

New study aims to quantify the risk of cemeteries and develop guidelines for their future development

Cemeteries have become much more than a place to bury the dead. They provide a space to remember loved ones and safeguard the stories of our past.



In the Braamfontein cemetery in Johannesburg, for example, you can see the dynamite explosion monument from 1896. It was erected in memory of 71 persons who died in an explosion at Braamfontein station on 19 February 1896. The cemetery also houses the memorial of Enoch Mankayi Sontonga, the composer of South Africa's national anthem. Valliammai and Nagappen, early martyrs of Mahatma Gandhi's passive resistance movement, are also buried here.

Today, cemeteries are also seen as opportunities to create green footprints within urban belts. For this, there's no lack of opportunity, as they have expanded exponentially as populations burgeoned and cities mushroomed.

The City of Cape Town manages 41 cemeteries, while Johannesburg City Parks takes care of 35, as well as two crematoria. In 2006, the Waterval Cemetery in Midrand opened – the first new burial ground in

Johannesburg for nearly a quarter of a century. The 200 ha cemetery has space for 720 000 burials. Diepsloot Memorial Park opened in April 2007, providing much-needed space for 120 000 burials.

According to the City of Tshwane's mayoral spokesperson, Blessing Manale, "there are approximately 64 known cemeteries in the City of Tshwane." Of these, 33 are owned and directly managed by the city, while the remainder are managed and controlled by various stakeholders, such as tribal authorities, and others being informal and illegal.

In the North of the city, the Klipkruisfontein cemetery in Shoshanguve is under development, as is the 600 ha Tshwane North Cemetery in Hammanskraal, which will be the biggest cemetery in the City of Tshwane. It is being developed in stages over time, and burials are yet to commence. In terms of commissioned sites, the biggest in the City is the approximately 247 ha Zandfontein cemetery, which

currently hosts an estimated 59 635 burials. “The site still has vast open spaces that will in future be pegged into more graves,” says Manale.

Except for these sites, Mabopane cemetery (in Mabopane), Heatherly cemetery (in Mamelodi/Nellmapius), Ga-rankuwa cemetery and Centurion cemetery have been earmarked for expansion since there is available municipal land adjacent to them. According to Manale, “suitability studies for these sites are commencing in the current financial year.”

Yet, the overall legacy left by cemeteries is being questioned, as is their impact on the environment or potential detrimental effect on human health has been given little thought when most were established. Of even more concern are burials in rural areas, or illegal burial grounds, where there is little or no control or monitoring.

While the topic might not have received plentiful attention in the public sphere in South Africa, the health hazards associated with burials were first recognised by British surgeon, Dr Alfred Walker, as early as the mid-19th century. Since then, the potential risk of cemeteries has become well documented, but the reality of the situation in South Africa is mostly unknown.

According to Dr Matthys Dippenaar, University of Pretoria (UP) Senior Lecturer for Hydrogeology and Engineering Geology, “the big problem is what we don’t know.” A 2010 report by the Department of Water Affairs describes cemeteries as ‘low risk’ but it could be worse in rural and peri-urban areas, where there is no regulation and people are dependent on extracting freshwater directly from its source, he says. “While it won’t be a problem everywhere, it will

be a problem somewhere, and we have to figure out how we can locate the high-risk areas.”

Dr Dippenaar is the project leader of a new study that was recently approved for funding by the Water Research Commission (WRC). The project aim is to quantify the risk of cemeteries, and develop guidelines for new and existing burial grounds. The study will be conducted under the auspices of the UP. The holistic project will include researchers from numerous disciplines, says WRC Research Manager for Water Quality, Dr Jennifer Molwantwa. These include experts in the fields of water quality, health, environmental protection, hydrology, governance, society and regulation.

WHAT DO WE KNOW?

Early research warned of the danger of burying the dead near water sources, later establishing a clear link between water and cholera. It became widely established that groundwater could be contaminated by raw sewage and decaying bodies, after which new cemeteries were established outside city borders – a legal requirement throughout Europe and North America.

There is a host of potential contaminants that can seep from graveyards. This is not only limited to pollutants that emanate from decomposing bodies, but also from the material that they are buried in.

During the process of putrefaction of a human corpse, matter containing bacteria, viruses and organic and inorganic chemical products leach from it. Pathogens such as Anthrax and Smallpox viruses and TB bacteria are known to survive in soil and water. The fear is that certain pathogenic bacteria and viruses could filter into groundwater, spreading diseases.

A heavily ornate coffin could be seen as a sign of stature, but the damage it could do to the environment is nothing to be proud of. Varnished or painted, fitted with metal hinges and handles and treated with sealers and wood preservatives, a wide range of heavy metals and other potentially harmful compounds may be released from them. This includes lead, zinc, copper and steel. Substances such as arsenic mercury were used in past embalming and burial practises. Arsenate pentachlorophenol and formaldehyde, a carcinogen, are released from burial materials and embalming fluids.

“Any form of contamination of water resources can be a cause for concern,” maintains Manale. “As it relates to burial sites or cemeteries, some form of

While specific project sites have not yet been identified, the project will look at cemeteries all over the country. This scenic resting place is located outside Garies, in the Northern Cape.



pre-cautionary regulation has been put in place by the relevant environmental competent authorities who require an impact assessment to be conducted prior to commencing with burials on especially new sites. It is however, important to continuously monitor groundwater quality in and around existing cemetery sites, *albeit*, the residents in the City of Tshwane make use of reticulated municipal water supplies.”

However, in South Africa, the legal guidelines that dictate where cemeteries should be located, were only published in 2004, and are not uniformly implemented across the country. “This is probably because cemeteries are seen as low risk,” notes Dr Dippenaar. Furthermore, the guidelines are a standardised set of instructions such as the depth of the excavation and the distance that it must be located from a water source. Besides, most cemeteries were established before the guidelines were promulgated.

The first analysis of groundwater and surface water in and surrounding cemeteries were conducted in Australia by Dent in the late 1990s. He identified potential harmful elements from decaying bodies in the aquifers below cemeteries in diverse environmental settings and showed that rainfall played a major roll to transport these.

In fact, the risk of groundwater contamination through leachate from cemeteries is not uniform, and is influenced by a number of factors such as soil characteristics (type of soil, depth, pH, permeability and porosity); climate (rainfall and temperature);

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geology, the hydrological setting, and terrain features. In comparison, the most important factors in establishing cemeteries until relatively recently were that the soil had to be soft enough to dig in, the area’s accessibility and the proximity of dwellings.

In South Africa, a 2012 study by Cornelia Jonker and Prof Jana Olivier investigated the mineral contamination of cemetery soils in Zandfontein Cemetery. They compared the mineral concentrations of soils within the cemetery to those off-site as well as those in zones with high burial loads with zones with fewer burials. They found that mineral concentrations of soils within the Zandfontein cemetery were considerably higher than those off-site. Soil samples in multiple burials blocks also had elevated metal concentrations. Yet, the researchers pointed out that the results do not necessarily reflect the situation at other cemeteries in Pretoria and surrounds. According to the final report, “the fact that this cemetery is located on the slopes of a mountain may cause leaching of minerals into groundwater and aggravate potential health risks.”

Issues around cemeteries do not include contamination, but also those that relate to burials where mechanical digging is not possible. In Taung, rocks are packed over bodies if a deep enough hole cannot be dug.



Petro Kotzé

"It is important to continuously monitor groundwater quality in and around existing cemetery sites."

Consequently, Suzanne Toinette Janse van Rensburg investigated whether the soils of the Pretoria East and Silverton cemeteries are contaminated with heavy metals for her Honours degree. In this case, the results of collected soil samples in both cemeteries showed that the on-site and off-site metal concentrations were fairly similar. However, by closer scrutiny of the results at the Pretoria East cemetery, it became apparent that the contamination effects of the cemeteries might have been masked by slope.

The new study will now aim to identify those cemeteries that could constitute a hazard to human health and the environment in order for mitigation measure to be implemented. At the same time, it will also identify those that are correctly sited and that could be revitalized for recycling.

SETTING GUIDELINES FOR CEMETERIES

The study will run from April 2015, starting with research to create a screen of contaminants from typical sources such as decomposition, coffins and associated materials as well as fertilizers from landscaping practises.

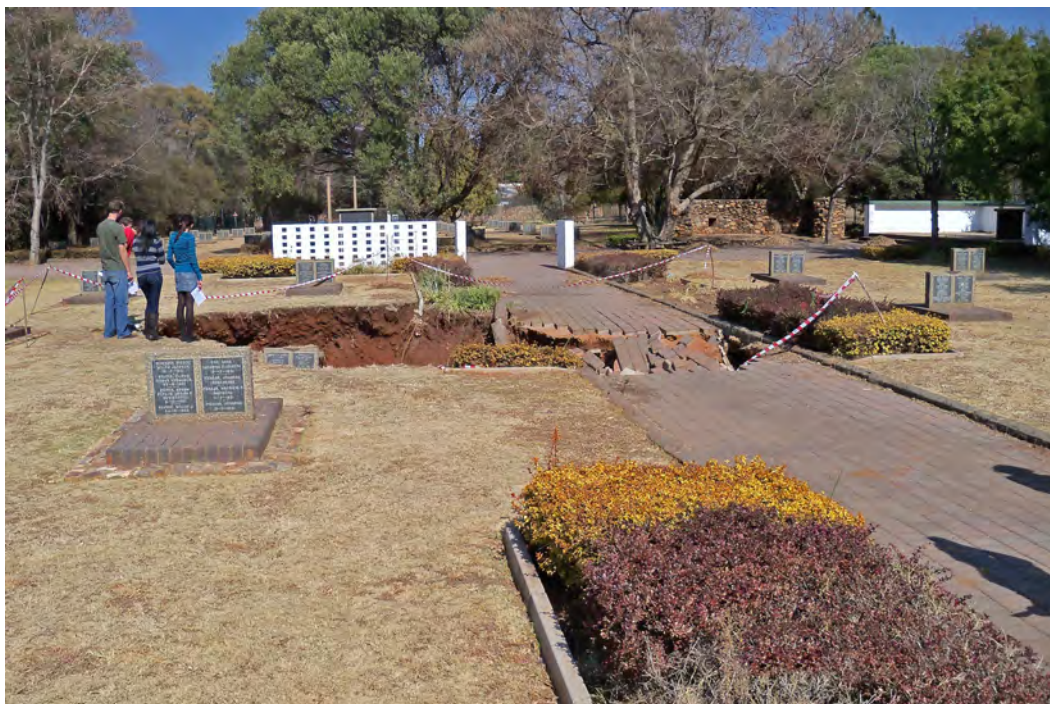
"The goal is to integrate all disciplines already looking at the issue," says Dr Dippenaar. He adds that the worse-case scenario is that they will find

contamination that could be detrimental to human health and the environment. In that case, they also have to find out if it is caused by the cemetery or industrialisation. "In order to do this, we want to identify a group of determinants that will indicate with reasonable certainty what the cause of the contamination is."

In addition, research will be conducted on cultural aspects of burials in the South African context in order to include cultural identity and heritage in the proposed guidelines. This is an "enormous" aspect, reports Dr Dippenaar. On the most basic level, this relates to the distance of people from the cemetery, particularly if they are not mobile, as well as the distance of the cemetery from water sources.

Specific study sites have not been identified yet, but they will be selected across country, and according to abiotic factors (geology, soil, geomorphology, climate and hydrology) in order to represent a wide variability and to allow for interpolation of results between sites.

"An urban cemetery such as the Pretoria East, which is located on shale, can perhaps be compared to a rural one in Temba that is also located on sedimentary rocks," says Dr Dippenaar. He explains that they can then work on a cemetery located on shale in an area with high rainfall and compare it to one in an area with a similar geology, but with low rainfall. "Maybe we can compare one in



At this cemetery in Irene another issue is clear, namely the formation of a sinkhole that is already an indication of concentrated water inflow in the sub-surface.

Matthys Dippenaar

Johannesburg on granite with one in Limpopo on granite.”

Further field work will include inspection of open graves for a thorough inspection of soils, sampling of soils from different horizons to determine the physical and mineralogical properties as well as surface infiltration and auger hole percolation tests to infer hydraulic parameters. Lastly, soil, surface water and groundwater will be sampled.

These finding will then be used to draw up the guidelines. “We want to add quantity to enable decision makers to quantify the risk.” This will allow them to properly investigate all relevant aspects to ensure that the development is safe.

While monitoring and remediation is part of the project, the crux is the quantification of risk involved, in order for new cemeteries to be improved, notes Dr Dippenaar.

A WAY FORWARD

“Our hope is that we will at least educate people on what the risk is and how you can improve the risk assessment,” he says. “Anything that we find will help.”

The aim of the final product, which will be entitled *State of the Art Cemetery Guidelines* is to quantify the potential risk of an existing or new cemetery, and to provide guidelines on how to mitigate this. It will probably be produced in a scorecard fashion. “Our

hope is that decision-makers will accept this as the best practise guidelines.”

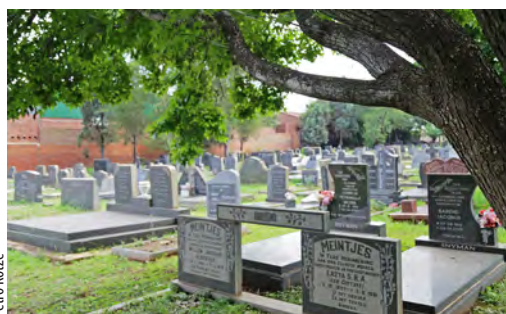
“As the implementation of the guidelines is out of our hands, it is critical to involve the South African Local Government Association.” As such, the project deliverables include a knowledge transfer workshop to convey the research results to relevant stakeholders. According to Dr Molwantwa, “The findings will be most useful for local government, as the results will empower decision-makers to identify the most suitable local areas for cemeteries.”

Dr Dippenaar adds that from a research perspective the project is an interesting opportunity to investigate the influence of surface material disruption on the vadose zone. The hope is that this will also create the opportunity for high-profile science research projects for Masters Students.

Dr Dippenaar is adamant that the idea is not to scare people away from cemeteries or burials. However, it is important for the public to realise that any land use has an impact. Even in death. 



Research at Silverton cemetery, in Pretoria, shows that there is little difference between the metal concentrations of soil inside the property and samples taken outside the fence.



Petro Kotzé



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Top left: Cemeteries are a place to remember and pay homage to those who have passed.

Left: Today, cemeteries are also seen as opportunities to create green belts in urban environments.