



## **Characterizing groundwater contribution to lowland streams using Travel Time Distribution**

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In recent years, it has become apparent that European freshwaters will fail to meet the ecological guidelines set for 2015 by the Water Framework Directive. 55 % of European surface water bodies have been reported to have a less than good ecological status, while the goal for 2015 is to have a good status for all water bodies. The deterioration of freshwater aquatic ecosystems is a problem worldwide. The current study, part of the EU FP7 project Managing Aquatic ecosystems and water Resources under multiple Stress (MARS), addresses this issue by focusing on the effect of multiple stressors.

Freshwater ecosystems are directly linked to the characteristics of catchments and streams they are located in as this determines the habitats present. One of these characteristics, the groundwater contribution to streams, is important for aquatic ecosystems as it influences (1) river discharge, (2) water quality and (3) temperature and (4) the riparian zone. Groundwater provides streams with sufficient base flow, good quality water and a stable temperature. Compared to hilly slope catchments, the lowland catchments of The Netherlands lack much topography and surface runoff, and as such, virtually all stream water originates from groundwater. Current approaches do not sufficiently address the contribution of groundwater to stream flow in lowland catchments, as existing hydrograph separation methods provide little informative value about the groundwater contribution itself. The amount and quality of groundwater input to streams depends on its flow path and travel time. Especially in lowland catchments the groundwater input in streams is composed of a wide range of travel times which vary in time and space and have different quantitative and qualitative characteristics. Thus in order to successfully manage lowland streams, it is critical to specify the input of groundwater in more detail and take in account the temporal and spatial variability in travel times.

We will present an approach in which the groundwater contribution is specified based on travel times. The travel time distribution of groundwater input was calculated for several bigger and smaller streams in the Regge and Dinkel lowland catchment in The Netherlands using a coupled groundwater-surface water model and linked to physical catchment characteristics. More knowledge about the groundwater contribution provides water managers with insights which would help improve the ecological status of streams.