

# Urban groundwater

## Monitoring the contamination of aquifers below cities

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The issue of urban water management is of growing importance for groundwater-dependent cities because urbanisation has a major impact on aquifers beneath cities. This results from factors which include the import of large quantities of water for supply, modifications to drainage patterns, extensive use of the ground for effluent discharge and waste disposal and large-scale groundwater abstraction from intra-urban areas. The consequences include problems of aquifer depletion, saline intrusion, land subsidence or, at the other extreme, locally troublesome rising groundwater levels.

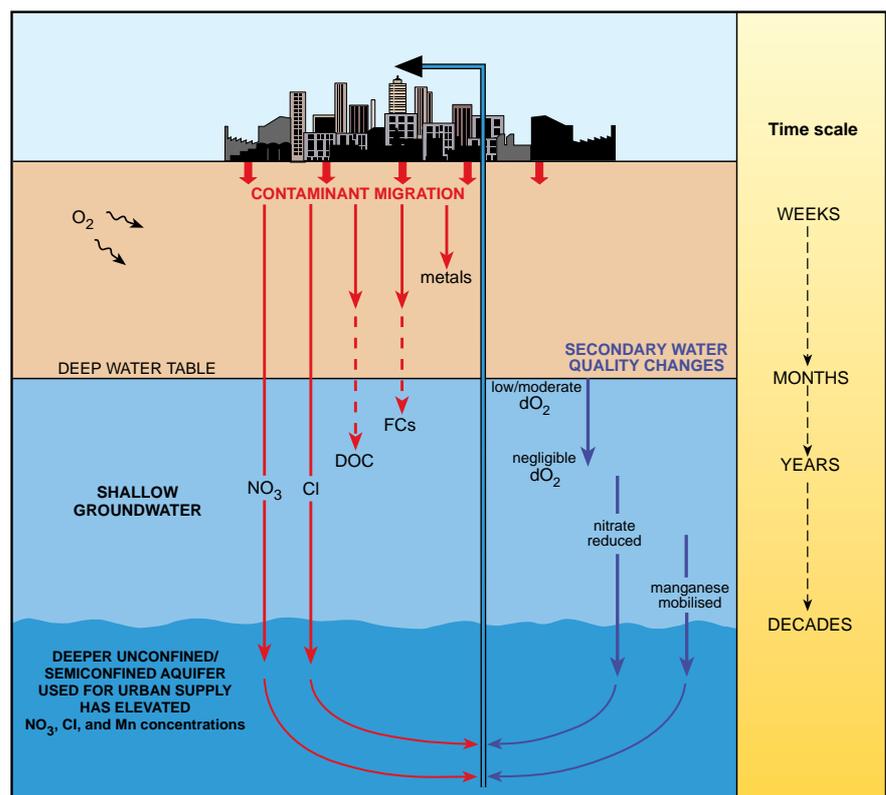
Furthermore, in most developing cities, population growth precedes the development of infrastructure to handle wastewater, leading to widespread contamination of shallow groundwater by domestic and industrial effluent. Given the large storage of most aquifers and long residence times, there is often a major time lag before the problems of groundwater pollution become fully apparent. The net outcome is increasing water scarcity with escalating long-term marginal costs for water supply. The traditional use of low-cost, minimally treated groundwater for public water supply in urban areas is being threatened and increasing health risks are involved.

With support from the Department for International Development (DFID), the BGS produced a report for the World Bank in its influential technical paper series, and has also continued to research pollution risk to deep groundwater from urban wastewaters. This study was conducted with partner organisations in Santa Cruz, Bolivia (the water services cooperative SAGUPAC), and in Hat Yai, Thailand

(with the Department of Mineral Resources and with the Prince of Songkhla University). A summary report for non-technical readers was produced early in 1998. The research conducted in both cities suggests that whilst nitrogen and chloride have penetrated to deeper aquifers, their concentrations do not represent a significant health concern even though, in the case of nitrogen, concentrations may exceed guidance values. Urban wastewaters in many developing countries appear to have lower concentrations (both actual and relative) of synthetic organics than

corresponding wastewaters in North America and Europe. This may change as the developing countries industrialise.

An important, if surprising, result of this research is that secondary water quality changes, caused by a reduction in the redox potential of the groundwaters, can have a major and possibly more serious impact, producing increases in iron and manganese groundwater concentrations. This water quality deterioration may require costly treatment. In addition arsenic (which appears to be associated with iron mobilisation) has been identified as a significant water quality concern. Concentrations of twenty times World Health Organisation guidelines have been observed in shallow groundwater as a result of redox changes caused by seepage to the ground of urban effluent containing a high organic load. Mobilisation of arsenic in deeper aquifers has also been confirmed. The health implications of excessive arsenic concentrations in drinking water are significant and therefore an important recommendation from this research is that urban groundwaters need to be monitored for arsenic especially where reducing conditions cause iron mobilisation.



Deep groundwater flow beneath cities: the controls on contaminant transport behaviour in an aerobic groundwater system.