Geophysical Research Abstracts
Vol. 18, EGU2016-14292, 2016
EGU General Assembly 2016

Ecohydrological modeling of a tropical tidal catchment exposed to anthropogenic pressure

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The study area is the highly polluted estuary system of the Thi Vai river and its catchment, located in South Vietnam. It is part of Vietnam's core regions for the development of industrial and agricultural production. The middle and lower parts of the river form an estuary, which is strongly affected by the tide.
As a result of untreated industrial waste water discharges, the Thi Vai river was considered as ecological dead from 1990 to 2008. Although the water quality of the Thi Vai has been improved due to waste water treatment and control, it must be still considered as polluted. These first successes could be rapidly negated by the ongoing development of industry, population and agriculture.
Today the water quality management is solely focused on the industrial zones adjacent to the estuary. The contribution of the catchment to the water quality pollution is not considered yet.
To quantify the pollution of the Thi Vai estuary and its catchment, a monitoring system for water quantity and quality was installed. The water quality of the Thi Vai estuary and its main tributaries is affected by elevated concentrations of NH4, NO_2 and TSS and partly reduced DO concentrations.
Within the German-Vietnamese BMBF research project EWATEC-COAST a model based management system was developed as an instrument for a sustainable improvement of the water quality of the Thi Vai estuary and the Thi Vai catchment.
Among others, the system consists of the hydrodynamic water quality model DELFT 3D and the ecohydrological catchment model PANTA RHEI WQ. The ecohydrological model PANTA RHEI WQ was developed within the research project. The developed ecohydrological model allows a sub-daily time step and includes in-stream water quality procedures, accounting for the interaction of aquatic biomass, dissolved oxygen, nutrients, detritus and sediment. Therefore, the implemented water quality model overcomes deficits found in common ecohydrological models. Despite of the scarce data situation, meaningful results for discharge, concentration and nutrient load calibration could be achieved. A sensitivity analysis demonstrated that the water quality processes of nitrogen are dominated by terrestrial transformation processes. The developed model is able to simulate the characteristic dynamics of mineralization, which are typically observed in the humid tropics. Beside the implemented "Availability and Demand Approach", which is accounting for a temporary storage of nutrients in the microbial biomass, the implemented moisture functions are of particular importance. The consideration of sediment compartments and processes related to periphyton activity were key components in the water quality modeling of the catchment.
The calibrated model was utilized to identify pollution sources and hot spots in the estuary and in the catchment. Furthermore, tracer simulations showed that the upper part of the estuary is more vulnerable to pollution then the lower part. This confirms the findings of the monitoring. In addition, predictions for water quality in response to anthropogenic changes regarding population, land use and industrial development were carried out with the coupled modeling system. Results of these scenarios are presented.