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WATER AND SANITATION FOR ALL: PARTNERSHIPS AND INNOVATIONS

Pit latrine effluent infiltration into groundwater

M. Chidavaenzi, M. Jere, M. Bradley, Zimbabwe

CONSIDERABLE EFFORT AND research has been directed towards developing technologies for protecting wells from external surface contamination. Little has been done towards investigating ground water pollution patterns arising from core existing pit latrines and wells. Generally latrines are sited within the homestead. Sites for wells are as determined by groundwater availability. Most rural sanitary facilities deposit wastewater into the ground from which water is obtained for domestic purposes. On-site wastewater disposal facilities must be monitored for the likelihood to pollute water supply sources to guarantee investments in rural water and sanitation supplies. In rural areas where the population continues to grow the land available for homestead use decreases in proportion. Land reform programs tend to increase homestead densities in zoned residential areas and reduce distances between pit latrine and family wells thereby increasing the possibility of groundwater effluent pollution. It is therefore possible that effluent from latrines may pollute adjacent wells within the homestead.

We are investigating the extent and seasonal variation of pit latrine effluent constituents in groundwater. This report presents preliminary findings from monitoring sites in Epworth.

Methods

Six monitoring sites where latrine are close to and upstream of family wells were identified in Epworth and Chivu in Zimbabwe. Tube wells were sunk in sets of varying formations and depths to form cross sections between latrines and family wells. Ground surface and groundwater surface slopes were determined with reference to site benchmarks. The direction of groundwater flow was determined by land surveying exercises. Water and soil samples are collected and analyzed for chemical and bacteriological parameters during dry and wet seasons.

Figure 1.

Results

During the dry season there is no lateral bacteriological soil contamination within the dry soil zone above the pit contents except within 1m depth of the top soil layers (Figure 1).

Groundwater surfaces sloped in the direction of ground surface slope and runoff. There was no significant difference between the ground surface and groundwater gradient in both dry and wet seasons (t-value=0.27; df=22 and t value=0.19; df=22 respectively). There was also no significant difference between ground water slopes during dry and wet seasons (t-value=0.038; df=22).

In Epworth there was a 3m dry soil layer between pit latrine bottom and groundwater surface. There was a significant rise in groundwater levels at monitoring sites in Epworth during the 1995/96 wet season.

In the dry season coliform density in groundwater decreased rapidly within 5 m from pit latrine. However, refuse pits and well water collection methods contributed to groundwater contamination.

In the wet season trends similar to dry season coliform density decrease were observed (Figure 3), although the counts were of significantly lower magnitude.

The latrine contribution to groundwater pollution extended for at least 20 m down slope in the dry season (Figure 4).

In the dry season groundwater nitrogen content decreased with distance from pit latrine. Refuse pits and well water collection were not significant contributors to groundwater nitrogen content. In the wet season there were no variations in nitrogen content between latrine and well. The latrine contribution to groundwater nitrogen content was significant in the dry season (figure 5).

Discussion

The results show that pit latrines do not contribute to lateral soil contamination in the dry soil layer above groundwater surfaces. Other methods of waste disposal

Figure 2

and of and use within the top soil layers contributed to soil contamination. Latrine effluents each down and out of the pit in the direction of the ground surface slope. Aquifers may drain through pit latrine upstream of well water sources. Most latrines siting activities are done without considering the direction of groundwater flow. It is important to survey for groundwater before siting pit latrines.

Groundwater flow is slower than surface runoff due to lower gradient and obstacles between voids. A 3 000 mm thick dry soil between pit latrine bottom and groundwater surface formed a barrier that filtered out contaminants within 20 m down slope. It is important therefore, to limit the depth of the latrine pit to ensure a thicker dry soil filtration layer between pit contents and groundwater.

Groundwater contamination is more pronounced in the dry season than in the wet season. In the dry season concentrated effluent flows from the pit towards groundwater. Seasonal groundwater recharge tends to dilute contaminants and rinse aquifers of nutrients.

The results showed a rapid decreases in contaminants within five meters from the polluting source. This may

Figure 3.

indicate the presence of dense colonies of commensal microorganisms within the soil voids around the pit latrine . These commensals remove nutrients and contribute to reduce the density of microorganisms reaching groundwater. The models also suggest that bacteria survive for longer distances within the soil after they have reached groundwater.

The human contribution to well water contamination causes a significant rise in coliform densities in groundwater around the well. It is essential to use lifting devices that promote hygienic use and restrict water contamination from external sources. Hygiene education is very important.

Data will be collected in 1997 before the final publication.

M CHIDAVAENZI.
M. JERE.
M. BRADLEY

Table 1

Table 2

Figure 4.

Figure 5.