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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.

TECHNICAL BRIEF

Sanitation

Investigating pollution from on-site dry sanitation systems

The Water Research Commission (WRC) has funded a study into the potential pollution from on-site dry sanitation systems.

Background

The increase in the extension of sanitation services provided by the South African government will eventually result in the establishment of some 6 million on-site dry sanitation systems. However, there remains questions about the overall health and pollution impacts of these systems.

The scale of application of these systems, in concert with highly variable climatic conditions and a range of geological formations and soilscapes, warrant a scientific assessment of the pollution potential of dry sanitation systems so that they can be properly sited, designed, installed, monitored and maintained.

The objectives of this WRC study was thus to:

- Develop an understanding of the conditions and processes that may lead to migration of pollutants from on-site dry sanitation systems
- To develop guidelines to minimise the impact of on-site sanitation to the water resources of South Africa
- Identify techniques, methods and models used in evaluating groundwater pollution
- Derive best practice guidelines for monitoring and minimising the impacts from on-site dry sanitation
- Observe selected sites comprising a range of geologies and sanitation types in coastal and midland conditions to derive an understanding of the effluent migration and to provide test cases or the guidelines.

The study comprised a comprehensive review of current research and systematic observation of selected sites, comprising a range of geologies and sanitation types in order to derive an understanding of the effluent migration sources, pathways and mechanisms to inform the development of best practice guidelines.

State-of-the-art

Many studies have been conducted on the widespread use of pit latrines. Regrettably, no consistent methodology has been used to monitor or report the extent of nutrient or pathogen movement. Very often, the studies comprise monitoring of local boreholes down gradient of informal or peri-urban developments.

Several case studies report incidences of nutrient and pathogen contamination as a result of on-site sanitation contaminating water resources. Elevated concentrations of nutrients and pathogens have been observed between 20 and 90 m from latrines.

Studies also claim that observations from boreholes some 900 m downstream of developments where pit latrines are used have shown increases in pathogen abundance. Only one study warns that the rapid lateral subsurface flow from extreme events may move nutrients and pathogens from pit latrines, but no observations are evident in the literature.

Methodology

Four sites one two geologies were established in this study. A transect of four VIP latrines were monitored on a hillslope and an associated background site was coupled with this transect.

Three other sites were established to monitor individual pour flush latrines.

Observations comprised sampling of water from nearby streams, subsurface water from shallow piezometers and infiltrating soil water. The piezometers were established at selected intervals downslope of the latrines as well as at background stations upslope of the latrine.

Infiltrated water was monitored through wetting front detectors. In addition, geophysical and hydropedological surveys were conducted at each site in order to define the flow pathways and connectivity of the hillslopes.

A nearby weather station was used to record meteorological data, while local rain gauges were established at the sites. Pit latrine contents were sampled on two occasions and analysed for nutrients and pathogens. Analyses on the water samples included stable isotopes of water to aid in the definition of connectivity of flow pathways, nitrate, ammonium, phosphate and a selection of cations and anions.

Main findings

Site 1: Taylors Halt

The first site identified was Taylors Halt, located south of Pietermaritzburg where the community uses ventilated improved pit (VIP) latrines.

The study found that in the streams, nitrate rarely exceeds 10 mg/ℓ, with occasional values over 20 mg/ℓ during extreme rainfall events. Near surface piezometers also exhibit low nutrient concentrations, again, except for at the toe of the hillslope after heavy rains, concentrations reached between 17 mg/ℓ and 91 mg/ℓ.

E.coli counts ranged from 1-18 600 MPN/100 ml in the piezometers. High values were again associated with toe slope stations after heavy rains.

Site 2: Slangspruit

The Slanspruit site comprised a rural community where an individual household used a pour-flush latrine.

Concentrations of nitrate nearest to the pour-flush ranged between 1 mg/ℓ and 1 656 mg/ℓ, however, it is unlikely that nitrate concentration will occur at distances further than 3 m, at this site, except during period of high rainfall. However, faecal coliforms may exceed 26 m at all times.

Site 3: Crèche

The third site comprised two pour-flush latrines servicing a busy crèche.

Piezometers exhibit a rapid nitrate response in relation to rainfall. Nitrate concentrations were highest at 0.5 m from the leach pit (661 mg/ℓ), which occurred after periods of high rainfall. Similarly, E. coli counts were higher at piezometers close to the leach pit, ranging from 86 to 7 710 MPN/100 ml.

This, however, may be due to the recent construction of an unimproved pit latrine located some 2.5 m away from these piezometers. At this site it is unlikely that contaminants will exceed 3 m, except in periods of significant rainfall, where contaminants are mobilised.

Site 4: Azalea

The Azalea site comprised a family home pour-flush system near a stream.

It is unlikely that nitrate and faecal coliform contamination will occur at distances further than 3 m, except during period of high rainfall, where the nitrate may travel up to 17.5 m downslope of the leach pit. In the streams, nitrate does not exceed 12 mg/ℓ.

Piezometers adjacent to the stream on the low-lying segment of the slope seldom record high values of nitrate and E.coli during the wet season.

Conclusions

In comparison to previous studies, nitrate movement does not appear to be as significant at the KwaZulu-Natal study sites compared to other studies. However, they are consistent with each other in terms of greater mobility during periods of high rainfall.

The same can be said for the mobility of E.coli. However, at the Slangspruit site, a distinct E.coli plume extended to 26 m, whereas the nitrate was only evident up to 3 m. At this site where the water table was consistently high it is suggested that in these circumstances, faecal coliform pose a rise of contaminating adjacent water resources.

Further reading:
To order the report *Investigation into pollution from on-site dry sanitation systems* (**Report No. 2115/1/15**) contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za