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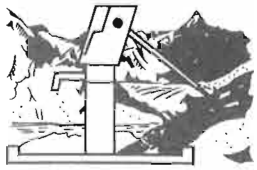
WATER, ENVIRONMENT AND MANAGEMENT



Groundwater pollution from double pit latrines

J P Padmasiri, G M Jayatilake and J P K Kotuwegedara

Twenty eight double pit latrines have been selected on random basis to look into the pollution threat of groundwater. Those pits have been categorized into two, based on the stage of decomposition. In the first category, the contents of one pit was fully decomposed and half empty, while the other pit was in use. In the second type one pit was full of excreta in liquid stage and the other pit was in use.

Sixteen double pit latrine sites chosen for this study were located in a higher elevation, where the static water level was below the bottom level of the latrine pits. The remaining 12 sites were located in the lower elevation, where the static water level was normally above the bottom level of the latrine. The water table of the area was influenced by the monsoon rains and therefore, it was fluctuating due to rainfall patterns. As the tropical climatic conditions prevailed throughout the year in this area, the tropical vegetation was a significant feature. Five sampling points were identified around the double pit latrine depending on the topography of the area (Fig 1 and 2).

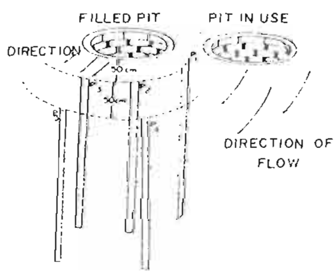


Fig 1: Sampling Points

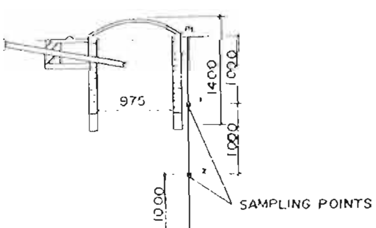


Fig 2: Depth of Sampling Points

The plant nutrients produced due to biological processes of excreta seeps out through the openings of the brick-lining of the pits. The biological process involved in the brick-lined pit with openings contribute to the movement of nutrients away from the pit. In addition, further seepage of these nutrients in the soil depends on the weather condition and topography of the location. These nutrients may then be available for plant growth. The root system of the plants were directed towards the latrine pits due to the availability of the nutrients and the moisture content. This is a man-made creation due to the existence of the double pit latrines. In addition the nutrients, which were not taken up by the plants and seepage due to flow direction can pollute the water sources around the site (Figure 3).

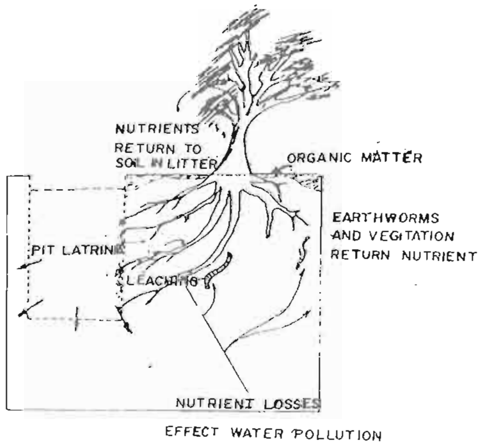


Fig 3: Leaching from Latrines

Also the burrowing actions of earthworms, ants, etc. may bring soil back nearer the surface and will thus bring nutrients, which have previously been washed down the soil profile back to the surface. Vegetation helps to offset leaching by the recycling of nutrients. Soil is thus a product of the soil parent material reacting to its environmental conditions through various chemical and biological processes taking place within the soil profile over time (Courtney, and Trudgill, 1984).

Table 1 classifies the water sources closest to the latrines. Of the twenty eight sites selected, twelve latrine sites were close to the water supply scheme. Four latrine sites were in close proximity to gravity water supply scheme. But in both these cases, there was no pollution

Table 1: Field Observation of D.P. Latrines and Water Sources

Site Number	Double Pit Latrine: Pit (1)	Double Pit Latrine: Pit (2)	Water Source
1,2	Decomposed half empty	In use	Alawathugoda WSS
3,4	Full in liquid stage	In use	Alawathugoda WSS
5	Full in liquid stage	Full in liquid stage	Alawathugoda WSS
6-10	Full in liquid stage	In use	Alawathugoda WSS
11	Decomposed, but again filled with rainy water	In use	Aswedduma gravity scheme
12-14	Full in liquid stage	In use	Aswedduma gravity scheme
15,16	Full in liquid stage	In use	Alawathugoda WSS
17	Full in liquid stage	In use	Hand pump well
18	Filled with earth by rats	Filled with earth by rats	Cemented open well
19-22	Full in liquid stage	Filled with earth by rats	Open wells
23	Decomposed	In use	Open wells
24	Full in liquid stage	In use	Hand pump well
25	Full in liquid stage	In use	Open well
26-28	Full in liquid stage	In use	Not in close vicinity

threat from pit latrines as water sources were located far away. The balance nine sites were closer to drinking/bathing open wells and hand pump wells. In these cases though wells were located far away from the stipulated 15m requirement from a latrine, the quality of water was found to be unsatisfactory (Table 2).

The nitrate content of water from these wells were low, less than 4 ppm. In the two shallow hand pump wells the bacteriological quality was not satisfactory with respect to standards. However, the coliform counts were low in comparison to the open wells.

The unprotected open well used for bathing at site 20 was highly polluted because of its location. The possible pollution threat from double pit latrine is rather low because it is situated about 100m away from double pit latrine. The bacterial count of the unprotected open well at the site number 19 was high and this can be due to it being situated close to a poultry. In these two sites: 19 and 20, the ammonia-nitrogen and nitrate-nitrogen values of the soils are very low. This reveals that the contribution towards pollution of groundwater by the double pit latrine is minimal.

As the static water level was below the sampling points, the soil samples collected were not wet. In general the NH_3 content of 50 percent of the soil samples collected one metre away from bottom level of pit latrine, was less than 10ppm (Table 3).

Table 2: Water Sources Closest to D.P. Latrines

Double Pit Latrine Site No.	18	19	19	20	20	22	22	23	25
Water Source	Cemented open well for drinking goes dry during drought	Open well for bathing close to a hatchery	Open well for drinking close to hatchery	Open well for bathing	HPW 24. Far away from D.P. latrine	Cemented open well for bathing	HPW 396 above the D.P. latrine	Open well in paddy field for drinking	Cemented open well for drinking
Distance from Latrine to Water Source in Metres	20	15	50	100	200	15	20	250	30
Nitrate mg/l NO_3	3.96	1.32	1.32	-	3.08	1.32	1.76	-	2.20
Total Coliforms per 100ml	1700	4200	8000	16000	64	1600	740	260	300
Faecal coliform per 100ml	200	500	5400	5800	12	500	310	80	nil

Table 3 Nutrient Levels of Soil at Different Depths 1 & 1.5m Away from the Centre of Pit Latrine

Depth m	1m Away		1.5m Away		1m Away		1.5m Away		1m Away		1.5m Away	
	NH_3-N ppm	No. of Sites	NH_3-N ppm	No. of Sites	NO_3-N ppm	No. of Sites	NO_3-N ppm	No. of Sites	P ppm	No. of Sites	P ppm	No. of Sites
1	0 1-10 11-50 51-85	2 15 8 3	1-10 11-30	20 8	0 1-10 11-30 31-85	3 6 15 4	0 1-10 11-30	10 14 4	15-50 51-100 101-170	14 4 10	1-30 31-60 61-100	12 12 4
2	0-10 11-50 51-120	9 16 3	1-10 11-30 31-45	20 4 4	0 1-10 11-30 31-65	2 5 12 9	0 1-10 11-30	7 10 11	15-50 51-100 101-170	11 11 6	1-30 31-60	16 12
3	0 1-10 11-50 51-120	4 9 10 5	1-10 11-30 31-60	20 4 4	0 1-10 11-30 31-50	5 6 11 6	0 1-10 11-30	11 9 8	0 1-50 51-100 101-170	4 9 11 4	1-30 31-60	18 10

But in some of the soil samples in between the pits the NH_3 content was in the range of 11-50ppm. This indicates certain amount of NH_3 leaching from the pits to the surrounding soil profiles. A similar trend was observed in the case of nitrate. Thirty two percent of the sites had zero nitrate levels at a distance of one metre away from the bottom of the pits. In the balance sites, the nitrate levels were in the range of 11-30ppm as NO_3-N. In case of twenty four sites, NO_3-N was either zero or very low 1.5 metres away from bottom level of the pits. But this amount of leaching may not be attributed to the pollution of ground water, due to most of these nutrients were been used up by vegetation. However, the nitrate content of soil could change over a relatively short period of time due to natural causes such as rainfall, seepage and sunshine.

In fifty percent of sites, the phosphorus level of the soil samples were in 0-50ppm, 1 metre away from bottom of the pit. The phosphorus content in the range of 0-30ppm was observed 1.5 metres away from bottom of the pit. The study revealed that the phosphorus content of sub surface soil formations, close to the latrine pits, has a decreasing tendency as the depth increases. This is due to the fact that Phosphorus is comparatively insoluble than nitrates. In general, the bacteriological data obtained showed absence of faecal coliforms and streptococci in most of these soil samples. In some cases counts were limited to one metre depth. Beyond one metre depth it does not survive due to the environmental factors (Table 4).

However, in the case of wet soil samples (site 19), the bacteriological counts were high, showing the movement of pathogens under moist conditions. It is concluded that the risk of pollution of groundwater from double pit latrines was minimal.

REFERENCES

Courtney, F.M. and Trudgill, S.T. (1984). The soil
Edward Arnold (Publishers) Ltd., London. 123p.

Davies, B.; David, E. and Finney, B. (1986). Soil Management.
Forming Press Ltd., U.K. 15-59p.

Feachem, R.G.; Bradley, D.J., Garelick, H. and Mara, G.D. (1983)
Sanitation and disease. John Wieley and Sons, London. 60-66p.

Hukka, J. (1989). Environmental Sanitation. Beyond the decade. Tampere University of Technology, Institute of Water and Environmental Engineering (Finland).

Sopisto, G.(1989). The Chemistry of Soils. Oxford University Press, New York. 10-15p.

Table 4 Total Coliform, Faecal Coliform and Streptococci Counts per 100ml in 10g Soil Samples Digested with Sterilized Water

In Dry Soil Samples Depth (m)	1m Away from Centre of Pit									1.5m Away From Pit					
	P_1			P_2			P_3			P_4			P_5		
	TC	FC	SC	TC	FC	SC	TC	FC	SC	TC	FC	SC	TC	FC	SC
1	80	Nil	10	50	Nil	40	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
2	120	Nil	Nil	20	Nil	10	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
3	70	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Site No.19 In Wet Soil Samples Depth (m)	1m Away from Centre of Pit									1.5m Away From Pit					
	P_1			P_2			P_3			P_4			P_5		
	TC	FC	SC	TC	FC	SC	TC	FC	SC	TC	FC	SC	TC	FC	SC
1	80	Nil	Nil	130	Nil	90	70	Nil	30	320	20	200	80	Nil	Nil
2	610	320	10	130	Nil	90	220	60	120	90	50	40	90	30	Nil
3	1220	870	140	120	10	80	1300	280	80	170	Nil	20	60	Nil	Nil

TC - Total coliforms at 35°C
FC - Faecal coliforms at 44°C
SC - Streptococci at 35°C