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OPTIMIZING THE CONJUNCTIVE USE OF SURFACE AND GROUNDWATER RESOURCES FOR DRINKING WATER PRODUCTION

Drinking water is a basic human need that is under constant and increasing threat of climate change. Specific changes in the climatic system are uncertain, which leads to uncertain surface and groundwater availability for drinking water production. Surface water supplies are highly variable and vulnerable to climatic processes, while the groundwater system changes more gradual and is less vulnerable. The resilience of drinking water production to climate change can be increased with the conjunctive use of surface and groundwater resources. This research focuses on the role of uncertainty in climatic conditions in the conjunctive use of surface and groundwater resources for drinking water production. A case study for De Watergroep, a drinking water company in Belgium that implements a conjunctive use strategy, was used to implement the proposed methodology. An adaptive forecast-based production strategy for one of the reservoirs was developed using a water quality forecasting model. Three different drought years were evaluated based on their performance on yearly groundwater use and the risk of water shortages.

Machine learning models were developed to forecast five water quality parameters that are decisive in the conjunctive use of surface and groundwater resources in the case study: nitrate, phosphate, sulfate, conductivity and bentazon. The autoregressive behavior of all compounds was captured with their lagged values and rolling statistics. External features that were investigated were calendar effects, precipitation, temperature, discharge, and land use. Six different algorithms were tested with 20 different feature sets, predicting one to three week(s) ahead for all water quality parameters. For nitrate prediction, the autocorrelation and calendar effects were of main importance, while all other water quality parameters perform best when precipitation, discharge, and temperature are included as well. Interdependencies of the climatic processes highly influence their predictive power.

An adaptive forecast-based production strategy was developed to find the optimal conjunctive use of surface and groundwater resources under uncertain climatic conditions. The goal of this new production strategy was to meet water demand with the trade-off of minimizing groundwater use and minimizing the risk of water shortages, under the physical constraints of the operating reservoir and surface water availability. The research shows that relatively simple models using water quality data and open-source climatic data can be used to develop an adaptive forecast-based approach with improved reservoir performance. The data-driven approach enables modelling without the need to investigate all individual relations in the climate-water system. The forecast-based strategy was evaluated by comparing the yearly groundwater use and the risk of water shortages to a traditional production strategy. It was found that the new production strategy averts the risk of water shortages, which sometimes comes at the cost of increased groundwater use. Improving the forecasting model results in a lower risk of water shortages.