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Real Time Monitoring of the Vadose Zone - Key to Groundwater Protection

Ofer Dahan

The Ben-Gurion University of the Negev, Ben-Gurion University, Zuckerberg Institute for Water Research, Midreshet Ben Gurion, Israel (odahan@bgu.ac.il)

Minimization subsurface pollution is much dependent on reliable and effective monitoring tools. Such monitoring tools should be capable to provide real-time information on the chemical and hydrological state of the percolating water, from land surface to the groundwater. Today, most monitoring programs are based on observation wells that enable collection of hydrological and chemical information from the saturated part of the subsurface. As a result, identification of pollution in well water is clear evidence that the contaminants already crossed the entire vadose-zone and accumulated in the aquifer. Unfortunately, only little can be done to fully remediate contaminated aquifers. Accordingly, effective monitoring program must include monitoring means that provide real-time information on the hydrological and chemical properties of the percolating in the unsaturated zone, long before contaminates reach the water-table and accumulate in the aquifers. Such monitoring programs may provide "early warning" for potential pollution processes that may risk groundwater quality.

A vadose-zone monitoring system (VMS), which was developed recently, allows continuous monitoring of the hydrological and chemical properties of percolating water in the deep vadose zone. Data which is collected by the system allows direct measurements of the water percolation fluxes and detect the chemical evolution of the percolating water across the entire unsaturated domain. The VMS is designed for long term continuous operation in a time scale of years to decades. Up-to-date the system has been successfully implemented in several studies on water flow and contaminant transport in various hydrological and geological setups. These include research projects on: (a) floodwater infiltration and groundwater recharge from stream channels and reservoirs, (b) impact of various agricultural regimes on quality and quantity of groundwater recharge, (c) subsurface pollution of dairy farms, (d) chemical evolution of landfill leachates, and (e) control of remediation operations in contaminated sites.