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Water quality prognosis of a production well field based on monitoring data and groundwater dating

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The water quality of production well fields is determined by the land use in the capture area, geochemistry of the aquifer and the travel time distributions of the production wells. The aim of this study was to project the water quality of the production well field Holten (The Netherlands) based solely on the travel time distributions of the production wells and the water quality data from the monitoring network in the vicinity of the well field.

The production well field of Holten is located in the east of the Netherlands, in sandy ice-pushed ridges and peri-glacial aeolian deposits. Land use in the capture zone is agriculture and natural forest in approximate equal proportions. The travel time distributions of 4 shallow production wells (15-45 m below surface) and 3 deep production wells (45-70 m below surface) have been determined by a combination of ^{85}Kr, ^{3}H/^{3}He and ^{39}Ar dating. Sampled groundwater from 9 monitoring wells (27 screens) has been dated with ^{3}H/^{3}He to relate the water quality data to the time of recharge.

Water quality data from the monitoring network provided the regional aggregated trend in water quality parameters, related to the time of recharge. These trends generally show an increase in agricultural contamination up to the 1980s, but decreasing concentrations in younger water. The regional aggregated trend of nitrate shows complete denitrification in older groundwater in deeper parts of the aquifer, confirmed by high dissolved N_2 concentrations causing high total dissolved gas pressures and occasionally degassing of groundwater. Excess N_2, from denitrification, coincides with elevated sulfate concentrations, indicating denitrification by pyrite oxidation. The regional aggregated trends from the monitoring wells provided the input for the water quality prognosis based on the travel time distributions of the production wells.

In general, shallow production wells with a very large young component are projected to show water quality improvements in the near future. The response of shallow production wells with intermediate age distributions is slower. Two of the three deep wells produce a mixture of groundwater containing a young fraction and these are projected to show deterioration in water quality in the future, although nitrate concentrations in these wells are kept low by denitrification and pyrite oxidation. Only a single deep well shows no vulnerability to water quality deterioration thanks to the travel time distribution containing exclusively old groundwater.

The combination of ^{3}H/^{3}He dating of the monitoring wells with discrete travel time distributions of the production wells based on ^{85}Kr, ^{3}H/^{3}He and ^{39}Ar dating provide a robust water quality prognosis and wells vulnerability assessment.