Water level forecasting for extended lead times using preprocessed data with variational mode decomposition: A case study in Bangladesh

-

Shabbir Ahmed Osmani*, Roya Narimani**, Hoyoung Cha***, Changhyun Jun****, Md Asaduzzaman Sayef*****

.....

Abstract

This study suggests a new approach of water level forecasting for extended lead times using original data preprocessing with variational mode decomposition (VMD). Here, two machine learning algorithms including light gradient boosting machine (LGBM) and random forest (RF) were considered to incorporate extended lead times (i.e., 5, 10, 15, 20, 25, 30, 40, and 50 days) forecasting of water levels. At first, the original data at two water level stations (i.e., SW173 and SW269 in Bangladesh) and their decomposed data from VMD were prepared on antecedent lag times to analyze in the datasets of different lead times. Mean absolute error (*MAE*), root mean squared error (*RMSE*), and mean squared error (*MSE*) were used to evaluate the performance of the machine learning models in water level forecasting. As results, it represents that the errors were minimized when the decomposed datasets were considered to predict water levels, rather than the use of original data standalone. It was also noted that LGBM produced lower *MAE*, *RMSE*, and *MSE* values than RF, indicating better performance. For instance, at the SW173 station, LGBM outperformed RF in both decomposed and original data with *MAE* values of 0.511 and 1.566, compared to RF's *MAE* values of 0.719 and 1.644, respectively, in a 30-day lead time. The models' performance decreased with increasing lead time, as per the study findings. In summary, preprocessing original data and utilizing machine learning models with decomposed techniques have shown promising results for water level forecasting in higher lead times. It is expected that the approach of this study can assist water management authorities in taking precautionary measures based on forecasted water levels, which is crucial for sustainable water resource utilization.

Keywords: Water level forecasting, Variational mode decomposition, Lead time, Lag time, Machine learning

Acknowledgments

This research was supported by Korea Environment Industry & Technology Institute (KEITI) through Water Management Innovation Program for Drought (No. 2022003610001) funded by Korea Ministry of Environment and in part by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (No. NRF-2022R1A4A3032838).

* Member, PhD student, Dept. of Smart Cities, Chung-Ang University, Email: shabbir218@cau.ac.kr

** Member, PhD student, Dept. of Civil and Env. Engineering, Chung-Ang University, Email: royan5688@cau.ac.kr

*** Member, MSc student, Dept. of Smart Cities, Chung-Ang University, Email: ckghdud2@cau.ac.kr

**** Member, Associate Professor, Dept. of Civil and Env. Engineering & Dept. of Smart Cities, Chung-Ang University, Email: cjun@cau.ac.kr

***** MSc student, School of Transportation Sciences, Hasselt University Belgium, Email: mdasaduzzaman.sayef@student.uhasselt.be