Opinions and debates

eThekwini Urine Diversion Toilets: A Threat to Groundwater

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Abstract: eThekwini municipality of South Africa has embarked on the use of urine diversion toilets as a means of providing a basic sanitation to its households. These urine diversion toilets are designed and constructed to be used in a seated position so that the faeces are safely directed into a vault and the urine simply directed into an adjacent soak pit. In this way, urine will induce nitrate contamination into the groundwater system; which if consumed at higher concentrations can be very harmful to humans. Therefore, improvement in urine collection of the eThekwini urine diversion toilets is paramount in order to safeguard groundwater resources from nitrate contamination.
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ethekwini's Water and Sanitation Programme in South Africa aims at providing an acceptable and basic level of water and sanitation to households in ethekwini municipality's rural and peri-urban communities by 2010 through the supply of urine diversion toilets and 200-litre yard tanks (WIN-SA,2004). Urine diversion toilet is a form of waterless ecological sanitation designed to separate urine and faeces so that the faecal matter remains dry and rendered disease free for safe handling over time. The ethekwini design uses a two vault system. Once the first vault is full, the pedestal is moved over to the second vault and the first vault is sealed. When the second vault is full, the first vault is emptied and so on (WIN-SA, 2004). The design incorporates a pedestal with two openings; one in front for passing urine and another large one behind for passing faeces, all in a seated position. The faeces go in the vault and the urine is **simply directed to the soak away pit**. Figure 1 below shows the inside of the eThekwini urine diversion toilet.

Figure1.The inside of UD Toilet

In fact, urine-diversion sanitation has been used worldwide for hundreds of years but with careful handling of urine; not merely directing it into the ground .In Yemen, urine is drained away (in urine diversion toilets) and evaporated on the outer face of multistorey buildings to obtain the dry faeces for later use as fuel (Esrey et al., 1998). In Sweden urine has been diverted and used to smear wounds and dry skin (Frode-Kristensen, 1966). Other historic uses of diverted-urine include tanning of hides and production of gunpowder (Stenström, 1996).

In the traditional EcoSan toilet, the system is designed to handle both urine and faeces in combination. In this case, urine helps in the removal of odors due to additional ventilation it causes because of evaporation into the atmosphere through the vent. As a result of natural biological process, the combined human waste gets broken down into dehydrated odorless compost like material. This dry waste is manageable and can be used in the making of compost or disposed off to municipal waste services or used as a source of fuel without danger to groundwater.

Unfortunately, eThekwini urine diversion toilets are not EcoSan toilets; they are best described by Duncan Mara (2006) as urine-diverting alternating twin-vault ventilated improved vault (or VIV) latrines. While urine diversion is good for the performance of this toilet, it can also be a great environmental threat to groundwater quality. In fact, urine has a high potential of inducing nitrate contamination in the groundwater. Historically, the primary sources of nitrate in groundwater have been untreated human sewage from septic tanks and fertilizer applications (Puckett, 1995). The source of nitrate in effluents from septic tanks is urea $\{ \ (CO\ (NH_2)_2 \ \}$ derived from human urine (Layton, 2002). This means urine once released in the soil, urea is introduced which subsequently gets converted to nitrate. Actually urea reacts rapidly with water (in the soil) to form ammonium. This ammonium subsequently undergoes bacterially-mediated oxidation to form nitrate: $NH_4^+ + 2O_2 \rightarrow NO_3^- + 2H^+ + H_2O$. Since nitrate is soluble in water, it is eventually carried down to the underlying aquifer by percolating rain, irrigation water or snowmelt. In addition to being soluble in water, nitrate is very stable, and therefore rarely combines with other compounds. Furthermore, it does not bind to soil particles like many contaminants do. This means that nitrate will move with groundwater and can pose problems even kilometers away from a potential source. Consumption or ingestion of groundwater contaminated with nitrate at concentrations greater than the WHO drinking water standard of 45mg/L may cause methemoglobinemia in infants, cancer and other diseases (Downs et al., 1999; Follet, 1989). Basically Nitrate (NO_3^-) is not in itself harmful to human beings and animals. But once it is ingested by the organism, it is converted by bacteria present in the organism, into Nitrite, which subsequently reacts with blood Hemoglobin to form compound called Methemoglobin. This compound reduces the blood's capacity to carry oxygen. The oxygen level then decreases, thus causing a disease called methemoglobinemia also known as “blue baby disease” to children under the age of 6, at a period when their digestive system is not mature enough to detoxify this compound. Chronic consumption of high levels of nitrate may also cause other health problems, for example some cancers and teratogenic effects; data are inconclusive, but cause for concern (Kross et al., 1993). According to the EPA (Environmental Protection Agency, U.S.), long-term exposure to water with high nitrate levels can cause diuresis (excessive discharge of urine), increased starchy deposits, and hemorrhaging of the spleen. Consequently, a maximum contaminant level (MCL) of 10 mg/L has been established by the U.S. Environmental Protection Agency for nitrate in drinking water. This is a health-based standard set because of the health risk to infants (Puckett, 1995).

Therefore, urine diversion toilets which direct urine into the ground are potential sources of nitrate contamination of groundwater. This is something that ‘EcoSanologists’ don’t really approve of (Mara, 2006). eThekwini urine diversion toilets could be improved in the method of urine collection so that groundwater which takes decades or even centuries to recover once contaminated may be jealously protected. Above all, diverted urine once properly collected can be put to better uses with less impact on groundwater resources.

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References

1. Downs TJ, Cifuentes-Garcia E, Suffet IM. Risk screening for exposure to groundwater pollution in a wastewater irrigation district of the Mexico City region. Environmental Health Perspectives 1999; 107: 553-561
2. Esrey SA, Gough J, Rapaport D, Sawyer R, Simpson-Hébert M, Vargas J, Winblad U. Ecological Sanitation. Swedish International Development Cooperation Agency. Stockholm, Sweden. 1998
3. Follet RF. Groundwater quality concerns about nitrogen. Elsevier 1989; Amsterdam: pp1-33.
4. Frode-Kristensen S. By the well at the turn of the century. Collected works from the archives of life of the people in Lund no. 8. Lund, Sweden. 1966
5. Kross BC, Hallberg GR, Bruner DR, Cherryholmes K, Johnson JK. The nitrate contamination of private well water in Iowa. Public Health 1993; 83:270-272.
6. Layton D. Urea for SCR-Based NOx Control Systems and Potential Impacts to Ground Water Resources. 2002
7. Mara D. Urine diversion: Sometimes good, but not always. Water21 2006; Magazine of the International Water Association: December 2006
8. Puckett LJ. Identifying the major sources of nutrient water pollution. Environmental Science & Technology1995: 408A – 414A
9. Stenström TA. Pathogenic microrganisms in wastewater systems-Risk assessment of traditional andalternative wastewater systems. Report 4683, Swedish Environmental Protection Agency and National Board of Health and Welfare. Stockholm, Sweden. 1996.
10. WIN-SA. eThekwini’s water & sanitation programme .Water information network. Pretoria,S.A. 2004.