ARTICLE

DYNAMICS OF WATER ACCESS AND ALLOCATION AMONG COMPETING NEEDS WITHIN THE HOMESTEAD: QUANTIFYING MULTIPLE WATER USES IN RURAL EASTERN CAPE

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ABSTRACT

South Africa is a water-stressed country, receiving an average rainfall of 450mm per annum, which is significantly less than the global average of 860mm per annum. The livelihood of the rural population depends heavily on the availability of water. While the dynamics of water access and use by urban households is well documented, little is known about the dynamics in rural households. This article describes how rural households obtain water; and in turn, quantifies how households allocate water among competing household uses; including cooking and cleaning, home garden irrigation, and supporting livestock. A case-study involving 30 households comprising 180 individuals used a mixed-methods approach and found that households allocate more water for productive use (60%) than they do for domestic purposes (40%). The findings suggest and describe certain rural nuances on how local peoples access and use water to support food security. This research emphasises the need for water services to be planned to support multiple water uses in rural households and further suggests that interventions to increase water storage and access to untreated water, especially in homesteads would yield significant results.

Keywords: household food production; multiple water uses; rural homestead; rural livelihoods; water access

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Introduction

This article examines water access and allocation for multiple competing demands—including domestic and production-related use in rural households, where water scarcity is keenly felt. Reduced water access examined in this study is responsible for reduced household food security and rural livelihoods. In South Africa food security and overall livelihood can be improved through increased water access and use (Cundill and Larsen 2011; Jacobs 2004; World Meteorological Organization 1992). Government water services and domestic water supply targets focus on domestic water use, which includes cooking, drinking, washing laundry, cleaning, bathing, and sanitation (Gleick 2003; van Koppen et al. 2009), and often neglects production-related uses, which include small-scale gardening, livestock management, tree growing, pottery making, and brick making—although other water-dependent enterprises could be included (Gleick 2003; van Koppen et al. 2009).

A broader awareness of household water needs and priorities, defined to include productive use, is essential for ensuring that water supply arrangements maximise local opportunities (Bingham 2007; van Koppen et al. 2009; Penning de Vries and Ruaysoongnern 2010; World Meteorological Organization 1992). Rural areas in South Africa remain among the most impoverished in the country, with poverty rates more than double of those in urban areas (Statistics South Africa 2014). Rural development and food security are national priorities reflected in the National Development Plan (Republic of South Africa 2011), but a better understanding of these issues ought to inform water resources development.

This study examined three villages, each located in a different district municipality in the Eastern Cape Province: Sirhosheni in Amathole District, Lutengele in OR Tambo District, and Mbekweni in Chris Hani District (see figure 1). Rainfall varies widely between these sites and each has a different history and settlement characteristics ranging from larger, traditionally allocated homesteads, to the smaller and regularised plots of the "Betterment" villagisation era (De Wet 1989; 1995). The diversity of the sites enables this analysis to explore the varied challenges and opportunities facing rural communities in the Eastern Cape.

This study employed both quantitative and qualitative data (a mixed-methods) approach (Creswell and Clark 2011; Creswell 2011; Denzin and Lincoln 2005) to evaluate water access and allocation between competing demands at household level within the boundary of the *umzi* ("homestead"). Thirty households comprising 180 individuals were chosen for intensive study in both wet and dry seasons in order to systematically investigate and document how and where households get water, how much they use, and for what purposes. This case study also documented attempts by households to improve access to water and how they respond to water stress in the homestead.

Figure 1: Site Locations of researched areas

Source: Google Earth

While the households studied are close to significant water resources such as major rivers and reservoirs, they use significantly less water on average than the South African and international households, mainly due to the poor access of these homesteads to water—and not because of lower demand. Seventy-one per cent of the individuals surveyed used less water than the quantity targeted by South Africa's Free Basic Water[1] (Muller 2008; Republic of South Africa 1997)—and 38 per cent used less than half of the target. Productive uses, primarily for watering home gardens and livestock, dominated household water use, representing 60 per cent of use, with the remaining 40 per cent directed toward domestic purposes.

To improve and enhance intervention strategies among rural communities and households, concerned stakeholders must understand local conditions and especially the dynamics of water demand, access, and use. A better understanding can inform and guide intervention strategies at homestead, community, or catchment level.

Frameworks Considered

Assessing water needs should be the starting point for developing or improving water infrastructure. We considered the following frameworks for conducting this assessment:

1 In 1996, the right to have access to sufficient water was enshrined in the Constitution of South Africa.

- The Multiple Use Services (MUS) framework acknowledges that water sources and storage facilities are often used for not only domestic but also productive purposes (Backeberg and Sanewe 2013; Bingham 2007). Following Denison et al. (2011), we treated these purposes as interconnected.
- Research frameworks that place gendered roles and responsibilities at the centre of the analysis (Cleaver and Nyatsambo 2011; United Nations 2014; van Koppen 2001; van Koppen et al. 2009; World Bank 2012). Indeed, the potential for agricultural production within the villages studied rests with work done by women and families and their focus to secure resources for practical development activities (Conner and Mtwana 2017; Shiva 2002).
- Institutional frameworks, including how governance might affect the customary rules and regulations of village communities, households, and families (Backeberg 2010; Manona et al. 2010).

Each of these frameworks informs a richer understanding of how households choose to meet their water needs. We combined insights from the opinions of authors cited above to inform the methodology.

In the three villages studied, community-level water assessments evaluated the surrounding natural resources and existing infrastructure by documenting the level of access through rivers, springs, dams, and government water supply systems, as well as the constraints impacted on these water sources. These assessments were paired with a random sample survey of socioeconomic indicators in each village, in which 18 per cent of the households (n=164) were polled. Eighty-seven per cent of the sample households hold some arable land, either in the form of fields or home gardens, and a detailed evaluation was made of the water use of 30 households with access to arable land. These households were chosen to represent homes in different geographic locations and households headed by both females and by males, and the evaluations were conducted over both the wet season (February 2013) and dry season (July 2013) in order to determine the average daily and monthly water consumption for each season.

Considerations when Undertaking Water Assessments

The assessments were intended to assist with the development and improvement of water infrastructure that supports both domestic and productive purposes and focused on the current use and demand for water as the areas for investigation within a MUS framework. Our assessments at the three sites considered the quantity, quality (and to a lesser extent), accessibility, and reliability of water services at site locations.

Issues of Water Quantity

The amount of water available affects the livelihood of rural households, where it is used for both domestic and food production-related activities. Data on urban water use are more readily available. Most studies focus on the use of water for productive use, while rural domestic use is rarely documented or even identified as a source of water demand (Gleick 2003; Rosen and Vincent 1999). Although the quantity of water use should be reported, tracking it can be difficult, so broad estimations are often used instead and little attention is given to productivity cycles and seasonal fluctuations in water sources. Our research addressed some of these shortcomings, with a focus on finding measures to quantify the water being used in rural homes.

Issues of Water Quality

The most important concern about the quality of water is its effect on the users' health. The effects of compromised water quality and the types of contaminants that compromise water quality have been documented by Songca et al. (2013) and Sibanda et al. (2015). Government regulations often focus on the quality of water (RSA/DWAF 1996a; 1996b; 1996c; RSA/DWAF 2013a; RSA/DWAF 2012). In South Africa, several white papers continually update water cleanliness policies governing domestic, livestock, irrigation, industrial, and recreational use (RSA/DWAF 2013b; RSA/DWAF 1994; Republic of South Africa 1997).

Water is also regulated to protect freshwater and marine aquatic ecosystems (RSA/DWAF 1996b). Regulations set the acceptable concentrations of bacteria, heavy metals, organic compounds, and nutrients in water sources. Poor water quality can expose system-wide issues, such as point-source pollution, water flow hindrance, or storage container contamination.

Since the collaborative work by White et al. (1972), researchers have concluded that the quantity of water available actually has a larger impact on human health than its quality. Rosen and Vincent (1999, 20) explain that:

> Because fecal-oral diseases have multiple transmission routes — hands, food, and dishes, as well as drinking water — they are more likely to be water-washed than waterborne. If a household has only a small quantity of water to use, it is likely that all aspects of hygiene — from bathing to laundry to washing of hands, food, and dishes — will suffer.

Thus, the quality of water, as well as efforts to ensure water quality, do not always translate into improved health. It is in this light that we aimed to ascertain the quantities of water utilised by those in the three villages studied versus prioritising assessments on water quality.

Issues of Water Accessibility

White et al. (1972), argue that proximity to a water source is crucial to increased access to water and hence, improved health and quality of life, while travelling to collect water does not have a huge effect on the quantity of water that households can access unless a water source is located directly inside the homestead. If the source is outside the homestead, the quantity of water used does not change much like when water is fetched from sources 30–1000 meters away from the household (Rosen and Vincent 1999). We reflected on this point and found that participants struggled to collect the water in the event that water sources were at a significant distance away from homesteads.

Adank et al. (2012) explain how appropriate community water infrastructure, which can be used as a water reservoir, converts water resources into water services, and how these services determine potential water use. The findings of this research equally found that investments in storage capacity translated to increased domestic use and agricultural productivity, but that financial hardship can prevent the realisation of these investments. A lack of storage capacity means that members of households must spend more time collecting water, which discourages water use.

A Mixed-methods Approach

The research was conducted using a mixed-methods approach (Creswell and Clark 2007; 2011), which includes quantitative and qualitative assessment. Quantitative techniques include structured surveys, diaries, and estimations to capture homestead water use statistics. Qualitative techniques include in-depth interviews and focus group sessions to provide context to, and deeper understanding of the quantitative data (Babbie and Mouton 2001).

Methods and Instruments used in Water Assessment

Method 1: Situational Water Resource Assessment

The Shared Water Resource Assessment (SWRA) included assessments of the wider village water resources, infrastructure, and documentation of water use practices and barriers that hindered members of households from accessing water. This resource-level assessment examined the water resources and infrastructure capacity of the areas under study, focusing on the range of sources, practices, and environmental (hydrological and runoff) factors that influenced water availability.

The main conclusions of the SWRA and the household water use assessment are as follows:

- Water deprivation is widely experienced and local disparity is high;
- Productive water use dominates household water consumption patterns;

- People with water infrastructure use more water;
- Water resources in the wider vicinity are markedly underutilised; and
- People need water in their *imizi* ("homesteads") as a matter of urgency.

Feature walks of the site. As recommended by Adank et al. (2012), observers noted water resources as well as how people used them during site walkthroughs. Points where water was collected, pathways to water sources, existing springs, watering points for cattle, washing points, and other relevant places in the village were identified and coordinates were mapped using the Global Positioning System (GPS), along with geographic features to provide an overview of each site. Each overview included observations about what affected local water resource management, formal and informal institutional arrangements, and key water-related infrastructure for agricultural productivity (e.g. the location of cattle dips, irrigation systems and schemes, and natural and communal resources were documented).

Situational maps. Geographic information system (GIS) based maps of each community generated by the walkthroughs were further populated, using contributions from the community's water users and participating support groups. Satellite imagery was easily recognisable to community members, facilitating contributions by focus group discussions and other participants. Influential factors affecting water use, such as distances traveled to water sources, physical land features, and infrastructural support (e.g. roads and water treatment plants), were perceived as parts of a whole system. Site-specific maps of each study area included notations of participating homesteads and relevant attribute data (see figure 2).

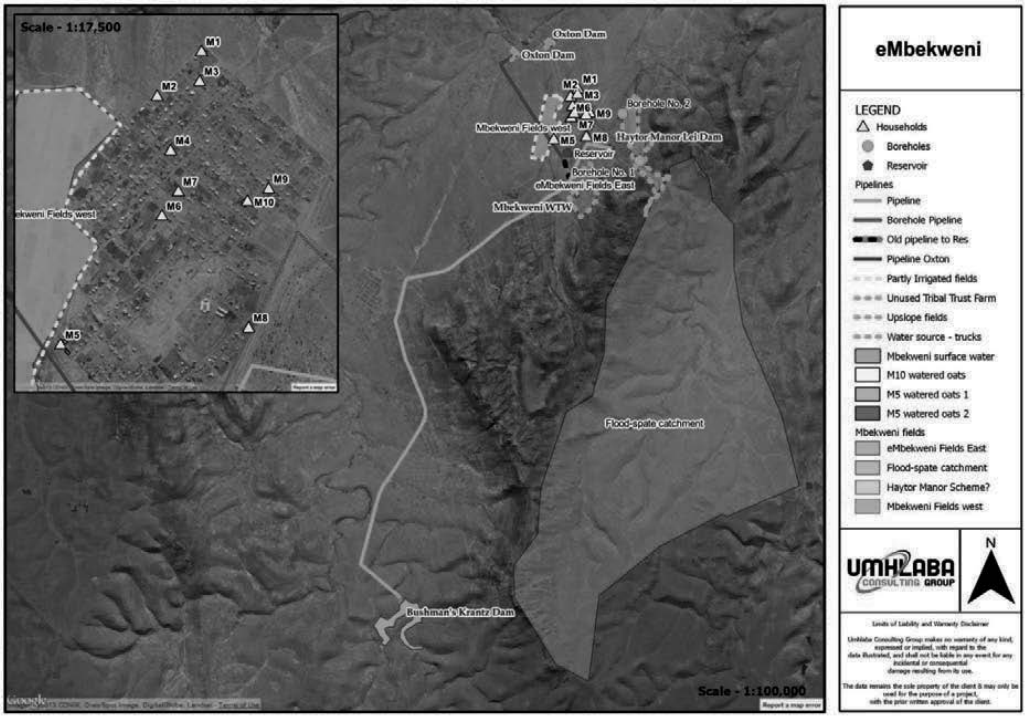

Figure 2: An example of a site description/Water resources and infrastructure at Mbekweni

Source: Umhlaba Consulting Group – Adaptation from Google Earth

Environmental water quantity estimations. After identifying water sources, the research team estimated water availability, based on approximate flows in rivers and springs, and by reviewing relevant documentation on dams and yields. Rainfall, runoff, and other hydrological data were taken from South Africa's Water Research Commissioned developed Water Resources of South Africa (WRSA) 2005 package (Middleton and Bailey 2008)[2].

Method 2: Homestead water use assessment

The homestead-level assessment aimed to measure categories of water use in the homestead or *umzi* (isiXhosa for homestead). The *umzi* is an important, socially-recognised settlement site with the heads of households leading participation in community-based decision making (McAllister 2006; Ngwane 2003; Spiegel 1997); this includes issues pertaining to water resource development.

2 http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT380-08.pdf.

Water use Categories and Boundaries for Measurement Activities

Each set of measurements took place in specific geographic boundaries. The local people, whose language is isiXhosa, used water and grew crops in different ways in their homesteads. Demarcations of these areas were identified early during previous field work by researchers, and were verified during the contextual socio-economic survey in each village. The use of water in each homestead revealed people's priorities and strategies for dealing with the challenges to water access facing them.

The identification of two different growing spaces within the boundary of the *umzi* supports the rationale for using a MUS framework. The *umzi* is the homestead space, within which reproductive infrastructure (houses and huts) and productive ones (kraals, pigsties and fowl runs), as well as home gardens, are located (Connor and Mtwana 2017; Perry 2013). This is the boundary of measurement for household activity and includes water uses, including:

a. the portion of the homestead, which consists of huts, houses, and kraals and—where water is used for domestic purposes (e.g., drinking, cooking, washing clothes, bathing);
b. the *isitiya,* which is a relatively small watered and usually intensive garden (a few 100 square meters) cultivated with green leafy and other vegetables; and
c. the *igadhi,* which typically occupies the largest part of the *umzi* behind the cluster of buildings, and is usually fenced—this is where rain-fed maize, beans, and squash are usually grown.

In addition, there is usually small livestock that requires drinking water within the *umzi*.

Beyond the *umzi,* typical households have an identified arable field, or *intsimi*, located some distance from the homestead. This is either a fallow, or is summer-cropped using rain-fed methods, or irrigation methods (see figures 3 and 4). Water measurements taken in these areas within the *umzi* was thus, the primary focus of this study.

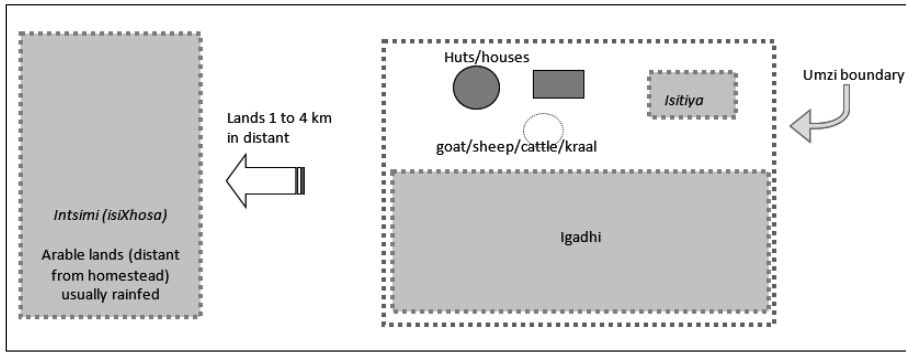

Figure 3: Schematic of the *umzi* boundary and MUS spatial water use elements

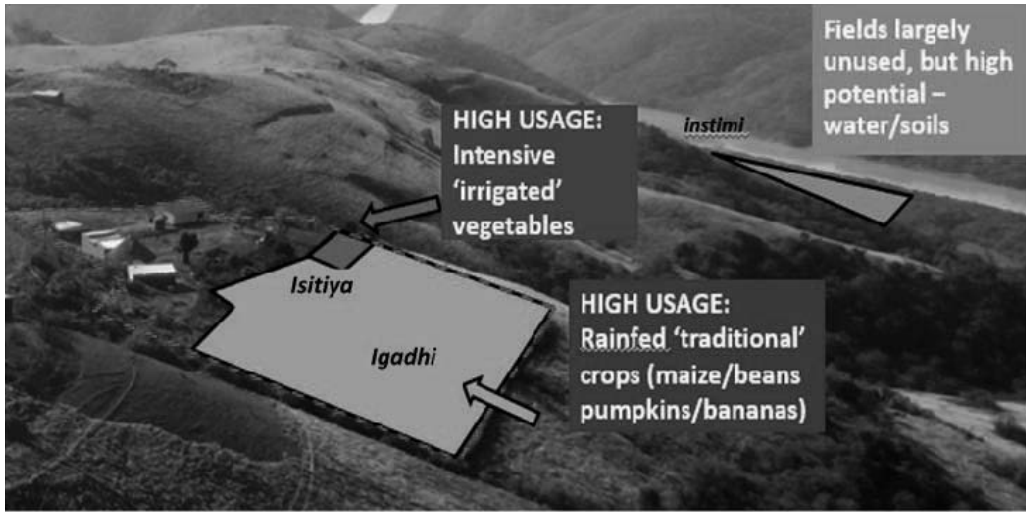

Figure 4: Differentiated cropping zones superimposed on Google-earth imagery

Source: Umhlaba Consulting Group

Case Study examples of households involved in the study[3]

A) Miss Zenzile[4], below, works part-time for the Apostolic Faith Mission in the area. She has four tanks and uses two to draw water from surface water runoff, while the other two are used to collect rain water from the roof gutters. She sees herself as a hard worker, and always attends meetings at her church and for WESSA[5], the NGO that assists in the area, that has made it possible for her to obtain the tanks. She has never been married but has one small child. Her family presently consists of four members, and as the head of the household, she owns a little shop, which sells alcoholic and non-alcoholic drinks, but by their own evaluation, it is not very lucrative, and the family debt is a constant worry. The garden boasts an array of produce and is visibly highly productive, with wild insecticide (*iantsanqwana*), apple, guava, peach, granadilla, and mango trees, as well as spinach, beetroot, tomatoes and other vegetables. Since receiving the tanks she rarely goes to the river to fetch some water—the water from the tanks, which is collected

3 These examples were taken from the 30 case-studies conducted, which examined water use in an extensive manner. The personal examples captured in this article are from the Lutengele site. We acknowledge the support and openness of this community, which contributed to the success of this project. Without the support and involvement of the women from this community (as well as others from other communities), our understanding regarding issues of multiple water usage and the challenges of collecting water would not have been enhanced.

4 Pseudonyms have been used to protect the privacy of individuals.

5 http://wessa.org.za/about-us/overview/.

overland, is used only for growing food in the *isitiya*. The un-purified water collected from the roof gutters is for both household and garden use.

Miss Zenzile does not use a hose pipe; rather, she waters by hand—so that she can use water sparingly and can thereby observe the amount of water she uses for her produce. Her desire is to increase her agricultural production—so that if she generates increased yields she would start selling surplus produce on a more permanent basis, in order to augment her income. The narratives about the relieved burden of collecting water are widespread across other tank owners from the three villages.

B) Mrs Mtwana (below), collects water in her rainwater tanks, and during dry seasons, she collects water from the nearest spring. When this water has dried up, she goes to Umzimvubu River, which is far. It takes 3 hours of her day to fetch 40 litres of water from Umzimvubu. When it rains, however, the water tanks provide reprieve from these arduous trips. She must go to the river more often during the winter months, when there is no alternative, and the local springs have run dry. Lately, it has been raining heavily—therefore, she has not been collecting water from the river that much.

C) Mrs Cwayi does not go to the river as often as she used to; because it has rained and her tanks are full. This has saved her the long trips to the rivers and springs. She draws water from the tank manually, and has not thought of connecting pipes or hoses from the spout, but insists on hand-watering (*gangashela*) in order to conserve the water.

D) Mrs Nqumba received four JoJo tanks from a project funded by the Department of Water and Sanitation (DWA)[6]. These tanks have helped her in her production activities, but because her garden is small, and is not fenced, it has been difficult for her to produce enough food. The water that she stores in her tanks is used for general domestic purposes—bathing, drinking, and washing clothes—instead of irrigation purposes. She finds that people are no longer sick as much as they were before the department made these tanks available. The benefits of the tank are quantifiable; her family's lifestyle has improved and they now have sufficient water to wash, bath and cultivate the garden.

6 A report to the Water Research Commission outlines how tank owners acquired their tanks (e.g. from government support, NGO assistance, or as acquired by an owners' capital investment).

Recording Methods

In spite of the fact that researchers are in agreement regarding the importance of homestead water use, they have not been able to reach consensus on how to record this type of data for complex water distribution systems, which use multiple and often unmetered sources (Wutich 2009, 50). MUS-based assessments conducted internationally have primarily used water consumption surveys to summarise quantity-based figures. These figures are gross estimates that may not have detailed information about how people use water with the survey results reflective of singular events, or an isolated setting.

Use of illustrated recording sheets (e.g. a water diary)

A literature review assisted with the development of recording sheets that were used to gather data on how land within the homestead is used differently for cropping, and how water is used for small livestock—for example, chickens, ducks, goat, sheep, etc., during the preparation of the livelihoods survey process (van Averbeke et al. 2011). The water survey sheet (figure 5) is a pictorial data collection tool that enabled these researchers to collect detailed information about water use at the homestead. These data allowed researchers to ascertain households' domestic crop and animal water use (Penning de Vries and Ruaysoongnern 2010).

While a questionnaire can provide a substantial amount of information about household water use, it relies heavily on memory (Alaszewski 2006; Angelsen and Friis Lund 2011). To gain a clearer understanding of patterns of daily water usage in the homestead, the use of a self-recorded research diary was adopted. As defined by Alaszewski (2006), a diary is a collection of documentations written by an individual, with certain predictable characteristics (Alaszewski 2006). Researches on the project thus aimed for objectivity in designing such a diary by supporting participants who were responsible for collecting and recording their reality.

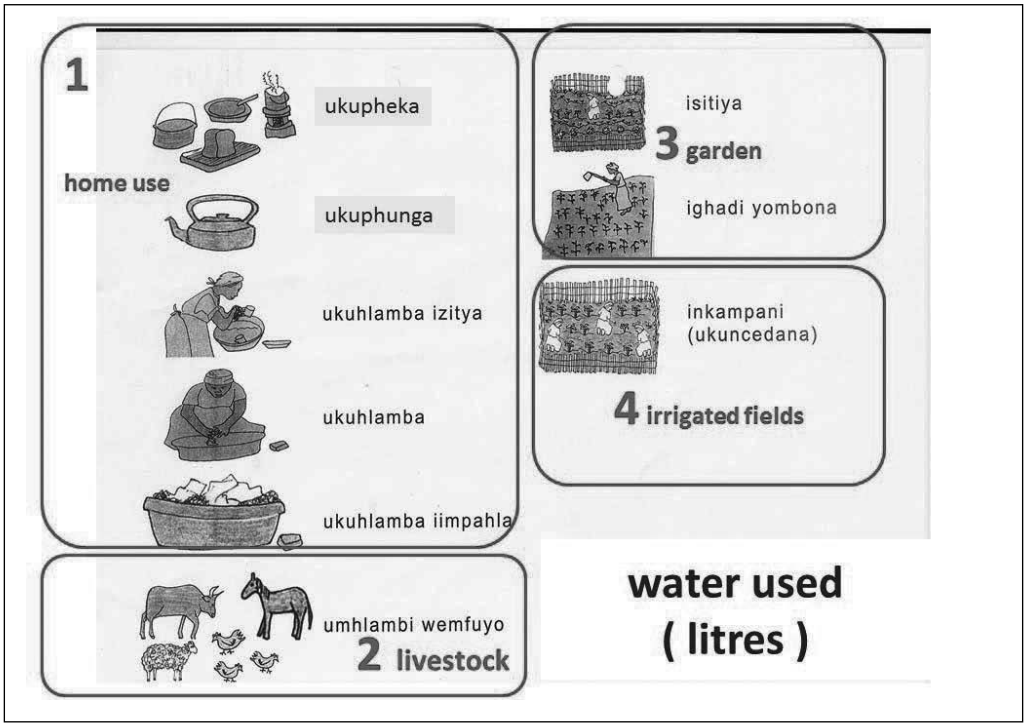

Figure 5: Data collection sheet for the household water use survey

Source: Umhlaba Consulting Group

Data on water use were recorded over a period of seven days by the 30 participating households. We analysed recorded water use in the diaries to determine whether any patterns had arisen (Alaszewski 2006). The water diaries revealed priorities that shaped water use along with ease of access to water, as well as the quality of water available. The diary was designed with illustrations to make them an accessible tool for homestead water collectors of varying ages and literacy.

Data collection details

a. ***Dry season and wet season recordings*** **-** Two sets of weekly data were collected at each site—one set in mid-February to reflect water use during a wet season and one set in mid-July to reflect water use during a dry season, to produce an average daily value for each season and to approximate monthly water use in each season. A representative water use pattern was established to allow seasonal comparison.

b. ***Measuring equipment and training participants*** - Research participants measured their water use with a set of standard five, 10, or 20-litre coloured buckets provided by team members. The volume used each day was recorded on the illustrated sheets and verified by local support staff who spoke isiXhosa.

c. ***Daily homestead visits and water use discussions*** - Every second day and sometimes daily, trained local research assistants and project team members visited each homestead to discuss and check data entries and to draw insight from observations and practices.

One week of typical recordings for the summer season is shown in Table 1. The full data set has been presented in 60 tables, with 20 tables collected from each of the three villages (e.g. 1 table per/household/season). These were combined into a summary matrix with data on the size of the garden, the number of people living in each homestead, the on-site water storage available, and the status of the household (headed by a man or woman, married family, nuclear or compound household, etc.).

Table 1: Typical data collected on water use in a homestead (e.g. a one-week period during the wet season in Feb 2013)

Homestead No. 7 Lutengele	**Type of use**	**6Feb**	**7Feb**	**8Feb**	**9Feb**	**10Feb**	**11Feb**	**12Feb**	**Total L/week**	**Aver L/day**	**Extra p/cu.m / month**
Cooking	*Ukupheka*	20	50	20	25	25	30	25			
Drinking	*Ukuphunga*	10	10	10	10	10	10	10			
Dishes	*Izitya*	10	10	10	10	10	10	10			
Washing	*Ukuhlamba*	25	50	25	50	30	25	30			
Clothes	*Iimpahla*	20	200	200	100	200	200	200			
TOTAL Home use		**85**	**320**	**265**	**195**	**275**	**275**	**275**	**1690**	**241**	**7.3**
TOTAL Livestock		**40**	**150**	**150**	**0**	**0**	**150**	**0**	**490**	**70**	**2.1**
	Isitiya	80	100	25	250	50	150	50			
	igadhi	0	400	0	0	0	600	400			
TOTAL Garden use		**80**	**500**	**25**	**250**	**50**	**750**	**450**	**2105**	**301**	**9.1**
TOTAL UMZI		**205**	**970**	**440**	**445**	**325**	**1175**	**725**	**4285**	**612**	**18.6**

Findings

The homestead water use assessment set out to measure how much water people were using, the purposes thereof, within the boundary of the *umzi*. The analysis was done across all three sites, as presented in Tables 1 and 2. The findings informed

interdisciplinary discussions with community members on the interventions that could be made to improve access to water.

Water use in the ***Umzi***

The average daily household consumption was calculated from the seven-day average of measurements taken by participating households in both seasons (see table 2).

Table 2: Average daily consumption measurements for multiple uses in the *umzi* in the wet and dry seasons (litres)

	Village	House (L/HH/ day)	Animal (L/HH/day)	Garden (L/HH/day)	TOTAL L/HH/day	L/cap/day	Equivalent L/HH per month
Wet Season	Lutengele	110	36	59	**205**	40	6234
	Sirhosheni	79	5	9	**93**	20	2828
	Mbekweni	53	9	131	**193**	47	5869
Dry Season	Lutengele	150	42	74	**266**	55	8089
	Sirhosheni	72	6	26	**105**	22	3193
	Mbekweni	34	15	335	**384**	93	11677
AVERAGE across 3 villages		**83**	**19**	**106**	**208**	**46**	**6315**

Note that all of the above water-use activities are within the boundary of the **umzi** *(i.e. within the homestead):*

- *House = water used for domestic purposes (drinking, cooking, body-washing, clothes-washing etc.).*
- *Animal = water used for livestock watering, typically small livestock (chickens, pigs, goats and sheep).*
- *Garden = water used for irrigation or supplementary watering of crops (food and pasture).*

Average household use (n=30): The average water use across the three villages and over both seasons totalled 208L/household/day—an equivalent of 6315L/household/month[7],—5 per cent more than government target of 6000L/household/month set by Free Basic Water.

7 Using 30.416 days per month.

Average per capita consumption (n=30): This was calculated for each household by taking the average daily amount and dividing it by the actual number of members in the household in each homestead. The average per capita consumption was 46L/person/day, which is an amount equivalent to 184 per cent of the target Reconstruction and Development Programme (RDP) minimum level of supply.

High local disparity in access and use (n=30): Although the average use across households suggests adequate access to water since it exceeds South Africa's target of 25L/person/day, the data are heavily skewed, so the average masks a wider reality of deprivation. A few households (at Mbekweni and Lutengele respectively) had a very high consumption rate, due to informal and illegal connections to either bulk-water irrigation pipelines running along the edge of the village, or to internal domestic water supply lines, or the households had significant rainwater storage tank capacity.

An analysis of the per capita water use for each household averaged over both seasons shows the disparity with four of the 30 households recording very high use of over 60L/person/day. The median value of 18L/person/day is more representative of the experience of most households, substantially less than both the average of 46L/person/day and the national target of 25L/person/day.

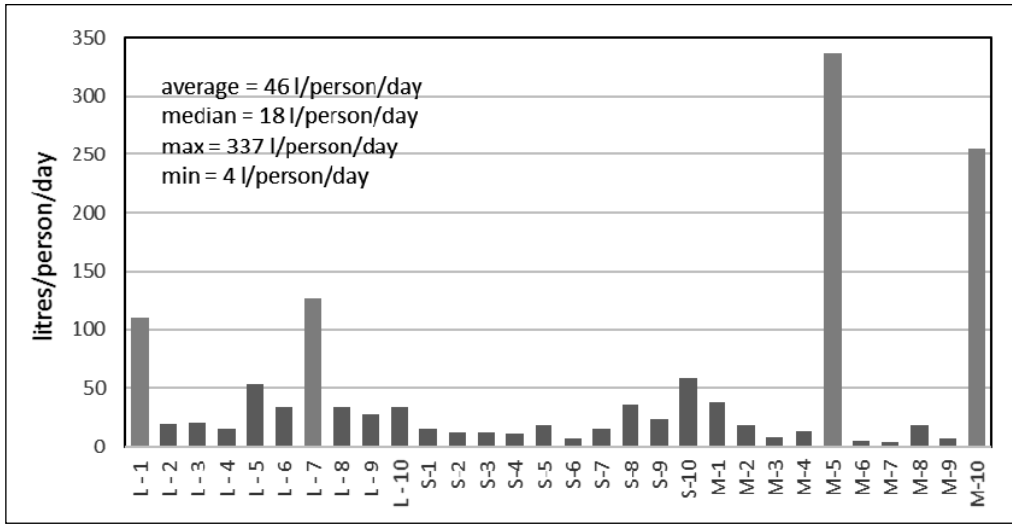

Figure 6: Per capita water use with high disparity at the three research sites (n=30)

Source: Umhlaba Consulting Group

Individual water use in case study households is shown in Figure 6, which clearly illustrates the wide data range and low water use in most households. The two homesteads considered to have a very high use were Mbekweni: households M5 and M10, which have direct (and unlawful) connections to bulk water pipelines. Households L1 and L7

at Lutengele have invested in rainwater-harvesting storage tanks, collecting from roofs gutters and surface runoff from adjacent roads.

There is an unusually high water consumption in the two Mbekweni homesteads because households in these homesteads irrigate their vegetable gardens freely during both seasons, from a practically unlimited and unregulated source. These households irrigate six or seven hours per day, two or three times per week without incurring water charges. Flow rates were measured in the arable area of the homestead, where oats was typically planted to feed pregnant and lambing ewes, leading to the water-use estimates. In the case of M10, a neighbour's yard was accessed through an informal loan arrangement and oats on this land was irrigated as well.

Household M10 was connected to the irrigation mainline from Bushmanskrantz Dam through the adjacent, largely dysfunctional Mbekweni irrigation scheme, while M5 connected to the municipal domestic water system through two boreholes. M5 and M10 are outliers in the data set from this research, but they reflect the reality that some 20 per cent of the households across Mbekweni, which has a municipal supply system, have unlawful connections. The demand for water within the homestead for purposes of production was evident—because of agricultural practices that members of households engaged in, as well as the measured water use, where existing water-infrastructure made this possible.

Households with extremely low per capita consumption (M7, M9 and S6, which recorded 4L, 7L, and 7L/person/day, respectively) were the three largest households of the 30 sampled, with 12, 11, and 10 people, respectively. These households were also headed by elderly members, who tend to adopt strategies for using water sparingly in response to the distance between the household and the water source.

Seventy-one per cent of the individuals surveyed (n=180) were still using less than 25L/person/day, and 38 per cent were using less than 12L/person/day. Across the three villages, most people experienced water deprivation, with only a few who had access to large volumes of water through illegal access to larger systems, or to household infrastructure investment in roof-water collection tanks. The different experiences of these households illustrated that access to water infrastructure is closely associated with increased productive use of water in these villages. This supports the argument that access to water in a village setting enables productive use.

Findings by type of use within the homestead

On average, across the 30 households:

- 3 224L/household/month (51%) is used for crop production;
- 578L/household/month (9%) is used for animal watering; and
- 2 513L/household/month (40%) is used for domestic purposes (See figures 7 and 8 on averages/day).

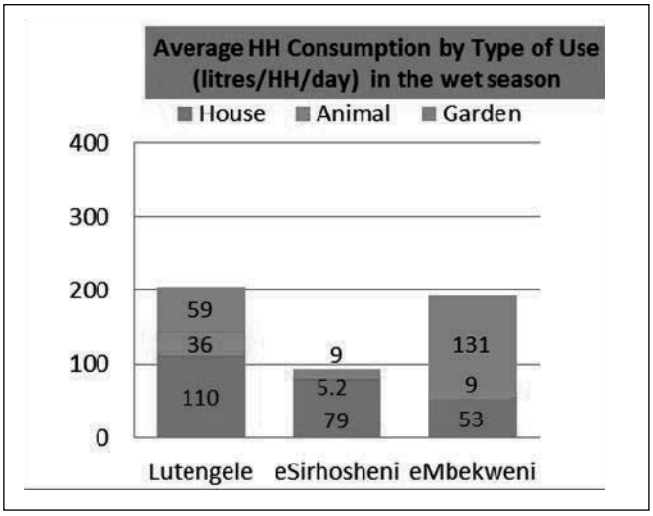

Figure 7: Water use for multiple purposes within the homestead boundary (n=30)

Source: Umhlaba Consulting Group

Productive use (water used for crops or animals) totaled 3 802L/household/month, an approximate 60 per cent of water consumed per month. The average use patterns observed in these case studies showed multiple use systems (MUS) in practice.

It is important that productive water use is prioritised by households and consumed such that a large portion of the total water is used in the *umzi*. This finding is supported by van der Horst and Hebinck (2017), who found that people in the two Eastern Cape villages unlawfully piped water for irrigation purposes to produce food and to generate some income. They propose a shift away from the current rigid planning approach that targets domestic water services, toward a multiple-use system (MUS) approach. The findings of this research position a similar conclusion and we align our final conclusions to that of van der Horst and Hebinck's insights (2017).

Variations across the Three Research Sites by Season and Type of Use

There were substantial variations across the three sites. Water use for food production was consistently prioritised in Lutengele and Mbekweni, whereas in Sirhosheni, a small amount of water was used to water the gardens—Sirhosheni is relatively far from a few significant rivers and streams in the area, and has only low-yielding springs nearby[8]. At the time the study was conducted, there was no piped municipal water system—and

8 Given space to publish here, the site maps outlining specifics features from Lutengele and Sirhosheni are not presented. Again, see the site map on page 8 from Mbekweni as an example of the level of detail captured on a per site basis.

only a few rainwater storage tanks in Sirhosheni that supported homestead agriculture, in spite of the stated interest in food production.

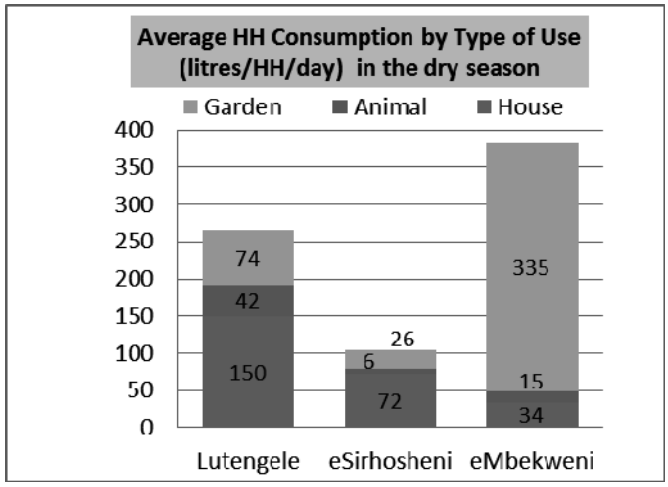

Figure 8: Average household consumption by type of use in the wet and dry seasons

Source: Umhlaba Consulting Group

In the wet season, the overall household consumption at Lutengele was similar to that at Mbekweni, with the respective average use of 205 and 193L/household/day, more than double the amount at Sirhosheni. This was probably due to the limited spring water resources at Sirhosheni, the higher rainfall at Lutengele, and the bulk water supply availability at Mbekweni. In Lutengele, 54 per cent of the water was used for domestic purposes, while the remaining—46 per cent was split between livestock and watering the gardens. In Mbekweni, 68 per cent of water was used for gardening, in part because of the illegal irrigation practices in the town. During dry seasons, in Lutengele and Mbekweni respectively—there was a marked increase in total consumption and a spike in water use to irrigate gardens at Mbekweni. Sirhosheni recorded similar practices for both seasons, reflecting the relatively low use of water for production-related activities.

The difference in water use, associated with connection to the bulk water supply raises the question of whether productive water use in the *umzi* could be increased by providing untreated water supply infrastructure to homesteads (Botha et al. 2003). Participants in focus groups answered this question in the resounding affirmative: restricted water supply is the most critical factor limiting food production, and investments in infrastructure and water storage in the village would make a significant impact.

On homesteads, bulk water provision and access was available in the fields, but this did not translate into productive use. In Mbekweni, only 15 per cent of the capacity of

the adjacent irrigation scheme was used, because unlike in the *umzi*, multiple factors limited food-producing activities (Denison et al. 2016; Manona et al. 2010). These factors include financing for agriculture at scale, mechanisation, marketing, fencing, insufficient knowledge, lack of tools for land exchange, and the related land tenure insecurity. There are, however, significant opportunities for improved access and better strategies for storing water within villages where homestead food production seems to be primarily limited by water alone; for instance, design strategies and adaptations for storing water within households potentially limit water scarcity.

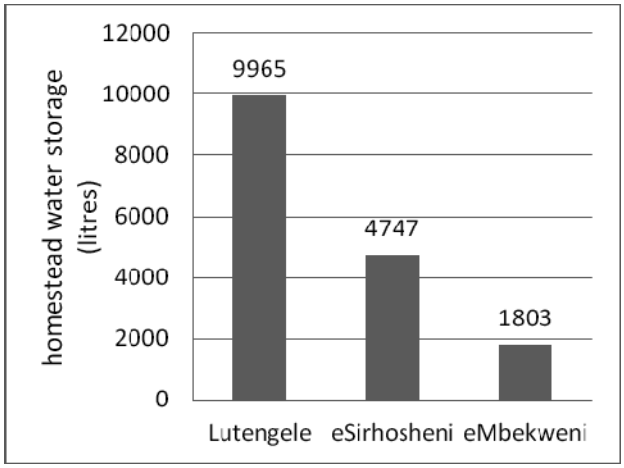

Figure 9: Average household water storage at the research sites (n=28)

Source: Umhlaba Consulting Group

Water use and Household Storage

Storage is useful and necessary to opportunistically capture water for later use, such as rainwater harvesting or hose-pipe connections to standing pipes at night. Figure 9 shows households' storage at the three sites. The two homesteads which had permanent connections to bulk irrigation-water pipelines at Mbekweni were excluded because they had no need to store water. At Lutengele, rainwater harvesting is promoted by the Wildlife and Environmental Society of South Africa (WESSA) with the support provided by government, in giving storage tanks to homesteads. Households have also made individual investments in rainwater tanks, which is not surprising—given that Lutengele is quite a distance away from several locally available water sources. The result of these investments is an average 9 965L/household of stored water, which reduces the time and energy spent in fetching water.

Homesteads at Sirhosheni store less than half this volume of water because they rely primarily on perennial springs. Households at Mbekweni were discouraged from filling their storage tanks with water from the municipally-operated borehole system. Roof-water is still a potential collection source, but there were few examples in the village of investment in storage tanks.

Figure 10 illustrates the average per-person consumption plotted against the average water storage in each village. The correlation between average storage and average per capita use appears very strong[9] as would be expected: An investment in storage at the homestead (or securing reliable hose connections) leads to increased water use in homes. Increased water storage infrastructure at the homestead would be expected to support food production-related activities within the homestead because increased water use tended to be used for production-related activities. This is not the case for field-agricultural activity in arable lands outside of the village. In both Limpopo and the Eastern Cape, limiting factors to field agriculture that can be more easily overcome in the small confines of the homestead garden interfere with a clear relationship between water use and productive capacity (Denison and Manona 2007; Denison et al. 2015; Denison et al. 2016).

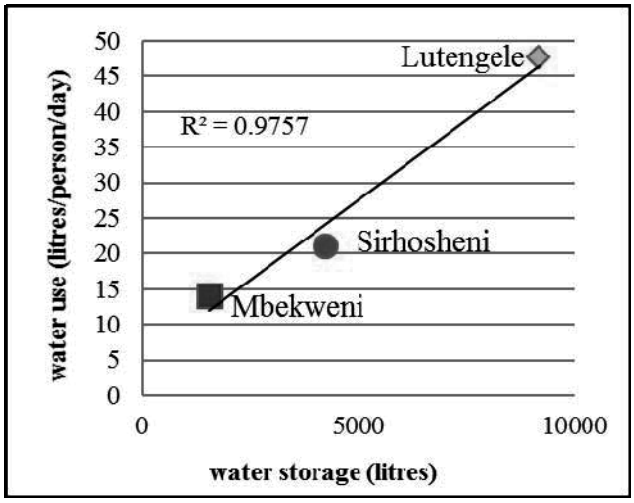

Figure 10: Average per capita use and household water storage at the research sites (n=28)

Source: Umhlaba Consulting Group

9 The two households in Mbekweni with permanent piped connections and exceptionally high consumption were treated as outliers and were excluded.

Water Resources in the Wider Vicinity are Markedly Underutilised

There are water sources in Lutengele and Mbekweni that are practically not used by local residents. The Umzimvubu River runs less than two kilometres away from Lutengele, and the water from this river is used almost exclusively for domestic use (e.g. washing), although in extreme times it is used to water seedlings despite its heavy silt and sand content. The Bushmanskrantz Dam supplies bulk water to the field edges at Mbekweni using gravity pressure, but the pipeline was closed by the Department of Water and Sanitation (DWS) in late 2014—following policy change (RSA/DWAF 2013b) that required payment by all irrigation users, including poor smallholder irrigators. However, this resource was only used for an estimated 15 per cent of the fields prior to this change. Less than three per cent of the total water resources near these villages suggests that the capacity to store water or transport it to where it's needed is more important than the existence of the water source.

The research noted that runoff from the 3 800 ha catchment above Haytor Manor, an older commercial farm, is not regulated or stored. The two boreholes that supply domestic water to the communal taps in Mbekweni are located on this old commercial farm, which was incorporated into the Ciskei in 1978. The farm is immediately adjacent to Mbekweni on the opposite side of the main access road, and while it was productive during the homeland era under government, it has not been used for many years. The original boreholes are now operated by the local municipality, Lukhanji, which is the official water service provider designated by the Chris Hani District Municipality.

A scoping level hydrology evaluation points out that there is sufficient water to irrigate a vast area and support Mbekweni. The construction of storage dams and/or provision for capturing floodwater would prove beneficial to the water needs of the area. There was an indication that 65 ha was irrigated previously by utilising floodwater before 1981 when the farm was producing commercially. Today, utilising floodwater and rain runoff is underutilised, but could provide a viable option for irrigating arable lands. There are implications, however, for water allocation reform—given the context of other commercial farming enterprises operating downstream to Oxkraal Dam. As with all water allocation reforms and possible interventions, the implications of providing alternative solutions to existing problems are that some solutions may confront existing policy and practice that protects the interests of certain lobbyists, such as those commercial farmers in the area, who vie for water as a needed resource for their farming operations. The institutions protected by commercial interest and farming can be different than those social and cultural practices that protect family rights to land and resources—given that the latter's practices are connecting to the enterprise of building and securing rural lands and homesteads (Bank 2015; Connor and Mtwana 2017; Fay, 2015; Perry 2017).

Therefore, we suggest a need to reflect on how competing levels of interest define the varied institutional dynamics that impact on individual, familial and collective rights to resources, as well as land and development opportunities in post-apartheid South Africa. Resident homeowners, small-scale farmers, local leaders, municipal planners,

commercial farmers, developers all vie for a different stake at securing water resources to realise their goals—and that institutional social and political organisations lobby for water resources in a region whereby water scarcity is keenly and felt speaks to a need for improving the cooperative mechanisms for sharing scarce resources. We note that a sharper understanding of how regional stakeholders compete for water resources impacts on the kinds of development strategies that are potentially viable. Recognising competing interests for water and addressing how those most in need can be served requires community-level responses in the context of regionally-specific realities.

People need Water in their *Imizi*[10] as a 2002 priority

The higher water demand at Mbekweni and Lutengele demonstrated that increased water supply to homesteads was expected to yield higher food-production returns and should, as such be prioritised (Denison et al. 2011). While fields near villages are suitable for irrigation, and sometimes get a supply of water from existing systems, they remain underused.

Conclusion

Interventions to improve water access should be based on an understanding of the contextual realities at each village site regarding how to better access, store, and use water resources (Denison et al. 2011; Grafton and Hussey 2011). This understanding can be gained through research, which has employed combined methods in collecting data from residents at village-scale, as well as from longitudinal research and mixed-method approaches to gain insight into the daily water use by rural South Africans.

The findings have shown that there was a need for several interventions. Firstly, storage capacity in rural households should be improved—given the interest and desire by participants to increase storage—and that increased storage capacity would translate to improved domestic and livelihood practices. Secondly, infrastructure that surrounds villages should be improved, in terms of both treated and untreated water access—given the widespread desire and needs for domestic uses, and for supporting home gardening and agriculture. Lastly, conservation strategies, awareness campaigns, and incentive programmes to support water conservation practices that support overall quality of life for rural South African citizens living in poverty should be adopted (Hemson et al. 2008).

The manner in which a community gathers, stores, and uses water and the various formal and informal institutions that govern water use contributes to water security in a particular community. Furthermore, water collection is physically demanding and time-consuming as well—with the burden to collect water falling disproportionately

10 *Imizi* is plural for *umzi*.

on women and children, which makes it imperative to look at the problem through a gendered lens.

Thus, this research sought to account for the quantity, quality, accessibility, and reliability of various water sources and services in three specific cases in rural South Africa to help policymakers consider the many factors that affect local areas. The study illuminates the slow pace of government that might stand in the way of effective service delivery, while water-use interventions made at household level with multiple uses in mind can have the greatest impact, not only to improve water security—but to increase productive water use and improve livelihoods among people in rural South Africa.

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