TWO DATA-DRIVEN APPROACHES FOR PREDICTING BED LEVELS IN 3D FOR THE WAAL RIVER

The Dutch waterways, like the Waal River, are among Europe's busiest navigation routes. Dredging is conducted to keep these waterways navigable. As future projections indicate more extreme low-flow events, the need for efficient dredging strategies increases. Currently, short-term dredging decisions rely on real-time bed level data. Providing forecasts on bed levels can support this decision-making process by identifying potential future bottlenecks, deeper locations for sediment disposal and areas where subsequent measurements may not be necessary.

This study aimed to obtain a two-weekly bed level prediction in 3D for the Waal River, by developing and comparing two data-driven approaches. This included the development of a data-driven dune migration model, which only considers the horizontal displacement of bed features, alongside improving the bed level prediction accuracy of the machine learning model TrajGRU (Shi et al., 2017). The initial machine learning model TrajGRU produced highly blurred predictions and little of the bedform patterns were captured accurately. To improve these machine learning predictions, five data preprocessing experiments were set up: sample selection, removal of outliers, coordinate transformation, wavelet reconstruction and consistent time intervals. Herein, each successive experiment built upon the previous experiments. Furthermore, three different loss functions were tested in the machine learning model: the root mean square error, a combination of the mean square error and structural similarity index and the Wasserstein loss.

The dune migration model showed to outperform the improved machine learning model. The machine learning model with the wavelet reconstructed data and the root mean square error loss function improved model performance most of all machine learning experiments. However, the blurring effect was still largely present, resulting a relatively high maximum bed level error of 0.77m. The dune migration model had a substantially smaller maximum bed level error of 0.30m, the locations of the maximum bed levels were captured more accurately with a locational error of 14.5m instead of 25m, and the bedform patterns were captured more accurately as well. Even when manually increasing the bed level spread of the machine learning prediction, the dune migration model outperformed the machine learning model.

Thus, the potential of a complicated machine learning model like TrajGRU for predicting bed levels in the Waal River shows to be small and the dune migration model proves more promising. Future research could focus more on the dune migration model and combine this method with an approach suitable for predicting vertical bed level changes as well.

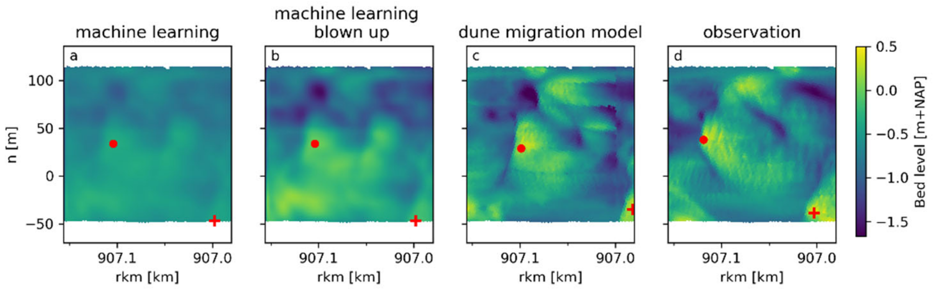

Figure 1: Example bed level predictions by (a) the machine learning model, (b) the machine learning model, with a manual increase in bed level spread, and (c) the dune migration model. (d) shows the observed bed levels for the predicted time step. In (a-d), the red dot and red plus indicate two maximum bed levels

Luuk I. van Laar

Graduation Date:
8 May 2024

Graduation committee:
University of Twente
Prof.dr. S.J.M.H. Hulscher
Dr. F. Huthoff

HKV
Ir. T. Stolp

UNIVERSITY OF TWENTE.