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Influence of the Alte Aare river on ground-water recharge and pollution in the Lyss area, Switzerland

The interaction between river and ground water plays an important role on ground water quality. The river water infiltrating to the aquifer also may transfer contaminants to the ground water. Some of these contaminants pose a serious risk to ground water, particularly in cases where ground water is used for drinking water purposes.

A number of methods for studying the role of river on ground water quality were selected. The study area is conducted near the town Lyss. This area includes a part of Bernese Seeland aquifer which is important regional aquifer. This region is transected by the Alte Aare river flowing from SSW to NNE and Lyssbach creek flowing from SSE to NNW. There are potentially 3 sources for contaminants identified in this research area: I) the plume on the east side of the Alte Aare river which has a length of 700 to 1000 m is contaminated with 50 µg/l of PCE concentration at the hot spot , which was used as a solvent by the GZM (extraction lant for ani al carcasses) factory in the ast; II) the waste water treatment plant (WWTP) of the town of Lyss and III) an old de osit u strea on the west side of the Alte Aare river. Downstream, there are two drinking water wells of the city of Biel on the west side of the Alte Aare river. The PCE concentrations in two drinking wells were 0.1 and 0.3 µg/l (Geotest AG, 2011).

The main goals of this study are to evaluate of ground water quality with considering these potential pollutants impact and also to investigate the influence of the Alte Aare river on ground water quality. The prediction and assessment of the influence of the contaminated plume on the two drinking wells is another question of this study. To address these objective the following methods were applied: on-site monitoring of ground water quality (pH, oxygen and electrical conductivity), a series of logger data for temperature and ground water level, mass balance calculations, and chemical and isotopic analyses of surface and ground water. A special focus was put on the analysis of acesulfame, as an anthropogenic tracer yielding information on ground water recharge and the impact of surface water pollutants on ground water quality. The analytical part of this study was conducted from December 2012 to August 2013.

For estimating the fraction of river infiltration on ground water recharge, first a water balance calculation for an area of 1.56*105 m2 was done. As a result, about 23% of ground water is recharged by the river. The ground water table fluctuations on the west side of the Alte Aare river in piezometers close and parallel to the river were affected more rapidly and more strongly by the river water height in comparison to the piezometers further away from the river. The most distant piezometers showed smoother variations due to dampening of river fluctuations. The large range in temperature in the ground water indicated that the upper part of the aquifer is not homogeneous and is influenced by the ambient temperature and its seasonal trend. The short time lags in temperature along the flow path from the river and from piezometers close and parallel to the Alte Aare, show that these piezometers are also strongly affected by the river temperature.

The isoto e signatures of δ2H and δ2O in surface water and ground water samples follow closely the local meteoric water line for northern of Switzerland. The isoto e signatures in δ18O and δ2H in the Alte Aare river were depleted in July because of the snow- glacial melting component. The de letion of δ18O and δ2H in ground water was induced by infiltrating river water. The δ18O and δ2H values of the most distant piezometers from the river and also in the two drinking wells were less influenced by river recharge.

The hydrogeochemical relationships were worked out to assess the evolution of cations, anions, heavy metals. The PhreeqC code was used to obtain information on geochemical processes in surface water and ground water. The hydrochemical composition of the surface and ground water is of Ca-Mg-HCO3 type. Dissolution of carbonate minerals, specifically of calcite, in the alluvial aquifer is the main source of calcium in the ground water. The Ca concentration in ground water samples from piezometers parallel and close to the Alte Aare did not follow the same trend as that of ground water samples located further away from the Alte Aare. This again shows the stronger influence of river infiltration in these piezometers.

PCE, TCE and cDCE concentrations in all groundwater and river water samples were below the threshold values for contaminated sites according to Swiss legislation (AltlV). Low PCE concentrations were found in the two drinking wells. These low PCE concentrations decreased from June to August due to increasing water recharge to the aquifer. The PCE concentrations on the west side of the Alte Aare river unexpectedly increased from upstream to downstream with increasing distance from the hot spot of the plume. From this pattern it seems that these contaminants may not originate from the main plume around the GZM factory.

Because artificial sweeteners are not attenuated or degraded in the wastewater treatment plant, these compounds such as acesulfame may serve as tracers for urban waste water. Acesulfame discharged from the waste water of the WWTP into the Alte Aare river was analysed in the ground water. The acesulfame concentration found in the ground water increased from winter to summer which indicated higher concentrations as consequence of higher river infiltration during this period. The maximum acesulfame concentration with a fraction of 20% of input acesulfame was observed at minimal distance 550 m from the WWTP. The two drinking wells showed a fraction of 0.9% with respect to the source concentration.

Based on the results of this thesis, it can be concluded that the Alte Aare poses a potential risk for transmitting pollutants to the ground water. On the other hand the river may act as barrier for pollutants from the east side of the Alte Aare . The groundwater data did not show any effect from the old deposits upstream. A long term pumping test in the drinking water wells is suggested to assess the origin of PCE concentrations.

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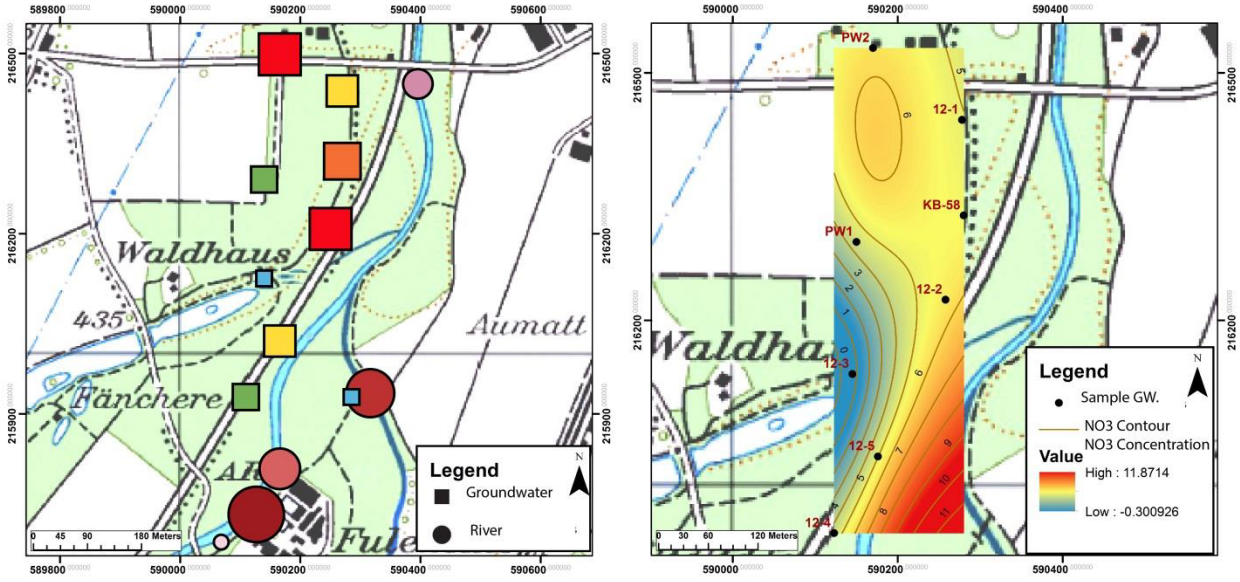

Spatial distribution of NO3- in ground water (August 2013)

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