THE IMPORTANT ROLE OF SPRINGS IN SOUTH AFRICA'S RURAL WATER SUPPLY: THE CASE STUDY OF TWO RURAL COMMUNITIES IN SOUTH AFRICA

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Abstract

Groundwater is one of the most important natural resources globally. In Africa, particularly, groundwater has been the most reliable water supply option for meeting the daily water needs of rural communities. This is mainly due to the fact that most rural communities are geographically located in hard to reach areas due to their dispersed nature and bad terrain. In South Africa, these conditions have made it particularly expensive and difficult for water service providers to effect services to rural communities. It is estimated that there is still about two million people, mostly residing in rural communities, in South Africa without access to basic water services. Such communities have no option but to rely on hand-dug wells and springs for their daily water needs. It is further estimated that about 80% of South Africa's rural communities depend on groundwater sources for survival. Rural communities regard springs as a sustainable and reliable means of obtaining water compared to formal water supply from the relevant service providers. However, the challenge is that water service providers disregard springs and consider them insufficient for water service delivery. This situation often leaves communities to have to struggle to maintain these sources by themselves with no support from relevant authorities. Furthermore information on the use of springs is not documented; hence no data is available on the quantities of water being abstracted on a daily basis. In a water scarce country such as South Africa this is a serious concern which contributes to unmanaged and uncontrolled abstraction and/or dewatering of the aquifers. Consequently, boreholes, wetlands and springs are drying up, new sites are explored and the cycle continues. This lack of data means that incorrect data sets are being used and incorrect assumptions are being made about groundwater use and sustainability. In addressing this issue, South Africa's Groundwater strategy puts emphasis on measures to improve awareness and knowledge of the importance of and potential of groundwater resources. Increasing research and documenting case studies demonstrating the use and importance of groundwater in rural communities is therefore critical objective of this strategy. In addition to showcasing the use of springs, the study advocates for springs to be formally recognized and recorded as a formal water supply alternative especially for communities where springs are considered a significant resource. In this way spring water sources can be incorporated in the planning of water services such that formal support can be allocated to communities relying on springs. This will ensure that communities still consume water of acceptable quality which will help improve on health, reduce poverty rates and address water service backlogs. This study uses two rural communities in South Africa as case studies to document the use of springs; through mapping spring water sources, understanding the extent of the use as well as the importance of such sources. The study will also show that conducting regular mapping of water points, irrespective of the source can provide valuable source of information to water service providers in achieving the important goal of scaling-up water services and ensuring sustainability and ultimately improving water service backlogs. Such information will further improve the planning and design of rural water supply schemes in the rural areas especially where springs are a significant resource.

Keywords: Groundwater, rural communities, springs, water services, municipalities

1. Introduction

Groundwater is one of the most important natural resources globally [1] and especially for the developing countries around Africa. This is mostly attributed to by the fact that many rural communities are located in areas with bad terrain and often no significant surface water resources (such as major rivers and dams).It is thus estimated that about 70% of the 250 million in the Southern African region depend on groundwater as their primary source of water [2]. In these areas groundwater and its quality directly influences the wellbeing and quality of life. In most cases water service providers often find it particularly expensive to deliver services to rural communities because of the bad terrain and especially because these communities cannot afford to pay for services. Consequently many rural communities around Africa still face challenges with regards to accessing water services from their respective water service providers. Often these communities have no option but to rely on informal, traditionally developed groundwater sources such as hand-dug wells, springs and rivers ([3]. Furthermore, while water services providers disregard these sources during the planning process; communities often consider these sources as very important in meeting their daily water supply needs. Hence Macdonald (2006) [4] emphasises the importance of groundwater in meeting the dispersed nature of rural communities. It is therefore critical to explore and understand the potential contribution to the delivery of water services in the rural communities. For the Millennium development goals (MDGs) to be met, water services planning should take into consideration all available resources including springs which have the potential to make a contribution to the water service process. Furthermore water services providers should be well capacitated to be able to understand the concept of groundwater especially for communities where groundwater is a significant resource.

This paper seeks to showcase the significant role that groundwater, in the form of springs, play on the daily water needs of some of the rural communities in South Africa. This study will therefore not only provide an understanding of the importance of groundwater in addressing water service delivery challenges in the rural areas, but will also help show the effect that daily use of springs can have on the availability of groundwater currently and in the future.

1.1 Background

The South African Government has done a lot to facilitate the delivery of services especially to the hard to reach rural communities. A number of processes have been put in place to ensure that services are rendered and that rural communities have access to water of acceptable quality as per constitution. Despite these major strides however, statistics still show that more than three million people in South Africa still receive water services that do not meet Reconstruction and Development Programme (RDP) standards, while more than one million do not have any water service infrastructure at all [2]. Consequently DWA statistics suggests that almost 80% of rural communities in South Africa are groundwater dependent, and groundwater has been the only source of water supply. In recognition of its importance the DWA Groundwater strategic plan recommends that research need to be conducted on various aspects of groundwater (quality and quantity) to quantify the impact on groundwater and on the communities that are dependent on groundwater [5]

1.2 Groundwater legislative framework in South Africa

In South Africa groundwater is recognised as a common asset whose trusteeship lies with the state [5]. The National Water Act (Act 36 of 1998) mandates the Department of Water Affairs to ensure that all water resources are well managed and protected, developed and conserved “for the benefit of all persons” and in accordance with the constitution [6].

Furthermore, Water Services Act (Act 108 of 1997) obligates all water service authorities to ensure the provision of at least a basic level of water services (which is 25l per person per day) at no cost, to all communities within their jurisdiction. The act however clearly stipulates that this duty is subject to the availability of resources. In terms of fulfilling this function it is therefore critical that municipalities as Water service Authorities and providers (WSA/P) and or planners have access to data/information with regards to the quantity and quality of the available and exploitable water resources within their jurisdiction. The Priority area 3 (***Promoting rural development***) of the National Groundwater strategic plan (2010) [5] puts emphasis on recognising the importance of groundwater as an important resource especially for water supplies to rural areas in South Africa. It also focusses on the issues relating to understanding the link between groundwater and service delivery in the rural areas.

2. Problem statement

In South Africa many rural areas lack access to formal water services hence it is estimated that about 80% of rural villages rely entirely on groundwater for their domestic water use [5]. It is also often highlighted that water service provision through surface water is often difficult to facilitate since installing bulk pipelines to draw water for several kilometres is often expensive to implement. For small municipalities, this is especially difficult considering the fact that most rural communities cannot afford to pay for services and have to receive services at no cost. A number of studies therefore highlight the importance of considering the potential of groundwater in delivering water to communities [5], [7]. According to MacDonald (2000) [8] groundwater is a better and cheaper alternative for water supply in the rural communities since not much effort is required to ensure that water is safe for human consumption. Furthermore, water from springs is always available and often without digging or using expensive machinery which means water services delivery can be implemented cheaply without extensive pumping costs.

The main challenge in South Africa however, is that the role of groundwater is often underestimated. In most cases, water services planners are well aware of the potential of groundwater; however, they often disregard it and not incorporate it into their water plans [5]. Consequently, communities have been using these sources for decades without any monitoring programmes in place. Furthermore, not much information has been documented on the actual quantities of spring water used on a daily basis in rural communities.

The lack of data on the use of springs presents a challenge in that significant amounts of water are used on a daily basis but have not been quantified. This challenge also means that the nature of physical, chemical and biological quality of the waters consumed by communities is not known and quite importantly the health risks associated with the use of these sources for drinking is also not well understood [2]. Studies indicate that because of lack of sufficient research and data on groundwater use, incorrect data sets are being used and as a result incorrect assumptions are being made about groundwater use and sustainability [9]. Furthermore, proactive action cannot be in place in order to mitigate the vulnerability of groundwater or the supply problems when and where there are water shortages [5].

3. Purpose of the study

The purpose of the study is to demonstrate the significant contribution that springs make on the water supply of most of the rural communities in South Africa. Furthermore this study will act as a database of springs used as well as the quality and quantity of water produced from the springs in the two villages. This can be used as a way of keeping track of the amounts of groundwater used in these rural communities.

4. Material and Methods

The study is part of the CSIR funded project “Developing a decision support tool for the management and development of springs for rural water supply” to assist water service planners to collect data on the springs available and used by rural communities within heir jurisdiction. The study uses both the qualitative and quantitative approach to understand the use and the role of springs in the two rural communities in the Limpopo province.

Technical (including geo-hydrological and hydro-physical) assessments were conducted to understand the feasibility of the identified springs in providing water to the specified households. The hydrophysical measurements on the identified springs targeted the quantification of flow (discharge) rate and these measurements were carried out using an OTT C20 current meter with OTT Z400 signal counter set and impellor # 1-239627 (diam. = 125 mm, pitch = 0.25 m) mounted on a 20 mm diameter steel rod. Hydrochemical Measurements targeted the field water chemistry (quality) variables of temperature, electrical conductivity (EC), pH, Eh and oxidation reduction potential (ORP). The measurements were carried out using a Hanna model HI9828 multi-parameter probe Microbiological samples were sent for analysis to the nearest laboratory.

Interviews were also held with randomly selected households to understand the role springs play in the water supply of the selected communities' and especially on the selected households.

5. Results and discussion

5.1 Location and characteristics of the study sites

The two rural communities, mainly Vondo and the Meidingen community are both located in the Limpopo province (See Figure 1) about 200km apart. These areas were identified by their respective water services providers as communities that rely on springs for their daily water needs. The two selected villages are characterized by high rates of unemployment and poverty. More than 60% of households in these communities survive by means of social grants and some subsistence farming.

Meidingen is located on a hilly terrain on the outskirts of Kgapane Township in Greater Letaba Local Municipality about 45km from Tzaneen town and about 20km from Modjadjiskloof. Vondo village is located in the north western side of both Thohoyandou and Sibasa towns about 12 km from Thohoyandou and 10 km from Sibasa. The summary of the demographics of the two villages is shown in Table 1.

These two villages are identified in the Map (Figure 1)

Figure 1: Location of Vondo and Meidingen Villages in South Africa

Table 1: Summary of key demographics of the Vondo and Meidingen

Village Name	WSA/Provider	Population (households)	Average HH size
Vondo cluster	Vhembe	1118	6.3
Meidingen	Mopani	783	5.3

5.2 Characterisation of Vondo Village

5.2.1 Access to water services

The water infrastructure identified in Vondo includes; four boreholes, 700m^3 concrete reservoir, three plastic water storage tanks and street taps. However, assessments found that three of the boreholes were not operational and only one borehole was supplying water to the community made up of 1118 households. Households' interviews highlighted that while the one borehole is operational, it can only provide water to households at intervals mainly, twice or three times a week. The operator has to switch off/on the borehole to allow water to reticulate to another section of the village. 24-hour borehole pumping tests (Multirate) conducted on the four boreholes also showed that all boreholes except for one (currently working) have very poor yields and would not be a sustainable water supply option.

5.2.2 The use of springs

A total of six springs were identified in Vondo. On average it was found that each spring was serving more than 20 households on a daily basis. Whilst there are taps in the community, households collect water from springs on a daily basis. Communities in this area connect pipes at the spring source to allow the water to gravitate into their households or communal collection points for those who cannot afford to install their own pipes (See Figure 2. About 90% of the households interviewed thought springs were the most reliable and important source of water in the community. The flow measurement from the identified springs were recorded (during spring season), and recorded between 0.1L/s to 0.5L/s. These measurements indicate that the potential water storage in 24hrs from all the springs in Vondo would be approximately 40 m^3/day This amount of water can supply a population of 1400 people (about 200 households) at RDP level (i.e. 25l/p.d^{-1}). These figures indicate that there is room for springs in water service planning.

Figure 2: Pipes connected at the spring sources (left) and water being collected from a pipe (right)

Interviews further highlighted that due to challenges associated with the formal water service provision, springs were used most often in households (100%). This water is used for all domestic purposes. The challenge identified was however that water quality test conducted found the presence of faecal matter, *E. Coli*, nitrates and other chemicals which rendered this water not safe for drinking. About 90% of the households indicated they consume this water without any treatment. This poses health risks to households and this issue can easily be addressed by the relevant service provider by providing storage and a small treatment facility for spring water. Furthermore, location of the springs was identified to be more than 200m from the nearest household, hence more than 50% of the households indicated the spring was far and walking to collect water was often difficult.

The local names, geographical location, water quality of the springs used by the households in Vondo villages are indicated in table 2.

Table 2: Location and water quality of springs in Vondo:

Name of spring	Coordinates/Position		Elevation (m amsl)	Water quality – Variables detected				
	Latitude (dd.ddddd)	Longitude (dd.ddddd)		EC (mS/m)	pH [$-\log_{10}(H^+)$]	Turbidity	Microbiological	Other parameters out of spec
Tshali spring	22º.926333	30º.369250	900	2.08	5.1	<0.2	Not detected	-
Matondoni spring	22º.935767	30º 371650	1027.9	No water				
Ramufhufhi spring	22º.918550	30º.381550	2550	3.71	5.9	0.7	Ecoli &Total coliforms (TC)	-
Tshinwela spring	22º.914683	30º.377117	805.6	6.47	6.1	1.6	Not detected	-
Tshawukani spring	22º.92393 E:	30º.36343	902	4.74	6.2	105	Ecoli &TC	Iron Fe & Aluminium
Tshivhase spring	22º.92403	30º.35566	976	No water				

Household interviews also revealed high incidences of water borne diseases in this village. This is shown in Table 3.

Table 3: **Incidences of disease reported in the last six months in Vondo**

Diseases	%
Diarrhoea	67
Bilharzia	2.9
Intestinal worms	37
Malaria	6

5.3 Characterization of Meidingen Village

5.3.1 Access to water services

The main source of water in Meidingen is groundwater, in the form of boreholes and springs. There are three working boreholes that currently serve the village. The boreholes have been networked and connected to two reservoirs of 100kl each. The network system is currently designed to have a single supply line that also serves as a reticulation line. This design has in the longer run created a supply problem as the two reservoirs cannot fill up due to a lot of street tap connections that are directly connected to the supply line. As a result the community cannot always receive water from the taps.

5.3.2 The use of springs

In Meidingen community, a total of six springs were identified. In this community springs are regarded as sacred in 100% of the households, and as such are treated with utmost respect. Flow measurements conducted revealed that one of the springs produces an average of 0.7L/s, and were serving more than 50hh on a daily basis. All households indicated using water from springs for more than 20years and continue to collect water from springs since it is the most reliable source of water. While the level of water drops in the winter season, most springs in the area are perennial; hence this water is available throughout the year. Households are able to collect water amounting to more 100L per household on a daily basis. However as in the Vondo village, water quality analysis showed the presence of faecal matter and high levels of nitrates (see Table 4 and figure 3) which might be due to the use of pit latrines and unsafe sanitation facilities in the village. This water was thus unsafe and required treatment methods to be in place.

Table 4: Location and water quality of springs in Meidingen Village:

Name of spring	Coordinates/Position		Elevation (m amsl)	Water Quality				
				Variables detected				
	Latitude (dd.ddddd)	Longitude (dd.ddddd)		EC (mS/m)	pH [–log10(H+)]	Turbidity	Microbiological	Other parameters out of spec variables
Raophala Seep	23.63665	30.25220	1 068	19.7	5.9	4.9	Ecoli & Ttotal coliforms (TC)	Nitrate + nitrite N Turbidity
Khelowa Seep	23.63332	30.25042	1 099	8.2	6.0	1.1	Ecoli & TC	Nitrate + nitrite N Turbidity
Majonini Spring	23.63593	30.24307	1 060	11.9	6.3	0.31	Ecoli & TC	Nitrate + nitrite N
Masekhekhe Seep	23.63895	30.24457	1 036	14.0	6.4	<0.2	Ecoli, HPC, &TC	Iron Fe Aluminium Al
Ke sa hlapa(1)	23.630417	30.256350	1072	11.2	7.2	2.2	Ecoli, HPC &TC	Nitrate + nitrite N Aluminium,
Ke sa hlapa (2)	23.630967	30.255233	1080	22.1	6.4	0.61	Ecoli, HPC, TC	-

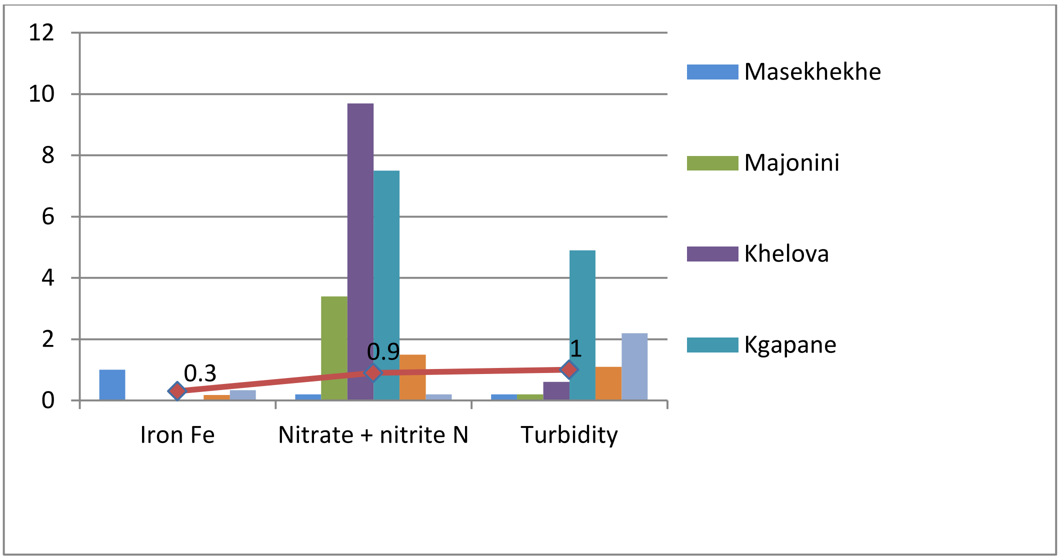

Figure 3: Water quality parameters above South African standard limits in the Meidingen springs

5.4 Common issues associated with springs in Vondo and Meidingen

In both communities, springs are regarded as very important and are currently the major source of water (see Figure3). According to flow measurements conducted on the identified springs, in both communities, water from springs is sufficient to meet daily water needs. The only challenge is that water from the springs was found to be contaminated and compromising to the health of communities. In both rural communities the municipal system was reported to be inefficient hence water from a spring is used on a daily basis. While the communal street taps are in place, about three days in a week, water is not available from street taps. This is in contravention of the Free Basic Water (FBW) policy which entitles everyone access to at least 25l per person (or 6000l per household per month) of clean water on a daily basis [10]. In this way the water services providers are failing to meet their constitutional mandate. On the other hand the FBW policy recognises that in most remote rural areas the cost of water service provision is too high, therefore providing 25l per person might not always be feasible. In this way WSA/Ps have discretion over the amount based on the water source or technology available to provide water. This provides an opportunity for identifying potential spring water sources and using them to improve the water supply process. Furthermore current statistics on groundwater use estimate that South Africa only uses between 2 000 and 4 000 of the 10343 million m^3/a groundwater available [11]. This shows there is enough groundwater available for exploration.

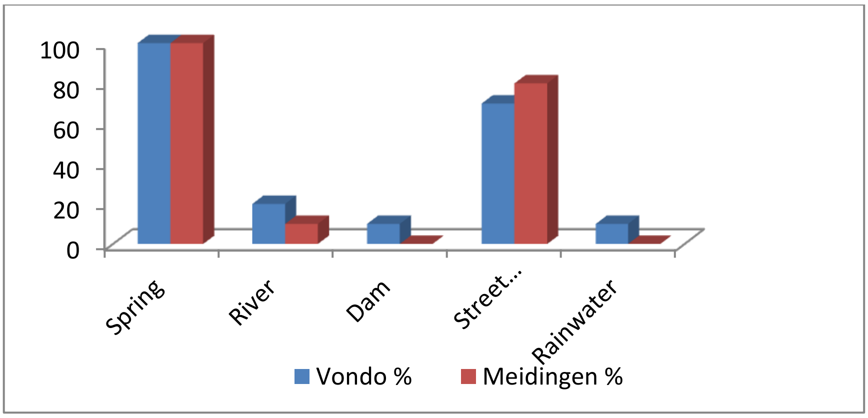

Figure 4: Main sources of water in the Vondo and Meidingen villages

In both communities' households highlighted that their respective water service providers were aware of their reliance on spring water however no monitoring of these sources was done by the municipality and no assistance was provided whatsoever, especially in terms of protecting these sources from contamination. According to Howard et al (2002) [12] the consumption of contaminated drinking water is a serious challenge, and remains one of the most significant causes of ill health worldwide. In South Africa approximately three million diarrheal cases and 50 000 related deaths are estimated to costs the government about $340 million annually [13]. It is therefore critical that the basic water supply (as per the FBW policy), through the use of developed and protected springs can at least be able to address this issue.

It was further indicated that, because of lack of storage facility for the identified springs, significant amounts of water is left to runoff the ground causing small piles of water which become breeding ground for mosquitos. This is a lot of water which is unaccounted for and no data available to quantify this loss. Currently this means South Africa is still a long way from being able to address the question exactly "how much groundwater does South Africa have" if a number of rural communities continue to use groundwater with no monitoring processes in place.

While water from the spring is available throughout the year, households indicated that during winter the level drops and hence during this time water is not sufficient to meet their households' needs. Recommendations from households included protecting and developing springs as well as installing storage tanks so that water can be saved. In this way, households feel that during winter water can collect and be stored throughout the night and be available for use during the day. Another challenge is that not all households can afford to buy pipes to connect to the actual springs, hence face a challenge of walking long distances to collect water from the spring, again which is an issue that can be addressed.

6. Conclusion

The study shows that in both Meidingen and Vondo villages springs are regarded as very important source in terms of meeting daily water demands. However the presence of contaminants poses a health risk to these communities.

The flow measurements conducted in the identified springs show that the identified springs collectively produce water sufficient to supply more than a hundred (100) households on a daily basis. These circumstances provide an opportunity for these sources to be considered as a viable groundwater source for bulk community water supply purposes. Considerations of these sources mean that funds are allocated to assist communities like Vondo and Meidingen to improve and develop springs to become a formal water supply. In this way quality of life in such communities can be improved and water services related challenges can be addressed.

7. Recommendations

From this study it is clear that springs have a significant contribution on the water supply of rural communities. However the value of this contribution is largely unexploited. It is thus recommended that springs be integrated into the community water supply programmes in order to capitalise on this potential. All the springs can be networked (depending on the potential yield) such that water is channelled into a storage tank with a mini treatment plant and taps can be installed for communities to collect water. Furthermore, it is essential that funds are set aside to investigate the nature of spring flows, the potential of these sources, and where feasible, development of springs should be proposed and incorporated into water service development plans (WSDPs). Municipalities as WSA/P should appoint people with hydrogeological background to ensure that groundwater is developed and managed sustainably within their areas.

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