FORECASTING HURRICANE IMPACTS ON US COASTS

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INTRODUCTION

Coastal zones are areas of high economic and ecological value which are under threat of natural hazards such as flooding and erosion. Already 10% percent of the world's population lives below 10 meters above mean sea level (McGranahan et al., 2007) and this number is likely to grow in the future. Moreover, coastal zones will experience accelerated sea level rise and will be subject to potentially increasing intensities of extreme water levels, due to extra-tropical and tropical storms, which will aggravate the impact of natural hazards.

In particular, Tropical Cyclones (TCs) cause flooding due to surge, waves and rainfall; which can result in damage and loss of life (e.g., Resio & Irish, 2015) with devastating impacts on coastal communities (Wahl et al., 2015) as demonstrated by recent landfalling events in the US, East Asia and East Africa.

These increased impacts and costs necessitate an approach to assess flooding and damages a priori for planning and mitigation purposes. It also calls for flood forecasting systems to alert authorities to be able to prepare for an impact and evacuate the population (Roy & Kovordányi, 2012).

While a number of forecasting systems are available, these usually focus on a relatively small area and a small number of hazards, mostly total water level, and rarely impacts. This presentation is about upscaling to larger regions, including more physics and more impacts.

APPROACH

The COSMOS2 (COastal Storm MOdelling System) forecasting system covers both a large area of the US East Coast and Gulf of Mexico, includes all relevant physics to compute compound flooding and includes flooding impacts. This system is an innovation of Barnard et al. (2014) who assessed hazards on the US West Coast.

In the present approach, we use much faster wave, surge and flooding models (SFINCS (Leijnse et al., 2021) and HurryWave), and use more complete 2D morphological impact models (Xbeach, Roelvink et al. (2009)). We apply this to the case of hurricane impacts on the US East and Gulf of Mexico Coasts that occurred in 2022 and 2023, such as Hurricane Ian, Idalia, Lee, and Ophelia.

To illustrate, the coverage of the SFINCS surge models extends from the edge of the continental shelf where surge becomes important to the 10 meter elevation and from the Mexico to the Canadian border (Figure 1).

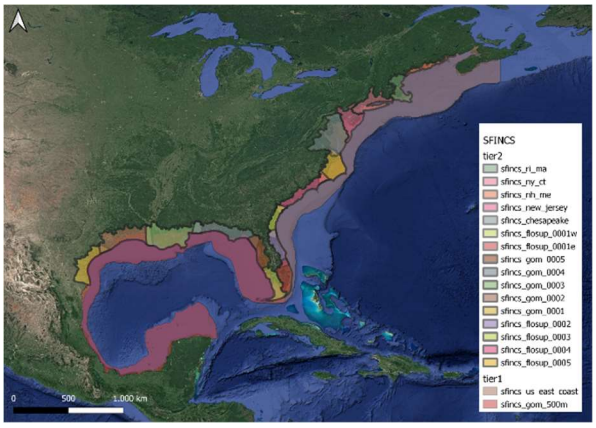

Figure 1 – Map view of the SFINCS surge and overland flooding models for the Gulf of Mexico and the Atlantic coast.

RESULTS

For Hurricane Ian which impacted South-west Florida in September 2022, Figure 2 shows the predicted flooded area which includes flooding due to surge and direct rainfall.

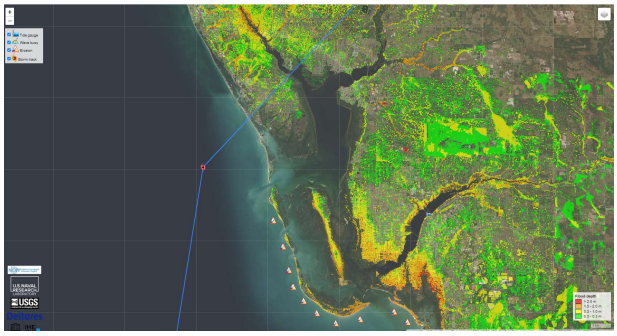

Figure 2 – Map of the flooded area around Ft. Myers, Florida due to Hurricane Ian.

The modelled water levels at the Ft. Myers gauge (Figure 3) shows that with the forecasted COAMPS-TC wind and pressure fields, we were able to make an accurate forecast of the water levels (orange line) as compared to the observations (green line) both in terms of timing and maximum value of the high water. The harmonic tidal prediction is given as a reference in blue.

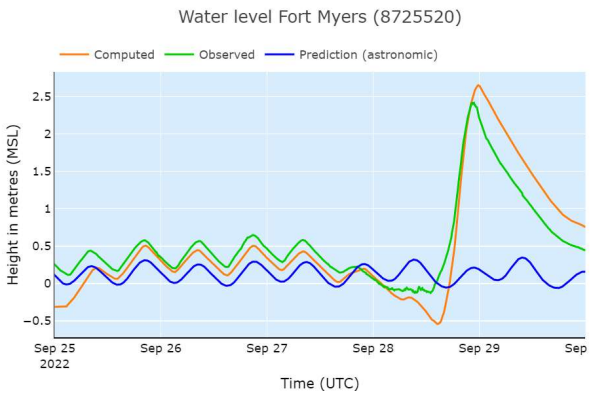

Figure 3 – Time series of the water levels at the Fort Myers NOAA gauge: observations (green), computed (orange), harmonic prediction (blue).

Using the hydrodynamic surge and wave forcing, local 2D Xbeach models are activated which can predict dune erosion, overwash and breaching. Figure 4 shows the observations of breaching at Lover's Key island near Ft Myers on the left and the model results on the right which are in close agreement.

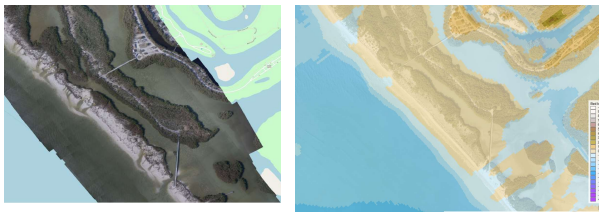

Figure 4 – Observed and modelled breaches at Lover's Key Florida due to Hurricane Ian. Left: observations, right: predictions

In the presentation we will discuss the performance of the modelling system for the 2023 hurricanes Idalia, Lee and Ophelia, as well as discuss the importance of taking uncertainties into account.

ACKNOWLEDGEMENTS

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