Geophysical Research Abstracts
Vol. 15, EGU2013-5513-1, 2013
EGU General Assembly 2013

Assessment of climate change and increased atmospheric CO_2 impacts on water quality in an intensive agricultural headwater catchment

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Climate change and increasing atmospheric CO_2 concentration can lead to disturbances in the global hydrological and nitrogen (N) cycling, and losses in catchment systems. Potential impacts on water and N cycling have been studied in large catchments with a variety of land uses but less attention has focused on agricultural headwater catchments. Despite their relatively small dimensions, headwater catchments of 1-10 km^2 play a dominant role in N transformations in the landscape, and streams in such catchments may have major impacts on downstream water quantity and quality. This issue is particular important for agricultural catchment which have to reach the WFD targets, where land use changes has to be analysed in combination with climate change.

The effects of climate change and rising concentrations of atmospheric CO_2 have been studied on (1) changes in hydrological and N balance components on a yearly basis and (2) the seasonal dynamics of water and N fluxes. The spatially distributed agro-hydrological model TNT2 (Topography-based nitrogen Transfers and Transformations) driven by ARPEGE (Action de Recherche Petite Echelle Grande Echelle) climate-model outputs from A1B scenario have been applied on the Kervidy-Naizin headwater catchment (western France), a long term hydrological observatory.

Consideration of atmospheric CO_2 concentration was implemented at two levels in TNT2: i) to account for the CO_2 effect on stomatal conductance TNT2; ii) to consider effect of CO_2 on biomass growth. Climate data from ARPEGE model, corrected with the quantile-quantile bias correction method, over 30-year simulation periods were used as TNT2 input (Salmon-Monviola et al., in review).

With increased CO_2, the main trends in water balance were a significant decrease in annual actual evapotranspiration, a moderate decrease in annual discharge and wetland extent, and a decrease in spring and summer of groundwater recharge and soil water content. Not considering the effects of increased CO_2 could lead to overestimating discharge decrease and underestimating AET decrease and wetland extent. Climate change and increased CO_2 could influence N cycling by significantly increasing soil N mineralisation, N fluxes by denitrification in wetlands that extend into upstream areas and decreasing N loads to streams. Since wetlands appears sensitive to climate change in particular concerning N fluxes by denitrification, improve modelling of this process in these areas is an important issue in climate change context.

Keywords: Water quality, Climate change, Nitrogen cycle, Hydrological cycle, Wetland

Salmon-Monviola J., Moreau, P., Benhamou, C., Durand, P., Merot, P., Oehler, F., Gascuel-Odoux, C., Effect of climate change and increased atmospheric CO_2 on hydrological and nitrate cycling in an intensive agricultural headwater catchment in western France. Climatic Change, In review.