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Entropy-based evaluation of a water level monitoring network in a wetland

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Existence of conclusive data is a prerequisite for water resources management in regulated wetlands. Due to economical constraints hydrological monitoring networks should be optimized with regard to their efficiency or informativeness. Various statistical approaches have been applied for this purpose, whereupon the entropy principle offers a possibility to directly measure the inherent information of a time series. While the method is used in hydrology especially for precipitation, groundwater or water quality monitoring networks, applications for water level observations are rare. The aim of this study is therefore to show the potential of this method to evaluate these monitoring systems, especially focusing on the comparison of surface water and groundwater gauges which are closely connected in wetlands.

The entropy method is based on the information theory, which enables the quantification of information. By means of the definitions of the entropy, as the uncertainty inherent to a random variable, and the transinformation, as amount of information that is repeated in two variables, an assessment of the monitoring network based on the (empirical) probability distribution of the measured variables can be carried out, including the pairwise comparison of different stations. The processed data set was taken from a monitoring network launched in summer of 2011, installed in a wetland subjected to controlled drainage in Northeast Germany. Water level information, which was measured at an interval of 15 minutes, of 5 groundwater and 10 surface water gauges of a time period of 4 months was used.

The results show that surface water gauges may have more commonalities with groundwater gauges than with other monitoring stations located in ditches or creeks. Also, the distance between two gauges not necessarily represents a valid measure for their correlation. For instance, the behaviour of a groundwater gauge can show more similarities to a remote creek than to an adjacent ditch. This differences result from the anthropogenic influence, i.e. the regulation via weirs, which has a significant impact on the hydrological system. Monitoring networks under these settings hence need to be handled in a different way than those in unregulated catchments. In doing so the use of entropy measures can represent a method able to detect monitoring stations affected by similar processes, serving as a basis to optimize the network accordingly.