IAHS2022-470, updated on 29 Jun 2022
IAHS-AISH Scientific Assembly 2022

Climate change and water quality responses in agricultural catchments with high legacy storages of nutrients

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The effects of climate change on the quality of freshwaters remains poorly investigated while these effects are likely to be ambiguous. Indeed, such effects are partly direct such as temperature control on reaction rates, and partly indirect such as decrease of dilution processes with drier low flows. How the fate of a given pollutant responds to climate change can differ depending on its sources, reactivity and mobilization processes. Therefore, investigating the hydrochemical response of streams to climate change requires considering several elements that differ in their sources and pathways, and in their sensitivity to local and global forcings.

A cross-analysis of hydro-climatic variables and the dynamics of three solutes - carbon (C), nitrogen (N) and phosphorus (P) - was conducted at multiple temporal scales using the long-term data sets from a Critical Zone Observatory in Western France (AgrHyS). We identified trends on climatic variables (air temperature increased, winters became wetter and summers drier) and stream concentrations (NO_3 concentrations decreased, DOC concentrations increased). However, no effect of air temperature and radiation was observed on stream-water concentrations for the three solutes and there was no clear response of seasonal water-quality signals to increased contrast among hydrological seasons. Therefore, despite observed inter and intra-annual effects of climate on water quality, long-term changes of stream-water concentrations seemed to be more related to agricultural changes than to climate variations.

In such a temperate and humid region, the seasonal amplitude of climatic variables is higher than the magnitude of their long-term changes. In addition, agricultural catchments of Western Europe have received high inputs of nutrients since the 1960s that led to create legacy storages in particular N and P in the soil, the vadose zone and/or the groundwater. The damped response of water quality may then be related to legacy storage, leading to lower sensitivity to climatic than to agricultural drivers. Disentangling the respective effects of climate and human activities on stream water quality is particularly challenging, even more in such contexts dealing with legacy storages. As a perspective, we show how using ratios of elements with contrasted properties or origin can help addressing this challenge.