



## **Assessment of the land use and water management induced changes in baseflow series**

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Previous studies have shown that it is very difficult to distinguish human-induced changes from those caused by natural forcing. In this paper we try to quantify land use and water management influence on low flows of the Upper Narew River in north-east Poland. In recent years both a reduction of mean flows and shorter flooding periods have been observed in the Upper Narew River, resulting in a serious threat to the rich wetland ecosystems in the National Narew Park (NNP). These undesirable changes have been caused by changes in local climate, manifested as mild winters and a reduction in annual rainfall that have resulted in a reduction of the valley's groundwater resources. Additionally, river regulation works performed in the river reach downstream from NNP have lowered water levels in the NNP. Flood peaks are also reduced by a water storage reservoir constructed upstream of NNP in Siemianówka (near Bondary). However, our knowledge of the possible causes of the wetland ecosystems depletion is not sufficient to develop effective methods to deal with the problem, as there is no information available on how the changes in land use and water management influence the water balance in the catchment. Application of a simple black box Stochastic Transfer Function model to describe daily flow routing between the Narew and Suraz gauging stations indicates changes in flow regime for low flows, but does not give any consistent changes in model parameters for whole years from the periods before and after the reservoir was built. In order to explain the nature of influence of land use and water management on low flows, we applied baseflow separation techniques including the Wittenberg nonlinear storage model, the Chapman linear filter and the Log-Transformed Low Flow (LTLF) model. The LTLF model in particular, provides uncertainty bounds for the baseflow estimates. The methods are applied to flow data from different time periods, before and after the reservoir Siemianówka was built, in order to separate the influence of land use induced changes from that of water management. Long term changes in land use are assessed using previous studies in the catchment. We present a comparison of baseflow estimates obtained using different techniques and compare them with flow measurements in the summer periods. The baseflow time series are classified according to land use and water management practices in the area. In order to relate the changes in baseflow with land use changes, we apply a temporal analysis of the number and duration of exceedences of low-flow thresholds.