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Groundwater level prediction method using deep learning for evaluating a nature restoration project in Kushiro wetland, Japan

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In this study, we developed a groundwater level prediction model using deep learning to evaluate a nature restoration project in Kushiro wetland. The accuracy of the model was verified and a method for analyzing the importance of model variables was proposed.

In the Kushiro wetland, the marshland was degraded by the straightening of the river channel in the past, and alder trees grew in abundance. In 2010, the river was re-meandered to its original meandering channel in order to restore the natural environment. The observation data of groundwater level time series were collected from this restoration area. In this study, we developed a deep learning model for the two periods before and after the restoration.

Long short-term memory (LSTM) was used as a deep learning model. In LSTM, the input layer contained six components as explanatory variables and groundwater level as an objective variable in three days, and the output layer predicted the groundwater level one day later. The six explanatory variables in the input layer were precipitation, air temperature, sunshine duration, snow depth, normalized difference vegetation index (NDVI) and river discharge. The accuracy of the models produced in the pre- and post- restoration periods was evaluated by the root mean squared error (RMSE) of the measured and predicted values. The results showed that the RMSE is 0.055m~0.162m, which indicated that the LSTM model can predict the groundwater level fluctuation characteristics accurately.

The importance analysis method proposed in this study was based on the Wrapper Method used in machine learning. This method (Applied Wrapper Method) was able to extract the most important variables from the explanatory variables if the its truncation caused a significant decrease in model accuracy. The results showed that the river flow discharge and precipitation had a significant effect on the groundwater level time series regardless of whether it was before or after the restoration.

The groundwater level prediction model based on the deep learning proposed in this study was confirmed to predict the groundwater level fluctuation characteristics in Kushiro wetland with good accuracy by providing important natural factors. In the future, we plan to incorporate the topography and soil properties of the wetland into the analysis to evaluate the effect of the nature

restoration project more accurately.