NUMERICAL SIMULATION OF DRIFTWOOD TRANSPORT BY WAVES IN A LABORATORY BASIN

Enda Murphy, National Research Council Canada, University of Ottawa, enda.murphy@nrc-cnrc.gc.ca
Andrew Cornett, National Research Council Canada, University of Ottawa, andrew.cornett@nrc-cnrc.gc.ca
Ioan Nistor, University of Ottawa, inistor@uottawa.ca

INTRODUCTION

Driftwood plays an important role in coastal ecosystems but, in large accumulations, can have negative impacts and pose hazards to navigation, infrastructure and communities (Murphy et al. 2021). The ability to accurately predict the fate and transport of coastal driftwood is central to informing sustainable management practices. However, there is a paucity of numerical modelling studies focused on driftwood transport in coastal waters (Murphy et al. 2021). Models developed for rivers (e.g. Ruiz-Villanueva et al. 2014) lack consideration of processes affecting driftwood transport and accumulation in coastal environments, such as wind waves. Murphy et al. (2020) conducted experiments in a 50-m by 30-m wave basin, wherein model driftwood was released and tracked within a 1/30 scale physical model of a sandy beach system with various coastal structures (Fig. 1). The tests revealed that several factors influence the mobility of coastal driftwood exposed to waves, beaching and washoff processes in particular.

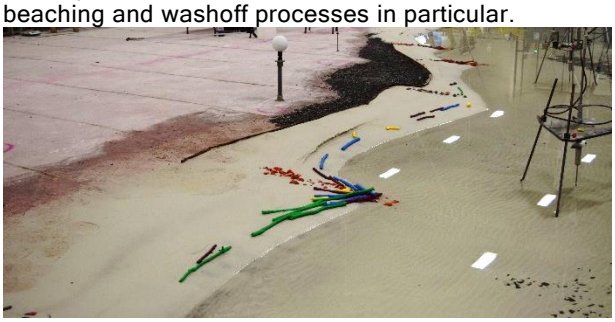

Figure 1 – 1/30 scale physical model at the National Research Council Canada's laboratories in Ontario.

METHODOLOGY

A Lagrangian-Eulerian model was developed in Matlab to simulate driftwood transport in a nearshore environment by waves and wave-driven circulation (Fig. 2). The Lagrangian driftwood transport model was driven by hydrodynamic output from a two-dimensional (Eulerian) XBeach coastal wave model, set up to replicate the Murphy et al. (2020) wave basin experiments at full (prototype) scale. The XBeach model was run in non-hydrostatic mode, and was calibrated and validated using sea states and current speeds observed in the scale physical model. The Lagrangian model incorporated a novel parameterization of driftwood beaching and washoff processes, adapted from a force balance model for woody debris entrainment in rivers (Braudrick & Grant 2000). This improves on heuristic approaches commonly applied in marine plastic debris models, which do not capture the physics of debris-shore interactions. Model skill was assessed by comparing simulated results to observed patterns of driftwood mobility and accumulation.

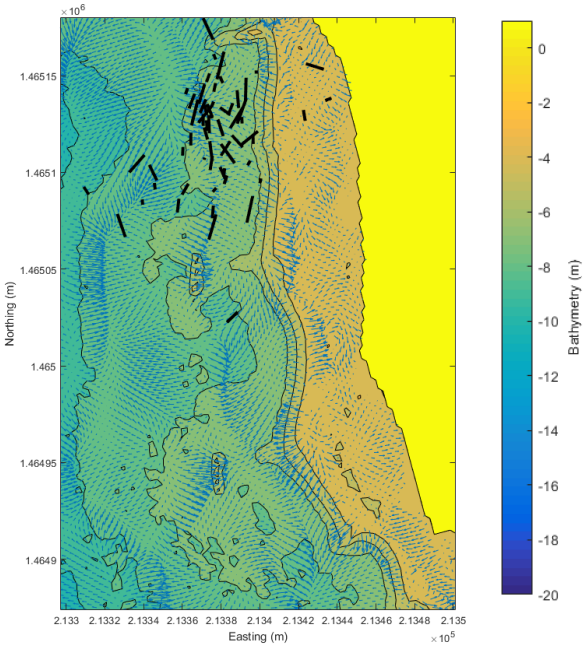

Figure 2 – Snapshot showing output from the Eulerian (XBeach)-Lagrangian(Matlab) driftwood model.

RESULTS AND FUTURE DIRECTION

The results confirmed the important influence of beaching and washoff processes on alongshore driftwood mobility in nearshore areas. The model skill assessment identified needs for improved parameterization of physical processes. The model will provide insight to factors influencing the accumulation of coastal driftwood, and guide potential management solutions, including incorporation of driftwood in nature-based solutions.

REFERENCES

Braudrick, Grant (2000): When do logs move in rivers? Water Resour. Res., vol. 36, no. 2, pp. 571-583.

Murphy, Cornett, Nistor, Baker (2020): Modelling transport and fate of woody debris in coastal waters. Coastal Engineering Proceedings, (36v), pp.1-1.

Murphy, Nistor, Cornett, Wilson, Pilechi (2021): Fate and transport of coastal driftwood: A critical review. Mar. Pollut. Bull., vol. 170, pp.112649.

Ruiz-Villanueva, Bladé, Sánchez-Juny, Marti-Cardona, Díez-Herrero, Bodoque (2014): Two-dimensional numerical modeling of wood transport. J. Hydroinf., vol. 16, no. 5, pp. 1077-1096.