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Pollutant transfer dynamics during a flood event in an agricultural watershed (Save, South West of France)

Desiree El Azzi (1,2), Roman Teisserenc (1,2), Maritxu Guiresse (1,2), Georges Merlina (1,2), Jean-Luc Probst (1,2)

(1) Université de Toulouse; INPT, UPS ; Laboratoire Ecologie Fonctionnelle et Environnement (ECOLAB); ENSAT, Avenue de l'Agrobiopole, 31326 Castanet Tolosan Cedex - France, (2) CNRS ; ECOLAB; ENSAT, Avenue de l'Agrobiopole, 31326 Castanet Tolosan Cedex - France

* Corresponding author: Jean-luc.probst@ensat.fr

Agricultural practices are identified as the main sources of water contamination in rural areas. One of the major inducers of pollutant transfer in these watersheds is rainfall events and subsequently, soil leaching and storm runoff. Consequently, during flood events, very high fluxes of pollutants are exported to the outlet of the catchment. These hydrological periods are therefore very important to understand the transfer dynamics of these molecules, particularly the different flow pathways (surface runoff, SR, subsurface flow, SSF, and groundwater flow, GF) from soils to the stream. Properties of the pollutants play a major role in influencing their concentration in stream flow and their partitioning between dissolved and particulate fractions. They can either be adsorbed onto eroded particles and transported in the river water by particulate matter, or complexed by dissolved organic matter (DOM) and transported in the solute fraction.

In order to investigate the riverine transfer of both pesticides and heavy metals, this study was performed in the Gascogne region (South West of France) on the Save river basin draining an area of 1150 km2 mainly cultivated with corn, wheat and sunflower.

Intensive sampling of river water is carried by ECOLAB since 2007. This study will be focused on the flood event of May 2010. Analyses were conducted in order to follow the chemical composition of major anions and cations, silica, alkalinity, pH and conductivity, DOC and POC, total suspended matter (TSM), heavy metals and pesticides (mainly, herbicides and fungicides commonly used in this catchment). Hydrograph separation was performed to separate the different stream flow components (SR, SSF and GF) on the basis of Maillet's formula for the recession period. Beside this method, we used a chemical approach based on TSM and Cl- respectively as tracers of SR and GF. These tracers were selected according to their opposite behavior during the flood event.

Both methods showed the important contribution of SR (33%) and SSF (40%) in the total displacement of pollutants during the storm event. GF contribution (27% for the whole event) returned to pre-storm levels in approximately 7 days following the event. The assessment of these different contributions allows a better understanding of the pollutant pathways from the soil to the river water.

All pollutant concentrations greatly vary during the flood event. For example, Cu content increases from 1.2μg/L during low flows to 3.2 μg/L at the peak. Concentration-discharge relationships exhibit hysteresis phenomenon between rising and falling limbs of the hydrograph. In some cases (example for Cu), higher concentrations were found during the rising period as compared to the recession period showing that copper is mainly exported by surface runoff. Moreover, Cu reveals a significant relationship (r2=0.8, p=1.2.10-8) with DOC which controls the mobility of this element during the fluvial transport. On the contrary, Cd content presents a general decreasing pattern with discharge, except at the peak flow, indicating that SR and GF are controlling its transfer. Pesticide concentrations generally increase with discharge as already revealed by Taghavi et al. (2010), showing that these molecules are primarily exported by SR and SSF.

This study demonstrates the importance of intensive sampling during flood episodes and of combining a variety of analyses. However, further investigations are needed in order to study the mobility and persistence of the pollutants displaced during flood events and to understand the possible interactions between organic and inorganic pollutants and other molecules present in the stream.

References

L. Taghavi et al., Intern. J. Environ. Anal. Chem., Vol. 90, Nos. 3–6, 15 March–15 May 2010, 390–405