Pollution from on-site sanitation — the risks? *What* risks?

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Just how does the threat of groundwater pollution compare to the risks to health posed by an absence of sanitation systems?

1. Lewis, W.J., *et al.*, 1980 (see Resources Guide).
Chairuca, L. and I. Hassane, 'Nitrate contamination in peri-urban Maputo (Mozambique)' in *Proceedings of 17th WEDC Conference*, Nairobi, Kenya, 1991.
2. van Ryneveld, M.B. and A.B. Fourie, 1997 (see Resources Guide).
3. Hoffman, J.R.,'Diffused (non-point) source pollution in the Hennops valley' in *Proceedings of 1st conference on environmental management, technology and development* SAICE, 7-8 March 27.1-27.9, 1994.
4. Mara, D.D., *Low-cost urban sanitation*, John Wiley, London, 1997.
Cotton, A.P., *Sanitation options — India.* WELL Task No. 18 WELL, Loughborough University, 1997.

On-site sanitation systems provide a viable, lower-cost alternative to water-borne sewerage. The basic problem is the potential pollution of groundwater, particularly in densely populated, urban areas where latrine pits and shallow wells are close together. Lack of effective urban planning means that it is very difficult to regulate and enforce the relative location of latrines and wells on plots, even in formally developed areas.

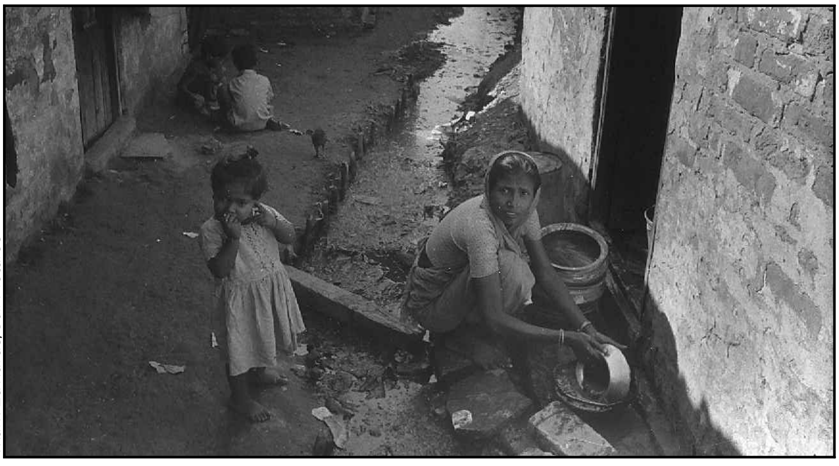
The issue is not whether on-site sanitation leads to pollution of groundwater sources, since this has been clearly demonstrated,[1] but as van Ryneveld and Fourie (1997, p.280) state '...what [the] implications of this potential pollution are as regards the viability of on-site sanitation in a particular instance, and whether these dangers can be dealt with in the planning and design stages.'[2]

One way to begin to address this point is by considering the relative risks. There are several arguments on this subject:

- on-site sanitation is not the only pollution threat to groundwater;
- the debate about groundwater is one of weighing relative health risks; and
- how serious are the pollution threats?

Contamination sources

The first of these points, originally made by Hoffman (1994),[3] is that all types of sanitation pose a pollution threat of some kind. What is needed is an assessment of the risk associated with pollution from on-site sanitation in relation to other forms of sanitation systems. The debate on groundwater pollution can sometimes read as if on-site sanitation is the only cause of contamination. This is clearly not the case. Sewers, unless well constructed and maintained, can contribute significantly to contamination of the environment, and of both ground- and surface water resources. Water-borne systems have the tendency to accumulate and concentrate raw sewage, in contrast to on-site systems, which dispose of wastes in a much more diffuse manner.



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Washing cooking utensils in an open drain. Such drains may be highly polluted as lack of sanitation can lead to indiscriminate defecation in the neighbourhood environment.

Relative risks to health

The second point strikes at the centre of the debate on groundwater pollution, and raises the idea of balancing relative risks. Both Mara (1997) and Cotton (1997) argue that in disease transmission terms it is preferable to pollute groundwater than to have pollutants on the ground surface.[4] Cotton develops this idea in greater detail in a review of sanitation options appropriate for the Cuttack Urban Services Improvement Project. It is clear that the primary objective of sanitation improvements is to permit the safe and sanitary collection, removal and disposal of human excreta. In many situations, the absence of facilities, coupled with poor user education, inevitably lead to indiscriminate defecation — the environmental risks associated with excreta being deposited on the ground surface, in ponds, drains and water courses, are very high. Lewis *et al.*, (1980) state, 'In communities which lack sanitation, most disease transmission occurs in the heavily contaminated neighbourhood environment independently of household levels of hygiene.'

In this context, the main priority has to be the removal of excreta from the immediate environment. In Cuttack, where alluvial soils are common, the health risk from groundwater pollution was lower than the health risk arising from fresh excreta in the neighbourhood environment.

It is improbable that any project intervention which has a sanitation component would allow indiscriminate defecation to continue, rather than have a latrine system which may pollute groundwater. Feacham *et al.* (1980) support this notion by ranking the relative health impacts of different sanitation options.[5] Pit latrines operating in the 'real world' (which can be interpreted as including areas of high water-table and flooding), are assigned a score of 6; the baseline of zero corresponds to no sanitary provision. The maximum score of 10 is not attained by any option, including sewerage with full treatment in stabilization ponds (which scores 9). Septic tanks score 7. Interestingly, the health impacts of a pit latrine in 'an ideal world' score 9.

Exaggerating the risks?

As regards the third point, the presence of particular contaminants (especially nitrates) is frequently used to promote the use of water-borne systems over on-site sanitation. But there is little critical analysis of the magnitude or intensity of these threats. Jackson (1997) goes some way to address this in an interesting discourse on whether the threat of groundwater pollution has been exaggerated; he uses a well-known example to illustrate the point. High concentrations of nitrates in drinking water can lead to (in addition to other predisposing conditions) methemaglobinaemia (blue-baby syndrome) in bottle-fed infants under three months old. However, as Jackson points out, the only country in which this is a notifiable disease, Hungary, reported 562 cases and 7 fatalities in the decade 1981-90, out of a population of 10 million.[6] In a developing world context, with the prevalence of breast feeding in rural areas, the risk appears to be minimal.

Furthermore, although there are links between nitrate levels and some forms of gastric cancer and congenital deformities, it is these risks must be considered very slight given the difficulty of establishing a clear relationship on the data available.

The way ahead

The groundwater pollution problem can be addressed in a variety of ways:

- ***Investigate modifications to the sanitation system***. For example, by providing on-site sanitation systems with a sand filter to reduce pathogen transmission.

Evaluation of the environmental impact of on-site sanitation

- Define the compliance requirements that must be met, in terms of both physical location (point of compliance) and allowable contaminant concentration.
- Estimate the risk of pollution by viruses or bacteria using the 'residence time' approach. This entails calculating how long it would take a 'particle' of water to travel from a latrine to the point of compliance. If the latrine is situated above the water-table, then this residence time might include time spent both in the vadose (the unsaturated zone between the water-table and the ground surface) and the saturated zones. Techniques for doing this could vary from simple, hand-calculation techniques, to sophisticated finite element computer analyses, depending on the complexity of the hydrogeological conditions underlying the latrine. If the travel time exceeds 150-200 days, microbiological contamination should be eradicated in all but exceptional circumstances.
- To estimate the risk of pollution of water resources by nitrates, use a mass balance approach. This approach requires knowledge of a number of factors, including the proportion of nitrogen leached from the on-site sanitation system, the amount of rainfall that infiltrates the subsurface, and the rate of denitrification in the subsurface. Rough estimates of these factors have been made, but require further investigation.
- For both microbiological and chemical contaminants, use a probabilistic approach (as far as the available data will allow), allowing appropriate margins of safety in design (although exactly what these margins may constitute is still to be determined).
- Until adequate data relating to the input parameters that are required for the above approach become available, it will be necessary to carry out field monitoring of at least selected on-site sanitation schemes. This will provide an early warning system should contaminant levels build up to hazardous levels, and will allow alternative sanitation strategies to be implemented, or remedial measures to be taken.

Source: Adapted from van Ryneveld & Fourie (1997, p.289)

- ***Investigate modifications to the water supply system***. For example, by establishing a reticulation system with standposts to reduce the domestic use of groundwater. If this is not possible, the best option is to allow or encourage householders to construct pit latrines, but to obtain water from a 'safe' area (which may be on higher ground, upstream of the latrines).
- ***Improve guidelines***. Guidelines which adopt a simplistic approach, that contain a few, easy to follow rules, are inevitably unable to accommodate the variety of factors that influence the potential environmental effect of on-site sanitation. Ryneveld and Fourie (1997) propose a recommended strategy for the evaluation of environmental impact of on-site sanitation (see Box, above).

Groundwater pollution — the risks? *What* risks? The title of this paper is deliberately provocative in order to encourage a critical evaluation of our understanding of the risks from groundwater pollution and the role that on-site sanitation plays in it. It is not to say that there are no risks, but that they need to be viewed in perspective to the risks from faecal contamination at the ground surface. ■

The main priority has to be the removal of excreta from the immediate environment.

5. Feacham, R.G., D.J. Bradley, H. Garelick, and D.D. Mara, *Health aspects of excreta and sullage management: A state of the art review*, World Bank, Washington DC, 1980.
6. Jackson, B.M., 'Are we exaggerating the dangers of groundwater pollution from on-site sanitation systems such as pit latrines?' Presented at the Quarterly meeting of the Geological Society of South Africa, Pretoria, 20 August, 1997.

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