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WORKING PAPER

A CASE FOR WATER AND SANITATION IN SOUTH AFRICA'S POST-LOCKDOWN ECONOMIC RECOVERY STIMULUS PACKAGE

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June 2020

CONTENTS

ABBREVIATIONS

DWS	Department of Water and Sanitation
GTAC	Government Technical Advisory Centre
IAPS	Invasive Alien Plants
ILI	Infrastructure Leakage Index
NGS	Next Generation Sanitation
NRW	Tackling Non-revenue Water
PICC	Presidential Infrastructure Coordinating Commission
POU	Point-of-Use
PPPs	Public-Private Partnerships
SMMEs	Small, Medium and Micro Enterprises
SWSAs	Strategic Water Source Areas
WWTWs	Wastewater Treatment Works
WC/WDM	Water Conservation/Water Demand Management
WfW	Working for Water
WoL	War on Leaks
WSAs	Water Service Authorities

1. INTRODUCTION

In the face of COVID-19, the South African government organised the emergency supply of water storage tanks, water trucks and sanitisers to water-stressed communities. As of 29 April 2020, a total of 16 224 tanks had been delivered to various communities and 9 223 had been installed and attached to a water source (EWN 2020). This response, while impressive, is vastly insufficient given the needs of poor South Africans, and it is a relatively expensive intervention. Further, this provides only temporary relief to these disenfranchised communities. An opportunity presents itself as part of a COVID-19 infrastructure and job creation response to provide a more sustained and structural intervention by improving the country's water and sanitation infrastructure as well as redressing historical inequalities. Such an intervention would also contribute to sustainably managing water and sanitation, reducing inequality and, importantly, paying special attention to the needs of women, girls, and those in vulnerable situations.

South Africa is known as one of the most unequal societies in the world, displaying the highest Gini and Palma ratios. This inequality is also evident in access to water and sanitation. Despite some commendable progress over the past two decades, South Africa is still grappling with a historically rooted apartheid legacy. The COVID-19 crisis has shed further light on the lack of access to water and sanitation services in the country. Combating the outbreak requires strict hygiene measures to prevent infection and the spread of the disease, and a well-resourced healthcare system. Clean water is needed to wash hands and surfaces, while sanitation is necessary for safe disposal of human waste. The crisis has put the spotlight on the stark social inequalities in the country. In 2016, while 93% of South Africa's households had access to improved water sources, only 43% had adequate access to water services (i.e. their access was good across all dimensions). For sanitation, while 80% of the households in the country had access to improved sanitation facilities, only 25% had adequate access to sanitation services (Mudombi 2020).

Compounding the epidemic is that South Africa is a water-scarce country. Without intervention, a 17% water deficit is forecasted by 2030 (WRG 2009). Frequent and longer-duration droughts have also had devastating impacts on communities, notably in the Eastern Cape and Western Cape. Ensuring water security, while providing access to water and sanitation for all, will further stress the system. South Africa's water and sanitation infrastructure is at various stages of deterioration with many water treatment plants, wastewater treatment works (WWTWs) and the distribution and conveyance networks requiring refurbishment as well as new investment to increase coverage and demand needs (SAICE 2017).

Having a robust and resilient water and sanitation system would enhance the capacity of the country to respond to various challenges, including those presented by future pandemics, similar to COVID-19. Indeed, water and sanitation are profoundly cross-cutting issues, which have strong linkages with other sustainability aspects, such as energy, health, food security and water for economic development (The CEO Water Mandate 2012).

As South Africa responds to COVID-19 as well as aims to stimulate the economy and job creation post-lockdown through an infrastructure-led package, an opportunity should not be missed to address many of the water and sanitation challenges in the country. This is much needed and would provide multiple benefits not only to the economy but also the poor communities that need the infrastructure and services, as well as municipalities that require strengthening of their water and wastewater infrastructure. This working paper looks at the benefits of including water and sanitation in the country's stimulus package and considers possible avenues to do so.

2. MULTIPLE BENEFITS OF FOCUSING ON WATER AND SANITATION

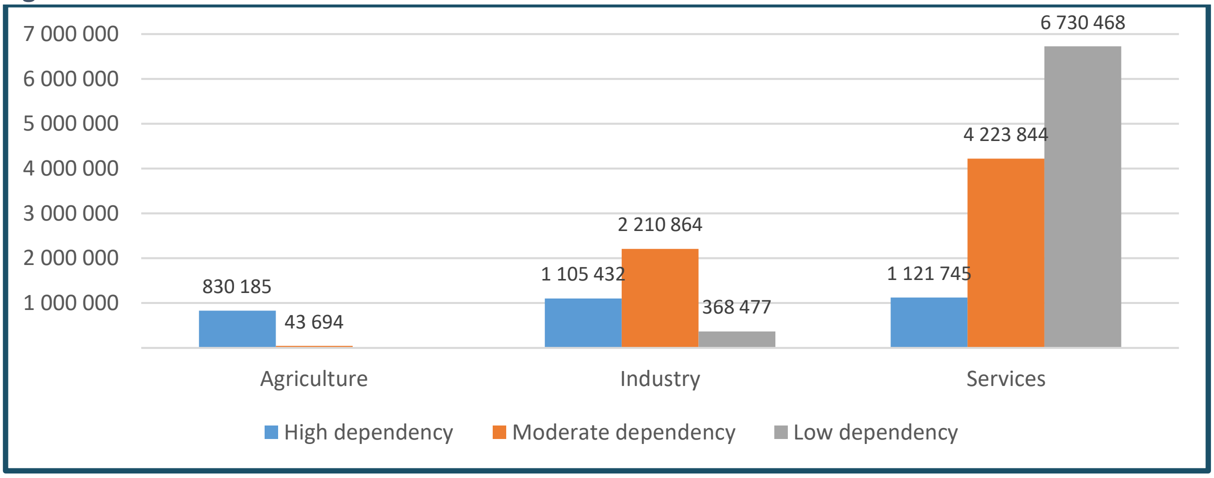
A focus on water and sanitation infrastructure as part of South Africa's economic recovery would bring multiple benefits. These range from poverty and inequality reduction, to improved health, pollution reduction, employment creation, strengthening municipalities, and industrial development. The multiplier effect of water and sanitation investment should be acknowledged in South Africa's journey toward economic recovery.

First, investing in water and sanitation is urgently required to ensure water security. The Department of Water and Sanitation (DWS) has estimated capital requirement of the water and sanitation sector is about R90 billion a year, with about R70 billion for water supply infrastructure, and about R20 billion for sanitation and wastewater collection and treatment (DWS 2018a). The current funding available is R57 billion, leaving a funding gap of R33 billion per annum.

South Africa, as a water-scarce country, has been grappling with an ever more stringent water crisis. Several regions, such as the Eastern Cape, have been struggling with water security for years and, in 2019, the Makhanda Municipality (formerly Grahamstown) introduced extreme water rationing. In early 2018, Cape Town implemented severe water restrictions to avoid a catastrophic interruption of supply and the so-called Day Zero.[1] Failure to strengthen water resources runs the risk of similar situations in multiple cities across the country and result in a water equivalent of "loadshedding".

Water availability is closely tied to sustainable livelihoods and critical to the economy and society. Without enough water, various socioeconomic activities are impossible or severely impaired and uncertain supply will lead to investment loss with disastrous livelihood and human impacts. Hence, ensuring water security would contribute to further economic growth and job creation, as well as protecting employment in the country. As presented in Figure 1, in 2016, about three million jobs in South Africa were estimated to be highly water dependent. The agricultural sector had the greatest proportion of high water dependency (95%), which translated into about 830 000 jobs. Industry had 30% of the jobs, or 1.2 million workers being highly water dependent. In the services sector, only 10% of the jobs were considered highly water dependent, but the large employment numbers in the sector amounted to about 1.1 million jobs highly dependent on water (Ward and Mudombi 2018).

Figure 1: Number of jobs shown by degree of water dependency based on 2016 employment figures

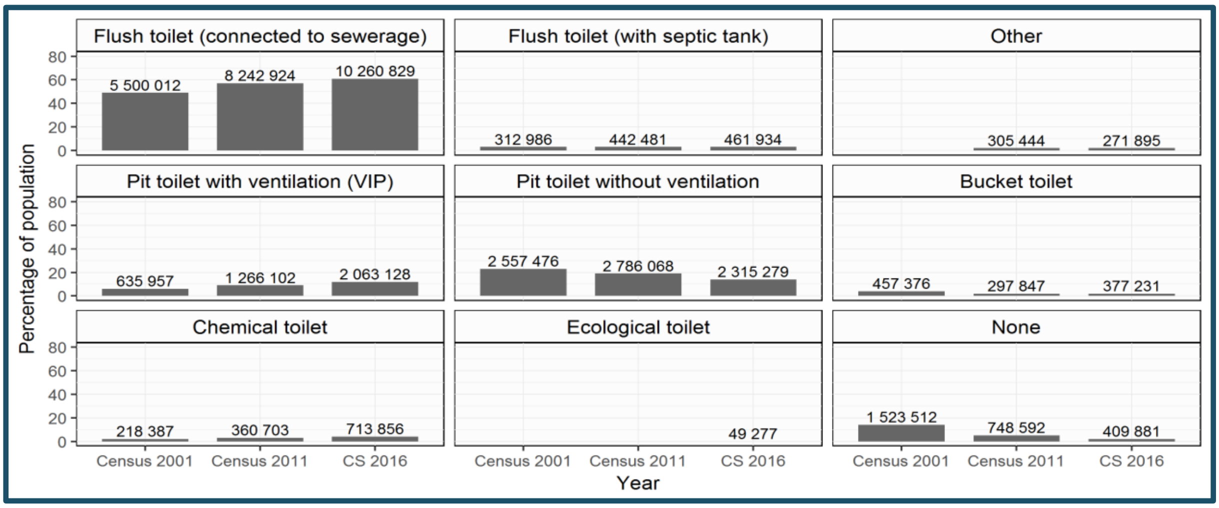


Source: Ward and Mudombi (2018: 14), based on data from Stats SA (2017) and definitions from WWAP (2016).

[1] During the crisis, authorities regularly modelled when Cape Town's municipal water supply would have to be shut off to preserve the water network and the functioning of critical activities. Dubbed Day Zero this day never materialised thanks to multiple interventions on the demand and supply side.

Second, improving access to water and sanitation would contribute to reducing multidimensional poverty[2] and inequality in South Africa. Inadequate access to water and sanitation services contributes to poor living standards, which exacerbates overall poverty and inequality, further raising the pressure on the health system and state dependency. A significant number of households still uses unimproved toilet facilities such as pit latrines without ventilation, bucket toilets, and some do not have any toilet facility (Figure 2). The lack of access to proper sanitation has a gender dimension. Women in most households take care of the family, including the sick and elderly. Often, the role of fetching water is also a burden that disproportionately falls on women (Mudombi 2020).Despite the emphasis on mainstreaming gender equality in the water services sector, the lives of poor women in this regard have not been substantively transformed in South Africa. This further impedes both poverty alleviation and sustainable development (Rust and Hanise 2009).

Figure 2: Percentage and number of households by toilet facilities in South Africa in 2001, 2011 and 2016



Source: Mudombi (2018a: 15), based on Stats SA (2016).

A COVID-19 stimulus package that prioritises water and sanitation access would also have major health benefits. Poor access to water and sanitation is associated with diseases, such as cholera and salmonellosis, and contributes to several neglected tropical diseases, such as intestinal worms (WHO 2019). Though preventable, these water-borne diseases kill about 1.6 million children each year across the world (BMGF 2010). In South Africa, the 2000-2001 cholera epidemic led to 114 000 cases, resulting in 260 deaths, the majority in KwaZulu-Natal where the outbreak started (Hemson 2016). Poor sanitation also contributes to anxiety, increased risk of sexual assault, lost educational opportunities, malnutrition and stunting (WHO 2019). Thus, the provision of safe water, sanitation and hygienic conditions enables the protection of human health during all infectious disease outbreaks, including the current COVID-19 outbreak (WHO 2020).

Third, the rollout of water and sanitation has the potential to stimulate industrial development and employment creation. South Africa has well-established local capacity in the water sector, with many firms involved in the research, development and production of water technologies in the country (Montmasson-Clair et al. 2017). South Africa's water market, supported by strong growth rates in civil engineering and equipment as well as components (respectively 18% and 17% of the market), reached US$9.5 billion in 2017. The market is, however, heavily dependent on imports. Despite noteworthy exports (between US$0.8 billion and US$1.1 billion over the 2012-2017 period), imports of water- and wastewater-related products are materially larger (between US$1.4 billion

[2]Multidimensional poverty is comprised of several factors that amount to poor people's experience of deprivation (Stats SA 2014).

and US$2.3 billion over the same period). This could open opportunities for import substitution, particularly for pipes, pumps and valves (50% of the total South African equipment market) as well as automation and control equipment (16%), which accounts for the bulk of the equipment demand in the country. With about two-thirds of expenditure in the sector allocated to operational expenses, the water market also provides many opportunities for small businesses to conduct the operation and maintenance of existing infrastructure (Montmasson-Clair 2018).

In addition, sustainable management of water resources has the potential to preserve as well as create jobs (Ward and Mudombi 2018). The approach used in the Working for Water programme has supported more than 20 000 people since its establishment and could be expanded through manufacturing wood pellets from invasive alien plants (IAPs). This could result in clearing an estimated 2.3 million hectares of IAPs, which in turn could generate many jobs and help households to transition from “dirty” cooking fuel to wood pellets. Combining potential job creation for clearing IAPs with manufacturing eco-matting products and wood pellets from IAPs would create further job opportunities (Jenkin and Mudombi 2018). Going forward, it is necessary to prioritise and embrace circular business and value-addition opportunities in intervention programmes. This regenerative approach of using waste as a resource would enhance local economic development.

Fourth, water and sanitation are central to South Africa’s transition to sustainable development. Beyond being one of the 17 Sustainable Development Goals, investing in water and sanitation allows governments to tap into opportunities arising from the shift to a circular economy. Adopting a circular approach (as opposed to a linear approach) goes beyond waste prevention and waste reduction to embrace technological, organisational and social innovation across and within all value chains to create synergy and realise multiple benefits (Zvimba and Musvoto 2018). Adopting a circular approach in the water and sanitation space relies on harnessing the value of used water and raw sewage to deliver new products, ranging from animal feed to plastics, cosmetics, nutrients and pharmaceuticals, as well as energy and water. A circular approach can generate economic benefits that can be used to establish and sustain sanitation facilities, with immense social and environmental co-benefits (TBC 2016). Sanitation can be transformed from a costly service to a self-sustaining and value-adding system of resources by embracing “human waste” as “toilet resources” (TBC 2016; Winblad n.d.). Accordingly, the National Water and Sanitation Master Plan (DWS 2018a) highlights that future approaches in the sanitation space must place more emphasis on resource recovery options.

Last, investing in improved water and sanitation solutions makes economic and financial sense at household, municipal and macroeconomic levels. New technologies, and fixing water reticulation infrastructure can generate financial benefits, either through cost savings or the creation of new revenue streams, facilitating the rollout of services. Globally, economic losses due to inadequate water supply and sanitation are estimated at about US$260 billion annually (WHO 2012). These losses manifest as premature deaths, healthcare costs, productivity loss, and time lost through the practice of open defecation.

South Africa’s water systems are highly inefficient. While this is largely in line with the world average, this is not tenable for a water-scarce country(Mckenzie, Siqalaba and Wegelin 2012). Water and sanitation interventions that enhance efficiency would generate water savings as well as other co-benefits for consumers and society at large. For instance, tackling non-revenue water (NRW) (discussed below)and promoting water saving both have positive economic benefits. Markantonis (2020) shows that reducing NRW by 30% would lead to annual gross domestic product (GDP) growth that is 0.7% higher compared to a business-as-usual trajectory (with a 17% water gap) over the 2012-2030 period. Likewise, an increase in water savings by 10% would contribute to yearly GDP growth that is 0.9% higher compared to business-as-usual scenario. Both would also contribute to reducing unemployment and increasing investment in the economy.

3. AVENUES TO INCLUDE WATER AND SANITATION IN THE STIMULUS PACKAGE

Several complementary avenues are available to emphasise water and sanitation as part of an economic recovery strategy. They encompass addressing NRW, fostering water demand management, investing in water and wastewater treatment, building ecological infrastructure, and rolling out smart water and sanitation systems.

Addressing non-revenue water

The first avenue to improve water and sanitation through a stimulus package is to address the disastrous state of the South Africa's water reticulation network. The poor condition of the country's water pipes leads to high percentages of water losses, in turn resulting in lower revenue for municipalities and higher costs for water service provision. The losses negatively impact on the ability of municipalities to provide sustainable and efficient services (Mckenzie, Siqalaba and Wegelin 2012).

Water losses can result from physical leakage (i.e. the water never reaches customers) or commercial losses (through incorrect or lack of billing for instance). This is captured as NRW, i.e. the volume of water supplied by a water utility for which it receives no income. About 2.6 billion m^3/annum (13.6%) of all distributed water in the country could be classified as NRW (Maila et al. 2018). The No Drop report (DWS 2015a) shows that the total volume of NRW from the country's metropolitan municipalities was 924 million m^3/annum, with the average NRW per metro at 35%. The National Water and Sanitation Master Plan (DWS 2018a) notes that municipalities loose about 1660 million m^3 per year through NRW, which amounts to about R9.9 billion each year (at a unit cost of R6/m^3) (DWS 2018a). While small, rural municipalities experience higher relative NRW percentages, about 75% of water losses occur in large metros. Importantly though, NRW and water loss percentages are increasing fastest in the B1 and B2 category municipalities[3] (DWS 2017b).

Aged and leaking infrastructure, due to a lack of proper maintenance, is the root cause of NRW. The average Infrastructure Leakage Index (ILI), an indication of the current physical losses versus the expected physical losses, stood at 5.4 for all metros in 2013/2014 – meaning that the current leakage in the system is 5.4 times the expected minimum leakage (Mudombi 2020; DWS 2015a). NRW is also associated with poor billing and a lack of proper metering (DWS 2015b). About half of the municipalities cannot provide reliable water balance data as a result of a lack of water meters and inadequate skills and capacity (DWS 2017b). Moreover, a significant number of water consumers, including many who can afford it, do not pay for the services they receive (Bekker 2016; Mudombi 2020). In addition, while these subsidies may be important for sustainable livelihoods, it is necessary for municipalities to be able to quantify and make explicit the extent of the subsidy and support to indigent households.

Addressing water losses would bring multiple benefits. Besides saving a vast amount of water, reducing losses would improve revenues for municipalities and water boards and delay the need for infrastructure investment for new water supply. When water is saved, opportunities are created for additional socioeconomic activities. Infrastructure refurbishment (reservoirs, pipe, water reuse facilities, water recycling, wastewater and sewerage refurbishments) furthermore creates

[3] Municipalities are classified into three categories, namely A, B and C. Category A consists of metros, B local municipalities and C district municipalities. The local municipalities have four sub-categories: B1, B2, B3 and B4. B1 consists of secondary cities and local municipalities with the largest budgets; B2 comprises local municipalities with a large town as core; B3 consists of local municipalities with small towns, significant proportions of urban population but with no large town as core. B4 comprises of local municipalities which are mainly rural with communal tenure (Stats SA 2016).

opportunities for partnerships between large civil engineering companies and small businesses. This enhances inclusion by supporting local businesses, often small, medium and micro enterprises (SMMEs), which can undertake a wide array of tasks including conducting the civil works, diagnostics, site preparation, and monitoring and evaluation. In fact, applying diagnostics and innovative technologies can accurately identify leaks hotspots and prevent large-scale digging up of the roads and other infrastructure, thereby preventing wastage.

Addressing NRW requires investment in improving the state of the water infrastructure, primarily pipes, as well as installing adequate metering and billing systems. Decreasing NRW is a cost-effective strategy, as the upfront investment is offset by the associated annual savings and/or additional income. To achieve this requires building significant capabilities at the municipal level and, at the same time, improving skills, increasing billing and collection, and fast-tracking maintenance.

Many reasons contribute to NRW, including that some municipalities lack the necessary skills and capacity to manage their water systems and water reticulation network. Municipalities are always in a crisis management mode with limited management information and poor decision-making processes (Mckenzie, Siqalaba and Wegelin 2012). For instance, some municipalities lack the capacity to develop bankable project proposals to access off-budget funding for water conservation and water demand management (WC/WDM). There is also a lack of political will to prioritise WC/WDM projects or their feasibility studies, coupled with low capabilities of compliance and enforcement authorities tasked with the responsibility to reduce water losses.

NRW can be tackled in a number of ways, all of which generate multiple benefits that include saving water, improving municipal revenues, and generating employment. Mckenzie, Siqalaba and Wegelin (2012) asserted that a realistic target for NRW of 25% is achievable over a period of 10 years if the required investment of about R2 billion a year is allocated to WDM interventions throughout all municipalities in the country. Though WDM interventions may seem expensive, they have the benefit of creating notable employment opportunities. For instance, there is a need for improved billing and tackling illegal connections in various municipalities. Plumbers, some of whom are unemployed, can be engaged to deal with leaks at household levels while fixing bulk and municipal pipes requires competent and experienced artisans and engineers.

Government initiated the War on Leaks (WoL) programme in 2015 in response to the huge water losses caused by failing/aging infrastructure and illegal connections (DWS 2018b). The programme was anchored in recruiting out-of-school youths to train as water agents, artisans and plumbers to deal with the leaks and other challenges. The programme trained 5 580 people in two phases. The programme, however, failed to address NRW as an issue and recent reports by DWS have shown that it was riddled with mismanagement. Training was essentially focused on outreach as opposed to plumbing and artisans. The shortage of qualified and experienced mentors in some municipalities compounded the problem of inadequate recruitment and curriculum. More fundamentally, the WoL programme did not provide the stimulus required to fix the pipes in municipalities.

Increasing the integration of information and communication technologies would also help improve service delivery, reduce losses and enhance water efficiency. Various software and devices have the capability to link consumption, payment, efficiency, awareness and training. The latter can stimulate behaviour change towards water conservation. If properly rolled out, they have the potential to improve the structure of engagement, interaction, and the quality of services. This could also be an opportunity for public-private partnerships (PPPs) with insurance companies and banks that offer “free apps” from South African innovators developed to monitor various aspects such as water use, geyser health, energy use associated with the bonded property.

Investing in water demand management

A second avenue is to incentivise material improvements in water demand management. The challenge of physical losses is indeed compounded by the wasteful and inefficient usage of water at the consumption level.

The agricultural sector, which accounts for two-thirds of South Africa's water consumption (Figure 3), is generally heralded as the first port of call for reducing water demand (Montmasson-Clair and Mudombi 2020). Water use in the agricultural sector is notoriously inefficient as a result of the lack of metered consumption, cases of unauthorised abstraction, and relatively low tariffs compared to other users (DWS 2017a).[4] Water supply for agricultural purposes is also largely financed through Water Use Associations where the users cover the costs of the water infrastructure and facilities that they use. This results in the agriculture sector accounting for only 2% of water sales in value (Figure 4) while consuming about two-thirds of the country's water. There is generally little incentive for agricultural operations to adopt water efficient irrigation practices. These dynamics make it imperative to improve the impact of agricultural operations on water systems, by reducing demand through improving water efficiency as well as reducing water pollution by minimising the use of agrochemicals.

To ensure food security while promoting employment creation and sustainable livelihoods in rural settlements, incentives should be put in place to foster water efficiency in the sector. Overall, the following interventions are required: metering of water (which may be utilised as a regulatory function for large productive farms); use of water administration systems for scheduling water use; precision farming techniques using drones and methods that increase food security through water efficiency; and innovative circular economy approaches to urban agriculture. Commercial farmers can be incentivised to reduce water use based on fair benchmarks. This could be linked to their "historic" water licences to change behaviour. Support could be delivered to smaller farmers (in particular black small-scale commercial farmers, as well as emerging and livelihood farmers) through aggregation (shared equipment, improved water and supply infrastructure, advisory services linked to crop type, soil-water-nutrient balance models developed for improved farming in water scarce areas, precision farming and crop rotation). PPP crop banks could be considered to provide market certainty for smaller, more vulnerable farmers. Support could also be provided to peri-urban zones within cities to encourage urban agriculture and strengthening food security.

Figure 3: Water use in South Africa

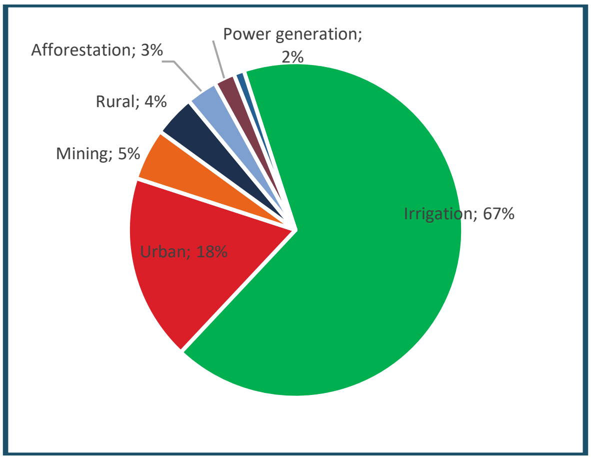
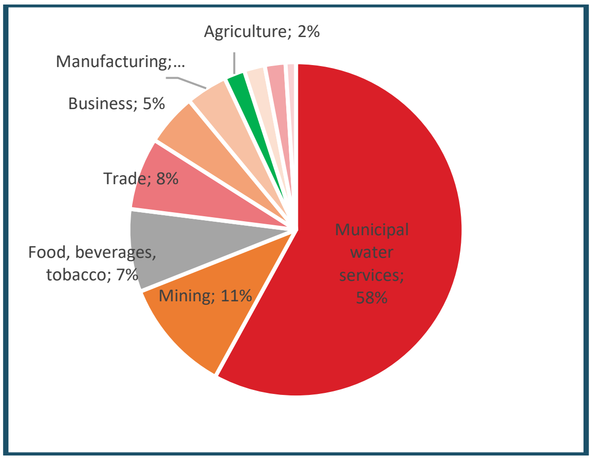


Figure 4: Financial value of water sales in South Africa



Source: Montmasson-Clair and Mudombi (2020) based on data from DWS.

4 This is somewhat compensated for by the fact that agricultural users generally use raw water (surface or groundwater) rather than water that has been treated and distributed by municipalities, which is cheaper in essence.

The potential to improve water consumption at the level of municipal consumers, i.e. mostly households and commercial buildings, is significant. Municipal water use, while accounting for only 18% of total usage in the country, corresponds to 58% of total revenue. Household demand management could generate significant savings (300-350 million m^3 annually), contributing to bridging about 10% of the supply-demand gap (WRG 2009). Strikingly, about 40% of water consumed by households in the country is just to flush toilets (Burger 2015; Mudombi 2018a). About 6L to 9L of pure water is used in each flush, wasting scarce water resources. Although South Africa's municipal water usage tends to be in line with global average trends, there are strong disparities in water consumption between regions and households in the country, illustrating the potential for quick wins (Montmasson-Clair and Mudombi 2020).

Last, water demand can be improved at the level of industrial processes, such as mining operations, power generation, textile manufacturing and agro-processing. Many industrial operations are particularly water-intensive, providing vast scope for improvement. Industrial activities also release significant amounts of effluents as part of their production processes, negatively affecting the quality of water. Water and effluent benchmarks are available per industry. These can assist high water consumption industries and high pollution generating industries to reduce water consumption and pollution levels. This also offers government an opportunity to stimulate advisory, supply and technical services from SMMEs that operate in towns and cities to improve their operations.

Overall, various technological solutions could be harnessed to improve the usage of water:

- A first group of low-cost solutions which have positive and short-term return on investment, while potentially generating material demand savings (the so-called "low-hanging fruits"). They cover a range of vast and disparate solutions. At the household level, these include fixing household leakage, smart metering, dual-flush toilets, water-efficient showerheads and faucets, rainwater and greywater harvesting and household landscaping. At the agricultural level, solutions such as improved soil techniques and no-till agriculture, irrigation scheduling, channel control, crop engineering and integrated plant stress management would help tremendously in reducing water usage. At the industrial level, low-hanging fruits that can improve water efficiency essentially include leakage detection and reduction, water efficient washing and pressure management. Implementing such opportunities revolves around staff awareness and incentive campaigns, improved metering and monitoring (e.g. smart metering, which can be used to detect leaks), water infrastructure retrofits (e.g. efficient spray nozzles, automatic shut-off values) and the reuse of higher-quality waste streams (e.g. pump seal water, cleaning-in-place rinse water).
- A second group gathers more complex and disruptive solutions around process equipment opportunities (upgrading or replacement of less-efficient equipment). These tend to be process specific and vary from one activity to another. Accordingly, their benefits (in terms of water demand but also payback period) vary widely. In agriculture, these range from improved germplasm, agricultural rainwater harvesting with fertigation, canal lining, precision farming, to drip irrigation and micro-sprayer. Examples of industry-specific process change interventions are fluidised bed combustion (power), dry debarking (pulp and paper), dry lubrication (food and beverages), dust suppression on haul roads (mining) and paste tailings (mining).
- A third group involves more advanced solutions aimed at implementing a circular "closed-loop" approach, notably through reuse and recovery opportunities. This includes next-generation sanitation as well as industrial symbiosis, mine water treatment, recycling of treated service water (mining), urban agriculture circular loop infrastructure, radical water (food and beverages) and reusing condensates. Effluent reuse (i.e. treating the final effluent to potable standards for onsite reuse, typically for non-product contact purposes) with or without energy recovery (biogas) is an opportunity within this group.

Unlocking the potential of these solutions would require a multi-pronged approach. Significant effort needs to be directed at raising awareness about water demand management, its benefits and the various solutions available in different contexts. Municipalities and companies have to be supported in the identification and trial of water efficient technologies and need to share the lessons learnt among each other. Increased capacity building, through extension services, would also positively contribute. More support is needed for entities, such as the National Cleaner Production Centre, which has been active in assisting commercial/industrial companies to identify opportunities for water efficiency. Policy also plays an important role in unlocking opportunities. For instance, the national building regulations and local by-laws need to be amended to require new developments to incorporate water efficiency and water reuse, particularly for non-potable uses such as toilet flushing.

Some have argued that South Africa's water prices remain too low to drive any meaningful investment in water efficiency, despite the technology being available, or to invest in other opportunities such as reuse. This argument centres on higher water costs leading to households, firms and agricultural users changing behaviour, investing in water efficient technology or fixing leaks quickly. Consideration could be given to raise prices for large consumers, from high-income households to industrial and agricultural users to drive these changes.[5] It would be beneficial to complement such a measure with support for demand management and the use of new technologies.

Investing in water and wastewater treatment

A third avenue to improve water and sanitation as part of a stimulus package is to invest in the country's failing water and wastewater treatment infrastructure. The Green Drop Report (DWS 2014) revealed that most of South Africa's WWTWs were not operating at optimal levels. Existing infrastructure is increasingly at risk of failure. Some infrastructure is completely dysfunctional due to inadequate refurbishment and, at the same time, investment is required for new infrastructure to deal with the increased loads. The dysfunctionality is also linked to poor investment in training of operators and the limited number of experienced engineers to manage the plants (assets).In 2014, about 474 out of the 824 WWTWs (58%) displayed high or critical risk, while only 135 (16%) faced a low risk.

The deteriorating and weak infrastructure could have dramatic consequences. The risk of contaminated water, such as raw sewage, entering South Africa's water system puts both the economy and the society's health at jeopardy, which would be exacerbated by COVID-19. The knock-on effect increases pressure on health services for waterborne diseases, increases absenteeism from work and school, as well as business uncertainty.

The challenges are a combination of institutional, infrastructure and finance-related issues, with 80% of WSAs classified as highly vulnerable (NBI 2019b). The situation is worsened by the fact that, on the on one hand, municipal-scale projects are capital intensive and are associated with operational complexity, while, on the other hand, accessing funding is a major constraint and most municipalities do not have the required skills to operate new technologies effectively (GreenCape 2020).

[5] The acceptability of price increases remains, however a point of contention. While customers would arguably be willing to pay more for better service, water revenues are not ring-fenced for the provision of water services. As such, increasing tariffs would provide important incentives for the modernisation of the sector but may not directly result in better service provision.

In this context, opportunities exist to harness the value of wastewater, in the form of water reuse, energy and materials. WWTWs can be retrofitted with systems that enable circular treatment processes. The South African water sector has not yet transitioned to a circular system and the current water and wastewater business cycle is predominantly based on the linear economy approach (Zvimba and Musvoto 2018). For example, while many WWTWs in the country already have anaerobic digesters, these are in various states of disrepair, and where biogas (methane) is produced, it is generally flared or just released into the atmosphere (GreenCape 2020).

For a wastewater biorefinery to be economically feasible, a suite of valuable products that are more valuable than energy products needs to be generated, with the conventional bioenergy products produced from residual organics (Harrison et al. 2017). Potential products that can be derived from wastewater are: first-level products (bioproducts derived from microbial bioreactors, such as organic acids, industrial enzymes, pigments and alginate); second-level products (biofuels and bioenergy, such as biogas, algal lipids for biodiesel and biomass for combustion, gasification or pyrolysis); third-level products (processed biomass, such as fertiliser, animal feed, fibre, compost); and fourth-level products (acceptable quality water that is fit-for-use or compliant for discharge) (Harrison et al. 2017).

The potential of many of the technologies has been successfully demonstrated in the country, however, what remains is the need to translate research into products through commercialisation by developing the appropriate business tools for municipalities to utilise such technological solutions (Pillay n.d.). For instance, several innovations have the potential to repurpose urine. These include: converting urine into struvite for fertiliser; the production of bio-bricks from urine; and human sanitation waste into charcoal briquettes. Zvimba and Musvoto (2018) highlight the potential of hydrothermal polymerisation to convert a wide range of biomass into a multi-use hydrochar. Wastewater works can be retrofitted and converted into resource recovery facilities that covert the fermenting waste into biogas for heating or generating electricity. There are also examples where municipalities are partnering with the private sector to harness the benefits of a circular approach to wastewater treatment. Projects include the Northern wastewater works biogas-to-energy project in Johannesburg; and the Distell and Veolia plant producing biogas and reusable water in Stellenbosch, Western Cape (Harrison et al. 2017; Montmasson-Clair, Kritzinger, et al. 2017). Another opportunity for municipalities is to invest in energy efficiency measures in WWTWs, through improving existing or upgrading to more energy efficient pumps, blowers and mixers. In metropolitan municipalities, the total estimated energy saving is around 358 460 MWh/year, which represents about R216 million/year in cost saving (GreenCape 2020).

Opportunities also exist to enhance wastewater treatment to enable the reuse of water used in industrial and mining operations. Desalination technologies could be adequately harnessed for these operations and niche usages (Patel 2018). This would notably be relevant in the coal, phosphate, steel, and other mining industries that discharge acidic water as effluent, including water contaminated by acid mine drainage. The rollout of seawater desalination on a large scale is deemed improper due to its high cost, high energy intensity and potential environmental harm.[6] Some companies have already harnessed the wastewater desalination treatment technology. Examples include Anglo American, which processes effluent mine water into drinkable water at its Witbank

[6]Main challenges with desalination technologies are: high energy intensity and energy cost; the high cost of membrane maintenance due to their cost and short lives; the high risk of failure of the pumping systems due to their high pressure operation; the growth of bacteria on membranes affecting the quality of desalinated water (Al-Karaghouli and Kazmerski 2012: 1; Banat 2007: 12) and the high cost of chemicals (Patel 2018). Advances in technology are progressively addressing these issues, notably through the use of renewable energy (Mahmoudi et al. 2017).

plant, and reselling it to the municipality, Glencore, which similarly supply Hendrina, and Sasol's Secunda Synfuels operations.

Against this backdrop, partnerships with the private sector offer multiple avenues.[7] Various institutional options of engaging the private sector are presented in Table 1. Institutional arrangements range from management and performance contracts, which aim to address a lack of technical capacity and skills, from concessions and leases, which provide for private capital, generally to construct or rehabilitate plants. Some of the main PPP opportunities in the water value chain include resource development (dams, desalination plants for mine and industrial wastewater, wastewater reuse, groundwater extraction and aquifer recharger), bulk infrastructure (WWTWs, pipelines) and distribution and reticulation (NRW reduction) (NBI, 2019c).

Table 1: Possible institutional arrangement for private sector involvement at the utility level

<table>
<tr><th>CONTRACT TYPE</th><th>KEY FEATURES</th><th>CAPITAL EXPENDITURE REQUIREMENT FOR PRIVATE PARTNER</th><th>DEGREE OF CONTROL OF PRIVATE PARTNER</th></tr>
<tr><td>Investor-owned Utilities</td><td>Private utilities, generally with regulation of prices and service quality): rare and the result of privatisation (UK, Chile) or historical quirks (US). This would not be regarded as a suitable option for South Africa.</td><td>High</td><td>High</td></tr>
<tr><td>Utility leases</td><td>Based on releasing equity from public water assets on the basis of long-term utility leases: used as an answer for small-size, cash-strapped municipalities (US, Australia).</td><td>Medium</td><td>High</td></tr>
<tr><td>Concessions and canon contracts</td><td>Equity release similar to utility leasing, as the concessionaire has direct control over capital spending, but with increased focus on performance.</td><td>Medium</td><td>High</td></tr>
<tr><td>Affermage-type contracts</td><td rowspan="2">The private contractor concentrates on operation and maintenance without taking risk on capital expenditure: used in different countries with varying degrees of responsibilities allocated to the private operator (main models originate from the US, France and Spain).</td><td>Low</td><td>Medium-high</td></tr>
<tr><td>Operations and maintenance Contracts</td><td>Low</td><td>Medium</td></tr>
<tr><td>Management Contracts</td><td>A private operator takes management responsibility for the utility for a period, typically to achieve some transformational objectives.</td><td>Low</td><td>Medium-low</td></tr>
<tr><td>Performance contracts</td><td>Address specific issues (from performance improvement to leakage reduction, energy management or smart metering) at the utility, with remuneration dependent on successful delivery: well spread in both developed and developing countries, with support from donor agencies.</td><td>Low</td><td>Low</td></tr>
</table>

Source: Montmasson-Clair (2018), based on Global Water Intelligence information

[7] The corporatisation of public utilities can be complementarily pursued, as an avenue to improve the management of operations and the involvement of the multiple parties (including the private sector) in the value chain.

Historically, private sector participation in the South African water and sanitation sector has been extremely limited (GWI 2017). Only a few PPPs have been implemented in the sector and results have been mixed. Indeed, PPPs are not a one-size-fits-all solution. They are, for instance, not suitable when a municipality has limited capacity to undertake the procurement process required. According to (NBI 2019c), only four of the 144 WSAs in the country, namely City of Johannesburg, eThekwini Municipality, City of Cape Town and Ekurhuleni Municipality, have an excellent PPP potential. Another 24 have a very good or good PPP potential, while most WSAs (116) had low or very low PPP potential. In many cases, PPPs are also not recommended to deliver public goods. Even if PPPs make technical and economic sense from the perspective of improving water security, they are not always desirable option for households and society at large (NBI 2019a). Fombad (2013) identified challenges associated with accountability in PPPs in South Africa as: lack of public consultation and transparency, corruption, lack of competition, accounting issues, ineffective contract management, failure to monitor performance, and failure to ensure value for money and equitable risk allocation.

Building ecological infrastructure

A fourth avenue is to put further emphasis on protecting and building South Africa's ecological infrastructure. The ecological infrastructure is important in ensuring sustainability in the water sector.

For instance, Strategic Water Source Areas (SWSAs) are areas of land that either supply a disproportionate amount of mean annual surface water runoff in relation to their size and are considered nationally important; or have high groundwater recharge or where the groundwater forms a nationally important resource, or both (Le Maitre et al. 2018). Surface water SWSAs produce just over 50% of the mean annual runoff from just 10% of the land area (Le Maitre et al. 2018).The Drakensberg mountain range occupies less than 5% of South Africa's total surface area, but produces 25% of the country's surface water runoff, with a supply reach that covers almost 60% of the country (Blignaut et al. 2008). Unfortunately, some of the country's ecological infrastructure is degraded (SANBI 2014; Mudombi 2018c).

While ecological infrastructure is an under-realised asset, it plays a significant role in enhancing returns on investment in built infrastructure and in ensuring a water secure future (DWS 2018a). In this context, water stewardship has been touted as one of the solutions towards developing and maintaining the ecological infrastructure. Water stewardship is defined as the use of water (by the private sector generally) that is socially equitable, environmentally sustainable and economically beneficial, achieved through a stakeholder-inclusive process that involves site- and catchment-based actions (AWS 2014).

Businesses are looking beyond their "factory fences" and collaborating with other stakeholders, to reduce the risk that water may have on their profitability and long-term viability (GreenCape 2017; Ward and Mudombi 2018). Various companies are participating in water stewardship through the Strategic Water Partners Network South Africa initiative, an informal and voluntary collaborative platform which seeks to address water risks and challenges in the country, as well as the International Water Stewardship Programme and the Alliance for Water Stewardship (Madden 2015; NEPAD Business Foundation 2013; WRG 2012). An example is chemicals company AECI, which has supported community groups to monitor and enhance river health in the Mbokodweni catchment through the Wise Wayz Water Care project (for more details, see Ward and Mudombi 2018).

While some companies have already been involved in water stewardship, their involvement and interest, to a large extent, has been driven by corporate social responsibility and environmental objectives. However, for a meaningful and wider adoption of water stewardship, companies need to embrace water stewardship as a key strategy towards securing their water future. For businesses, water stewardship starts at a basic level, where water awareness and internal action are central. This then advances towards collective action and influencing governance through strategic engagement (GreenCape 2017). Collective action is central to the success of water stewardship programmes. Water stewardship can be promoted through a variety of high-level channels, namely: building capacity; mobilising new forms of finance for scale; aligning and coordinating collective action efforts; improving contextual performance (from metrics to monitoring); and linking formal and informal water governance (Morgan 2018).

Another key component of securing ecological infrastructure focuses on eradicating IAPs that threaten biological diversity, water security, the ecological functioning of natural systems and the productive use of land (DEA 2017; Jenkin and Mudombi 2018). At least R6.5 billion of ecosystem services are lost every year as a result (Driver et al. 2012). About 10.1 million hectares in South Africa and Lesotho are invaded by IAPs (Stafford et al. 2017). Across the country, IAPs reduce mean annual runoff by anywhere between 1.4 and 3.3 billion m^3 (i.e. 3% to 7%) (Le Maitre et al. 2016). The Working for Water (WfW) programme, led by the Department of Human Settlements, Water and Sanitation and the Department of Environment, Forestry and Fisheries, has been at the forefront of eradicating IAPs since its inception in 1995.It has been highlighted as a “success story” (Bek et al. 2017), which has inspired the formulation of many other “working for” programmes.

The clearing of IAPs contributes to improved water security as well as employment creation through clearing of the IAPs and value addition (Jenkin and Mudombi 2018). The WfW programme has been a valuable source of employment for unskilled workers. In addition to the job creation from clearing IAP, there is also significant employment creation potential from value addition. The removal of alien invasive plants could be sustained by leveraging circular economy opportunities linked to their beneficiation (see, for instance, Jenkin and Mudombi 2018). Besides common products, such as timber materials for lumber, wood crafts and furniture as well as the production of charcoal, firewood, wood chips and pellets, other opportunities are emerging in biofuels (torrefied biomass), biomaterials (biochar, filtration, absorbents and insulation), and biochemicals and nutrients (lignin, tannins, cosmetics and chemicals) (Jenkin and Mudombi 2018). While there is need to ensure that the value addition programmes are financially feasible, such programmes need to be managed carefully so as not to create dependency on unmanaged IAPs as a biomass resource (Stafford et al. 2017), as the ultimate objective is to eradicate the IAPs.

The preservation and enhancement of ecological infrastructure is premised on the adequate valuation of natural capital. Thus, a new water paradigm that embeds water sustainability and resilience in day-to-day practices is necessary (Taing et al. 2019). Businesses need to be driven to make corporate water sustainability a business priority. This could be supported and promoted by instruments that incentivise and reward good practices, including pooling resources to stimulate more private investment in water-related projects (The CEO Water Mandate 2012), as well as regulatory requirements. Industries and corporations should consider the potential impacts of water risks on their operations. If a corporation has high water-related risk exposure, then a proactive response to the risk can lower the overall materiality of that risk (Molnár 2019). Gauging the extent and forms of water usage through water assessments can enable the formulation of viable and sustainable strategies to improve water usage and efficiency (NCPC-SA 2017). There is a need to establish fair and appropriate valuation of water for agriculture, industry, and people, as well as to support the development of a standardised cross-industry framework for measuring and reporting water use and impacts (Amis et al. 2018). For example, this might require a wider adoption of the international standard ISO 14046:2014, which outlines the principles, requirements and guidelines on assessing water footprint (ISO 2014). Understanding the water footprints of products and services can help companies embrace a holistic approach on water issues. This would, in turn, motivate them to embrace strategies, such as water stewardship, which can help to guarantee their water security.

Rolling out appropriate sanitation systems

Another avenue to include in a COVID-19 economic stimulus package is to support the rollout of appropriate sanitation technologies. While South Africa has made remarkable progress in sanitation provision, there are notable challenges associated with this access. About 60% of households in South Africa have access to a flush toilet connected to a centralised sewerage system, as shown in Figure 2. But having the flush toilet as the most common type of toilet is not desirable as most parts of the country are water scarce. Given persisting challenges, the need to think beyond sewers as a solution to providing universal access to sanitation is indeed evident (BCG 2014).

Increasingly, it is necessary to promote sanitation systems that embrace the sanitation economy. In this context, the sanitation economy entails three distinct but related areas for business and societal benefit (WRC and TBC 2018). The first is the toilet economy, which relates to toilet product and service innovation that provides toilets fit for purpose for all contexts and incomes. The second is the circular sanitation economy, which encompasses the biocycle, using multiple forms of biological waste, recovering nutrients and water, creating value-adding products such as renewable energy, organic fertilisers, and proteins. The third is the smart sanitation economy that comprises digitised sanitation systems that optimise data for operating efficiencies, maintenance, as well as consumer use and health information insights. The growing emphasis on the need for smart cities is an opportune moment to integrate the technologies. Sanitation can be included in smart cities architecture for monitoring public toilet usage, sewage treatment, health indicators, and to detect the need for maintenance and repair throughout the system (WRC and TBC 2018).

In this context, next generation sanitation (NGS) or non-sewered sanitation systems are relevant. There are three key types of technology toolboxes that this new industry will introduce, namely: water efficient front end technology (pedestals); modular and innovative backend technologies that are SANS 30500 compliant; and various centralised, decentralised and on-site sludge treatment technologies that remove the threat of pathogens and pollutants from people (SASTEP 2020). Some of the specific available technologies include: low flush systems; full reclamation toilet units; community ablution blocks; decentralised wastewater systems; and greywater treatment systems (WRC and TBC 2018).

These systems eliminate some components of the conventional sanitation value chain. There are many benefits associated with these technologies, such as massive water savings, development of SMMEs that support supply and the services part of the sanitation value chain, and sludge transformation into inert or valuable products (WRC and TBC 2018; Mudombi 2018b). NGS systems can be applied in two ways. First, they can be used to leapfrog those who currently do not have proper access to water and sanitation services. Second, they can be harnessed to disrupt market segments that currently have inappropriate or unsustainable services and technologies. There are various technologies that can be applied in different settings (urban and rural) and at varying scales (single-unit or multi-unit). A crucial feature of South Africa's household sanitation market is the distinction between indigent and non-indigent households, which also determines who pays for the services. Indigent households are deemed poor, hence they depend on support from the government or other organisations, while the non-indigent have the capacity to pay for themselves. Government plays a key role in constructing public houses and providing sanitation services in schools, and can hence easily stimulate demand for such technology. The high-end market that can be leveraged include large property developments, such as shopping malls, eco-estates, community centres, and airports. At such centres, it is easier to apply resource recovery on a large-scale.

One key issue to spur the rollout of NGS technologies is to ensure building standards are accommodative of these systems. Most of the smart technological solutions are new, hence there is need for dedicated support in showcasing and piloting their capabilities. Another major challenge is the difficulty in procuring systems (or entering in service level agreements), as the delivery of NGS requires long-term commitments from municipalities. There is a need for interaction between government departments as well as government and the private sector, in creating opportunities for unlocking the domestic production of such technologies related to the sanitation economy, and resolving the procurement impediments. There are efforts to build on. For instance, the 2017/18-2019/2020 Industrial Policy Action Plan (the dti 2018), aimed to position South Africa as a leading manufacturer of NGS technologies. From an industrial perspective, this is an opportunity for expanding manufacturing, services and the supply of sanitation technologies.

As with sanitation technologies, there is a variety of smart water innovations for capturing, storing, dispensing and treating water that can be rolled out as robust point-of-use (POU) devices for communities. The POU systems are possible short- to medium-term options for improving water quality for rural communities and geographically isolated areas where centralised water networks are not feasible (Momba et al. 2013). Such systems can be easily rolled out without significant civil works. Linking these technology options with appropriate and innovative business and community models, such as multiple use water services (Van Koppen et al. 2020) and social franchising models (Wall and Ive 2010),has potential to enable better access to water services as well as ensuring community and business resilience.

4. CONCLUSION

The inclusion of measures to tackle water and sanitation challenges in South Africa’s COVID-19 stimulus package is necessary and timely. Multiple benefits can be leveraged, which include: reduction of poverty and inequality; improvement in health, including in the fight against COVID-19; enhancing water security, and protecting the economy and livelihoods; job preservation as well as job creation; promoting sustainability through circular economy; and financial savings. Some of the areas that can be targeted in the short to medium term are: addressing non-revenue water; investing in water demand management; investing in water and wastewater treatment; building ecological infrastructure; and rolling out appropriate water and smart sanitation systems.

A number of options can be explored to implement these strategies; however, their suitability depends on the context. Some would need a change in legislation and institutional arrangement to overcome current technical and skills limitations in various municipalities. A key challenge in these municipalities is the lack of financial and human resources. To address this, having a targeted subsidy for the poor coupled with cost-reflective tariffs for other users, supported by more accurate billing, can contribute to the much-needed revenues. This would avail resources to attract better skilled staff and, at the same time, allow infrastructure development and maintenance, which would ultimately improve service delivery and sustainability of services. Different forms of PPP arrangements can be tailored to specific needs to create synergy, as well as share risks and rewards between the public and private sector. This would require municipalities to test new ways of funding water and sanitation services, such as leasing models for large capital expenditure projects, PPP options, guarantees through blended finance models, ring-fenced financial management, and procurement mechanisms that allow for public-private funding models.

It is necessary to build capacity in municipalities to manage such projects. For instance, long-term planning, implementation, monitoring and evaluation of projects and programmes need to be enhanced and budgeted for. One of the key enablers is project preparation support to municipalities for water and wastewater infrastructure projects. For example, the Project Preparation Facility, led by the Development Bank of Southern Africa and supported by the Government Technical Advisory Centre (GTAC) and the Presidential Infrastructure Coordinating Commission (PICC) Technical Project Management Unit, can assist entities to prepare infrastructure projects by funding and facilitating technical and feasibility studies. Having such capacity would increase the pipeline of projects that can potentially be funded by foreign investments, development finance institutions, or private sector finance.

Demand for the water and sanitation technological solutions need to be stimulated through aligning local procurement, building regulations, and norms and standards. Looking ahead, successful implementation also rests on harnessing new technologies and solutions to develop a coherent and viable project pipeline. The stimulus package is an opportunity to bridge the water and sanitation gaps, through rolling out locally manufactured solutions that would also strengthen South Africa's global competitiveness and export potential. Co-benefits would be immense, strengthening local innovation capability, generating much-needed employment, and supporting small business and inclusive community development.

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