In-situ monitoring of agricultural return flow impact on groundwater quality

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Land use and groundwater quality
Common approaches in vadose zone hydrology
Vadose Zone Monitoring System

Flexible waveguides

Groundwater
Vadose zone Monitoring System
Infiltration from stream channels and reservoirs

Buffels River, South Africa

Andarax River, Spain

Wadi Arava, Israel

Zukim, Israel

Dahan et al., 2007. Journal of Hydrology
Dahan et al., 2008. Groundwater
Dahan et al., 2009. Vadose zone Journal
Yanai et al., 2011. Water Resources Research.
Land use impact on groundwater quality

Rimon et al., 2007: WRR
Rimon et al., 2010. VZJ
Rimon et al., 2011. VZJ
Infiltration of diary farms waste through clay soils

Chemical transformation of landfill leaches

Aharoni et al., 2017. Waste Management.
Bio-Remediation of contaminated vadose zone

Avishai et al., 2016. Journal of Hazardous Materials
NO₃(mg L⁻¹)

Turkeltaub, et al., 2016: Hydrol. Earth Syst. Sci
Impact of intensive organic agriculture on groundwater quality

The graph shows the δ¹⁸O (‰ vs. VSMOW) and δ¹⁵N (‰ vs. Air) values at different depths for Organic and Conventional treatments. The data points are color-coded for each treatment:

- Organic: Green circles (δ¹⁸O) and red triangles (δ¹⁵N)
- Conventional: Green circles (δ¹⁸O) and red triangles (δ¹⁵N)

The graph includes a legend indicating the depth ranges for each treatment:

- Org 0-5 (m)
- Org 5-15 (m)
- Con 0-5 (m)
- Con 5-20 (m)

The legend also includes labels for different sources of nitrogen:

- NO₃⁻ Fertilizer
- NH₄⁺ in Fertilizer and rain water
- Soil N
- Manure

The graph also includes an inset showing a diagram of the root zone, vadose zone, and groundwater, with a monitoring system and an observation well.
Liquide vs. Solid fertilizers

NO$_3$ (mg/kg)

Depth (m)

Liquid fertilizer
Solid fertilizer

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Lu Wq 2017
Organic farming

Conventional fertigation
Impact of switching crop type on water and solute fluxes in deep vadose zone

Turkeltaub et al., 2016. Water Resources Research.
NO$_3^-$ (mg L$^{-1}$)

Tomato

Lettuce

VSP at 2 m depth

VSP at 6 m depth

VSP at 15 m depth

Depth (m)


Aug-2010  Dec-2010  Aug-2011  Apr-2014

Sep-2010  Jan-2011  Sep-2011  Sep-2014

Turkeltaub et al., 2016. Water Resources Research.
Turkeltaub et al., 2016. Water Resources Research.
Infiltration of diary farms waste through clay soils

Monitoring Setup

Waste channel and its margins

Waste Lagoon and its margins

- Sandy loam
- Clay
- Calcareous sandstone

Wastewater

Desiccation cracks

Groundwater

Cl^− ~800 mg L^−1 NO_3^− ~300 mg L^−1

Groundwater observation well

RFW1 & RFV1

RFW1 & RFV1
Flow: Changes in the water content across the vadose zone

Sharp response to rain events which crosses the entire clay layer (<12 m) within hours
Flow: Wetting fronts propagation

Wetting front arrival time (h) vs. Depth (m)

- Sandy ephemeral river bed
- Sand dune
- Coarse alluvial deposits
- Clay

Baram et al., 2011
Desiccation cracks in clay soil
Summary

• Water flow and contaminant transport in the vadose zone may be monitored continuously, from the root zone down to groundwater.

• Pollution processes may be identified in the vadose zone long before groundwater pollution is evident.

• Irrigation and fertilization efficiency may be controlled on the basis of real time information from the vadose zone.

Farmers – Accessible data on losses of agricultural inputs
Water authorities – Early warning on pollution processes