

A high-resolution robust operational coastal flood forecasting system over the Bengal Delta: the Band-SOS project

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Abstract

Tropical cyclones are among the most devastating natural disasters, with Bangladesh experiencing some of the highest cyclone-related casualties globally. Situated in the northern Bay of Bengal, this extremely vast, low-lying deltaic region features a shallow shelf, a dynamic coastal ocean, and extensive river networks, making it highly susceptible to extreme storm surges. Despite the urgent need, an operational coastal flood forecasting system was still lacking until recently.

Developing such a system has been challenging due to data scarcity and appropriate modeling framework to tackle the complex hydrodynamics of the Bengal Delta. This macro-tidal region exhibits strong tide-surge interactions and significant wave setup extending over 50 km inland, and large-scale inland flooding modulated by coastal defenses. Addressing these challenges required a high-resolution, cross-scale ocean model capable of resolving tides, waves, and storm surges while integrating proper ocean and river bathymetry, inland topography and engineering structures. Additionally, computational efficiency was crucial for real-time forecasting.

Leveraging over a decade of advancements in developing reliable bathymetry, topography, and scale-appropriate storm surge modeling, we developed Band-SOS, an operational coastal flood forecasting platform. The system employs a calibrated validated, high-resolution (250 m) unstructured ocean-wave model, which is the most accurate amongst the published models in this region. The model is forced by bias-corrected global weather forecasts through innovative merging of analytical wind fields. Operational since November 2022, Band-SOS produces 5-day forecasts every six hours, disseminated via a web portal (<https://bandsos.github.io>). The system runs in a containerized environment, ensuring robust performance under a constraint computational environment and has proven highly reliable during recent cyclone events, significantly aiding disaster management.

Band-SOS offers a cost-effective, open-source solution for coastal flood forecasting, providing a replicable framework for other regions facing similar operational forecasting challenges.