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Data Driven Methods for Real-Time Flood, Drought and Water Quality Monitoring: Applications for Internet of Water

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Abstract: The Internet of Water (IoW) is a large-scale permanent IoT sensor network with 2500 water quality sensors spread across Flanders, Belgium. This intelligent system will permanently monitor water quality and quantity in real-time. Such a dense network of sensors with high temporal resolution will provide unprecedented volumes of data for drought, flood and pollution management, prediction and decisions. Here we present several data mining and machine learning initiatives along with a database infrastructure which supports environmental modelling efforts and large scale monitoring networks like IoW. Examples include interpolating grab sample measurements to river stretches to monitor salinity intrusion. A shallow feed forward neural network is trained on historical grab samples using physical characteristics of the river stretches. Such a system allows for salinity monitoring without complex convection-diffusion modeling, and for estimating salinity in areas with less monitoring stations. Another highlighted project is the coupling of neural network and data assimilation schemes for water quality forecasting. A long short-term memory recurrent neural network is trained on historical water quality parameters and remotely sensed spatially distributed weather data. Using forecasted weather data, a model estimate of water quality parameters are obtained from the neural network. A Newtonian nudging data assimilation scheme further corrects the forecast leveraging previous day observations, which can aid in the correction for non-point or non-weather driven pollution influences. Calculations are supported by an optimized database system developed by the Hasselt University which further exploits data mining techniques to estimate water movement and timing through the Flanders river network system. As geospatial data increases exponentially in temporal and spatial resolutions, scientists and water managers must consider the tradeoff between computational resources and physical model accuracy. These type of hybrid approaches allows for near real-time analysis without computational limitations and will further support research to make communities more climate resilient

Keywords*:* machine learning; real-time modelling; water quality; internet of things