Application of D-Flow FM for Storm Surge Modelling: Case Study of TC Yasi

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INTRODUCTION

Tropical cyclones (TC) induced storm tide poses a great risk of loss of human life. The east coast of Queensland, Australia, has a high exposure to TCs, with 207 known impacts since 1858 [1] and several low lying major population centres.

A pilot ensemble real-time storm tide forecasting system has been established to support emergency management. A hydrodynamic model of the Coral Sea is a key component of this system and is required to:
- Processes: Both the tidal signal and storm surge must be predicted accurately.
- Water level fluctuations due to other processes are neglected.
- Spatial resolution: High spatial resolution in areas of complex bathymetry.
- Simulation time: The modelling system needs to be computationally efficient as an ensemble modelling approach is to be adopted given the high uncertainty in TC track, timing of landfall and intensity.

D-Flow FM Coral Sea Model

The Coral Sea, bounded by the east coast of Queensland, is characterised by the Great Barrier Reef (GBR) along the edge of the wide and shallow continental shelf (Fig. 1). South of the GBR, the continental shelf narrows. The tidal regime is highly variable.

At Clump Point, the modelled surge (no tide) was 2.77 m and 3.03 m (dynamic tide) compared to the measured peak of 3.03 m. The modelled peak storm surge of 2.52 m AHD compares well with the measured peak of 2.60 m AHD.

Storm Tide Modelling Results

The D-Flow FM Coral Sea model was firstly run with cyclonic wind forcing on an initial constant water level of 0 m AHD with no tidal forcing. We predict storm tide by forcing the model with the cyclonic wind plus tidal boundary conditions. To assess the interaction between the surge and the tide, the surge was also calculated by subtracting the tidal level from the storm tide.

Modelled storm surge and storm tide water levels (Fig. 6) show the storm tide amplifying around Cardwell. When no tide is included in the model forcing, the modelled surge slightly under predicts the measured peak measured storm surge at Clump Point, Cardwell and Townsville (Fig. 7). The addition of the tide in the simulation increases the modelled peak storm surge levels, resulting in better agreement with the measured data (Fig. 8). The increased surge at the day to the inclusion of the tide is consistent with enhanced surge development in shallower water [15].

Analytical modelled storm surge and storm tide for TC Yasi at (a) Clump Point, (b) Cardwell, (c) Lucinda and (d) Townsville storm tide gauges.

CONCLUSIONS

We have described the first application of D-Flow FM for modelling both storm surge and storm tide for the case study of TC Yasi. The results demonstrate that D-Flow FM is capable of accurately predicting storm surge and storm tide for this event. D-Flow FM has potential for the intended application as a component of an ensemble-based real-time storm tide forecasting system, with advantages in computational efficiency and accessible data formats.

The case study suggests that including the dynamic tide is a requirement of a storm tide model. This event. D-Flow FM is capable of accurately predicting storm surge and storm tide for this event. D-Flow FM has potential for the intended application as a component of an ensemble-based real-time storm tide forecasting system, with advantages in computational efficiency and accessible data formats.