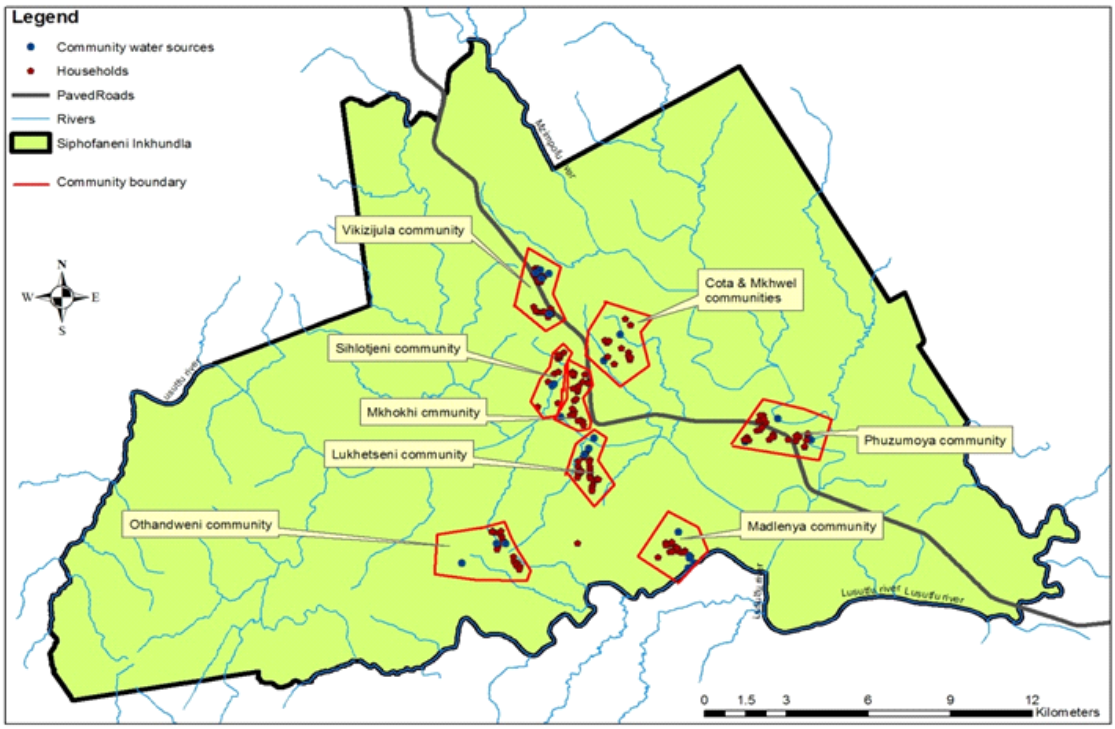

Fig. 1: Map of Siphofaneni area showing the sampled households and their domestic water sources

employed in this study whereby households were sampled from each of the four chiefdoms on the basis of population proportionality and this was done to ensure adequate representation. The simple random sampling procedure was used to determine the household heads who were interviewed in the eight communities within the four chiefdoms (Fig. 1). Numerical values were allocated to each homestead and then randomly selected to be part of the sample. The questionnaire was pilot tested to ascertain its validity and adequacy of the sampling variability within the population to be surveyed.

To assess the water from the sources of water studied for quality, water samples were collected from 13 locations in Siphofaneni using sterilised glass bottles and transported to the laboratory in a cold box for analysis. The sampling locations were as follows: Madlenya borehole (S1); Duze unprotected well (S2); Lukhetseni spring (S3); Mshumpula stream (S4); Othandweni standpipe (S5); Lukhetseni hot spring (S6); Cota earth dam (S7); Phuzumola standpipe (S8); Sihlotjeni unprotected well (S9); Mtimpofu stream (S11); Mhlatuze river (S12); and Duze standpipe (S13). The parameters that were considered were physical factors like pH, colour, taste and odour. Most of the chemical and biological quality measures were neglected because the study discovered that they had nothing to do with the water collecting behaviour of rural households. As a result when respondents were asked about the quality of the water they used, only physical factors were mentioned and this indicated that to rural households, the quality parameters that matter the most in shaping water demand are the physical factors.

RESULTS AND DISCUSSION

The study discovered that 35.4% of the households in the study area relied on rivers as their main source of domestic water; 20.8% used communal standpipes; 12.8% used wells; 10.1% depended on private standpipes; 2.8% used boreholes and rainwater; and 6.7 and 0.7% used earth dams and springs, respectively. Only 35.6% of the respondents indicated that they used protected water sources that are surrounded by either thorny bushes, or fenced with wire. Reasons given for having most of the sources unprotected included that these sources are communally used and hard to protect because nobody takes the responsibility since everyone thinks it is everybody else's responsibility.

Figure 2 highlights the main challenges related to the water sources used for domestic purposes. Generally, households showed informed views about water quality issues in the area, with 40% expressing various concerns. The multiple response analysis indicated that the most cited challenges were the long distances (in some cases exceeding 2 km) of the water sources from the homesteads with 19.5% household heads reporting that the water sources are far away from the homesteads while 17.3% reported that water pollution was their major

Table 1: Quality of water from various sources

Sample	Water source	pH	Colour	Taste	Smell	Uses
S1 Madlenya	Borehole	8.72	Clear	Saline	No smell	Drinking, cooking and bathing
S2 Duze	Unprotected well	6.78	Dark	Bitter	Bad odour	Drinking, cooking, washing clothes, bathing and animal drinking
S3 Lukhetseni	Spring	9.13	Clear	tasteless	Bad odour	Washing dishes, washing clothes and bathing
S4 Mshumpula	Stream	7.03	Clear	Slightly saline	Bad odour	Washing, drinking, cooking, bathing, watering vegetables and animal drinking
S5 Othandweni	Standpipe	7.23	Clear	Saline	No smell	Bathing, washing, cooking and drinking
S6 Lukhetseni	Hot spring	8.98	Whitish	Saline	Bad odour	Washing and bathing
S7 Cota	Earth dam	7.22	Dark green	Sour	Bad odour	Drinking, cooking, bathing and washing
S8 Phuzumola	Standpipe	7.98	Clear	Saline	No smell	Drinking, cooking, washing and bathing
S9 Sihlotjeni	Unprotected well	5.96	Whitish	Saline	Bad odour	Drinking, cooking, washing, bathing, and cleaning houses
S10 Siphofaneni	River	7.38	Turbid	Normal	No smell	Drinking, cooking, washing clothes, bathing, animal drinking and watering vegetables
S11 Mtimpofu	Stream	7.00	Clear	Normal	Urine odour	Washing, drinking, cooking, bathing, watering vegetables and animal drinking
S12 Mhlatuze	River	7.84	Turbid	Normal	No smell	Animal drinking, washing, cooking, drinking, bathing, watering vegetables
S13 Duze	Stand pipe	6.50	Clear	Bitter	Chlorine smell	Drinking, cooking, washing, bathing, and cleaning houses

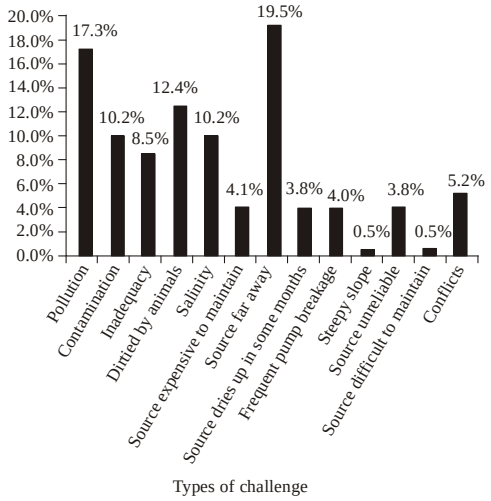

Fig. 2: Challenges associated with water sources

challenge. Worth noting is that 12.6% of the respondents stated that their main challenge was water contamination by lifestock while 10.2% were concerned about contamination of the sources by water collectors. As many as 10.1% reported water salinity as a major problem; 12.3% were concerned about the frequent drying up of water sources resulting in water shortages; 5.3% cited water conflicts; and 7.9% mentioned that they experienced frequent water pump breakages and periodic drying up of the sources, including water sources being difficult to maintain or the water sources being difficult to access due to poor location on steepy slopes. It was observed during the survey that some of the unprotected sources like the streams, rivers, wells, and hot springs were used *in situ* for livestock drinking, washing and bathing and generally have dirty water with bad odour. Also, households which relied on water from boreholes and community standpipes complained that it was salty and was not good for washing or bathing as it leaves white patches on clothes or bodies of users.

Respondents were asked how they ensured that the water from the sources was free from germs and other impurities. Only 25% of the households indicated that they treated the stored water using chemicals or by boiling it in order to decrease bacteriological health hazards. Also, the respondents were asked to state their views on how the government could help to improve the quality of water used for domestic use by the rural population. As many as 42% were of the opinion that government should drill communal boreholes fitted with pipes in order to ensure that the rural population has access to clean water.

As a follow up on the water quality survey of household perceptions about water quality a laboratory water quality analysis was undertaken on selected domestic water quality parameters. Results of water quality analyses are shown in Table 1. The pH was measured in order to establish whether the water was acidic and presented a threat to human health. A pH of lower than 7 indicates that the water is acidic while a value above 7 shows that it is alkaline. The normal range for surface water is a pH of 6.5-8.5 and for groundwater is 6-8.5 (Manahan, 2000; Pierce *et al*., 1998). The pH tests conducted for the selected water sources indicated that the area is characterised by a wide range of acidic and alkaline water sources. Water collected from the unprotected wells was acidic, dark, tasted bitter and had a bad odour (Table 1). The most striking acidic water source with a pH of 5.96 was Sihlotjeni well which serves Madlenya 1 and Mkhweli communities. This implies that the water is corrosive and might present some health risks to humans and animals. The communal standpipe at Mkhweli chiefdom, which supplies households at Phuzumoya with treated water, was found to be acidic, implying that the chlorine levels in the water are high. The Madlenya borehole, Lukhetseni springs, standpipes, and Othandweni and Phuzumola rivers had alkaline water (Table 1).

Table 2: Classification of the water sources according to their pH values

pH Range	No. of Sources	%	Type
5.96-6.78 (<7.00)	3	23.1	Acidic
7.00	1	7.7	Neutral/normal
7.03-9.13 (>7.00)	9	69.2	Alkaline

Colour, taste, smell and turbidity are the quality parameters mostly used by rural households to determine the water sources to be used. The study found that while some of the sources had clear water others had dark, dark green or whitish water. The Sihlotjeni unprotected well and the hot springs had water that was whitish in colour largely due to the presence of minerals in the soil and the soaps and detergents used when bathing or washing clothes in rivers. Cota earth dam and Duze unprotected well have dark green water because livestock drink from these sources and also because chemicals from the nearby dip tank easily get transmitted into the water. Water from the rivers was slightly turbid due to deposits of particulate matter and suspended sediment from eroded topsoil resulting from agricultural activities and occasional tropical rain storms. Large drop sizes are a common characteristic of tropical storms (LAL, 1985) and these contribute to erosion and the subsequent transportation of sediment in streams and rivers.

Table 2 depicts the pH types and ranges of the various water sources investigated. Three, (or 23.1%) were acidic, nine, (or 69.2%) were alkaline while only one, (7.7%) was neutral/normal. Hence, most of the sources have alkaline water except for the unprotected wells and the Phuzumoya standpipe which has treated water. The only source with normal/neutral water with respect to the pH-value was the Mshumpula stream which is seasonal. These levels are typical of tropical rivers as tropical soils have pH values ranging between 5.8-7.5 (Payne, 1986).

The taste of the water from the different sources varied from normal, saline to bitter. Most ground water tasted salty due to low rainfall and low ground water recharge in the lowveld region. The water at unprotected sources was mostly shared between human beings and livestock and it tasted slightly sour and had an unpleasant urine odour.

CONCLUSION

Improving the quality and quantity of water supplies remains a priority for rural development in many African countries. The study filled a research gap by contributing knowledge on quality of domestic water in rural areas of Swaziland. The results reveal that most households still use unprotected water sources for domestic purposes. The study concluded that the unprotected water sources are used due to lack of alternative good quality water sources. The quality of water obtained from these sources is poor but rural households continue to use these sources for different domestic purposes because of the absence of alternative improved sources. Most households in Swaziland still use the river because it is a source that provides water at no cost to households. Since water quality remains a major challenge in rural areas, the government should organise awareness campaigns in order to sensitise the rural people and enable them to realise the need to treat water from the natural sources by boiling it. In addition, the government should consider subsidising water treatment chemicals so as to enable more rural households to buy water treatment chemicals. Water quality remains a sustainable development challenge in the rural areas of Swaziland and a lot more has to be done in the area of water pollution management.

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