Introduction

The goal of Coastal Inundation Forecasting Demonstration Project (CIFDP) is to provide accurate forecast of inundation from hazardous meteorological forcing including storm surges caused by direct wind and wave forcing, wave set-up form large swell events and inundation form inland flooding interacting with sea-level variations in coastal areas. BMKG as National Meteorological and Hydrological Services for Indonesia has the responsibility to operate the system and issued a daily forecast, especially during these extreme events to warn people for the possible threats. To make this project a success, BMKG need to coordinate with other institution and form a national partnership to make this possible.

Model development

With respect to technical aspect, BMKG is collaborating with Deltares to develop the required Hydrodynamic models to be used for CIFDP-I. As part of this collaboration, a Joint Development Delft3D model workshop has been held in Deltares, Netherland between 29th of October and 9th of September 2016. This joint development activity had successfully developed high resolution, on-line coupled, Delft3D storm surge and wave models for Jakarta and Semarang in Windows and Linux platform (BMKG ~ High Performance Computing (HPC ~526 cores). Boundary conditions for these models are derived from the South China Sea (SCS) model for the storm surge and a regional Pantura (Northern coast of Java) model for the storm surge and wave signal. Tidal components are also prescribed at the open boundaries of the detail model to obtain as accurately as possible forecast of total water level at Semarang and Jakarta to allow for proper flood forecast.

Figure 1 Delft3D Flow-Wave model scheme for CIFDP-I
Example of the grid coverage of SCS, Pantura and the two detail models are shown in Figure 2. The detail models cover also land areas that are prone to flooding. Different river discharge sources can be specified at the model boundaries.

The storm surge is computed by the South China Sea (SCS) model (see next Figure for an overview of the model). Its results is fed to the Pantura model and subsequently off-line nested to the detail models. It is the ambition of the BMKG to further refine the detail models, to improve the DEM and the bathymetry and to add tide to the Pantura model.
An example of a time series of the computed water level compared to observation at Jakarta under influence of tide, surge and wave set-up is shown below. The results below are preliminary.

1 Tide is not include in the SCS model as during the short period available we were not able to reproduce the very complex tide behavior in Jakarta due to numerous amphidromic points.
Regional wave and atmospheric model
To complete the overview, below the model coverage of the regional wave model (WWIII, resolution 0.0625 by 0.0625 degrees) and WRF atmospheric (resolution 10 by 10 km) are presented. They are currently being tested and run in operational mode.

Figure 4 Regional wave model and atmospheric model already developed by BMKG. Black line denotes the approximate boundaries of the SCS model and red line the Pantura Model.

2 Coverage of the regional wave and atmospheric models are larger (towards the West and North) than shown in the figures.
Follow-up
Based on test results, evaluation of the available data and discussions on further improvement on the detail models during the joint work, it is found that:

- The grid could be more refined (at the moment it is approximately 150 m),
- bathymetry and DEM (Digital Elevation model) are slightly outdated and inaccurate and must be updated
- coastal protection structures (in the form of weirs\(^3\) and thin dams\(^4\)) for local model Jakarta and Semarang must be added properly.
- River discharges BC are yet to be provided, but provisions for these have been made

For the last point, it is important to discuss with PusAir that operates the Jakarta Flood Early Warning System (J-FEWS) on how to couple the models developed above for provisions of river discharges boundary condition (BC).

Acknowledgement
Finally, BMKG would like to thank you for Deltares, especially Mr. Deepak Vatvani, Mr. Emil Moerman and Mr. Adri Mourits for their support during this joint development workshop.

\(^3\) Weirs are sub-grid structures that blocks the flow that however can be submerged (when water level exceed weir heights; friction forces are taken into account; may be used to schematize e.g. groynes)

\(^4\) Thin dams are sub-grid structures that blocks the flow that can never be submerged (may be used to schematize e.g. narrow elongated islands or capes where flooding is not considered)