POLICY BRIEF

December 2018
The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

Improving the management of cemeteries to mitigate negative impacts on groundwater

Interment by burial in cemeteries is an ancient practice embedded not only in sanitation and healthy living conditions, but also in culture and religion. It has been found that cemeteries, generally considered to be fairly low-risk, may pose more hazards than previously thought, particularly if they are located near surface or groundwater sources. Partnering with representatives from the South African Local Government Association (SALGA), the WRC investigated certain identified research questions pertaining to cemeteries. Results from the study have not only increased scientific knowledge regarding the risk posed by cemeteries, but have been fed into the standardised protocols for hydrogeological and engineering geological investigation for new cemeteries, as well as for the monitoring and management of existing cemeteries.

Background

Throughout history, almost all societies have employed different practices for disposing of the dead, however, burial in cemeteries remains popular, particularly in South Africa. Research conducted over the last century-and-a-half has brought attention to the potential hazards cemeteries pose to particularly water sources.

For example, bodies decompose, and during this process, leachates that contain bacteria, viruses and organic and inorganic chemical decomposition products are produced. Pathogens such as Anthrax, Smallpox and Tuberculosis are known to survive in soil and water and some are even able to multiply if soil conditions are favourable. It is therefore possible that certain pathogenic bacteria and viruses could percolate to groundwater, spreading diseases such cholera, smallpox typhoid and hepatitis A.

Coffins also decompose, and a wide range of heavy metals and other potentially harmful compounds may be released from coffins to eventually seep into the groundwater, and from there to boreholes or streams.

Until recently, the most important factors in establishing cemeteries were the type of soil (suitable for digging), accessibility and proximity of existing habitation This has resulted in numerous cemeteries being located in areas subjected to flooding, in wetlands, in swamps, on drainage lines, on cliff edges, close to wells and water tables, and in ecologically sensitive ecosystems.

Investigation for cemetery sites require the detection of a wide range of different contaminant groups, at typically very low to concentrations (if present), natural and geological impacts on the proposed developments; and with important human and ecosystem health effects if undetected.

Given the sensitive nature of interment and the established notions of acceptable practice at an individual and personal level, assessment of cemeteries is often frowned upon as

being an infringement on people's humanity. Cemeteries are, therefore, considered to require understanding of environmental or sanitary aspects, geotechnical or engineering aspects, and social aspects.
This project was developed as part of a long-term series of projects on vadose zone hydrology led by the WRC. The latest study aimed to quantify the risk of cemeteries, and develop guidelines for new and existing burial grounds.

The study was conducted under the auspices of the University of Pretoria and included researchers from numerous disciplines, including experts in the fields of water quality, health, environmental protection, hydrology, governance, society and regulation.

Results and recommendations

The project made contributions to the environmental risk assessment, monitoring and management of cemeteries. Emphasis was placed on the hydrogeological and engineering geological investigations as these are of fundamental importance in environmental impact assessments and water use license applications. Additionally, these pose potential health and safety risks to people, livestock and the receiving environment.

Case studies entailed controlled laboratory and field investigations to address questions identified that are of relevance to cemeteries. Novel findings included the following:

Corrosion and mobility of metals
Environmental conditions affecting the leaching, mobility and persistence of selected metals were addressed in the study. The study found that leachate from sands tended to be more enriched, while clays were found to be more corrosive to metals. Low pH, unsaturated conditions, fine-textured soils, and warmer temperatures are some of the controls enhancing corrosion of metals.

Mobility and persistence of formaldehyde
Environmental conditions affecting the leaching, mobility and persistence of formaldehyde were addressed in the study. Formaldehyde did not appear to affect the plate counts of ***E. coli*** despite it being used as a biocide in the embalming process. Formaldehyde breaks down within days in the subsurface and is therefore not extremely persistent despite its high toxicity. It does, however, keep on leaching out in the first days to weeks, with highest concentrations leaving the system around week 8 of experiments.

Partially saturated flow at the soil-rock interface
Flow at partial saturation from soil into fractured bedrock is complex, but affects natural flow, as well as any cutting or excavation such as a grave. Dispersion plumes are found to exist in soils over open fractures due to capillary barriered scenarios, from where various flow mechanisms result. Saturation tends to decrease with depth in the fracture, coupled with increasing flow rates to maintain continuity. This affects whether preferential flow will occur when certain in-situ moisture contents are breached, whether interflow will be induced, or whether natural attenuation may be promoted at partial saturation in the vadose zone where contaminants are temporarily immobile.

Antibiotic resistance of E. coli
Some E. coli were found to be antibiotically resistant at one of the field study sites. Although this might not necessarily be a result of the cemetery itself, it does inform about the behaviour of certain microorganisms in the vadose zone. Additionally, the complexity in contaminant types are accentuated.

Isotope hydrology in the vadose zone
The use of isotopes in vadose zone systems entailing interflow, perched water tables, and interaction between the surface water and groundwater have been highlighted in adding more detailed understanding to the complex subsurface flow systems affecting and affected by cemeteries. Using isotope results together with hydraulic and laboratory data improves results and subsequently understanding of the complex flow systems.

Complexity in unsaturated zone geological models
Geological complexity is added to conceptual models through addressing a wide variation of different earth materials, climatic regimes, and land uses. This is work being continued under the auspices of a new WRC project, K5/2826 on the complex and anthropogenically altered vadose zone.

Associated report:
Environmental risk assessment, monitoring and management of cemeteries (K5/2449). For more information, contact Publications at Tel: (012) 761 9300, Email: orders@wrc.org.za or Visit: www.wrc.org.za.