

Reducing the simulation time of coastal numerical models with deep learning-based emulators



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1 - Introduction

Reducing the simulation time of hydro-morphodynamic high-resolution numerical models is of utmost importance to implement real-time forecasting and warning systems. A deep learning (DL) model was implemented to reduce the time required by those numerical models (XBeach), allowing a faster forecast maintaining its accuracy.

2 - Methodology

The XBeach software was used to generate images of hydro-morphodynamic variables results, which were used by the DL models as input and output data (Fig 1). Two domains were implemented, and different combinations of inputs and outputs were tested (Fig 2).

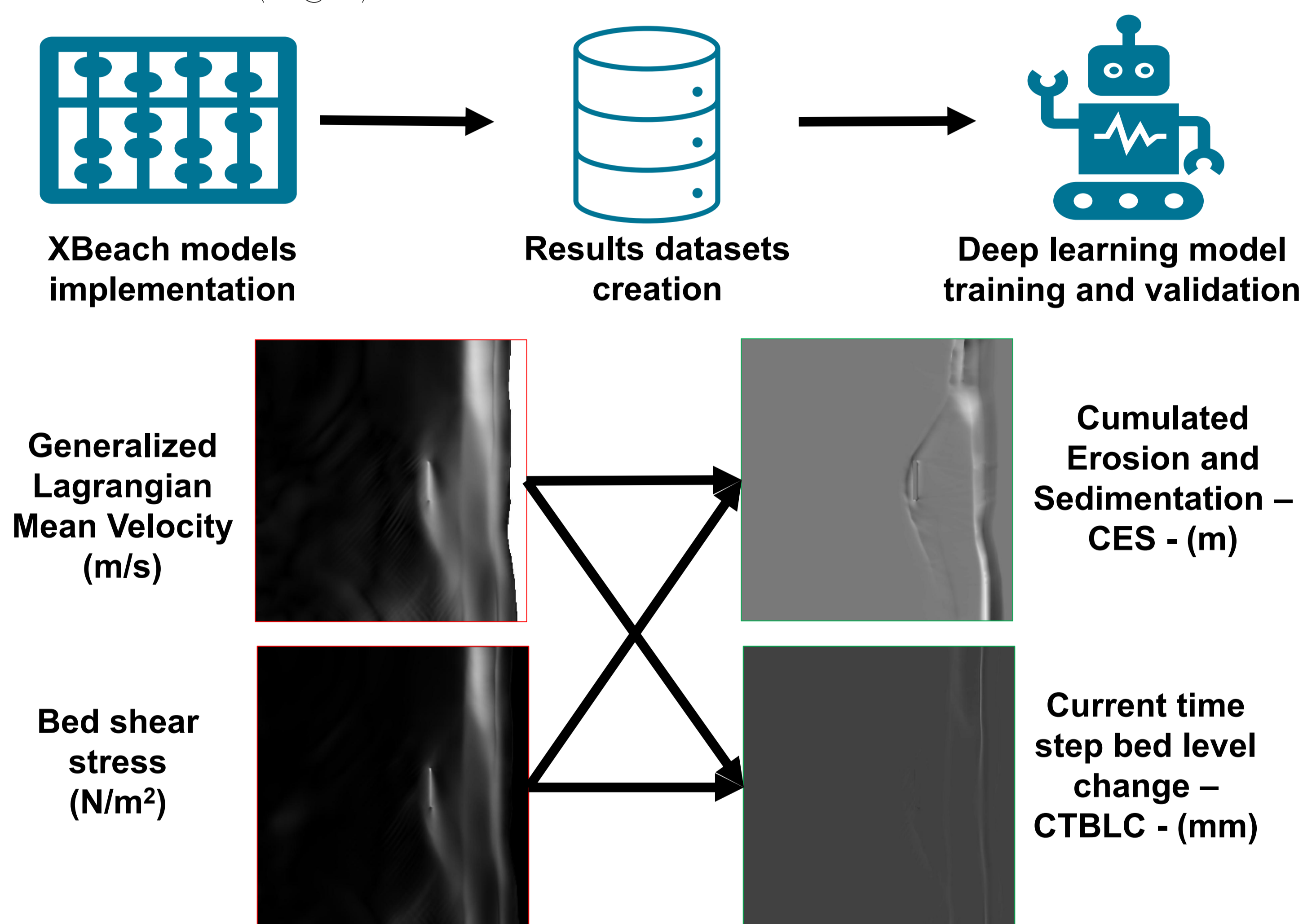


Fig 1. Methodological framework.

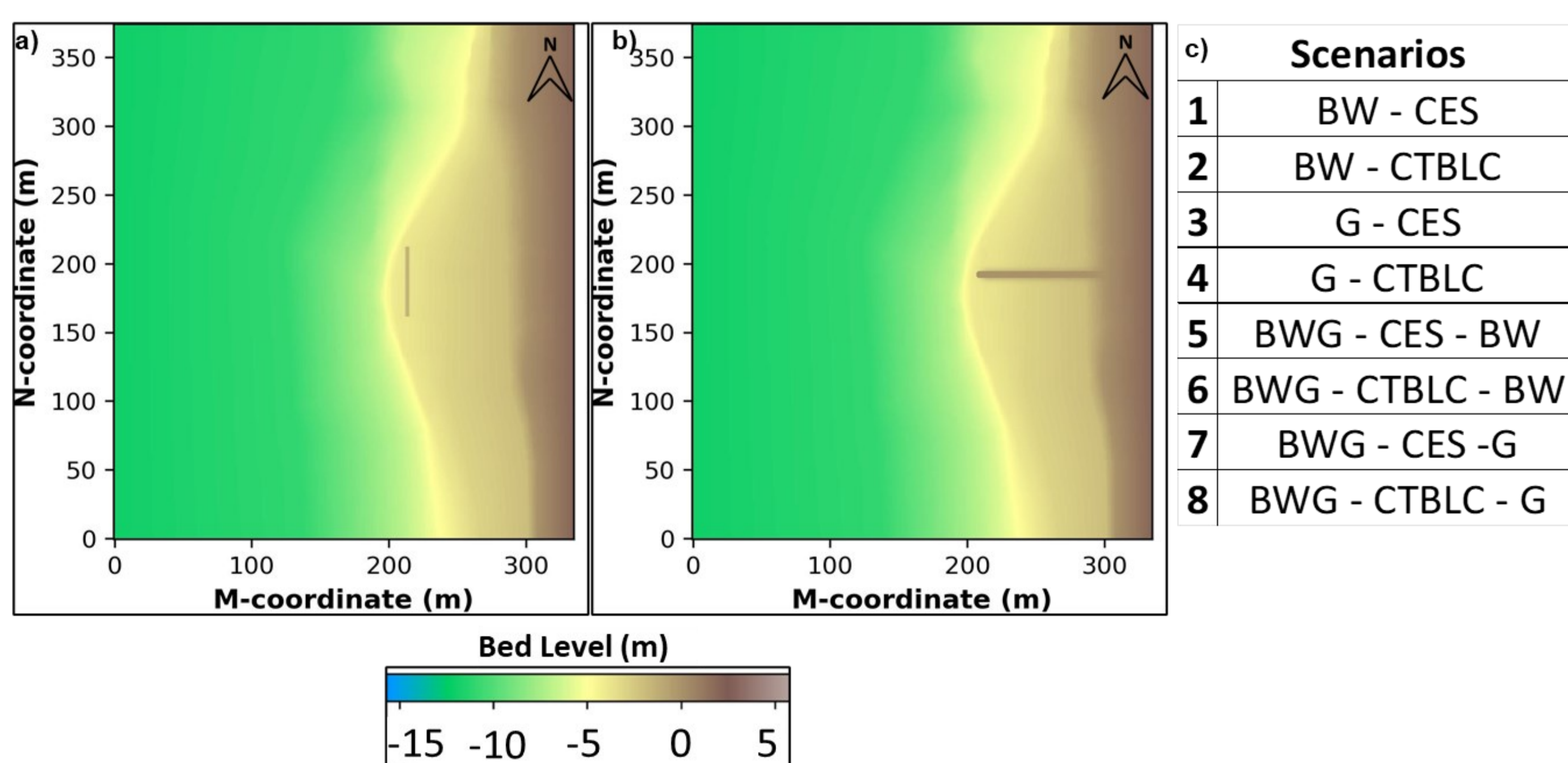


Fig 2. Study area and testing conditions. a) Submerged breakwater (BW) domain; b) Groin (G) domain; c) Testing scenarios. The first acronym refers to the domains used to train the model, the second refers to the simulated morphodynamic variable and the third in scenarios 5 to 8 refers to the test domain used by the models which were trained for both domains.

3 - Results

The DL models' error (Fig 3) demonstrates the reliability of the methodology in simulating morphodynamic variables, which achieved a low error variance. Additionally, the methodology achieved a simulation time reduction of 23%.

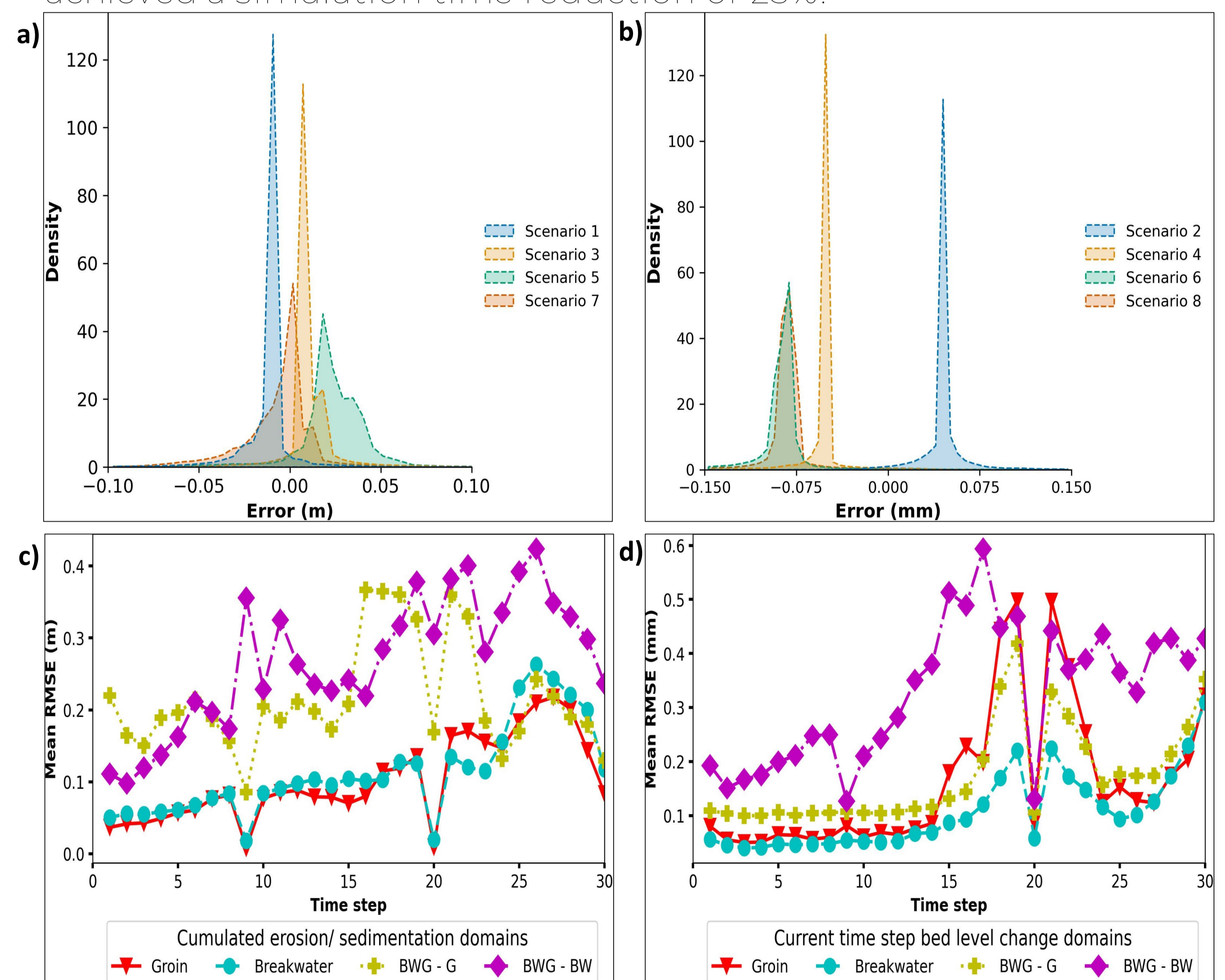
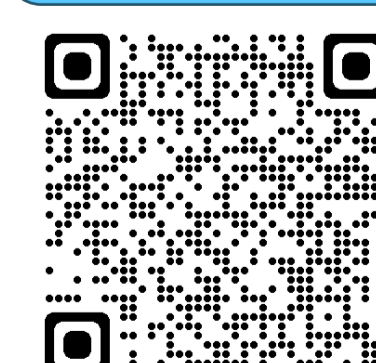


Fig 3. Errors of the models. a) Error distribution of single-domain trained models; b) Error distribution of models trained in both domains; c) Mean RMSE in CES prediction; d) Mean RMSE in CTBLC prediction.

4 - Conclusions

- The methodology successfully reduced the simulation time of high-resolution hydro-morphodynamic numerical models;
- Both morphodynamic variables were accurately simulated;
- The models trained in two domains had biased results, achieving a better forecasting performance in one of the domains.

5 - Reference



Weber de Melo, W., Pinho, J., & Iglesias, I. (2023). Coastal morphodynamic emulator for early warning short-term forecasts. *Environmental Modelling & Software*, 105729.

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