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The effects of sewer infrastructure on water quality: implications for land use studies.

Dirk Vrebos, Jan Staes, and Patrick Meire
Ecosystem Management Research Group, University of Antwerp, Antwerp, Belgium

The European Water Framework Directive requires a good ecological status of the European water bodies and the necessary measures to obtain this have to be implemented. The water quality of a river is the result of complex anthropogenic systems (buildings, waste water treatment infrastructure, regulations, etc.) and biogeochemical and eco-hydrological interactions. It is therefore essential to obtain more insight in the factors that determine the water quality in a river. Research into the relation between land use and water quality is necessary.

Human activities have a huge impact on the flow regimes and associated water quality of river systems. Effects of land use bound activities on water quality are often investigated, but these studies generally ignore the hydrological complexity of a human influenced catchment. Infrastructure like sewer systems and wastewater treatment plants (WWTP) can displace huge quantities of polluted water. The transfers change flow paths, displace water between catchments and change the residence time of the system. If we want to correctly understand the effect of land use distribution on water quality we have to take these sewer systems into account. In this study we analyse the relation between land use and water quality in the Nete catchment (Belgium) and investigate the impact of the sewage infrastructure on this relation.

The Nete catchment (1.673 km^2) is a mosaic of semi natural, agricultural and urbanized areas and the land use is very fragmented. For the moment 74% of the households within the catchment are connected to a WWTP. The discharges from these WWTP's compose 15% of the total discharge of the Nete. Based on a runoff model the surface of upstream land use was calculated for 378 points. These data were then corrected for the impact of WWTP's. Using sewage infrastructure plans, urban areas connected to a WWTP were added to the upstream land use of the WWTP's water receiving stream. In order to understand the effect of the sewage infrastructure we analysed water quality parameters and upstream land use with, and without, taking the sewage infrastructure into account. Water quality data were obtained from the Flemish Environmental Agency.

The incorporation of the sewage system in the upstream land use calculation resulted in important changes in the upstream land use area. While some sample points experienced a reduction in total upstream area up to 18% compared to the run-off model, others saw an increase in their upstream area up to 43%. Upstream urban area decreased by 100% or increased up to 430%.
Our results clearly demonstrate the importance of the impact of the sewer systems on the river water quality. Almost no significant results were found between urban area and water quality if sewage system transfers were disregarded. When however a distinction was made between WWTP-connected and not-connected households, we found comprehensible, positive and significant results for several water quality parameters. Our study demonstrates that if upstream land use areas are calculated without taking the sewer system in to account the impact of certain land use classes and the impact of anthropogenic activities on the river system in general can be underestimated.
We believe that these results not only demonstrate the importance of sewer infrastructure that relate land use to water quality, but that it also has important implications for water quantity and quality modelling. In complex, human influenced catchments, simple run-off models simply cannot realistically represent the catchment system.