Use of Geophysics, SRTM and Remote Sensing to Characterize Groundwater Contamination from Oil Shale Wastes in South China*

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Abstract

Mapping the extent of groundwater contamination beneath landfills and hazardous waste sites is a major environmental challenge, particularly in developing countries. Monitoring wells are scarce, expensive, and commonly fail to define the full extent of contamination. Remote sensing observations from Earth orbit, as well as geophysical methods operating at the Earth’s surface, offer innovative and noninvasive tools for identifying subsurface contamination in these situations, as illustrated by this study of the Maoming oil shale landfills.

Between the 1950's and 1990's oil shale mining and retorting northwest of Maoming City, southern China, produced 50 million tons of waste that were dumped in two huge landfills averaging 6-7 km long, 1-2 km wide and 5-6 m high. Rainfall and surface water percolating through the waste has led to pollution of adjacent aquifers by landfill leachate containing heavy metals and organic compounds. Values of pH as low as 3.0 have been measured in some residential and village municipal wells adjacent to the landfills. Resistivity soundings and profiles were made over and adjacent to the north landfill in 2001, in conjunction with sampling water quality in village wells surrounding the landfill. Soundings identified a very low-resistivity layer (less than 10 ohm-m) at 5-6 m depth in a village with contaminated wells about 1 km southwest of the north landfill - this conductive zone may represent leachate contamination of a shallow confined aquifer. Resistivity models, combined with groundwater specific conductance values, suggest an apparent formation factor of 10.6 ± 2.8 for the oil shale waste and formation factors of 1.7 - 3.9 for the Laohuling Formation aquifer that surrounds the landfill. This information, and other electrical properties of these formations, will be used to design and model...
future 2D resistivity and EM surveys. In addition, Shuttle Radar Topography Mission (SRTM) data provide excellent constraints on
elevation of the north landfill and may be used to infer water table elevations, based on elevation of surface water bodies. Landsat
Thematic Mapper, and Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) data have also proven useful in
defining the extent of waste areas and their degree of vegetation. Remote sensing the extent and type of vegetation will be useful in
planning and monitoring phytoremediation at this site.

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Abstract

Groundwater contamination is a major problem in the Muanning oil shale area in South China. The contamination, which is caused by leachate from oil shale disposal sites, is a serious threat to groundwater resources and human health. In this study, we used SRTM data, geophysical methods, and remote sensing to assess the extent of groundwater contamination. Our methods were designed to improve the accuracy of contaminant detection and to enhance our understanding of groundwater contamination processes.

Objectives

- Map the water table across the north landfill
- Assess the potential for pollution of deeper confined aquifers

Timeline and Methods

- February 2000: SRTM data collected
- March 2000: water levels and samples from village wells
- August-December 2001: Geophysical measurements and additional water samples
- July 2005: repeat water level measurements

Conclusions

The SRTM and geophysical data collected in this study provide a valuable tool for assessing groundwater contamination. The data suggest that groundwater contamination extends beyond the immediate disposal sites and poses a significant risk to the local population.

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