Faecal Sludge Management and Improvement of Water Usage Within the Municipality of Polokwane

PAP Mabotha
University of Limpopo, South Africa

FG Netswera
Northwest University, South Africa

F Ganda
Walter Sisulu University, South Africa

Abstract: In 1994, a democratic South Africa enabled racial groups to acquire one man one vote status. Democracy makes it mandatory for post-colonial countries to conduct elections on a regular basis as prescribed by their constitutions. It is during election periods that different political organisations' manifestos and campaigns make promises to the electorate to provide better health care to all, improve the social wellbeing and the lives of citizens through effective health policies. In the sanitation sector in most countries, improving the lives of citizens is just a promise as rivers, wells, lakes and sources of fresh water are contaminated with domestic faecal sludge and effluent from industries, filling stations and hospitals. Despite well-developed policies about effluent release into the environment. Two of Polokwane Municipality's main sewerage plants in Seshego and Polokwane already receive more daily effluent than their designed and planned capacity and the total capacity of the Polokwane plant was not expanded post-1994, although the population of Polokwane has since more than doubled. An alternative plan for re-use of grey and sewage water is not in place. The paper provides insights into projected population growth and expected sewage capacity and recommendations for alternatives to sewerage plants including re-use of grey water and dry sanitation in peri-urban areas.

Keywords: Sanitation, Faecal sludge, Effluent, Sewage plants and water borne

1. Introduction

An acceptable sanitation is a dream of many people globally. However, most countries in the world in general, and Africa in particular, are experiencing difficulties when attempting to achieve Sustainable Development Goal (SDG 6) which states that there is a need to ensure availability and sustainable management of sanitation and water for all by 2030. Attempts to achieve this goal should be guided by the Millennium Development Goal (MDG 7) which states that there is a need to ensure environmental sustainability. In ensuring that sanitation policies are working in the world, there is a need to focus on SDG 10 and SDG 11 which state that nature-based sanitation solutions harness the power of ecosystems to help treat human waste before it returns to the environment (Writer, 2018). The contention of this paper is centred around two faecal sludge management systems in Polokwane, South Africa, which are sewer plants and pit latrines. Both have adverse effects on the quality of water provision if not well managed through pollution of rivers and/or underground water (Strande, Ronteltap & Brdjavonic, 2014). Continually increasing utilisation of these two faecal sludge management methods has significant long-term effects on the quality and volume of water provision for human consumption, most particularly since municipal infrastructure of the conventional sewerage network has not been expanded since 1994 (Polokwane Municipality, 2007).

The capacity of the three Polokwane Municipality waste water treatment plants (Polokwane, Seshego & Mankweng) has not kept pace with the need for sanitation of the growing urban population especially with the illegal extension of houses for backrooms and lack of maintenance plans for sewer infrastructure, low budget allocation for operation and inadequate plant maintenance. The Polokwane plant is capacitated to 28ml/day but currently, the load is 34ml/day. It is only now that the Polokwane Municipality is planning to expand the plant with an additional 6ml/day with the help of Anglo American (Polokwane Municipality, 2018). If a waste water treatment plant experiences an intake which is

higher than its capacity, water streaming out of the plant pollutes the downstream rivers which are used by local communities for consumption, bathing and other household chores. The current wastewater management system has a negative impact on humans and the environment (Human Rights Commission, 2014). There is a perception that the bucket faecal sludge management system has relevance only in relation to informal settlements in South Africa. Poor faecal sludge management and its consequences, however, are worldwide problems that affect rich and poor alike. South African municipalities should participate in programmes that are designed to look at alternative faecal sludge management since the country is water scarce. For example, the Ventilated Improved Toilets (VIP) installed in Newline Mpumalanga fulfilled their function for almost 11 years after installation and the feasibility of using pour flush or low flush systems needs to be tested (Still, Walker and Hazelton, 2009).

This paper reports on research intended to achieve the following objectives:

- To determine the processes that the Polokwane Municipality apply to faecal sludge management;
- To ascertain how water conservation can be applied in faecal sludge management in the Polokwane Municipality;
- To evaluate the cost management system which the Polokwane Municipality applies to faecal sludge management;
- To investigate the faecal sludge management approaches/plans applied by the Polokwane Municipality;
- To examine how the faecal sludge production and management system can be improved in the Municipality of Polokwane.

The findings of this study will be useful to both the *'focus'* (practitioners of public administration) and *'locus'* (those who study public administration as a subject). Knowledge gathered from the literature and the research findings could change the mindset of some faecal sludge management practitioners, including planners, engineers, policy makers (politicians) and environmentalists through encouraging them to consider different approaches to sanitation besides waste water as a sanitation method. In some instances, the study could encourage intergovernmental planning as it cuts across the different sectors of Governance planning in practical terms and municipal service delivery implementation.

2. Literature Review

2.1 Human Settlement, Faecal Sludge Management and Water Supply

A human settlement is described as a place where people live, play, sleep and worship. An area to be developed as a human settlement should be zoned according to the type of houses to be constructed as that has a bearing on the type and sizes of pipes needed for transporting water and faecal sludge to sewage networks. According to HAD Limpopo (2013) dwellings that contain more than two individuals per room are considered to be overcrowded. Therefore, most people living in shacks that are not in backyards in Limpopo, South Africa, are regarded as living in overcrowded conditions. Interventions are needed to address scattered settlements to make it easier to provide services and ensure that people's quality of life improves as lack of such amenities causes areas to depopulate (Blukes, 2010). Another challenge experienced by municipalities is caused by people who develop illegal structures and additional backrooms, thus contributing to high urban population densities and consequential constraints on the management of urban faecal sludge and water provisioning infrastructure. An additional challenge is a lack of understanding and interpretation of sanitation policies (Mjoli & Bhagwan, 2012). The Polokwane Municipality, like most areas on the African continent, did not manage to achieve the Millenium Development Goals of 2010 because, in some cases, municipal boundaries were changed and new borders had to accommodate areas with no water supply network. Thus, in Polokwane, land increased from 122 816 square kilometres in 1996 to 125 254 in 2011 (Stats SA, 2011).

2.2 Legislative Framework

The South African Constitution is seen as the cornerstone and the foundation of an equitable and just society. It is aimed at ensuring that everyone is guaranteed the right to a protected environment that is not harmful to their health or well-being and it gives guarantees to citizens that they will have water and proper sanitation (Department of Public Works,

2012). According to LHR Publication Series (1/2009), South Africa is regarded as a country with scarce water resources and it is characterised by historical inequalities in the use of water. Furthermore, the executive power to deliver water and sanitation in terms of the constitution is the responsibility of the local government as prescribed by the Municipal Structures Act 117 of 1998; the Municipal Systems Act 32 of 2000, the Local Government: Municipal Finance Management Act 56 of 2003 and the Public Finance Management Act 1 of 1999.

2.3 National Bucket Sanitation Replacement

In his 2006 State of the Nation Address, former President Thabo Mbeki indicated that South Africa had to eradicate all bucket toilets in the formal areas. This process became successful because there was political will from the presidency, cabinet, ministers, members of the executive council and the provinces. The programme was termed 'business unusual' and it was adopted by local governments to facilitate accelerated implementation (Mjoli, 2012). The programme was taken forward by the new administration led by former President Jacob Zuma who, in his 2014 State of the Nation address, stated that the South African Government had begun an intensive programme to eliminate the bucket system as part of restoring the dignity of the South African people. It was highlighted that the first phase would be eradicating buckets in informal settlements in all provinces (Human Rights Commission, 2014).

When eradicating the bucket system, water problem constraints and a lack of qualified human resources were overlooked in the determination to put the favoured waterborne toilets in all areas as per the political decision that was taken. Engineers who were on site trained junior technicians to operate the wastewater treatment works. In some municipalities, there were no municipal staff who could be trained to operate the wastewater treatment plants and this resulted in water sources being contaminated (Mjoli, 2012).

2.4 National Water Act, (Act 36 of 1998)

The National Government, through the minister, must ensure that there is proper use, conservation, management and protection of water. Infrastructure should be developed and controlled in a sustainable and equitable manner to ensure that the people's benefits are in accordance with the constitutional mandate and so that future generations can be catered for (LHR Public Series, 2009).

2.5 Water Service Act (Act 108 of 1997)

According to Section 2 (a–e), when read with Section 6, it is the responsibility of the water authorities (such as the municipalities) and a function delegated by the Department of Water Affairs and Forestry, to ensure that there is access to both basic water supply and the right to basic sanitation services through water service providers. The delegated task includes providing citizens with free basic services such as water and sanitation, in both formal and informal settlements. Any use of services other than these basic services has to be paid for by the user, irrespective of where the person lives (Carbonneau, Elbarg & Krasinkas, 2009).

2.6 The Local Government Municipal Structures Act (Act 117 of 1998)

According to this Act, a municipality is required to review a community's needs and prioritise them, as well as involve the community in the process of achieving the set objectives. This process applies to all the municipal categories as established by the Act. These categories include metropolitan, local and district municipalities (LHR Public Series, 2009). Amongst other requirements, a municipality should provide appropriate health and hygiene education and safe toilets that are reliable, environmentally sound, easy to keep clean, provide privacy as well as protection against the weather and are well ventilated (Carbonneau *et al.,* 2009).

2.7 The National Environment Management Act (NEMA), (Act 107 of 1998)

This Act regulates water pollution limitations, the right to an environment that is not harmful to health or well-being and creates a specialised enforcement unit for environmental management. The inspectors are charged specifically with the enforcement of environmental management legislation and co-operative environmental governance by establishing principles for decision making on matters affecting the environment. They also enforce environmental management laws that foster intergovernmental co-ordination of policies, legislation and actions relating to the environment and eliminate negative impacts on the environment (NEMA, Act 107 of 1998).

2.8 Laws Regulating Wastewater Treatment, and Industrial and Hospital Effluent

The treatment of wastewater is regulated by Section 60 of the Environmental Protection Agency Act of 1992, which intends that wastewater treatment plants are operated to the highest possible standards. The municipalities responsible for waste water treatment plants must also improve maintenance practices including assets, educate operators and equip them with essential skills, provide knowledge of treatment standards as well as create awareness of the ways in which equipment should be used. According to the regulations, a limited number of samples are allowed to fail where biochemical oxygen demand, chemical oxygen demand and suspended solids are limited to 50mg/l O_2, 250mg/l O_2 and 87mg/l. The discharge to sensitive waters should be limited to total phosphorus (2mg/l P) and total nitrogen (15mg/l N) where the agglomeration population equivalent is between 10,000 and 100,000. The larger agglomerations have to comply with standards of 1mg/l P and 10mg/l N (Environmental Protection Agency, 1997). To ensure that wastewater entering a treatment plant does not hinder the performance of the plant, discharges of industrial waste to sewers are licensed under Section 16 of the Local Government Waste Pollution Acts of 1990 and 1997 or Section 85 of the Environmental Protection Agency Act of 1992 (Environmental Protection Agency, 1997). Regulations state that before hospital effluent is released into the municipal waste water treatment system, it should be separately treated using specified and specialised methods because hospital effluent contains new antimicrobials which encourage and preserve bacterial resistance within the environment in which the effluent is discharged. Such bacteria vary in their antimicrobial resistance (Morris, Harris, Morris, Cummin & Cormican, 2008).

In the vicinity of Tzaneen, it was found that hospital effluent consisting of human faeces, blood, toxic waste and other dangerous medical waste was flowing directly into the waters of the Letaba River. Other foreign objects found in the river were surgical gloves and bandages. This problem was caused by a failing hospital pump and contributed towards killing of the river as well as endangering the local community because trucks supplying the villages with water collected it just 200m below the point source of the hospital effluent discharge. The danger, therefore, was not only to humans but to the entire ecosystem (Boshego, 2018).

2.9 Faecal Sludge Management Planning and the Macro-Environment

The micro-environment associated with household faecal sludge transported from homes using potable water ends up having an impact on the macro-environment. This is mostly seen when municipalities do not treat their effluent properly and it impacts negatively on the natural environment and causes water supplies to deteriorate, resulting in unhealthy conditions (Genc, 2009). Such conditions are described by the World Health Organisation and UNICEF (2014) as diseases that are associated with poor water, poor sanitation and poor hygiene. Such diseases can cause deaths, for example, diarrhoea contributed to almost 1.5 million deaths in the 1990s. Despite attempts by the world to formulate post-2015 Sustainable Development Goals, almost 2.5 billion people still lack access to improved sanitation and one billion people still practice open defecation, mostly in rural areas. Approximately 748 million people lack access to drinking water and it is estimated that almost 1.8 billion people use water which is contaminated by faeces.

2.10 African Governments and Design of Institutional Roles

A major factor not taken into consideration in provision of sanitation is thorough planning which encompasses budgeting and a coordinated approach between departments such as water, sanitation, solid waste, human settlement, human resources, roads, storm water drainage and environmental health (Peal, Evans, Blackkett, Hawkins & Heymans, 2014). An outcome of this is that municipalities end up implementing budget on non-suitable sanitation methods because officials are afraid of being accountable for non-budget spending (Pan, Armitage & Van Ryneveld, 2015). Most of the time members of the community are involved in projects designs only when they need services to reach them and their involvement is not always constructive, for example, when communities embark on strike action, both legal and illegal, for non-delivery of basic services. One challenge that has been faced by municipalities in sanitation system design over the past two decades (1990s) is that the majority of the municipal managers have not had appropriate knowledge of water and sanitation technology assessment requirements (Infrastructure Dialogue, 2015).

Currently, South Africa is facing a backlog in the provision of adequate supply of proper basic services

such as water and sanitation of almost 1.4 million households and 2.1 million households respectively. In some areas, this backlog is caused by inappropriate infrastructure inherited by municipalities during the democratic dispensation which is unable to cater for the current demand (Infrastructure Dialogue, 2015). In order to resolve the water contamination and infrastructure problems, appropriate human resources should be selected on merit so that suitably qualified individuals can implement the research outcomes on the re-use of water and desalination technology (National Planning Commission, 2011).

In South Africa, a Department of Water and Sanitation survey highlighted that 37% of the country's water is consumed at municipal level and does not generate income due to the inappropriate systems that are applied which include the pricing strategy, water-use meter monitoring, billing and payments (Infrastructure Dialogue, 2015). According to Watson (2001) in Paradza, Mokwena and Richards (2010), as stipulated in the White Paper on Local Government, it is expected that municipal councillors should work with institutions of civil society and community structures to resolve matters that affect them so that there can be local solutions to local problems. Effective cooperation between government and society was demonstrated in 2011 by UNICEF Malawi when a mixed method market research approach was used to improve sanitation in areas with sandy and with clay soils. The problem was the collapse of pit latrines dug in both soil types. In areas that had clay soil, wooden flooring used to cover pit holes was eaten by termites and rotted within 12 months of construction due to intrusion by surface water. As a result, the sanitation programme could not meet household requirements (Cole, 2013).

In resolving the problem, UNICEF Malawi moved away from a textbook approach to toilet construction and turned to participatory design for solutions, applying participatory design methodologies as documented in Spinizzi (2005) and IDEO's 'Human-centered design toolkit' (2009). Local builders/masons, health workers and Environmental Health Officers (EHOs) were invited to develop toilet designs and critique each design so that the best option could be adopted with professional engineers ratifying and authenticating the designs and structures. Design prototypes were constructed on-site and these were evaluated and critiqued by both male and female users and the best design was chosen from three prototypes (Cole, 2013).

2.11 National Development Plan: Vision 2030

According to the National Development Plan: Vision 2030, South Africa needs to develop better planning for rapid urbanisation. For this to happen there should be appropriate data on the movement of people within the country and those entering the country (National Planning Commission, 2011).

This was emphasised by Dhesigen Naidoo, the CEO of the Water Research Commission when he said:

> *"the movement of people from rural areas to towns and cities will increase while migration, predominantly from other African countries is likely to continue. This is a serious threat to the country given the scarcity of water and treatment plants of municipal and industrial wastewater which is reintroduced into rivers after treatment. There is a need to upgrade the systems so that water released should not contaminate the source at all. Currently, many municipalities lack the technical capacity to build and manage their wastewater treatment systems" (National Planning Commission, 2011).*

2.12 Monitoring Inputs and Enabling the Environment

South Africa is regarded as a water scarce country. Consequently, care should be taken regarding how this finite and easily contaminated resource can be preserved, locally and globally. In the light of this, the World Health Organisation is implementing the objectives of the UN–Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS). The intention is to monitor the inputs from human resources, finance, enable the environment by ensuring that plans, policies, institutional arrangements and monitoring are adhered to. Through the GLAAS initiative, there is further analysis of factors associated with progress for the purpose of identifying advantages, disadvantages, bottlenecks and drivers of water policies in the world. In addition, GLASS facilitates the creation and strengthening of government-led plans for improving water, sanitation and hygiene service delivery (GLAAS, 2014). The positive impact of GLAAS on government policies which were electioneering smoke screens in the past was felt when it turned the tide by reducing the number of children dying from diarrhoeal diseases associated with poor water, inadequate sanitation and hygiene from 1.5 million in 1990 to approximately 600 000 in 2012 (WHO, 2014).

In South Africa, the monitoring of water quality, faecal sludge and sanitation should be done by the Department of Water and Sanitation (DWS) through its Blue and Green Drop programme and reports should be produced on a regular basis. The most recent Green Drop report was released in 2013, and, by its own admission in March 2018, the DWS has not produced any further reports over the past five years. Lack of capacity was cited as the reason. The 2013 Green Drop report was released only because the DWS was forced to do so after an opposition party won a case in court under the Promotion of Access to Information Act, Act 2 of 2000 (Savides, 2018).

In the 2014 Blue Drop report, the DWS acknowledged that the overall quality of drinking water in the country had decreased from 87.6% to 79.6%. The 2013 Green Drop report indicated that, out of 824 wastewater treatment plants in the country, only 60 were in excellent condition. Regarding the rest, as many as 284 were judged to be in critical condition and 161 were said to be in poor condition. Thus, in 2013, 49.6% of South Africa's waste-water treatment plants were failing to meet the required legislative requirements for the quality of treated water released to the environment (Savides, 2018). It was heard in parliament that, instead of solving the problems on the ground at the wastewater treatment plants the DWS channelled financial resources to pay costly project management and professional fees, placing the department in financial distress. In addition, leadership instability and a skills crisis were cited as part of the problem, despite the DWS having nine Deputy Directors generals and 74 chief directors in its employ (Savides, 2018).

3. Methods and Materials

Empirical data was obtained from interviews with the municipal officials and councillors of Polokwane Municipality who are directly involved in sanitation activities.

4. Results and Discussion

4.1 Water Required to Transport Faecal Sludge and Urine

According to Conradin, Kropac and the University of Limpopo's Department of Water and Sanitation (2012), it is estimated that each person produces 50kg of faeces per year which equates to 136.99 grams per day. On average, each person produces 500l of urine per year which is equal to 1.37 litres per day or 1 370g per day. Ultimately, 20 000 litres of fresh water, a scarce resource, is required to flush away these amounts of waste. This equates to 54.8 litres of fresh water per person per day. It is said that the quality of faeces produced daily depends on the food consumed and the people's lifestyle. Those who consume unprocessed foods with high fibre produce a higher quality of faeces by mass and volume compared with those who take in larger amounts of meat-based and processed food (Nlwagaba, Mbequere & Strande, 2014). A study on human excreta and sustainable water management in Hungary showed that water consumption was 34.1 m^3/year/person in 2011 and the combined amount of faeces and urine produced per person was estimated to be 1.5 litres a day which amounts to 550 litres per year (Zseni, 2015).

4.2 Expansion of Houses but No Infrastructure Development

When looking at the Stats SA figures from 1996-2011, the trends showed that the population of ages 5-24 years and ages 25-85 years had increased on average by 9 000 per annum. This has resulted in more people needing water supply and ablution facilities and has created a high demand on faecal sludge management facilities. This increased need for sanitation was confirmed by the respondents in this study who indicated that houses were being built, new establishments constructed and informal settlements or back rooms occupied by people but the sewage systems were constructed to cater for people under the Group Areas Act, 41 of 1950. This sanitation supply deficit was noted by Hedden and Cilliers (2014) who state that, since 2004, the demand for water and sanitation has gone up and consequently, South Africa is presently exploiting renewable water resources nationally. This study also stated that rural-urban migration, as well as expected income levels, will ultimately fuel up the residential consumption of water as the gap between demand and supply increases daily in South Africa. This is evident in the three sewage plants in Seshego and Mankweng which were for blacks and the town sewage plant which was for people of colour and Europeans (known as whites). The challenge for the town sewage plant began when the homelands were abolished and the government administration was located in the city of Polokwane (SA City Network, 2014). The infrastructure experienced increased demand as people moved with their families to be

closer to their places of work. Squatter camps and RDP housing also became part of the picture with no expansion of the existing sewage infrastructure. This created an overload on the faecal sludge management systems within the Municipality of Polokwane and water supply came under pressure as more water was needed (Mabotha, 2019).

4.3 Faecal Sludge Management in Rural Areas and Informal Areas of Polokwane Municipality

When the municipal land occupation increased from 122 816 square kilometres in 1996 to 125 254 in 2011, the Polokwane Municipality adopted more rural areas which did not have access to running water and sewage networks. According to the respondents in this study, the faecal sludge management technology used in these areas was pit toilets and most were not lined to protect contamination of ground water. The other sanitation method that was utilised was bucket toilets, mostly used in informal settlements as there was no place to dig pit toilets because of the high population density. The infrastructure also did not provide for the supply of water. Water supply and faecal sludge is still a challenge, according to the respondents, because there are no data that show how many people live in backrooms in some yards around the municipality.

Currently, the municipality provides lined VIP toilets in the rural areas. In the urban areas, there is no other sanitation method except the sewage network system which is waterborne (Mabotha, 2019). This finding correlates with the sentiments expressed by Dodane *et al.* (2012) who indicate that South African people are in conflict with the United Nations and the World Health Organisation that consider onsite septic tanks and onsite VIP toilets to be equivalent to improved sanitation systems in the MDG. This was further evidenced by people in the rural areas of Tokologo Municipality who rejected the 270 VIP lined toilets supplied by the municipality when eradicating the bucket system.

4.4 Problems Faced by Wastewater Treatment Plants of Polokwane Municipality

As previously mentioned, Polokwane Municipality has three sewage plants (Mankweng, Seshego and Polokwane). Of the three sewage plants, the only one that is currently coping is Mankweng although it faces challenges associated with hospital effluent and abattoir waste which adds a lot of oil to the ponds. Excess oil affects the natural wastewater treatment process as it blocks the primary settlement tanks and suffocates the bacteria. Problems associated with abattoir waste have also been experienced in Klerksdorp (Mjoli, 2012) where high Biological Oxygen Demand (BOD) became septic in the inlet screens and caused blockages from clots of abattoir wastewater. Another problem is the uncontrolled release of wastewater from chicken processing factories as this results in high BOD wastewater flowing to the treatment plant. In addition, chicken feathers block the system and impact negatively on the treatment process. Lastly, fat deposits increase the concentration of suspended solids, mainly in winter. Another problem is caused by people who open man holes near their homes thus enabling sand and stones to runoff to the treatment plants (Mabotha, 2019).

The Polokwane and Seshego plants have deteriorated in performance owing to high wastewater intakes that exceed their capacity and are attributable to high rural-urban migration which took place after the 1994 democratic elections. This problem is exacerbated by a high density of housing infrastructure that has been constructed around the city with no associated extension to the sewage plants. Mjoli (2012) indicates that when experiencing this problem, the Matlosana City invested in the expansion and upgrading of sewage networks and wastewater treatment plants. This approach, according to the findings of this study, is the route the Municipality of Polokwane is following by erecting a regional sewage plant that will be built in phases and will have a higher intake capacity than the existing plants (Mabotha, 2019).

5. Conclusion and Recommendations

This study focused on the faecal sludge management and improvement of water usage within the Municipality of Polokwane as water levels are low andpeople perceive good sanitation only as waterborne toilet systems. Studies conducted by Welsh Water and confirmed by Genc (2009), as pronounced by Cater (2006), stated that increasing world population brings forth new challenges for the environment and sustainability. This is as a result of the high consumption of fresh water used to flush toilets. Millions of people flushing waste daily creates environmental pollution of natural resources, resulting in unhealthy conditions. According to Quitzau (2007)

in Genc (2009), there is a serious need for the designers of flush toilets to change the system as these could result in the environmental downfall of the world. This is evidenced by statistics that show how much water is used in homes for flushing toilets as compared to water for drinking. Of the total amount of water delivered to houses, 95% goes down the drain and only 3% is used for drinking. Over a quarter of clean water, estimated to be 30%, is used to flush toilets. Care needs to be taken in that by 2025 there will be another two billion people in the world requiring food and water. It is estimated that 1.8 billion people in the world have drinking water sources that are faecal contaminated (GLAAS, 2014).

There is a need for integrated development plans to be supported by collaborative efforts of national governments, local communities and international agencies. Governments need to be persuaded to show strong support for universal access to drinking water and sanitation supported by political will. There is also a need for the improvement of inter-departmental capacity for monitoring, tracking funding for water and sanitation as well as proper utilisation of data for investment and report back on deliverables (GLAAS, 2014). In the Polokwane Municipality, as in most countries, faecal sludge management experiences insufficient finances, especially for operations and maintenance which are keys to sustainable and safe service provision. Furthermore, another critical factor is the lack of human resources in the sector. Most countries reported to GLAAS that they do not have human resource strategies in water, sanitation management and hygiene for both urban and rural areas (GLAAS, 2014).

References

Arce, A. 2003. Value contestations in development interventions: Community development and sustainable livelihoods approaches. *Community Development Journal*, 38(3):199-212.

Austine, L.M. 2006. Guidelines for the design, operation and maintenance of urine diversion sanitation system. Water Research Commission: Pretoria.

Blukes, R. 2010. *Polokwane Municipal Spatial development framework*. Town Regional Planners. Polokwane Municipality: Polokwane.

Boshego, D. 2018. *The hospital effluent consisting of human faeces and toxic waste.* Capricorn Voice, March 21-27, 2018.

Carbonneau, M., Elbarg, M. & Krasinkas, J. 2009. *Cape Town water and Sanitation design. A major qualifying project proposal submitted to the faculty of Worcester Polytechnic Institute.* Worcester Polytechnic Institute: Worcester

Cole, B. 2013. *'Participatory design development for sanitation', frontiers of CLTS: innovations and insights issue1*, Brighton: IDS.

Department of Public Works. 2012. *Small Waste water treatment works DPW design guidelines.* Pretoria. Government Publications.

Frankson, L. 2015. *Polokwane prioritises water and sanitation in rural areas.* Infrastructure news.

GLAAS. 2014. *Investing in water and sanitation: Increasing access, reducing inequalities.* UN-Water Global Analysis and Assessment of Sanitation and Drinking Water.

Genc, M. 2009. *The evolution of toilets and its current state*. Graduate School of Applied Natural Sciences. Middle East Technical University.

HDA Research Report. 2013. *Limpopo informal settlement status.* Housing development Agency: Johannesburg.

Hedden, S. & Cilliers, J. 2014. *Parched prospects: the emerging water crisis in South Africa.* Institute for Security Studies. September 15, 2014.

Infrastructure Dialogue. 2015. *Water and Sanitation: Municipal water and Sanitation Infrastructure.* IMIESA. February 12, 2015.

LHR Publication Series 1/2009. *Water Supply and Sanitation in SA – Environmental rights and Municipal Accountability.*

Mabotha, P.A.P. 2018. Faecal sludge production and management projections in the City of Polokwane. Unpublished Masters Thesis. University of Limpopo: Polokwane.

Mbewe, M. 2014. *The South African human rights commission Nandoni dam pollution investigation.* Unpublished Masters Thesis. University of Limpopo: Polokwane.

Mjoli, N.P. 2012. Evaluation of sanitation upgrading programmes - the case of bucket eradication programme. Water Research Commission, (1)(12):14.

Morris, D., Harris, S., Morris, C., Cummin, E. & Cormican, M. 2008. *Hospital effluent: impact on the microbial environment and risk to human health.* Environment protection agency. Ireland.

National Planning Commission. 2011. *National development plan 2030. Our future – make it work.* Sherino printers: Pretoria.

Nlwagaba, C.B., Mbeguere, M. & Strande, L. 2014. *Faecal sludge quantification, characterisation and treatment objectives*. IWA Publishing. United Kingdom.

NEMA Act. 1998. Notice No 1540. Government publications. Pretoria: Government printer.

Pan, S.M., Armitage, N.P. & Van Ryneveld, M.B. 2015. Sustainable and equitable sanitation in informal settlements of Cape Town: Common Vision? *South African Water Research Commission*, 41(2):222-231.

Peal, A., Evans, B.E., Blackett, I., Hawkins, P. & Heymans, C. 2014. *Faecal Sludge management: a comparative assessment of 12 cities. Journal of Water, Sanitation and Hygiene Development,* 4(4):563-575.

S.A. City Network. 2014. *Polokwane City of resilience and middle-class bling.* Braamfontein. Johannesburg.

Savides, M. *How safe is our drinking water? Don't ask water Department.* April 1, 2018. Sunday Times.

Statistics S.A. 2011. *South African statistics.* Statistics South Africa. Pretoria: Government printer.

WHO / UNICEF. 2014. *Progress on drinking water and sanitation.* 2014 update. World Health Organisation. Geneva.

Writer, S. *Acceptable sanitation a dream for many*. Cape Times, November 20, 2018.

Zseni, A. 2015. *Human excreta as an important factor for sustainable water management and agriculture*. Hungary. Istvan University.