



Predicting Decadal Groundwater Levels in Brandenburg: Deep Learning Approaches for Sustainable Management

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The federal state of Brandenburg is characterized by over 3,000 lakes and hundreds of kilometres of rivers and thus is one of Germany's most water-rich regions, but also ranks among the country's driest states in terms of precipitation. Climate change exacerbates this situation, with potential negative effects on groundwater resources: estimations under the RCP8.5 emission scenario predict a 10–20% reduction in total runoff for the period 2031–2060¹. Moreover, decadal groundwater level monitoring data from Brandenburg revealed that extremely low groundwater levels occur more often. Thus, careful management of water demand is crucial, especially given that over 90% of the region's drinking water supply relies on groundwater.

Decadal groundwater level predictions are fundamental to manage demands and allow to identify areas particularly at risk of extremely low groundwater levels. Data-driven methods, especially deep learning (DL) approaches, have recently demonstrated potential for predicting groundwater levels with high accuracy and are suitable for forecasting across larger regions where numerical flow models are not applicable.

In this study, DL models were established to generate decadal predictions for groundwater monitoring wells, based on data of Brandenburg's broad groundwater monitoring network. After preprocessing the time series data, including aggregation to weekly resolution, the dataset comprises 650 groundwater monitoring wells with consistent records dating back to at least 1980. For these monitoring wells, DL models were implemented and trained with data from different meteorological variables data as input parameters. The predictive performance of the DL models was then systematically evaluated. Groundwater monitoring wells with high predictive accuracy (NSE > 0.7) were used to calculate decadal forecasts based on the decadal climate predictions provided by the German Weather Service.

These decadal predictions enable spatial assessments of groundwater level trends over the next decade relative to the 1991–2020 reference period. The results offer valuable insights into mid-term future groundwater level developments in Brandenburg, supporting data-driven decision-making for sustainable groundwater resource management.

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