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Application of artificial neural network models for estimation of water levels in the Everglades, South Florida

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Analysis and forecasting water level of various water bodies is crucial to water management. One of the techniques used is data driven modelling (DDM). Although the physical process is not explicitly represented, this class of methods allows to find interrelation among different system variables and to pick up the logic behind it without detailed knowledge of a system's physical behavior. Within last two decades, DDM techniques have gain popularity and are seen as an important alternative (or a complementary tool) to physically-based modellings, if significant amount of data is available.

The Everglades is a natural ecosystem spread across a large area in South Florida, USA. The area is very well developed which discharges water with system of irrigation canals originated from Lake Okeechobee in the north, artificial wetlands with a series of discontinued compartments known as water conservation areas (WCA) and then through Everglades National Park (ENP) as a wide and shallow river into the Gulf of Mexico. The wellbeing of the wildlife spread across this area is highly sensitive to slight changes in the water level. This makes the estimation and forecasting of water level important.

The present study undergoes an analysis of available water resources data to understand and estimate the water levels in the study area using DDM techniques. Although, several DDM techniques are available, an artificial neural networks (ANN) with multi-layer perceptron (MLP) trained by backpropagation algorithm was adopted. Water level and rainfall was used as inputs in predicting future water level. An additional challenge in the modelling was due to the presence of water control structures. In the present study, five randomly selected water level gauging stations (Station 2A300, 3A-5, 3A11, 3ANE and W2) were considered. The coefficient of determination (R2) of the forecasted water level was higher than 0.90. In brief, model estimation showed good agreement with the observed data. Furthermore, in terms of model evaluation, root mean square error (RMSE) was about 0.03m for all the modelled stations and the percent model error (RMSE divide by the range of measured data) was less than 1%.

Subsequently, rainfall forecast from the European Centre for Medium Range Weather Forecast (ECMWF) was used in forecasting water level. Model results were compared with the measured water level at a number of locations and very good match was obtained.

Keywords: Everglades, artificial neural network, ANN, water level