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DestinE DT for compound flooding in coastal areas: impact forecasting and climate adaptation

1. DE370a Modelling Framework

Within this project a globally-applicable modelling framework is implemented for the simulation of compound flood impacts (Fig. 1). The resulting generic set of open-source models serves as a DigitalTwin for compound flood impact simulations as part of DT Extreme events and DT Climate Adaptation.

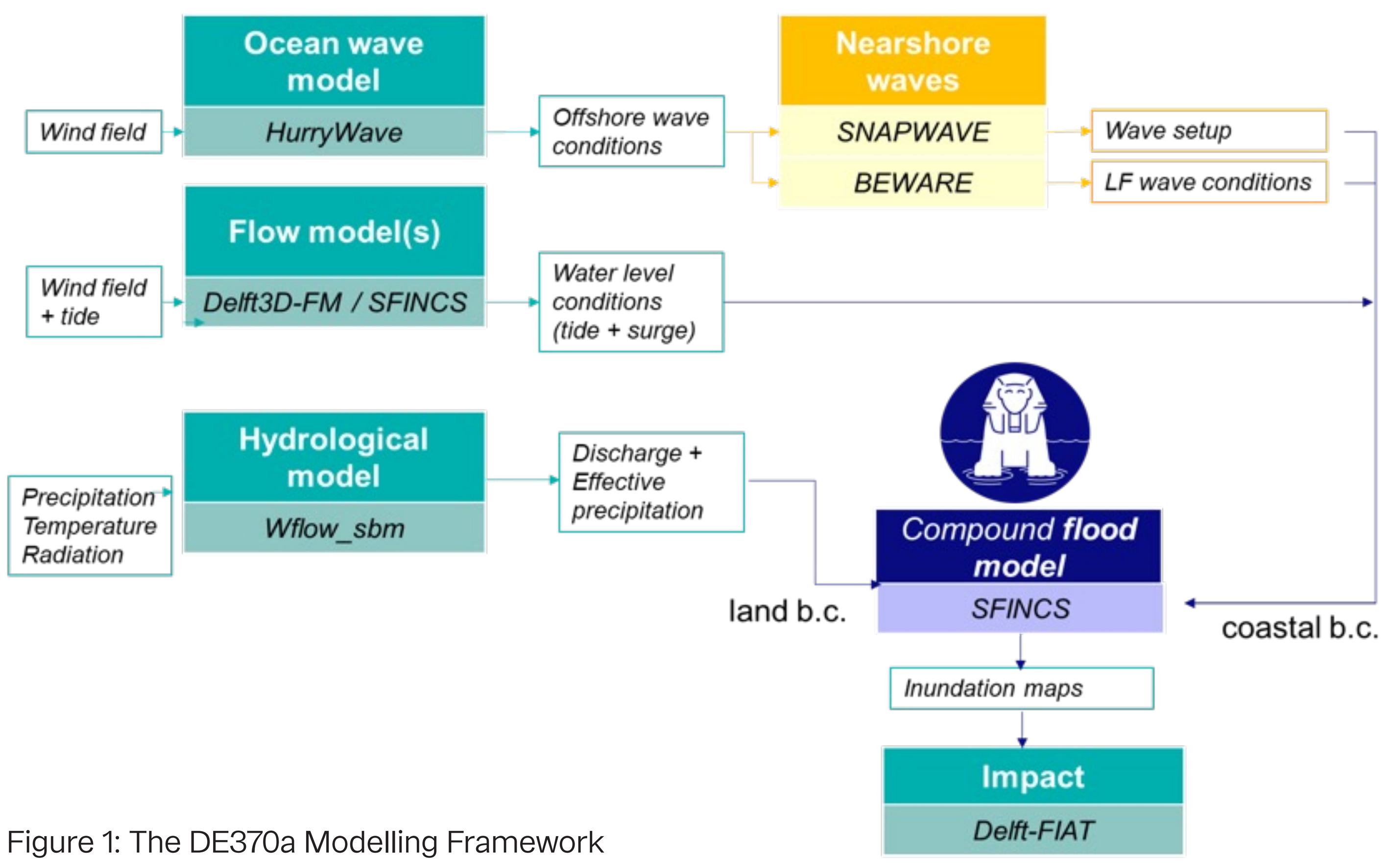


Figure 1: The DE370a Modelling Framework

2. Demonstration for La Reunion Cyclone Fakir (April 2018)

For the simulation of surge and tide a Delft3D-FM model (Fig. 2) is implemented along the coastline of La Reunion. The model resolution increases towards the coast. The Delft3D-FM model supplies surge and local tidal boundaries conditions for the flood inundation model (SFINCS) and the nearshore wave model (BEWARE – Fig. 3)

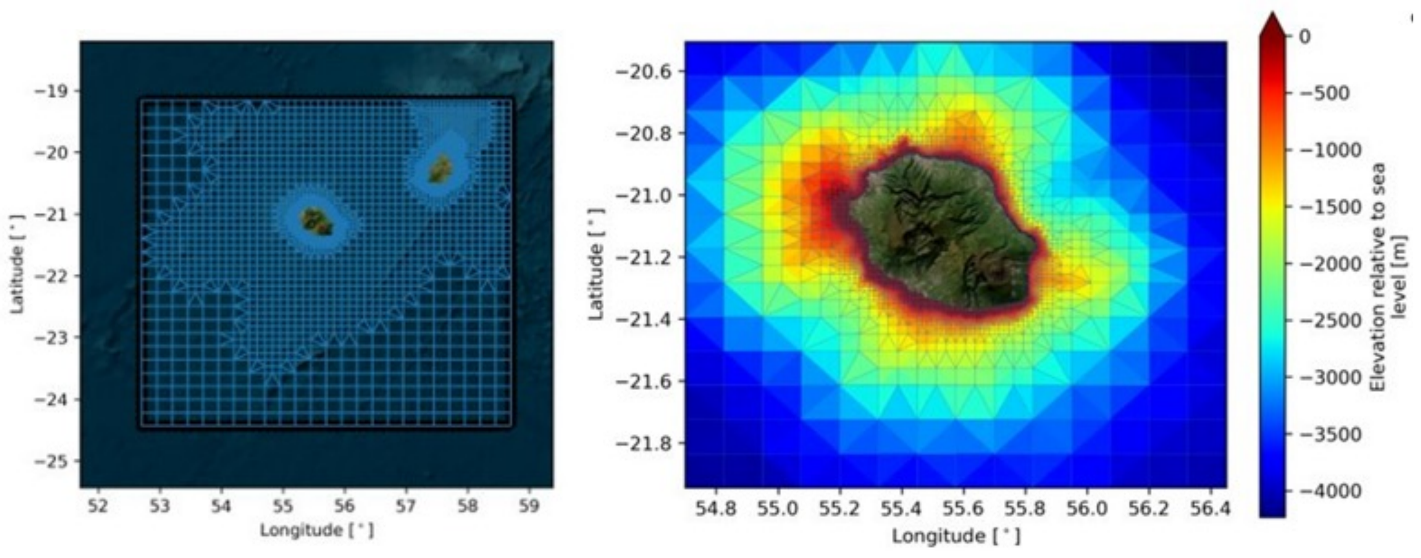


Figure 2: The tide and surge model Delft3D-FM with increasing resolution towards the coast.

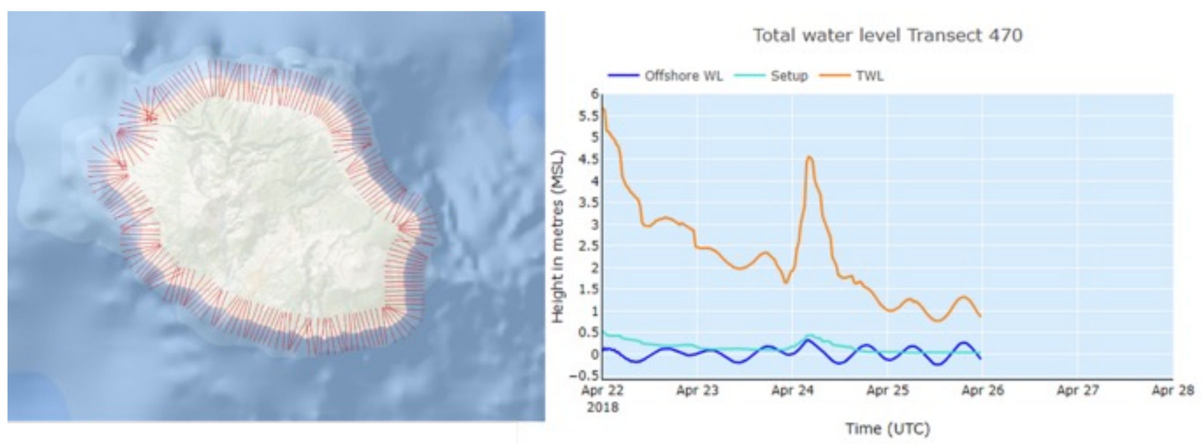


Figure 3: Total water level (metres above MSL) simulated with BEWARE for one of the coastal transects / slopes along the coastline of La Reunion.

The generation and propagation of sea-swell waves by strong wind is simulated using the HurryWave model (Fig. 4). For cyclone Fakir the HurryWave model was forced with wind fields and atmospheric pressure from spiderweb that provides reasonable track data.

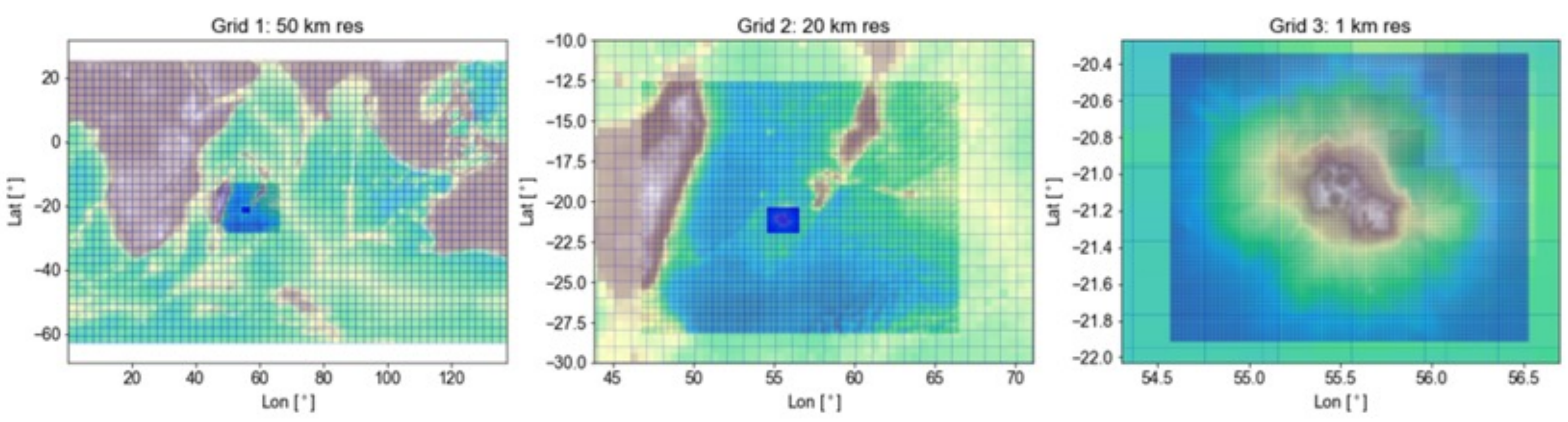


Figure 4: The implementation of the HurryWave model for the simulation of sea-swell waves.

For the simulation of rainfall-runoff processes the spatially distributed wflow_sbm hydrological model is implemented for the entire Island (Fig. 5). The model provides hourly discharge time-series that are used as boundary conditions for the SFINCS flood inundation model.

Finally, the SFINCS model (Fig. 6) is implemented and run using river flow from wflow_sbm and coastal water level data from Delft-3D as boundary condition. The model domain is based on watershed delineation and elevation. It extends from -50 metres in the see up to 100 metres elevation over land. Fig. 6 shows the maximum simulated water depth that will in the coming month be used to calculate the flood impacts (damage, effected people).

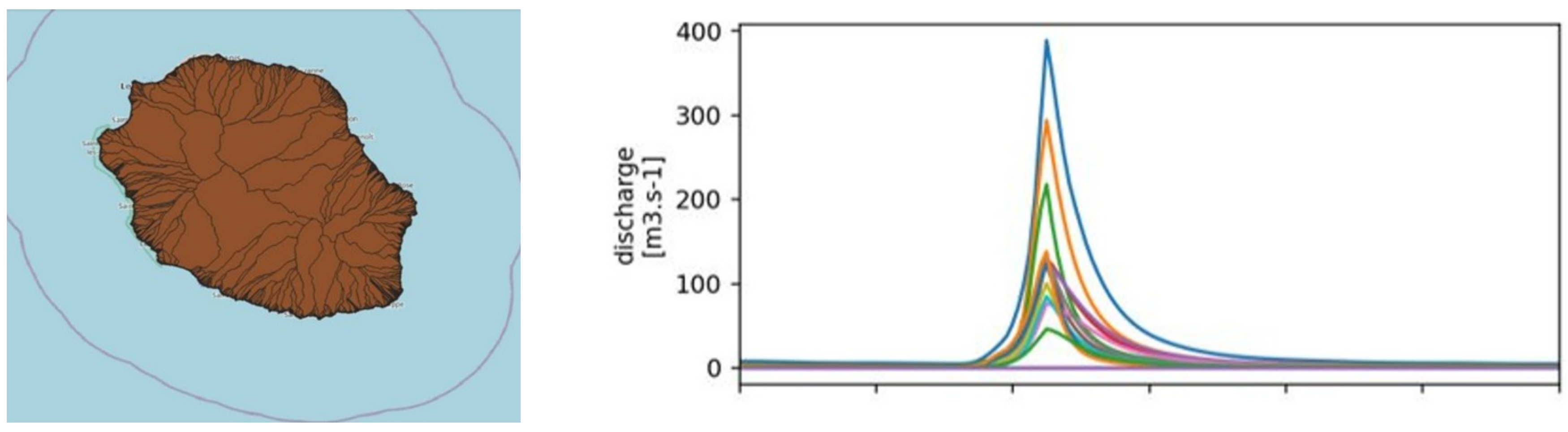


Figure 5: The implementation of the hydrological wflow_sbm model for La Reunion (left) and the discharges simulated for the 2012 event Fakir.

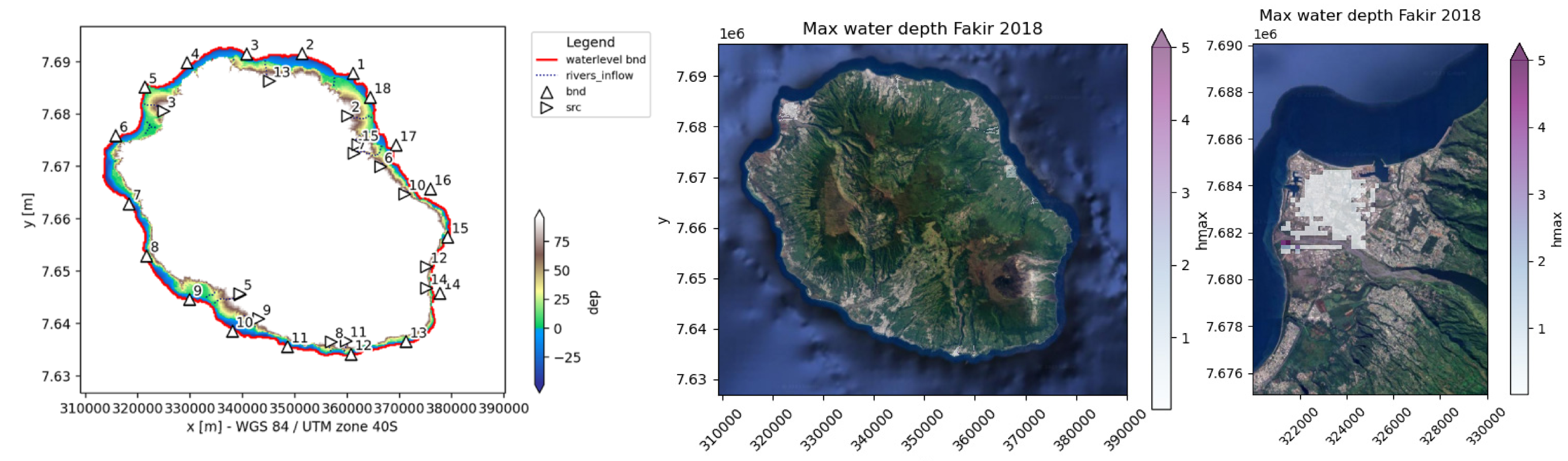
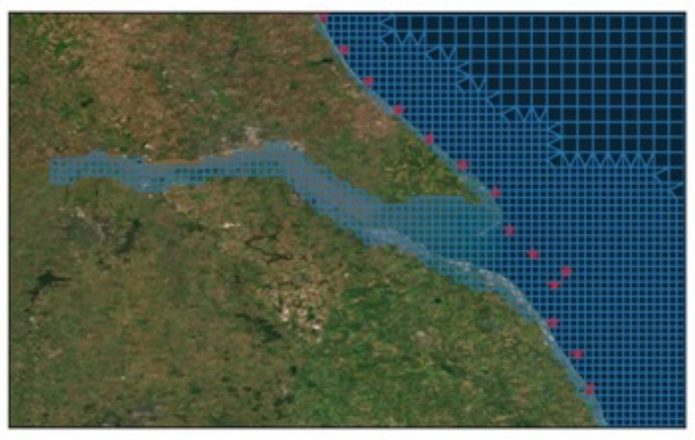


Figure 6: SFINCS flood vinundation model implementation for the coastline of La Reunion (-50 to 100m). SFINCS model domain (left) and the maximum water depths over land simulated for the Fakir event (right).

3. Demonstration for the Humber (UK) Storm Xaver (December 2013)

The Humber Estuary is located in the eastern part of England and highly vulnerable to flooding. We implemented a Delft3D-FM model (Fig. 7) for the simulation of sea water levels with highest resolution in the Humber Estuary.



To simulate overland flooding the SFINCS model was implemented (see Fig. 8) the model takes simulated river discharges from wflow and downstream water levels from Delft3D-FM as boundary condition.

Figure 7: The tide and surge model Delft3D-FM with increasing resolution in the Estuary

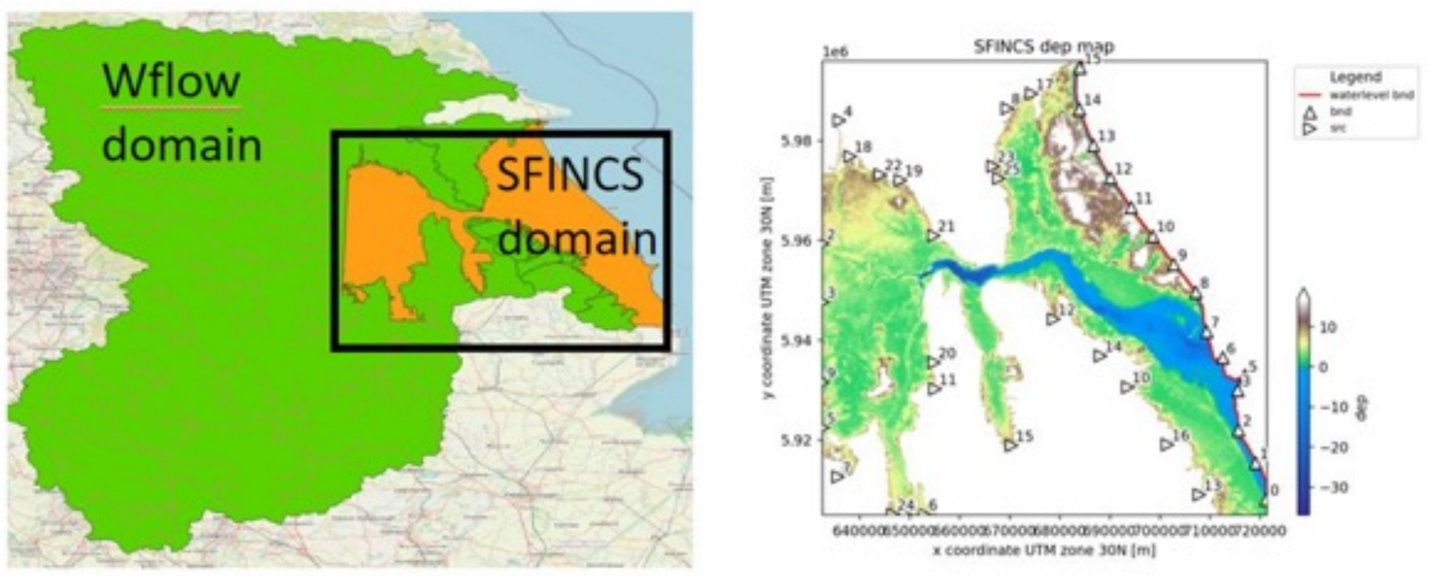


Figure 8: The extend of the wflow model covering the Humber catchment (green) and the SFINCS modelling domain with its boundary condition input locations.

4. Outlook

In the remainder of the project we will:

- Improve specific models with local high-resolution data based on user requirements
- Conduct an uncertainty analysis by replacing model components by existing local models and DE data streams
- Strengthen the link with (1) DE Extremes by using forecast datasets and (2) DE Climate Adaptation by using climate datasets and implementing WhatIf scenarios.
- Extend the automatic implementation of the modelling framework and test this automatization in another DE case-study area

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