WATER MARGINALITY IN RURAL AND PERI-URBAN COMMUNITIES

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Abstract

Water supplies in an increasing number of rural and peri-urban communities can be described as marginal; subject to failure or become unaffordable or difficult to access. A range of common factors contribute to water marginalisation or access bias. Firstly, by being on the margins of urban settlements, these communities may be poorly served by formal water infrastructure. Secondly, where water infrastructure exists, this may be prone to failure as local municipalities and water utilities with limited capacity and resources struggle to maintain and operate a widely dispersed system. Thirdly, when local water systems fail, they are often not repaired quickly, if at all, leaving communities to resort to fetching water themselves from neighbouring sources that may be some distance away. This requires people to manually carry water, or to pay someone to transport this for them. In this way, the characteristics of geography, urban settlement patterns, the choice of water distribution and operation systems, as well as local responses combine to create water systems that are unreliable, unaffordable and difficult to access, leading to water marginality.

This paper investigates water marginality in communities in rural and peri-urban areas in South Africa. It utilises surveys and interviews of communities, local authority, water and urban planning officials, to understand the nature of this marginality, and investigate the key contributory factors. This forms the basis for proposals on how access challenges can be addressed, and conclusions and recommendations developed. The paper provides valuable insights on how, and why, water marginality occurs, as well as strategies for sustainable solutions. As climate change and rural-urban migration accentuate water marginality, the study offers important and timely insights in an area that urgently requires further research.

Highlights

- Water marginality or access bias can be described as water supplies that are subject to becoming unreliable, unaffordable and difficult to access.
- Water marginality is increasingly prevalent in many rural and peri-urban communities in developing countries.
- Water marginality is explored to identify the key factors that contribute to its occurrence.
- Strategies and recommendations to address water marginality and for further research in this emerging field are proposed.

Keywords: human settlements, livelihood, rural areas, peri-uban areas, water access bias, water marginality.

Introduction

Water is an essential requirement for life, health and human dignity. As human beings, we need water to drink, cook and wash; for leisure to support physical, mental and psychological wellbeing; for agriculture to provide food and sustenance; for industrial and manufacturing processes to maintain the economy; and for ecosystems to maintain resilient built environment and natural habitats. Water insecurity is the

lack availability of sufficient water of good quality to meet basic human requirements, livelihoods and ecosystem functions, and an increased risk of water-linked disasters (Ray and Shaw 2019). Water security underpins the achievement of development agendas across many sectors – including health, energy, agriculture, environment, mining, and other industries and water infrastructure is vital for delivering water security[2] (Hurford, Moschini and Woolhouse 2017). Water infrastructure that is inadequate, and vulnerable to future climate change uncertainties, among other factors, compromises water security. UN (2010) indicators for water security are: resource availability, access, risk, policy and institutional capacity, and social capacity.

The challenges facing human settlements, especially in developing countries, are inadequate and marginal access to safe water, improved hygiene and sanitation facilities on one hand, and increased frequency and intensity of resource stresses on the other. These broad issues impact on the livelihood, productivity, health and well-being of those affected (Ray and Shaw 2019). While there has been some progress, limited technical capacities combined with scarce resources mean that many countries and regions still struggle to achieve equitable access to water and sanitation. The challenges manifest in many ways including through:

- **Climate and environmental change.** Environmental change and adverse natural events affect economic, social, political activities as well as both the physical (built) and natural (ecosystems) environments. Climate change, weather cycles and variability influence resource availability along spatial and temporal scales. The impact is felt on human livelihoods, welfare and wellbeing, and consequences could include geo-spatial displacements due to conflicts, famine, floods, drought etc.
- **Income inequality and Livelihood.** Studies using tools like the Gini Coefficient, the Sustainable Livelihood Index etc. have demonstrated correlations and connections between access to human, physical, natural, financial and social capital (DfID, 1999; Donohue and Biggs 2015) and deprivation, wealth and livelihood inequalities. Wang, Qin and He's (2019) study found that inequality changed with the variation of natural, socioeconomic, and environmental conditions in time and space. Farrington, Ramasut and Walker (2002) also highlight this spatio-temporal variation, stating that the relationship between household livelihood strategies and environmental sustainability is clearer in rural areas where households are directly dependent on, and often forced to deplete natural resources for their livelihood activities (Ranganathan *et al.* 2018).
- **Population growth and migration.** The United Nations forecast that about 6.3 billion - two-thirds of the global population - would reside in towns and cities by 2050 (Mekonnen and Hoekstra, 2016; Stimmel, 2015). This wave of rapid urbanisation is partly due in part to rural-urban migration, and transitions in socio-economic trends particularly in developing countries. In addition to other factors, the need for improved income and livelihoods, as well as equitable access to resources can drive high levels of rural-urban, transnational or even transcontinental migration.
- **Spatial transitions and linkages.** Despite global urbanisation, linkages and flows of information between commodities, people, and monies between rural and urban areas remain (Unwin, 2017; Tacoli 2003). However, these flows may be disproportionate, promote inequalities or dependencies on external aid or support in resource-rich but product/income poor areas. Further, the limited spatial capacity of urban areas, rising costs and other social-economic factors has resulted in sprawls in the urban periphery and the rise in informal settlements.
- **Infrastructure.** All types of infrastructure: transport, water, energy etc. in both developing and developed countries are struggling to cope with the increasing demands due to all the above (Trebilcock and Rosenstock, 2015). This is in addition to the environmental and climatological challenges in both the built and natural environments. Where they exist, aging and poorly maintained water infrastructure compromises the ability to deliver resilient water access for many, particularly those in marginal peri-urban and rural areas.

The tipping point of population increase in urban areas, unmanaged resource abstraction, indiscriminate land development – typically housing, infrastructure differences, intersectional biases and difficulty in benchmarking rural and urban areas have resulted in uneven global distribution of available water (Bain *et al*. 2014), resulting in populations' with marginal access to water resources (Carr *et al*. 2015). It also confirms how societies that are at the margins of social, economic and infrastructure systems, also often have marginal water resources (Gatzweiler *et al.* 2011). Addressing this, requires an understanding of this marginality in order to identify opportunities for, and barriers to, developing more resilient systems (Husmann 2016).

This study examines urban and non-urban water in relation to water infrastructure and resilience. It builds on the interdependencies that exist between the different spatial strata and functions of infrastructures in human settlements. The decisions, activities and actions including the policy and procedural framework governing the built and infrastructure development of settlements in one area, impacts on the other and vice versa. Thus, to achieve infrastructure resilience, it is necessary to understand and address the connectivity between available resources, geographical/ecological limits, technological factors, policy/institutional innovation, economic opportunities and socio-cultural norms.

Is there an urban bias?

Marginality is an involuntary position and condition of groups at the edge of social, economic, and infrastructure systems. This marginality limits access to trans-spatial resources and services, restrains choice and prevents the development of capabilities causing poverty (Gatzweiler *et al.* 2011). Addressing marginality requires the understanding of the linkages between rural, peri-urban, and urban environments, how they operate as a system, and how administrative and environmental boundaries impact on resilience (Meerow *et al*. 2016). The rapid urban population growth and expansion of the built area, technological change, global economic restructuring and the impact of externally driven macro-economic adjustment policies have combined to profoundly alter the interface between the rural and urban in many places (Allen, 2012; David *et al.* 2006). This has resulted in efforts to categorise space and resources according to known parameters such as population, land use type and scale, infrastructure types and scale. However, the concentration on geographic location as a basis for defining urban, peri-urban and rural areas undermine an understanding of the rural-urban spectrum as dynamic, interactive and transformative (Fraser *et al*. 2017; Laquinta and Drescher 2000). Spatial flows and linkages between the population in low-and middle-income countries living either in small and intermediate urban centres or depending on them for access to goods and services are therefore overlooked (Tacoli 2003; Figure 1).

Fig 1. Rural-urban linkages (Adapted from Tacoli 2003)

The role for both rural and urban areas – and the associated infrastructure - to create opportunities in maintaining livelihoods, and for livelihoods to be sustained in rural and peri-urban areas through links with cities and adjacent urban areas are important for addressing marginality (Tacoli, 2018; Narain 2010; Tacoli 2003). Rural, peri-urban, and urban environments operating as a system rather than independently must be recognised. Therefore, it is necessary to study water access and resilient water infrastructure in the context of these flows and linkages, rather than in isolation of each other. Exploring these links ensure

that levels of capacities, vulnerabilities, imbalance and inequalities are holistically understood such that the right strategies are formulated to improve the capacities of all residents to benefit in rural and urban assets and resources as well as the consequential livelihood opportunities (Akkoyunlu, 2015; Narain 2010; Tacoli 2003). Figure 2 presents a graphical illustration of the conceptual indicators for a social-economic-ecological system. In this study, Wang *et al* (2018; Figure 2) researched administrative boundaries, highlighting the need to understand the systemic risks and spill over effects. Stating that without this, it would be difficult to find efficient policies to improve the urban planning systems, and to device efficient and effective resource allocation measures.

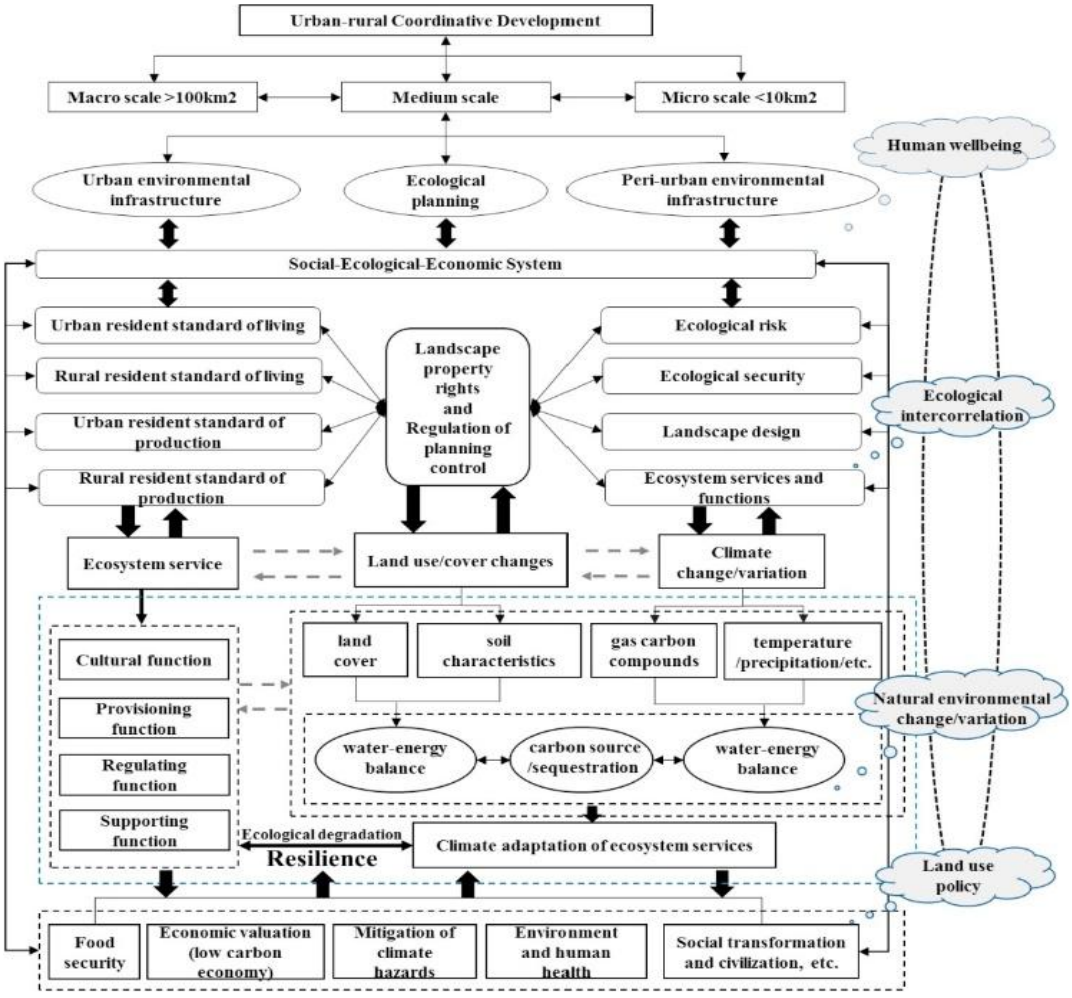


Fig. 2. Conceptual indicators for a social-economic-ecological system (Wang et al. 2018).

These conceptual indicators (Figure 2) are based on significant, rather than the absolute availability of natural resources in relation to population numbers and density. They are useful mechanisms, which regulate access to, and management of, such resources. However, land tenure systems and the role of local government in negotiating the priorities of different users and in providing a regulatory framework are also necessary to safeguard the needs of the most vulnerable groups while, at the same time, making provision for economic and population growth (Teshome *et al.* 2016; Tacoli 2003). Without ignoring the spatial differences in access levels, resources (land, water etc.) may be abundant outside of urban areas, but water infrastructure access bias can exist which can affect the developmental opportunities and resilience of the people located where the resources are exploited. Thus, WHO/UNICEF (2017) found that 80 percent of the people that lack access to potable water live in rural areas. Globally, 2 out of 5 people in rural areas use piped water supplies compared to 4 out of 5 in urban areas. In Sub-Saharan Africa, almost 20% of rural dwellers had to walk at least 30 min to collect their water compared to only 7% of urban dwellers (refer to Figure 3a & 3b). Therefore, it is important to identify where and how different

stressors interact to affect people's health, wellbeing and livelihoods (de Waal 2013). Inequality in environmental quality, shelter and access to both natural and social resources (such as education and healthcare) are rooted in social and political factors, as shown by the struggles and delays poor people face in getting water and achieving resilience e.g. avoiding pollution and flooding (Douglas 2012, 2006).

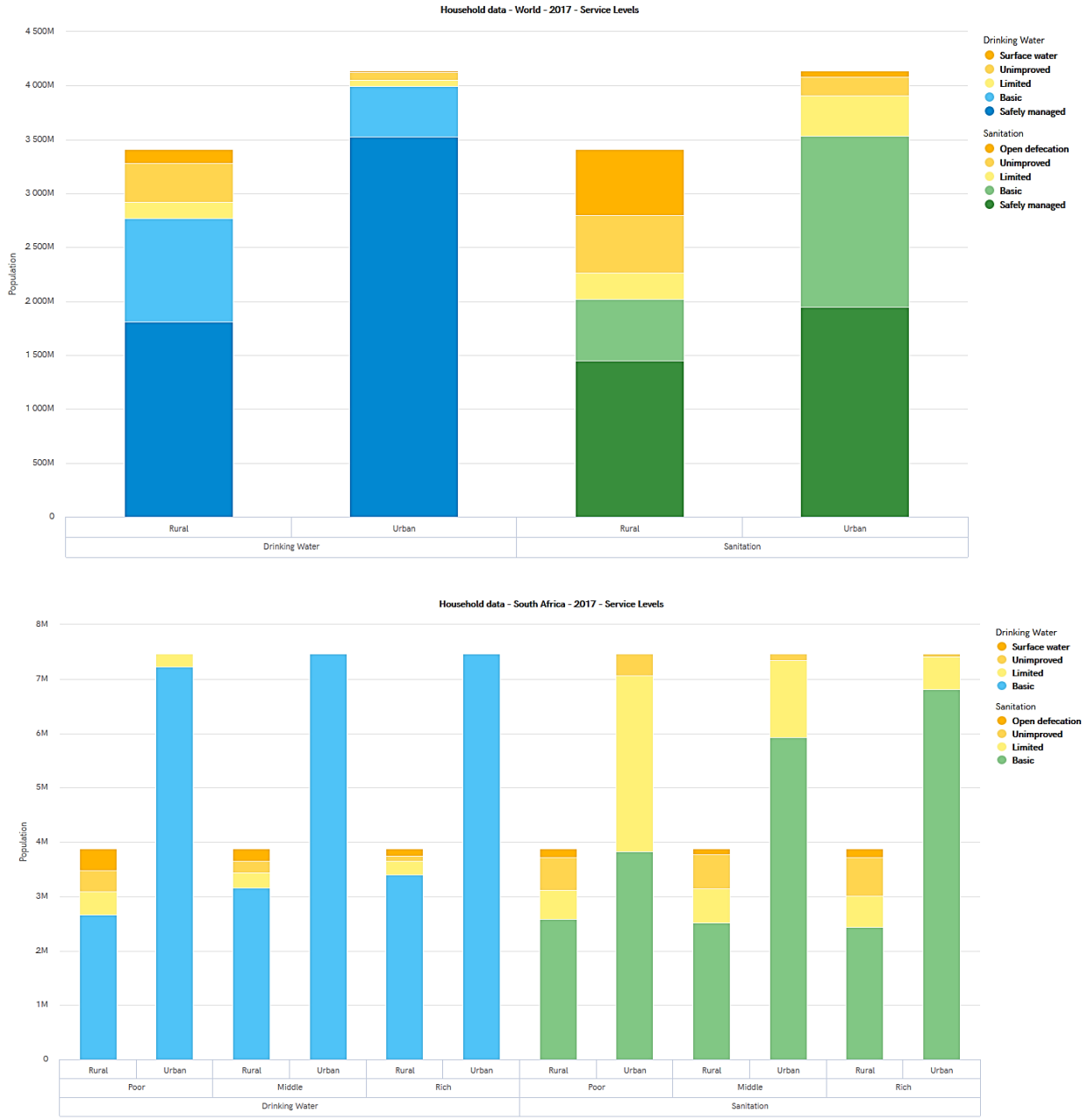


Fig 3. Rural and urban drinking water and sanitation service levels per population (a) World. Some country data missing (b) South Africa showing wealth levels. (Source: Washdata.org 2017: https://washdata.org/data/household#!/dashboard/new).

Dimensions of water access

The Oxford Dictionary define resilience along two dimensions: of People, collectively: The capacity to recover quickly from difficulties; toughness and Things: The ability of a substance or object to spring back into shape. Water systems by nature, are social–ecological–technical systems, comprising natural (hydrological and ecological), and physical, organizational, and social systems (Newman *et al.* 2011). A resilient water system will have the capacity to restore and maintain water services under extreme circumstances (Butler *et al.* 2017), including in the face of environmental, social, economic, and political

change. This cannot be achieved independently and without consideration of the inter-connectedness and collaborations across social, economic, political and organizational domains (Adeyeye *et al.* 2018). Adger (1999) confirms the strong links between inequality and resilience. Inequality reduces the communal allocation of resources and therefore the pooling of risk. The concentration of resources in fewer and private hands reduces the extent to which these are available to address hazards that may, for instance, result in water supply failures (Adger and Kelly 1999). The distribution of resources is primarily a function of local institutions and therefore the nature and structure of these is a key factor in addressing water marginality and improving resilience. Local institutions may be formal (such the state) or informal (such as cultural) and directly affect marginality by governing economic activity and property rights (Adger 1999). This can be illustrated through the provision of potable water to households; there needs to be a resilient water source, infrastructure for treatment and distribution and an organisational system and pooled resources to run the process and, expectations of the people who use and pay for that water (Geels *et al*., 2004; cited by in: Newman *et al*. 2011; Bettini *et al*. 2015).

Water infrastructure resilience, is a significant challenge to water security in developing countries, and the combination of both can result in marginalisation. Complex governance, skills shortages and competencies, limited financial resources and capacity, ageing infrastructure, and social acts like theft and vandalism mean that municipalities struggle to keep up with water demands and water service backlogs exist, in many urban areas (Fatti and Patel 2013; Wensley and Mackintosh 2015); and poor water service delivery in rural areas. A study by the Potsdam Institute for Climate Impact Research[1] found that the municipal (domestic) sector requires the least overall water resource, but adequate access to high quality water infrastructure and water quality are essential Their results in three case study countries found that infrastructure and water quality, rather than water resources were the limiting factor for adequate water access.

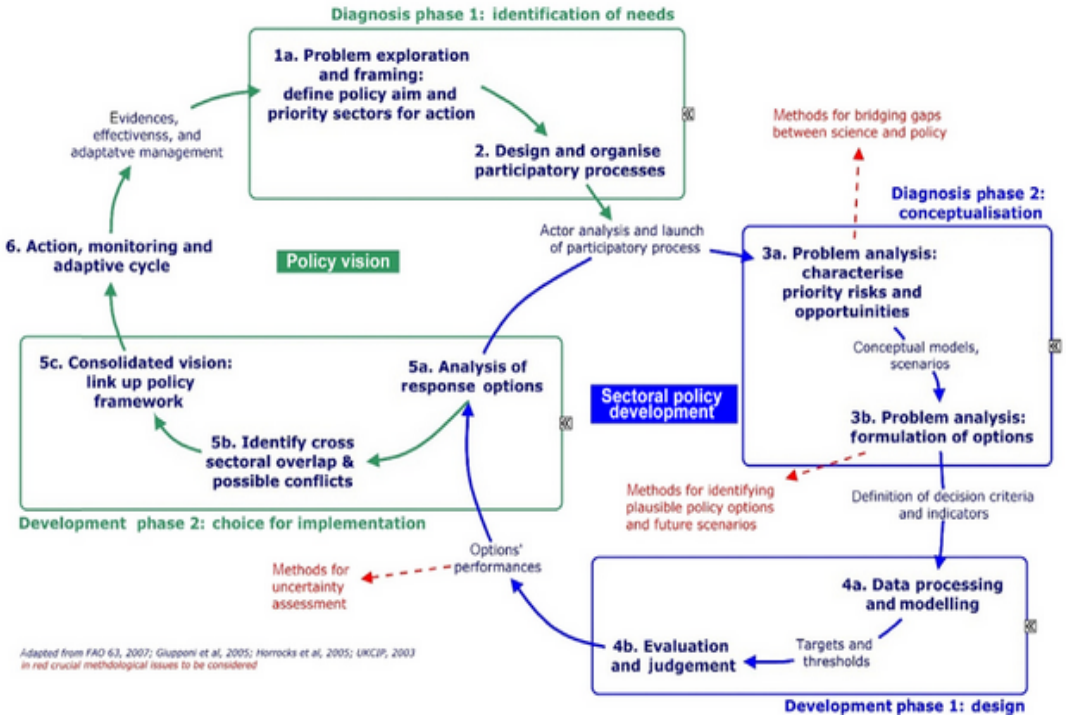


Fig 4: Cyclical decision-making flowchart for climate change adaptation and risk management (Giupponi et al. 2014)

Investments and efforts towards the equitable development of new water systems in unserved and under-serviced areas and the upgrading of existing systems offer the opportunity to develop systems that

[1] http://www.pik-potsdam.de/cigrasp-2/lhc/water-and-livelihoods.html

are more resilient to current and future issues such as climate change (Brikké and Vairavamoorthy 2016; Muller 2007). However, the multifactorial nature of water infrastructure resilience requires strategies that goes beyond financial instruments and investments (Figure 4). As water and sanitation infrastructure may last over 100 years before being upgraded, it is important that future variations, such as climate change, that may occur during its lifetime are taken into account in terms of water infrastructure and service planning. To facilitate improved service planning processes as well as transitions to multi-benefit water infrastructure, policy decision-makers must engage with stakeholders who have historically been excluded from the decision-making process (Pearson *et al.*, 2010). All stakeholders must be involved in defining goods and values and to articulate innovative options, whilst accounting for uncertainties about the future (Truffer *et al*. 2010). These niche actors need to be proactively engaged so that they can be strategically prepared at the onset of future extreme events if the transitioning opportunities associated with extremes are to be harnessed especially to expedite water system solutions (Keath and Brown 2009). Giupponi *et al*. (2014) agrees, but highlights the challenge of integrating and synthesizing for resilience without addressing the need to decide among contrasting definitions or omitting causal and functional relationships. Similar to Horita *et al*.'s (2016) breakdown of information and decisions, they proposed two coupled cyclic processes to better mainstream sectoral measures with policy implementation (Figure 4).

The South African Context

Africa is rapidly urbanizing at a growth rate of 3.9% through to 2050 (Bahri *et al*., 2016). Much of this growth is projected to occur in smaller towns with limited infrastructure. Therefore, new water supplies will be required in addition to addressing existing, large backlogs (Bahri *et al*., 2016; South African Cities Network, 2014). Densification and increasing populations in existing suburbs, as well as changing lifestyles, have increased water consumption (Popkin, 2006). Prevalent impervious landscapes have magnified runoff in many urban areas, increasing storm water flows and flooding (Roberts, 2010).

In 2017, Statistics South Africa estimated that 13.6% of households in South Africa lived in informal dwellings and a significant proportion of households (11%) did not have a water supply on their premises (Statistics South Africa, 2017). In addition, 18% of households in South Africa in 2017 were deemed to have substandard toilet facilities such as chemical toilets, pit latrines without vents or bucket or ecological sanitation (Statistics South Africa, 2017). Lack of maintenance of the ageing water infrastructure in many municipalities has also led to significant losses through leakage (South African Cities Network, 2014; SAICE 2011; Wensley and Mackintosh, 2015; Bahri *et al*., 2016). Increasing backlogs and poor infrastructure heighten the risks of poor health and the outbreak of disease (Gundry *et al*., 2004). Climate change has also had significant impact on rainfall, water resources and urban water systems. These impacts will become more severe and climate change models project increased occurrence of reduced and irregular rainfall in some areas and the intensification of extreme rainfall events and floods in other areas (Engelbrecht, 2016). Patterns of water scarcity also exist. In 2014, the Department of Water and Sanitation indicated that water resources in 30% of South Africa's towns were already in deficit and suggested that water shortages would be expected in at least another 15% of South Africa's towns in the next 5 years. With an additional 12% of towns suffering shortages in the 5 years (Department of Water Affairs, 2013).

South Africa's National Development Plan (NDP) acknowledges current water service delivery challenges within the spatial fragmented post-apartheid human settlements landscape (National Planning Commission, 2012). These include the limited capacity by poor households to pay for services, poor management at municipalities and limited capacity and financial resources to deliver services. It also includes insufficient bulk infrastructure to supply all households with electricity and water services. Lack of coordination and accountability was identified as key contributors to poorly planned development where infrastructure development has not been aligned with local water requirements. These challenges are compounded by a dwindling pool of experienced water engineers to support efficient development and maintenance of water systems as well as unrestrained water use by some users, which has meant there is insufficient water for others (National Planning Commission, 2012). Climate change is identified

as an issue and increased conflict and migration because of reduced water availability and food was acknowledged as a future risk.

Despite these challenges, the NDP sets the following broad targets for ensuring affordable and reliable access to safe water by 2030 (National Planning Commission 2012):

1. Expenditure on public infrastructure - transport, energy and water should be 10% of gross domestic product.
2. A comprehensive water management strategy including an investment programme for water supply and wastewater management for major centres.
3. A more effective management of water resources and infrastructure to include systematic monitoring that involves users.
4. A water demand-reduction target of 15% below business as usual by 2030 for municipalities, industry and agriculture and in urban areas.
5. A more effective and coordinated planning from local government to improve access to, and the reliability of, water supplies. While municipalities in most areas will retain the responsibility for managing water services, alternative solutions should be explored. These include community-based management, local franchising and the use of regional water utilities.
6. A review of norms and standards for water and sanitation services to consider whether service provision outside formal settlement areas is advisable, given the high cost of servicing scattered communities. As an alternative, a 'household grant for self-supply' is proposed.
7. More water reuse and desalination research to increase wider application where effective and to improve the skills base required to operate the systems.
8. Implementation of sustainable and integrated spatial transformation human settlements compact and dense developments to counter service delivery spatial fragmentation inefficiencies.

Methods

This research utilises an epistemological abductive logic qualitative approach (Thomas 2010; Ritchie *et al.* 2013) to synthesise subjective participant views and investigate the various categories of meanings that are unaccounted for by existing theories (Jacob and Buijs 2011). The selection of the participants and setting were purposive (Ritchie *et al.* 2013; Patton 2002). The work is underpinned by a single instrumental case study. In research, case studies give insight into an issue and multiple sources of evidence such as observations, interviews and narrative reports are used (Punch 2013 p. 144,145).

The study and approach builds on previous work by Rietveld, Haarhoff and Jagals (2009) and Majuru (2015) situated in the same Limpopo region of South Africa. The former proposed a technical assessment methodology for the water supply systems based on four criteria, namely availability, capacity, continuity and condition. The latter utilised qualitative methods to investigate the reliability of water systems in the peri-urban and rural areas in Limpopo based on criteria such as the quality, age and reliability of water systems, frequency and duration of supply, flow rate, cost of water service as well as the cost of coping with poor water service. Interesting findings include the general willingness to pay for more safe and reliable water services, , wealthier households having higher capacity to cope with poor or unreliable water access whilst poorer households experience a higher rate of water-borne diseases - diarrhoea, and pay a higher proportion of their income to access 'basic water'.

This study builds on issues of marginalisation in water access by exploring the technical, socio-policy and spatial biases. It focuses not only on the previously studied metrics such as availability, reliability but the extent to which policy and infrastructure decisions and actions impact on fair access, life and livelihood across spatial domains, and especially in non-urban areas. The research questions are:

1. What interlinked factors e.g. climate change, urbanisation, policy and economics, affect water access, water marginality and infrastructure resilience? Action: Examine the urban versus non-urban dichotomies as it pertains to inclusive water resource access.

2. How can water marginality be addressed? Action What can be done to improve safe and equitable water access for improved livelihood and resilience?: (a) Understand the non-technical factors including the policy and procedural framework governing the built and infrastructure development of settlements in one area, impacts on the other. (b) Formulate recommendations and actions for improved water access that emphasises the fair connectivity between available resources, geographical/ecological limits, technological factors, policy/institutional innovation, economic activities and socio-cultural norms (c) Understand the marginality aspects of the local context in order to identify opportunities for developing more resilient and inclusive systems.

Table 1. Research design

Purpose		Case study approach			
	Ethnography	**Interviews (unstructured)**	**Interviews (structured)**	**Focus group**	**Workshop**
Problem identification	X	X	X	X	
Current practises and impact		X	X	X	X
Risks and opportunities	X	X	X	X	
Future change			X		X

The findings contribute to the theoretical and professional discourse, on the resource interdependencies between the different spatial and infrastructure functions of human settlements. In this study and in the South African context, an urban area is defined as cities and towns with a high density of houses, commercial buildings, road and other transport networks. In 2015, about 65% of South Africans live in urban areas (Lall *et al*. 2017). Non-urban areas are villages and hamlets, often within travel distances to nearby cities and towns. The research design and purpose is summarised in Table 1.

The qualitative methodology approach are justified as follows:

1. **Problem identification**: Ethnography and resource maps, informal interviews.

Ethnography *(researchers)***:** The ethnographic study enabled the researchers to understand local issues and context, immerse in local cultures and understand issues which are outside their scope of experience. The researchers visited key urban, peri-urban and rural settlements as well as the main water sources – rivers, dams and reservoirs in Vhembe and other districts in Limpopo to understand the nature and use of accessible water resources. The study was conducted during two separate trips to the case study area during September (dry season) and March (wet season). Notes, voice recordings, photographs and sketches were taken to record observations and informal conversations with residents and people met in the streets, shops etc.

2. **Current practices, impact and future improvements:** Survey, workshop

Interviews *(government and professionals)***:** A semi-structured interview was conducted with a key water resource decision maker in the district. Further, 11 structured interviews of key planning and water resource planners were conducted. The interviews aim to explore the spatial, economic and social challenges for delivering and maintaining resilient water infrastructure in the region. The questions helped to further understand the policy and decision-making processes and how the relationship and interactions between urban and rural areas affect water access for the population.

Focus group and narratives *(community and professionals)***:** The interface between rural, peri-urban and urban areas can result in changes in livelihood opportunities and options including unequal distribution of risks and opportunities (Narain 2010). The impact on the population will vary depending on households' and individuals' wealth and status, the knowledge and adaptive capacity of the various stakeholders as well as the policy and governance frameworks for water services. Therefore, a community focus group was held in one of the key villages affected by severe water access issues. A 1-day workshop was also held with water infrastructure and planning professionals

to further understand risks and opportunities, and provide training to address key knowledge capacity gaps.

Table 2. Professionals' profile

Interviewee	**Job title**	**Experience (years)**	**Gender**	**Municipality (district or region)**	Municipality profile	
					Rural/ peri-urban (%)	**Urban (%)**
A	Deputy director, spatial planner	11-25	Male	Limpopo	80	20
B	Town and regional planner	11-25	Male	Capricorn	30	70
C	Town planner and GIS graduate	1-5	Male	Vhembe	80	20
D	Town planner	1-5	Male	Thulamela/ Vhembe	80	20
E	Town planner	1-5	Male	Thulamela	80	20
F	Water Manager	20	Male	Vhembe	80	20
G	Land use management officer	1-5	Female	Vhembe	80	20
H	Town planner	20	Female	Capricorn	80	20
I	Town planner	6-10	Female	Sekhukhune	80	20
J	Spatial planner	1-5	Female	Vhembe	80	20

Case study

The Limpopo province in South Africa shares international borders with Zimbabwe, Botswana and Mozambique. The region hosts the Waterberg biosphere consisting of the Bushveld, and part of the Kruger National Park. It has the highest deposit of Platinum in South Africa as well as some coal reserves. The main economic activities are mining, agriculture and tourism. Limpopo is divided into five district municipalities: Capricorn, Mopani, Sekhukhune, Vhembe and Waterberg, which are further divided into 25 local municipalities. 97.3% of the population is Black, the highest regional percentage in South Africa. The area is water stressed due to a number of factors (Nel and Driver 2015):

- High variability in amount of rainfall per region, coupled with high evapotranspiration rates
- High probability of cyclical extreme environmental events e.g. droughts and floods
- High impact, over-abstraction of limited freshwater resources
- High water demand to supply ratio

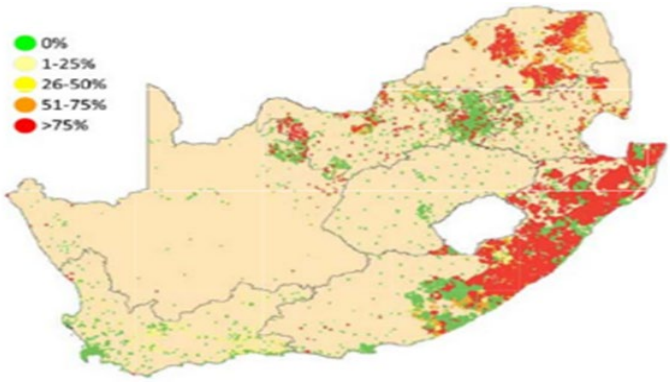
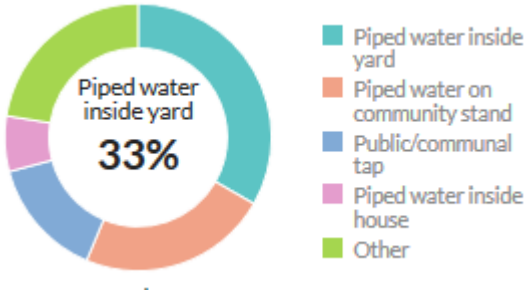


Fig 5. Backlog of water supply to households in Limpopo, South Africa (Source: Department of Water Affairs)

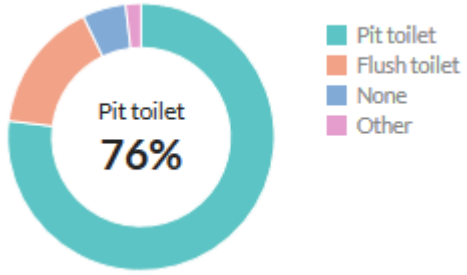
Limpopo's five district municipalities cover 125,806 square kilometres, with a density of 46.1 people/km2). Limpopo has a population of 5,799,090, consisting of 1 601 083 households. An example profile of Vhembe district municipality, one of the 5 districts in the province are as follows: The municipality covers 25,838.9 km2 and as at 2016, it has a population of 1 393 946, median age is 21 years old (Limpopo: 22). On average, there are 53.9 people/km2. There are 382 357 households, 2.8% live in

informal dwellings (Limpopo: 4.8%). Employment rate is 24.9% (Limpopo: 27.41%, SA: 38.3%). Median estimated annual income is R15,000 (Limpopo and SA: R30 000). 78.1% have basic access to water in various forms and 5.2% have no access to any form of toilets. Comparatively, only 3% have no access to electricity (Statistics South Africa 2016; Figures 6a & b).



	Vhembe		Limpopo		South Africa	
Piped water inside yard	33.30%	464,014	36.00%	2,089,675	29.70%	16,523,269
Piped water on community stand	23.00%	320,993	16.40%	950,339	9.20%	5,116,890
Public/communal tap	14.60%	202,751	9.50%	552,673	4.60%	2,550,910
Piped water inside house	6.70%	93,471	11.50%	665,855	42.40%	23,571,808
Other	22.40%	312,721	26.60%	1,540,547	14.20%	7,890,777

Fig 6a. Water source per population in the sample district, Limpopo and South Africa



	Vhembe		Limpopo		South Africa	
Pit toilet	75.80%	1,056,652	72.70%	4,215,986	30.20%	16,788,957
Flush toilet	15.70%	219,102	19.50%	1,129,271	58.50%	32,568,164
None	5.20%	72,237	3.50%	200,951	2.40%	1,332,582
Other	1.80%	25,527	2%	113,084	1.70%	948,024

Fig 6b. Toilet facilities per population in the sample district, Limpopo and South Africa

A visual catalogue of the province are shown below.

Fig 7a. Comparative impact of weather and climate variability on vegetation

Fig7b. Economic activities range from one man businesses, to many shopping complexes and industry to support the agricultural sector

Figure 7c. Tourism activities includes safaris, ranching, supported by businesses including clothing, guns and armoury, bait, tour guides etc.

Figure 7d. Mining and agricultural plantations are prevalent. Some impact of agricultural activity observed on nearby water sources even during the wet season.

Fig 7e. Prevalence of scattered, sparse peri-urban and rural settlements in the province. Housing typologies range from traditional adobe with thatch roofs to modern block construction with metal roofs. The location of the settlements are typically unplanned with ungraded roads.

Fig 7f. Urban dwelling are typically single or double story housing with front lawns and fenced/gated boundaries. Houses in urban areas have metered piped water supply. Typical meters shown to the right.

Findings

The main interviewee was a Water Authority Director and Chairperson of the Water and sanitation forum in one of the province's district municipalities. His roles include interpreting and implementing water and sanitation policy, working collaboratively with other municipalities to meet water and sanitation targets, formulating water plans, overseeing implementation, and troubleshooting. Other duties include knowledge capacity, resource and finance management. It was found that over 800 peri-urban and rural areas in the municipality experience severe water access issues in this district alone. Most rely on periodic water tank supply, which is not adequate, reliable or sustainable. Therefore, an ethnographic visit and focus group was held with the community water group in one of these water scarce areas - a small settlement of about 800 adults, to explore the water infrastructure challenges first hand and understand the social, livelihood impact. The settlement has a primary school and a day care in the community centre. Other facilities – healthcare, secondary education etc. are in nearby towns. The team met with the Water Steering committee, which consisted of the Mayor (unable to attend), chief elder, chairperson and representatives from the Youth Association, Councillor, Municipality Water Director (interviewed), other male and female representatives. After discussions, the team and the group visited the water infrastructure in and around the settlement.

Fig 8. Top left: Images of emaciated animals and dried-up Local River. Top right: Water access point at neighbouring settlements with irregular supply. Bottom images: visit to one of the boreholes 2km from the settlement. The borehole has some water but has been vandalised and pumps stolen.

A workshop was also held with water and planning professionals representing the 5 districts in Limpopo to further explore the findings so far and understand the linkages between settlement development, and water access inequalities. The event took place in two parts: a training workshop for 30 water and urban planning professionals and a structured interview of 10 sampled attendees (Table 2). The structured interview aimed to investigate the contextual issues and challenges pertaining to water infrastructure and access in the municipalities in the region. It also aimed to understand the policy and decision-making processes and how the relationship and interactions between urban and rural areas affect water access. In the following sections, the interviewee consensus was discussed as few*: if less than 2 agree*, some: *if 3-5 agree*, many: *up to 7*, most/majority: *if more than 7 interviewees agree*.

The broad range of gathered data and information provided insights into the explicit and subjective water access issues of this case study area. The multiple perspectives were also invaluable for cross validating the findings. The findings are structured and discussed based on adapted criteria from Nefale, Kamika and Momba (2017) triangulated again the UN's water security metrics (Table 3).

Table 3. Qualitative findings, analytical structure and approach

	Municipality	**Community**	**Professionals**
***Policy and* management issues and practices**	Effective water policy	-	Water governance; policy implementation
Physical and resource factors	Water supply infrastructure	Consistently sufficient water supply	Water availability
	Water access	Physically accessible water	Water access and distribution
	Water quality	-	Settlements, urbanisation
Human resources	Knowledge capacity	-	-
Financial systems	Infrastructure funding/ Finance	Affordable water	-
Communication systems	-	-	Information and communication strategies
Safety, Health and Environmental quality	-	Acceptable water	-
	-	Safe water	-
	-	Locally/socially sensitive access solutions	-
Community involvement and awareness	Water demand	-	-
	Security of supply infrastructure	Impact of anti-social behaviours and crime on water supply	-

Policy and management issues and practices

The municipalities prioritise water supply over sanitation. The national Natural Water Act (Act 36 of 1998) focusses on improved access to rural areas; infrastructure maintenance; water and climate change adaptation and resilience. However, there remains a lot of focus on the resource (where it is and how to abstract it), than on the infrastructure. "*Water supply to non-urban areas are costly in terms of material, then money, then time, this increases the risks".* There are currently over 5,000 boreholes (pumped or non-pumped), 9 dams, several weirs in the district. Rainwater harvesting is considered not viable as there is inadequate supply and where viable, positive public perception is low. Dam supply is failing and expensive to construct and maintain. Still, "*there are plans for better waste water systems and four major water supply schemes which will be managed by the Department of Water and Sanitation".* With new infrastructure, the questions are *"What type? What scale? How will they be monitored and managed? Do we have the capacity and competencies?*

From the professionals' perspective, the participants confirmed that the local government was responsible for water provision including the associated infrastructure in rural, peri-urban and urban areas of the districts. Some mentioned that the regional government played some role, whilst others highlighted that private individuals were more likely to source their own water in non-urban areas. It was stated that most municipalities have a Water Plan, which is typically communicated during public consultations. Half stated that there are different water access policies for urban and non-urban areas whilst the rest said it was the same. Comments on special provisions to address gaps include:

> *"Focus on integrated water supply and services"*
>
> *"Urban areas are charged for usage, while rural areas do not pay at all."*

"Water tankers; water reticulation connections are provided in non-urban areas (urban areas have mains tap supply)"

There was no real consensus on economic, social and environment priorities in the water plans. Comments show the contradictions in the implementation:

"The policy is well prepared and documented but implementation is weak"

"There are environmental aspects such as forests and wetlands that need conserving in the areas that have a lot of economic aspects e.g. fertile soil where people practice farming"

Most professionals agreed that the water policies or plans in their areas considered minimum travel distance for water, minimum water quality standards, water pricing, and infrastructure provision per set population. However, the challenge was not the policy but the implementation. The participants stated that the water policies and plans are ineffective for reducing environmental impact, and moderately effective for promoting sustainable practices. Most considered the water plans moderately effective for delivering improved water access for all. However, it can be effective for creating local jobs, increasing skills and training and increasing land and property value. This suggests more emphasis on economic/livelihood benefits compared to environmental and social – health and wellbeing. The majority stated that population growth, nature and type of settlements inform how and the level of water infrastructure provision in the municipalities. Most agreed that the structure and operation of local or regional management are significant determinant factors, whilst others stated that the amount of available water resources is the deciding factor, more than the water quality or the type and quality of the infrastructure in the municipality.

Questions on the extent to which spatial-infrastructure metrics such as distances between settlements, to local schools, hospitals and work places impact on municipality policy and decisions on water provisions were asked. The views again varied with some consensus that housing, access to government institutions, the distance between urban and non-urban areas, access to employment and labour markets, and access to healthcare and educational facilities are occasionally considered when making water supply decisions at the municipality level. There was also a prevailing view that access to good roads and public transport, as well as to other localised resources are rarely considered. There were split views on support for local agricultural activity where for some municipality this is rarely considered whilst others always include this in decision-making. The ethnographic study and visits confirm this for the municipalities with large agricultural industries. Other notable comments from the professionals include:

"Water access mainly focussed on linkage (infrastructure) from source (rural area) to supply (urban area). Other socio-economic drivers are not normally considered".

"Water shortage in non-urban areas depends on the villages as different situations apply".

"The municipality is doing little to encourage communities to use non-centralised solutions".

Physical and water resource factors

The ethnographic visits found that water sources were depleted and/or over-abstracted in many places because of natural and man-made factors. Water systems in non-urban areas consisted of private wells, municipal supplied boreholes, rainwater capture (minimal), transportation of water in jerry cans using wheelbarrows, drums on donkey carts, using buckets of water (often women). This confirms the findings from the previous studies. The National Development Plan (2030) acknowledges problems with current water systems model and suggests more local devolved systems, which include households (household grant), communities (community-based management) and private sector (franchises). However, many informal conversations with the public in particular confirmed that the current system was inadequate and new models of governance and service delivery was needed.

According to the municipality water director, water supply to non-urban area was challenging because *"this municipality (areas covered) has diverse water availability issues and people perceive water*

availability in different ways". The fundamental challenge for the municipality is water availability: "*Where is the water source? – There has to be water in the first instance. Then, where is the demand and how to get the supply to the demand? These before demand management, and level of service (urban and rural areas have different defined levels of service for instance)".* Demand management covers billing, water awareness campaigns and metering. *"Water resources and supply to the centralised urban areas are adequate. The challenge are the extreme (peri-urban, rural) zones where there are little or no water sources. Rivers are seasonal (with rainfall). So there is over-reliance on underground sources through boreholes. Therefore, for outlying areas, the challenge is the source of water, and management where water sources are constrained*. *In addition, many settlements develop in locations that have no water; still people expect water to be provided to meet changes in lifestyle".* In the western area of the catchment, there is a lot of nitrate in the water. Other areas have high fluoride content so water quality is a challenge. Treatment interventions are needed either at the point of abstraction or at the point of treatment. These are infrastructure and cost intensive.

Professional interviewees were asked to compare water availability to urban versus non-urban areas. The view from two participants from one municipality was that water shortages occur all the time in both urban and non-urban areas. However, for the majority, it was rare or for less than 3 months in the year in the urban areas, whereas it was all the time or for 9-12 months in the year for the non-urban areas. The reasons for shortages were predominantly climate change, population growth, nature and number of settlements and local water resource management, or lack thereof, and lack of innovation in the water sector. Followed by the quantity and quality of available water sources, type and quality of water infrastructure and poor water practices or demand management.

For the community, it was more about whether the water supply was sufficient. The WHO indicates that between 50 and 100 litre per day per person are needed. Supply must be sufficient and continuously available for domestic use including drinking, washing and food preparation. In their settlement, the water supply used to be from a river (now dry) and boreholes. The boreholes were installed by the municipality and all except one are dry or in a state of disrepair. The one functioning with some water has been vandalised and the pump stolen. The boreholes are located where there is water but these are typically are far from the settlement (the one visited was 2km from the settlement) – making them difficult to protect from vandalism. Alternative, improved water sources are in nearby towns and villages; a journey of 10 – 51km is required to access water. Yet, these sources are not regular or reliable so there is no assurance of water even after undertaking the journey. For those than can travel to reticulation points, water costs around R5 for 20 litres, the same amount from resellers will cost R20. The energy supply to boreholes are unreliable. The municipality requested assurances against vandalism and theft for some boreholes to be reinstated. The group responded that in view of the extreme nature of their water stress, the community would make every effort to safeguard water sources if reinstated by the municipality. Comparatively, those in urban areas with piped supply pay R3-4 for 1m3 of water. These issues highlight the opportunities for municipalities to work collaboratively to design, implement and manage water infrastructure.

Human resources

The municipalities' human resource capacity to manage existing systems are low. Knowledge capacity to implement schemes were also found to be low. The government restructuring of departments from the national departments to local municipalities have caused problems: People were transferred to national departments to municipalities; new staff were not effectively integrated; no education/training provided at start; experienced staff retiring without adequate knowledge transfer mechanisms in place. There are also no funding to employ new skilled employees. "*So there is reliance on automated systems where it is cost effective or affordable. However, these tend to be vandalised as no-one is there. Day and night staff are needed".*

Financial systems

"*We currently receive about 16% of the operational expenditure (OPEX) budget needed per annum to maintain existing infrastructure. Therefore, there is currently R23 billion in maintenance backlog".* OPEX budget for sanitation and sewer management also insufficient. Funding models do not account for regional differences, challenges e.g. size, and amount of infrastructure, source and location of water supply etc. No capital expenditure (CAPEX) funding for sewerage/wastewater infrastructure, even for new settlements.

Majority of the professionals stated that water infrastructure investment was highly prioritised in urban areas, with medium to low priority in non-urban areas. There was no consensus on water infrastructure schemes that connect urban and non-urban areas. Interestingly, half of the participants said there was medium priority to achieve human development goals such as water, hygiene and sanitation. However, higher priority was given to economic activities such as agriculture and industry e.g. mining and manufacturing. As a result, water access in non-urban areas is nearly always from private wells or boreholes, directly from water bodies e.g. lakes and rivers, municipality-provided water tankers/bowsers or from private sellers using 'bakkies'. There is little or no support at the municipality or community level for alternative water supply solutions e.g. rainwater harvesting or water reuse for irrigation. Little is being done by the municipalities to provide information or advice, training or demonstration, or financial incentive schemes, although, some effort has been made on simple water treatment solutions to minimise health impacts. The participants felt that the lack of municipality and community support affect the wider uptake of alternative water solutions. However, they felt that this was more due to the lack of information and awareness, cost and complexity of technologies and in some cases lack of land/land tenure or building materials (e.g. thatch roofs). The interviewees recommended these financial measures: *"incentivising people to report water leakages, keep pipes closed after use", "By-laws that penalises wasteful water usage - watering of gardens", "tariff system that penalises use of water beyond minimum thresholds", Implementation of metering and payment service/ engineering contribution to the municipality for business users".*

Communication systems

Some of the planners mentioned that some municipalities use public media notices or direct communication e.g. letter or email. One participant said: "*Low level of information leads to lack of interest in information about water".* Majority however stated that local communities are involved in water infrastructure decision processes through the Integrated Development Planning (IDP) forums and other consultation processes. Although one commented that: "*They (people) are only involved in participation that stipulates the services they need from the municipality, rather than infrastructure*". There was no consensus on whether the feedback from Integrated Development Plan (IDP) processes inform water infrastructure decisions and actions taken by the municipalities. With some stating that this is always, occasionally or rarely the case.

Safety, Health and Environmental quality

People considered water from improved sources e.g. via boreholes or water tanker supplies to be safe. Whilst access to quality sanitation services with or without water remains a challenge. The focus group highlighted the problems of improper cleanliness and hygiene, and the instances of poor health in the community due to lack of reliable water supply. The lack of water in general makes whatever available source of water acceptable. Self-treatment using basic techniques are utilised where possible. The team visited the only borehole where water can be extracted with some effort. The water was visually of poor quality, but the community reps considered this acceptable as long as they had access to water.

Community involvement and awareness

Informal conversations with the public during ethnographic visits found that many rural settlements are characterised by high unemployment, with many of the economically active men and woman departing

to urban areas. Some capacity for local social organisations and structures other than traditional administration (chiefs) and local councillors (ANC etc.), church and other civic organisations were observed. However, the capacity for these groups to effect improved water services were not apparent.

"No water, no life" said the chief elder of the settlement. The community group persistently raised the issue of equitable access. The fact that neighbouring towns and villages have direct access through pipes which by-passes this settlement by a mere 2.5km was raised. The impact on the health and sanitation especially for children as well as livelihood were also mentioned. Majority of the adults in this settlement were unemployed and unable to undertake subsistence farming. It was visually apparent that all farmlands and grazing areas were dry and the animals were emancipated. The housing typologies in this settlement consist of round, single-room traditional adobe huts with thatched roofs, and more modern 1-2 room block-built houses with metal roofs. When asked about alternative water and energy sources, the group mentioned that there has been less and less rainfall in recent times. In addition, it is difficult to collect water from thatch roofs, and when mentioned by the researcher, they had not considered the option of covering the roof with a membrane to overcome this barrier. The cost of rainwater systems was also mentioned. Similarly, energy was needed for the pumps even if the boreholes were serviceable. Solar power is viable but constrained not just due to cost but also anti-social issues like vandalism and theft. The quote at the beginning of this section was repeated several times during the meeting and shows the mood and contagious despair of the participants. The link between water, health and livelihood were reiterated including: the lack of income and job opportunities especially through local enterprises and agriculture. The lack of youth employment and dependency on government aid, as well as the lack of educational progress and productivity.

Comparatively, the municipality officer stated that "*Lifestyle is driving up demand e.g. increase in outdoor water use, car washing is an increasing trend. This creates jobs but wastes water*. *Also, people don't want to pay, they expect the government to pay".* He highlighted that social issues like illegal connections and vandalisms are prevalent. However, recognised the need for better community engagement and communication. The IDPs offer opportunities for both bottom-up and top down hybrid solutions/systems. So there are opportunities to explore decentralised solutions for resilience, to improve community stewardship of existing capacity (e.g. to reduce vandalism), and to increase local capacity to own and manage their water infrastructure.

The professionals also raised social factors such as *"Rising domestic usage", "Service delivery protests", "Elections, strikes, protests and vandalism", "Population growth", "reducing cholera and other epidemics", "the leadership influence – importance of good leadership"*. External social drivers were also raised e.g. *"Rising domestic usage", "Service delivery protests", "Elections, strikes, protests and vandalism", "Population growth", "reducing cholera and other epidemics", "the leadership influence – importance of good leadership"*. Majority stated that water demand and management practices or innovation in the water sector e.g. exploring alternative water sources never, rarely or occasionally informed water policy. Some municipalities will consider water demand practices only if there is limited water supply.

Discussion

Due to limited social and market capacity to fulfil these roles, the government play a crucial role in delivering basic infrastructure and services such electricity, water in developing countries. Budgets are often enacted nationally, but the responsibility to deliver policies and development targets for basic water services typically rest with the regional and local municipalities. It was found that the good intent with water policy and instruments, and willingness at the municipality level to meet these challenges, does not always translate to equitable water access. Policy instruments and efforts to address these issues are constrained on the one hand by natural and environmental processes such as climate change and environmental and water quality degradation as well as the limited financial and knowledge capacity to deliver, innovate and maintain water infrastructure. And on the other, population growth, rising unemployment, unplanned settlements and sprawl, lack of accountability, policy and infrastructure

implementation bias between urban and non-urban areas, poor knowledge capacity and skills among municipalities, the prioritisation of economic and job-centric processes over other needs such as water and sanitation. These factors combined with limited livelihood opportunities - high unemployment and low income - exacerbate the gaps in water supply and service delivery to already marginalised areas. The impact is then cyclical with limited productively and livelihood opportunities, poor health and wellbeing, anti-social behaviours etc. which then translates to further risks in delivering better and more equitable water access.

Table 3 shows that water access issues and priority differs according to stakeholders. For the municipality, the challenges are due to, but also resolvable through more effective water policies, the need for improved and equitable infrastructure, finance and budgets as well as social issues such as managing water demand in urban areas, and anti-social issues. For the professionals, important are effective governance and policy implementation, water availability and fair distribution, planning and management of settlements and improvement social engagement through effective information and communication strategies. For the community priorities are fair and equitable water access that is consistent, sufficient, safe, and accessible. Equitable water access has direct bearing on their physical health, wellbeing and livelihood and the significant impact on quality of life and productivity of those with poor water access in marginalised non-urban areas were widely observed.

Table 3. Summary findings showing the challenges to water access

Physical	Technological	Social	Economic	Policy/Institutional
• Climate change, weather variability • Poor water catchment management; • Dispersal and sprawl; unplanned settlements; absence of land use schemes • population growth; Densification • Maintenance; maintenance funds • Source of water, connectivity and access to non-urban areas • Lack of sustainable water resources • Distance from water source to community • Water quality	• Rainwater harvesting; greywater usage, recycling • Lack of knowledge capacity and water systems, planning and management strategies • Poor infrastructure choice, implementation and maintenance; • Poor investment in new water infrastructure including water treatment works; • Cost of technology; availability of technology • Ease of use of technology; knowledge to operate and maintain technology • Use of chemical treatment of waste water impacting on natural ecosystems	• Poor knowledge capacity about the social, environmental and economic importance of positive water citizenship and behaviours; • Poor social capital e.g. through local water groups to safeguard water resources; • Ineffective use of public awareness and use of awareness tools e.g. social media • Lack of equity • Anti-social behaviours e.g. Crime, Vandalism, theft and corruption; • Social impact of poor water access including distance from water supply source • Unwillingness to pay for water services • Community engagement strategy • Local labour supply to support water infrastructure activities • Interrupted water supply impacts on health, wellbeing and livelihood; • Poor water quality impacts on health, wellbeing and livelihood	• Infrastructure costs; lack of funds; change costly to implement • High unemployment with low water competencies • Prioritising agriculture and industrial usage over domestic; • relying on vendors to supply water • Densification; connectivity or urban-rural linkages • Vandalism; • Cost; affordability; sustainability • No-budget in the municipality for IDP • Municipal cost recovery; loss of revenue for businesses; lack of investment	• Poor decision making about resource exploitation, distribution and management • Inadequate demand management measures • Poor or ineffective allocation and prioritisation of water resources e.g. over-abstraction for agriculture • Decisions influenced by political, economic drivers • Poor or inadequate balancing of social, economic and environmental goals • Poor decision making for resource as well as human resilience

Therefore, some degree of negative rural-urban interactions do exist as a result of resource and infrastructure mismatch between urban and non-urban areas. The negative non-urban versus urban gaps were found to be due to these internal/external, technical/non-technical factors relating to policy, resource and infrastructure mismatch. Summarily, the internal factors are:

- Unregulated and unmanaged human settlements, urban sprawl
- Policy and infrastructure implementation bias between urban and non-urban areas resulting in limited infrastructure investment and maintenance, and little or no consideration of alternative water technologies
- Poor knowledge capacity and skills among municipalities
- Poor liaison between policy maker, water providers and the community. For instance, water marginalisation in some communities are caused by inadequate or ill-maintained water infrastructure whilst in many; it is due to corruption, inadequate funding mechanisms combined with default of water payments, theft and vandalism.
- Unmanaged or unregulated water demand in urban areas and for economic activities, population growth and rural – urban migration, urbanisation and indiscriminate development of settlements are contributory factors.

External factors included:

- Natural and environmental processes such as climate change, and environmental and water quality degradation
- Industrialisation as well as macroeconomics whereby resource emphasis is placed on activities and the production of goods and services with minimal contribution or value to the local area.

The findings show that the pragmatic factors that affect water availability and access were multifaceted and across social, physical, policy, economic and environmental domains. The particularly: unregulated human settlements, local water policy and regulation, national water policy and regulations, poor financial management, inadequate financial incentives, poor local consultation and engagement, and minimum infrastructure investment and poor infrastructure maintenance, little or no consideration of alternative water technologies, and social factors such as theft and vandalism (Table 3).

Conclusion

The study presented in this paper water access and water marginality in non-urban areas. Water access challenges experienced in marginal rural and peri-urban areas were found to be across the following domains:

- **Urbanisation** (spatial/temporal): Population growth; Rural – urban migration not just of people but also resources, jobs, goods and services; Siting, planning and development of settlements.
- **Community** (Social): Little or no access to local resources where it exists, lack of ownership or engagement in decision-making processes, anti-social factors – vandalism, theft and corruption.
- **Technical:** Poor or inadequate water infrastructure, climate change and variable weather, and freshwater ecosystem decline.
- **Policy/ governance:** Policy based on population numbers and density are the mechanisms which regulate access to, and management of, such resources. This results in the inequitable distribution of resources, processes and practices for the abstraction, distribution and management of water resources. Other policy derivatives were found to include limited financial capacity and poor financial management including water charging processes, complex or ineffective governance; failure of policy to promote technical and non-technical innovation in water services including market-led, community-led solutions as well to failure to address water demand in urban areas and for economic activities.

These findings make original and significant contributions to the theoretical and professional discourse, on the resource interdependencies between the different strata, spatial and infrastructure functions of human settlements. It builds on previous work by Rietveld, Haarhoff and Jagals (2009) and Majuru (2015) based in the case study area. The previous and current findings effectively combine to establish the underlying premise of inherent interdependencies non-urban and urban domains:: dependencies that can lead to or exacerbate marginal water access for the former. Beyond defining sustainability goals and

setting water access benchmarks, the lack of understanding of these linkages and action through effective policy and professional practice will result in water access bias and water marginality. It confirms that the urban bias increasingly emphasised in sustainable development studies as well as the recent United Nations World Water Development Report (2019) – Leaving No One Behind exist. It also confirms the redundancy of existing strategies, which utilises the absolute availability of natural resources in relation to population numbers and density, as the mechanisms, which regulate access to, and management of, such resources. It highlights the gaps in urban planning, land tenure systems and the role of [local] government in negotiating the priorities of different users and in providing a regulatory framework which safeguards the needs of the most vulnerable groups while, at the same time, making provision for the requirements of economic and population growth (Tacoli 2003, 2018).

Therefore, the following policy and practice recommendations are proposed:

- Policy solutions to support de-centralised water solutions especially in non-urban areas. Financial/funding mechanisms needed to address income and affordability gaps.
- Improve financial accountability and sustainability; Innovative capital funding options for water infrastructure. However, this has led to a prevalence of Public Private Partnership (PPP) schemes, which may be costly and have negative social impacts. Alternatively, improved water systems that are run by municipality or private franchises based on borehole, dam, river, with the system maintained through local fees or through municipal funding.
- Policy to promote community/neighbourhood-level water schemes. For instance, shared borehole/well/large rainwater harvesting capacity, community based model to own and manage local water sources, operate, maintain and commission new water infrastructure systems. Proactively implement the water service plans; revise by-laws as necessary; engage with traditional leadership structures
- Policy for fair and equitable pricing and water access especially to non-urban, low-income households.
- Improve catchment management practices and solutions; reduce faction-based maintenance of systems; enact water catchment policy and provide adequate funding for implementation and commission good research to inform future investment and improve future resilience.
- Improve knowledge capacity of all stakeholders through effective information, communication and education policies. This will result in improved water decision managing, operation and management practices. Improve citizenship, social cohesion and avoiding conflict, theft and vandalism through water saving awareness campaigns to improve water behaviours and promote public participation. This includes making better use of social media, websites, IDP, public participation, water master-plan etc.

Globally, the sustainability development goals and activities need to redefine water access targets and associated metrics against the urban-urban bias by ensuring that: the minimum benchmark should be universal access to safe water *in rural areas*, not urban areas; and service levels, which covers water pricing and water quality, are measured against this baseline.

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