



Impact of water overstock on groundwater quality of the Bassee plain area (France)

L. Gourcy (1), M. Pettenati (1), N. Baran (1), and P.Y. Durand (2)

(1) BRGM, 2 av. C. Guillemin, BP36009, 45060 Orleans, France (l.gourcy@brgm.fr/33238643446), (2) IIBRBS, 8 rue Villot, 75012 Paris, France (P.Y.Durand@iibrbs.fr)

The project, inspired by the structural flood plain management measures of the Rhine River, consists in the temporal removal of a maximum amount of water from the Seine River in order to leave priority to the water from the River Yonne. Yonne River and the Seine are presenting their maximum water flow usually at a same time. The space located between Bray-sur-Seine and Montereau-Fault-Yonne corresponding to the La Bassée plain (agricultural area of 23 km²) is well adapted to this project of temporary and artificial flood.

The objective of the project financed by the Institution Interdépartementale des barrages Réservoirs du Bassin de la Seine (IIBRBS), the BRGM, the Seine-Normandie Water Agency, the European Community through the Interreg IIIB SAND project is the evaluation, at a local scale, of the impact on groundwater quality of the temporal Seine water storage.

Indeed, the water over storage i) changes hydraulic conditions and therefore modify water and pollutants transfers through the unsaturated and saturated zones and ii) bring at soil surface a water (Seine River) potentially containing contaminants that may move to groundwater and consequently changed physico-chemicals conditions (redox) of groundwater.

The estimation of the vulnerability of groundwater to changes and loads needs hydraulic and geochemical modelling of transfer through the unsaturated zone as well as the study of pollutants fate in static conditions.

Retention properties of some metals (Pb, Ni, Cu, Cr, Zn) in soils and materials of the unsaturated zone by chemical processes were performed determining adsorption coefficient (K_d) by laboratory experiments. These experiments are showing that nickel mobility is lower in the argillous layers than in the sandy part of the unsaturated zone. Ni mobility is controlled by iron hydroxides and precipitation of other secondary minerals. Its complexation on organic ligands increases its mobility in soils. Copper concentration is influenced by CaCO₃ presence and soluble organic ligands. Zinc is strongly adsorbed on the solid matrix at all tested soils. At basic condition, such as normally encountered at the Bassée floodplain, chromium adsorption is very low or null. Based on these results, batch modelling (without transport) were carried out for Cu and Ni. That confirms that nickel adsorption is controlled by iron hydroxides in porous media. For copper, the main processes controlling adsorption is organic ligands complexation that increases the mobility of this element in the soils.

To complement the information acquired on metal compartment in the unsaturated zone and because pesticides were detected in soils and groundwater, laboratory experiments were performed using glyphosate alone and combining this pesticide with the tested heavy metals. The tests are highlighting the strong relationships between metals and pesticides. For the 5 soils used glyphosate adsorption is increased when metals are added to the solution. At the opposite, the experiences for the evaluation of the impact of the increase of glyphosate on the quantity of metals adsorbed (Cu, Ni, Ni) were not conclusive.

The geochemical calculation code PHREEQC was used to model reactive transfer of solutes in a 1 D saturated column. Results obtained indicate that some contaminants (nickel) are mainly retained at the iron hydroxides surfaces even at very high concentration. Stability of metal depends then on the maintaining of oxic conditions in the porous media. After adsorption, nickel concentrations in soils remains well under average natural concentrations. Results of the project allowed the risk evaluation of a groundwater contamination by the Seine River during overstock episodes. During derivation of the Seine River into the Bassée floodplain, infiltration of water and solutes in the unsaturated zones will be done quickly. Some metals (Zn, Ni, Cu), and the glyphosate, will stay in the first centimetres of the soils due to their intrinsic properties. Even if a change of the physico-chemical conditions (mainly redox, organic matter contents) of the Bassée floodplain has very little probability to occur, this change may lead to

very important changes in the comportment of heavy metals and pesticides. Other elements (Cr and other anionic metals) are not retained in the shallow soil horizons and, as water, will infiltrate very quickly in the unsaturated zone during inundation phases. Persistence time, estimated by modelling, of dissolved elements in the unsaturated zone is few years.

The results showed that the probability of groundwater contamination due to overstock episodes is very low to null but consequences may be important. This assessment obliges to consider the installation of a water quality monitoring program for the control of the Seine River upstream the alluvial plain about 5 days before filling up the retention basins and up to the end of the replenishment procedure.