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

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Research Background

The development of social infrastructure in and around rivers has a significant impact on the natural environment and landscape.

Nature restoration projects are planning to maintain a balance between social infrastructure development and nature conservation, and have restored precious aquatic landscapes.

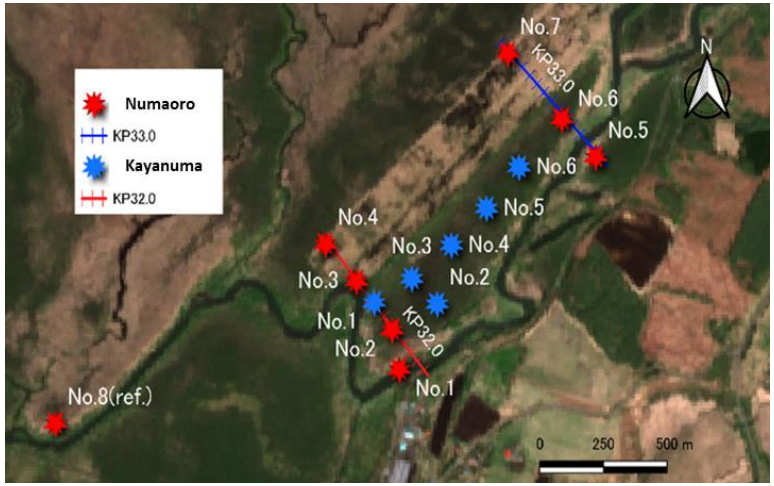
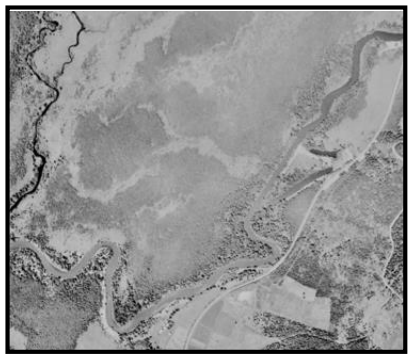


Fig 1 Kushiro wetland

Research Background Nature restoration projects



1948

1977

2013

original state

straightening

2010 Natural restoration Project

re-meandering

Advance Research

Groundwater level is critical.

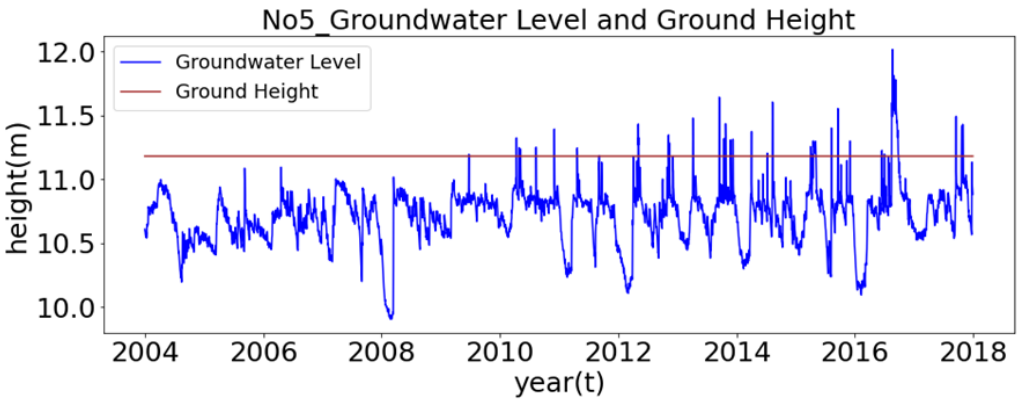


Fig 2 Time series of groundwater levels

Research Purpose

(1)Create a model to reproduce the groundwater level using the LSTM

(2) Propose the new method of importance analysis *"Applied Wrapper Method"*

Research Method -(1)-

Model creation with LSTM

Before Restoration

Prediction period：2004～2008

Evaluation period：2009

After Restoration

Prediction period：2012～2016

Evaluation period ：2017

Variables used

Explanatory variables

- Daily precipitation
- Daily average temperature
- Daylight hours
- Deepest snow of the day
- NDVI
- River discharge

Objective variable

- Groundwater level

Research Method -(2)-

6-variable model's $RMSE_6$

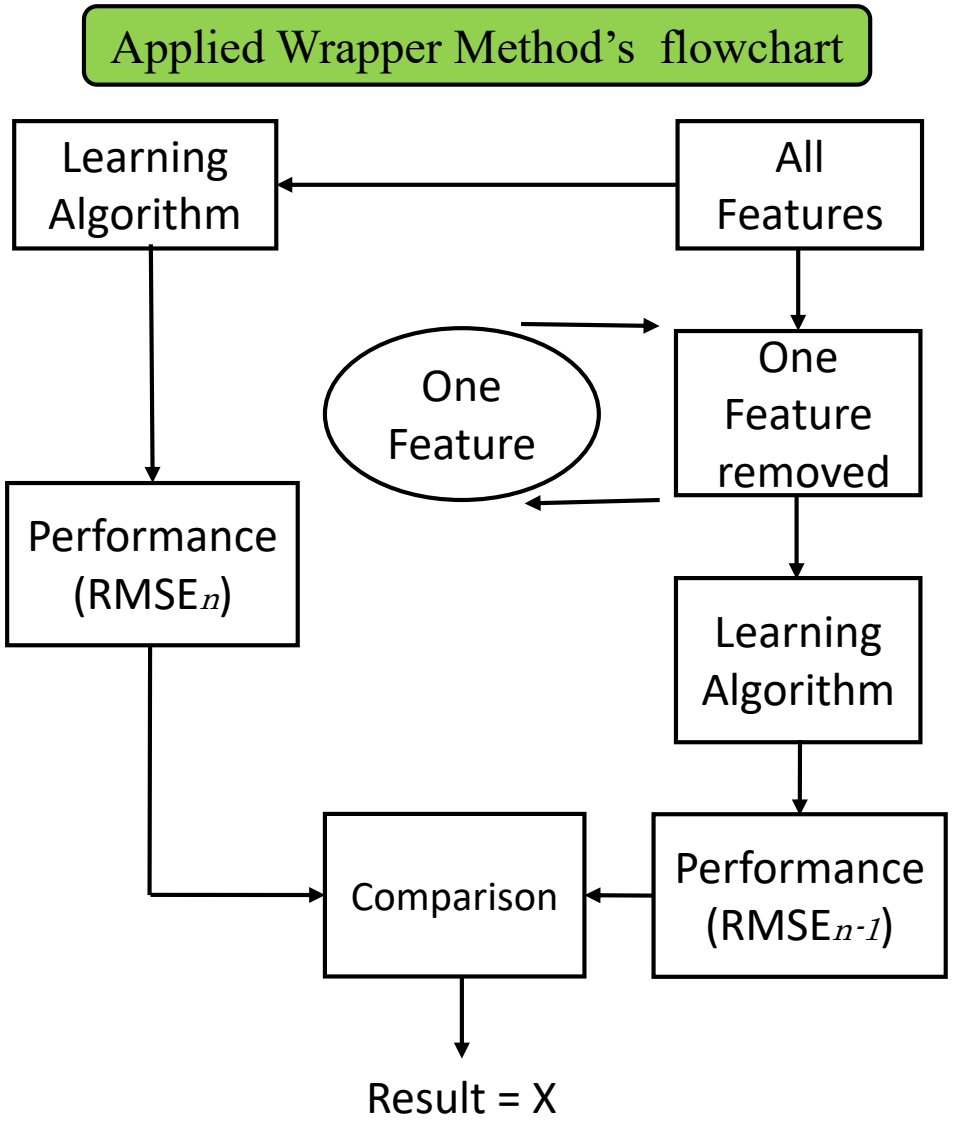
VS

One Feature removed model's $RMSE_5$

$$X = \frac{RMSE_5 - RMSE_6}{RMSE_6} \times 100$$

The larger the difference, the greater the impact of the factor.

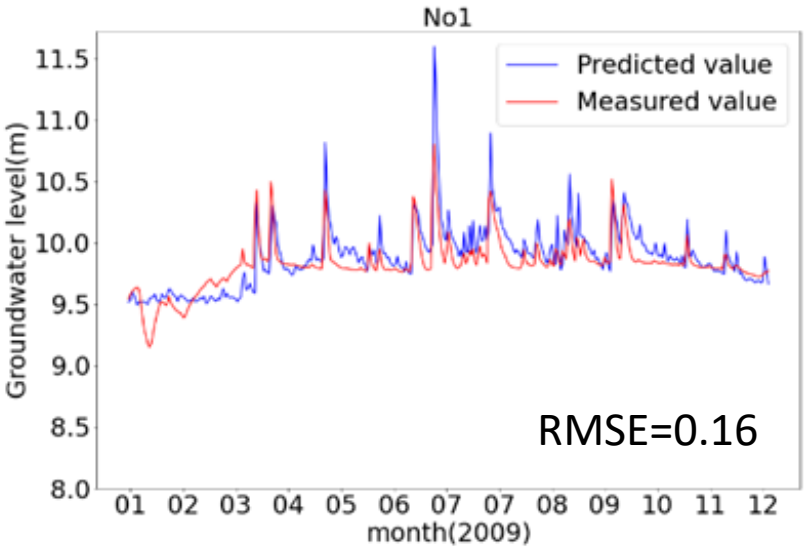
Positive: Necessary factor
Negative: Unnecessary factor



Research Results -(1)-

Before Restoration

After Restoration



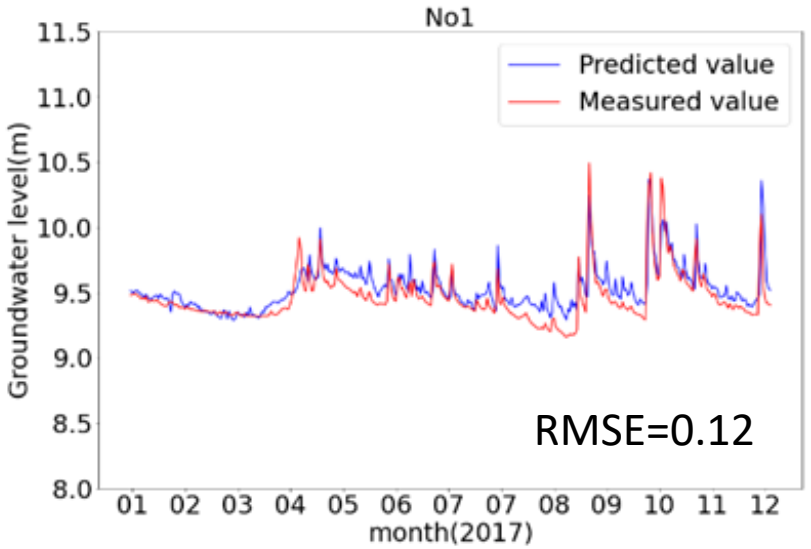


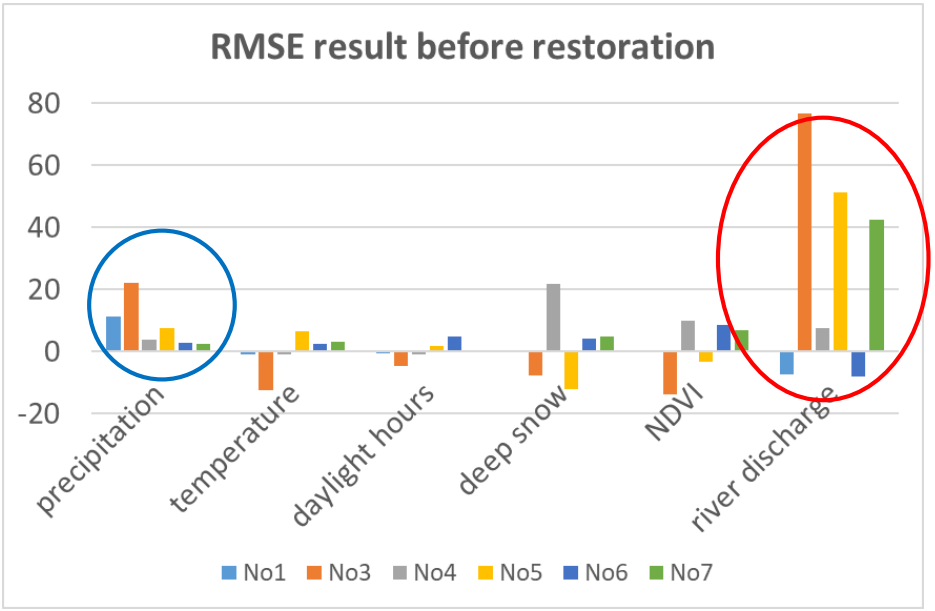
Fig 3 Measured and reproduced LSTM values.

RMSE : 0.05-0.16 m.

Research Results -(2)-

Before Restoration

After Restoration



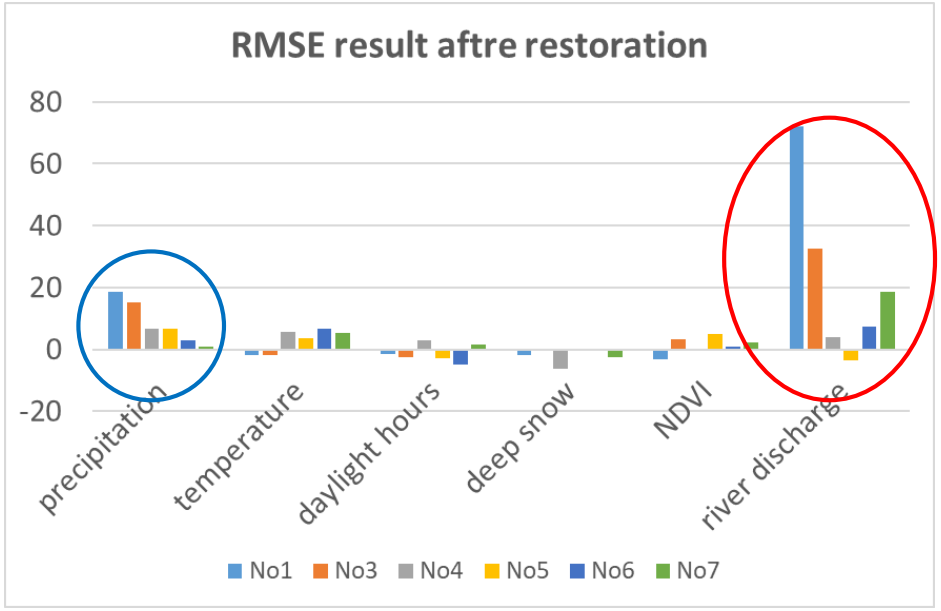


Fig 4 AWM Results

Conclusions

- Create a model to reproduce the groundwater level

✓ Modeled groundwater levels using LSTM.
✓ The issue is to examine the preprocessing methods and the selection of explanatory variables.

- Analyze the importance of natural factors

✓ A high applicability of the new "Applied Wrapper Method" was confirmed.
✓ The primary factor is river discharge and the secondary is precipitation

A model for the alder overgrowth phenomenon has not been introduced in the LSTM algorithm, which will be a future research issue.


Thank you very much for your attention