EGU24-12509, updated on 25 Jul 2024
https://doi.org/10.5194/egusphere-egu24-12509
EGU General Assembly 2024

Evaluating a +100-year storm surge using a real-time distributed flood forecasting system

Emma Dybro Thomassen[1], Michael Butts[1], Sanita Dhaubanjar[1], Jonas Wied Pedersen[1], Sara Lerer[2], Mathias Rav[2], Morten Andreas Dahl Larsen[1], Kristine Skovgaard Madsen[1], Phillip Aarestrup[1], and Grith Martinsen[1]
[1]The Danish Meteorological Institute, The Weather Research Department, Copenhagen E, Denmark (emt@dmi.dk)
[2]Scalgo, Aarhus, Denmark

Estimating the geographical flood extent is a key element in impact-based flood forecasting and crucial for countries with long coastlines, and places where storm surges pose a significant risk, such as Denmark. For local flood mitigation measures and climate adaptation strategies, inundation mapping is often performed using physical models. However, in the context of flood forecasting and early warning, these are computationally demanding and therefore may not be able to provide timely forecasts and effective warnings.

The Danish Meteorological Institute (DMI) has developed a real-time flood forecasting system for storm surge events in Denmark together with the company SCALGO. This system couples the HBM regional oceanic storm surge forecasting model, developed by DMI, with a rapid inundation mapping, developed by SCALGO, using a 0.4 m resolution Digital Elevation Model (DEM). All inland pixels in the DEM are connected to a coastline pixel through pre-computed hydrological flow paths. The predicted water level from the storm surge model at each coastline pixel is then instantaneously projected inland through the pre-mapped flow paths. This study evaluates the performance of the flood forecasting system on the Oct. 20-21 (2023) storm surge event, with an estimated return period of over 100 years and affecting large parts of southern Denmark (and northern Germany).

This flood forecasting system creates a simple inundation mapping based on forecasted sea levels based on a high-resolution DEM modified to account for hydrological flow processes. This real-time flood mapping allows for a visualization of full five-day ocean model forecasts updated continuously at 6h intervals and has been operational for flood warning since October 2022, to supplement DMIs operational ocean forecasting system [1].

The evaluation is performed by comparing the inundation map from the flood forecasting system with media reports, photographs, and other data sources to get an overview of spatial and temporal accuracy and accuracy of the severity of the event. We see a large overlap between areas with forecasted flood risks and actual flooded areas. In some cases, the extent of the flooding differs from the area at risk due to errors in the DEM or local emergency services mitigation strategies.

We conclude that the flood forecasting system is useful for identifying coastal areas at risk. While it does not account for detailed physics of flow on land, it is able to reflect the effects of, even very local, geographical variations in sea level that determine the distributions of local-scale flood risk. The current inundation mapping does not currently include the impact of waves, which resulted in larger differences between predictions and actual flooded areas, for easterly-facing locations exposed to large waves. Proposed activities to include the effect of waves will therefore improve the flood forecasting system.

[1] Andrée, E., Su, J., Larsen, M. A. D., Madsen, K. S., & Drews, M. (2021). Simulating major storm surge events in a complex coastal region. Ocean Modelling, 162, 101802.