Developing large scale and fast compound flood models for Australian coastlines

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THE NEED FOR COMPOUND FLOOD MODELS

The recent 2022 large scale rainfall events in Australia's east coast have put in evidence the region's vulnerability to severe flooding events. In the future, climate change and sea level rise are expected to exacerbate these vulnerabilities. Accurate and reliable flood predictions are required to develop effective emergency management practices as well as appropriate adaptation and mitigation strategies. During events, detailed predictions of flooding can improve early warning systems and enhance the preparedness of relevant governments and communities. To this end, numerical models capable of simulating compound flooding produced by different drivers (e.g., marine, pluvial and riverine) are needed. These models must also be developed at an appropriate level of detail to produce accurate and relevant flood maps.

FAST MODELS

The challenge to derive compound flood models for coastlines as vast as Australia's, is that numerical models are either fast but too simple to simulate compound events accurately, or detailed enough but too computationally intensive, which often translates into long simulation times unfeasible for real-time decision making. The Super-Fast INundation of CoastS (SFINCS) model was developed to tackle this challenge. It combines all relevant processes to model compound flooding events and applies a reduced-complexity solver (Leijnse et al. 2021), which significantly reduces computational times to model large areas. Furthermore, recent additions like sub-grid features make it possible to calculate accurate flood maps at high resolution while still computing fluxes on a relatively coarser grid. This work presents the development and application of 13 SFINCS models along the coastline of the states of New South Wales, Queensland and Northern Territories covering a total coastline of 7000+ kilometers. Corresponding hydrological Wflow models have been set up to provide upstream river boundary conditions for the SFINCS models. The computational times for these models have proven to be small enough to be suitable for flood assessments and real-time early warning systems.

FAST AND FLEXIBLE MODEL SETUP

Besides the computational speed, creating compound flood models for such large stretches of coastline is challenging because it requires a lot of data and a lot of (manual) processing to set up all the models. In this work we demonstrate that using tools as Delft Dashboard (van Ormondt et al. 2020) and HydroMT (Eilander et al. 2022) it is possible to set up these models quickly and in an automated way. The framework is very flexible so that local details, like higher-resolution DEM data, river bathymetry or manning roughness, can be incorporated where more accurate information is available. Because both the Wflow and SFINCS models are set up in HydroMT with the same base layers, these are well connected and incorporate knowledge on local watersheds.

VALIDATION

The Wflow and SFINCS models were verified using observed data for 2 historical events in the Brisbane River catchment (Jan 2011 and Nov/Dec 2021) and 1 event for the Bohle and Ross Rivers catchments near Townsville (Jan/Feb 2019). The simulated results compared well to the recorded values and it was demonstrated that better input data (e.g. DEM) equals better model results.
This work thereby demonstrates that the framework to set up the large scale SFINCS models is flexible and enables the generation of coastal compound flood models that both capture large scales, produce accurate results and are computationally efficient.

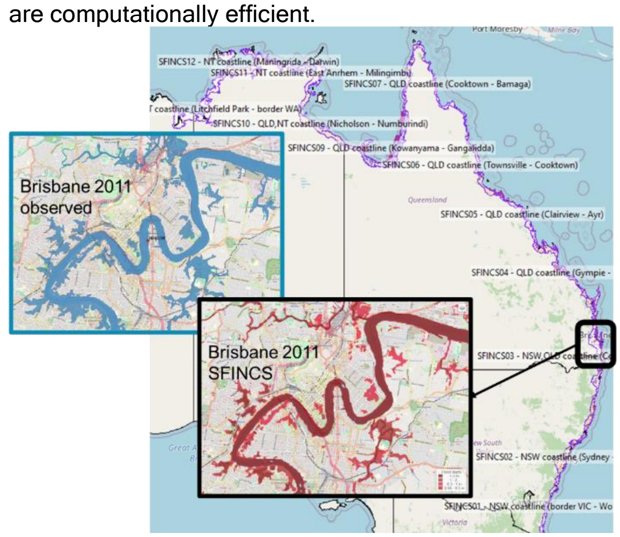

Figure 1 – Overview of 13 coastal SFINCS domains for NSW, QLD and NT – Australia, with observed and modelled flood extents for the 2011 event in Brisbane

REFERENCES

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