Webinar "Ocean modeling and Early-Warning System for the Gulf of Thailand"

Questions about wave modelling:

1. **What does "specular" mean in the slide on SWAN modelling?**

    The SWAN code slide mentioned that SWAN accounts for two types of reflections against obstacles: "specular reflection" reflecting at a definite angle and "diffuse reflection" reflecting in all directions. For more info or downloading the SWAN code & documentation, see http://swanmodel.sourceforge.net/.

2. **Is the water level for the wave model supplied from the D-Flow Flexible Mesh model?**

    In the present application this is not the case. The existing FEWS-GoT does not use a one- or two-way coupling between hydrodynamics and wave models. This could be implemented in a future phase.

3. **What is water level used for SWAN?**

    We specified a zero water level for SWAN (mean sea level).

4. **It is stated that wave induced setup is included. Can a nearshore grid of 250mx250m adequately resolve the wave breaker zone to have an accurate calculation of the wave setup?**

    For the record, the wave modelling work was led by HAII in Bangkok, with only occasional support by the Deltares team.
    The SWAN local/detailed model has a horizontal resolution of 300m by 300m. However, it is not SWAN producing the wave setup estimates.
    The output from SWAN detailed model is used to provide input to an empirical equation which determines the wave setup estimates – at many locations along the Thai coastline. This empirical equation (Eqn. 19 of Stockdon et al., 2006, Coastal Engineering 53) was applied to provide wave setup at the coast based on wave conditions at 10m isobaths and takes into account other factors such as the nearshore slope. In the FEWS-GoT application, this is done within Delft-FEWS.

5. **Could you please explain how you transferred wave height from 300 m grid to the shoreline?**

    See question 4 above.

6. **What were the challenges when calibrating the wave model? What is the coupling between wave and flow module?**

   For the record, the wave modelling work was led by HAII in Bangkok, with only occasional support by the Deltares team.
   Generally speaking, the major tasks were (i) obtaining adequate bathymetry (spatially dense, good quality, well-referenced in the vertical), (ii) obtaining good forcing (NOAA's WaveWatch III) and deciding the location for the open boundaries of the larger regional model, and (iii) ensuring the proper nesting between the larger and the smaller SWAN models.

7. **Was there an on line coupling between SWAN and D-Flow Flexible Mesh model?**

   No. See question 2 above.

8. **How do you input significant height and period to Delf3D? Is there a feedback from Delf3D to SWAN?**

   Delft3D Flexible Mesh does not use nor compute Hs. There is no coupling between hydrodynamics and waves, in the FEWS-GoT application.
   Wave model SWAN does need wave conditions defined at the open boundary, which may be given either as wave parameters (e.g., Hs) or as wave energy spectrum. For more info or downloading the SWAN code & documentation, see http://swanmodel.sourceforge.net/.

9. **Do you input the wind data in flow or wave model and do you update the water level in wave model with the water level in flow model?**

   The existing FEWS-GoT does not use one- or two-way coupling between hydrodynamics and wave models. This could be implemented in a future phase. So there is no "on-line" communication between the hydrodynamics (Delft3D FM) and the waves (SWAN) models. The Delft3D FM model runs separately to the SWAN models. Wind is forced separately on each model.

10. **Are the SWAN simulations done on the same Delft3D flexible mesh grid? Are they capable of running on the flexible mesh, and how does this add to your runtime?**

    The existing FEWS-GoT does not use one- or two-way coupling between hydrodynamics and wave models. This could be implemented in a future phase. So there is no "on-line" communication between the hydrodynamics (Delft3D FM) and the waves (SWAN) models. This could be implemented in a future phase.
    SWAN unstructured could be run on the same Delft3D FM (unstructured) mesh. A more well-tested solution would be to run SWAN structured models over the (unstructured) Delft3D FM mesh. There is no need for exact fitting, as long as domain extents are approximately the same. No tests were carried out for runtimes.

11. **Has a validation of the results of wave model been carried out? Especially during storm surges? Was it possible? If not, how do we handle this uncertainty?**

No. During the model development (2016) a validation hasn't been carried out. Probably, this will be done in 2017-2018.

12. **Do you apply boundary conditions for wave modelling as well or are the boundary conditions computed by the wave generated itself?**

See also question 6, above.
For the record, the wave modelling work was led by HAII in Bangkok, with only occasional support by the Deltares team.
The regional SWAN model is forced using boundary conditions from NOAA's WaveWatch III forecasts. This regional model, in turn, provides boundary forcing to the local detailed SWAN model. Thus both SWAN models simulate both wave propagation and wave generation (also having wind forcing at the surface).

Questions about hydrodynamic modelling:

13. **Which turbulence model is employed for the hydrodynamics?**

This is a depth-averaged (2D) model for which no (vertical) turbulence model is needed. In the horizontal, a simple approach is used with a fixed horizontal viscosity and diffusivity coefficient.

14. **Which coefficient for the horizontal viscosity and diffusivity do you use?**

In the present FEWS-GoT application, the horizontal eddy viscosity was set to a uniform value of 1 m^2/s. This value is a function of typical cell size, typical depths, and type of application (e.g., 2DH versus 3D).

15. **Could you explain a bit more about `Courant grid', say what is the meaning of this kind of grid and how to generate this grid in the presence of an island (finest grid along the coast line of the island and increase grid size gradually at places away from the coast line)?**

A Courant grid means that the grid resolution depends on the bathymetry. The deeper the bed level, the larger the mesh size. In this way, the courant number remains more or less similar over the whole model domain, which enables a larger time step. This saves computation time. For details please have a look at the Delft3D FM documentation (user & technical manuals).

16. **Could you explain a bit more about `Courant grid', say what is the meaning of this kind of grid and how to generate this grid in the presence of an island (finest grid along the coast line of the island and increase grid size gradually at places away from the coast line)?**

   See also question 15 above.

   Using the grid-generation tool with the Delft3D FM package, a Courant grid can be generated automatically. The deeper the bathymetry, the larger the mesh size. Around an island, just like approaching the mainland, the mesh size is refined as one approaches land.

17. **In mesh generation, did you only use the automatic mesh generation using the courant or manual adjusting is done as well??**

   Some "manual adjustment" was done; see slide no. 20 of the webinar, in which we state that horizontal resolution was as fine as 250m along Thai coast and as fine as 1000m along other coasts. We did not need super fine resolutions far away from our region-of-interest, so adjusted depths accordingly – only during grid generation. Actual depths were interpolated onto the final grid. Coarser than Courant cells over shallow cells are numerically allowed; finer than Courant cells over deeper cells would make the model crash.

18. **Do you use an adaptive time step?**

   Yes; the D-Flow Flexible Mesh module uses an adaptive time step to ensure numerical stability. This goes automatically. After each simulation, the user can see (part of history file output) what time-steps were actually applied.

19. **Since you have a regional model, is the vertical datum of the bathymetry based on a constant MSL or a varying MSL? If using varying MSL, do you produce MSL map?**

   The model's vertical reference is MSL, so all bathymetry datasets were converted to MSL before interpolation. The global data was obtained already in MSL. The nautical charts data was originally in LAT and converted to MSL by HAII – using a spatially-varying correction between 0.7 and 2.1m.

20. **What is the tidal spin up period of the model?**

   During model development using yearly runs, the model was started from rest and results from the first week were not used in any analysis (e.g., tidal constituents). This was more than required. Upon inspection, it was concluded that 48h was sufficient.

21. Assuming that the wind field is continuous over land, is there any special treatment of wind dissipation over land?

The wind is not 'constant over land', nor did we need to make any assumptions or corrections or land/sea masks on the surface forcing. The meteorological model used operationally, HAII's WRF-ROMS with 9km resolution is so fine that it can be expected to resolve the coastline with sufficient detail.

22. To predict storm surges globally of a day, how much time does it take for one computer to finish the simulation?

A 10-day forecast with the global tide and surge model (GTSM) takes less than 1 hour (I believe we use a 12 core server at present). The present GTSM configuration uses mesh resolution between 50 and 5km. For some background on the global forecasting system, also see https://www.deltares.nl/en/projects/global-storm-surge-information-system-glossis.

23. For large mesh sizes the numerical diffusion could be very high and perhaps these coefficients may be have to be set high. Is this the case in this model?

This was not the case in the GoT model.

24. Which roughness values are applied and what are their sources?

A Manning bed roughness formulation was chosen, representing bottom roughness, with a spatially-uniform value of 0.023 sm$^{-1/3}$. This is very near to the default value recommended. A small sensitivity test was performed, before settling on this value.

25. Could tsunami also be modelled in this simulation?

The Delft3D FM software is able to simulate tsunami events.
However, this specific Gulf of Thailand EWS for tide and storm surges was not set-up to capture tsunamis. In order to do this, an extra implementation in the EWS would be required – the functionality to quickly define the initial earthquake disturbance causing the tsunami, which Delft3D FM would then propagate over the existing grid. This already exists in the codes (Delft3D FM and FEWS), just wasn't implemented in FEWS-GoT.

26. Is the wind field continuous over land? Is there any special treatment of wind dissipation over land?

See question 21 above.
For us it is not clear what 'continuous over land' means. See slide 40 of the Webinar powerpoint presentation. The meteorological fields extend over the land.

27. Is the inundation domain over land part of the coastal surge model? How is the land roughness defined then what is the grid size on land?

In the present FEWS-GOT system, overland inundation is determined within FEWS, by examining the hydrodynamic and wave setup flooding levels at the coast together with a detailed DTM in the upper Gulf of Thailand. So no, the hydrodynamic grid (in this case) does not extend over land and land inundation is not modelled dynamically.

28. For global surge modelling (GLOSS), how do you simulate the tides? I assume you simulate tides and surges together?

Yes, GLOSSIS simulates both tide and surge simultaneously, in a global 2DH model. There are no open boundaries in such model, so the tides come from the tidal-generating forces activated in Delft3D FM. These are also activated in the FEWS-GoT application, since it's a relatively large domain.

29. I suppose the WRF model is running in real time too. Is it considered in the cpu times you mentioned?

No; this is not the case. Runtimes mentioned are from Delft3D FM simulations.

30. For static inundation modelling, what kind of data source was used for land/building elevations?

The Digital Elevation Model (DEM) used in inundation modelling is based on the benchmark survey conducted by Royal Thai Survey Department (RTSD). This DEM was further processed by HAII to remove artefact and unrealistic topographic features. The processed DEM was subsequently resampled to horizontal resolution of 0.0002 degrees.

31. What type of water level and wave measuring sensors were used in and around the Gulf of Thailand?

This cannot be answered by Deltares, because we did not do any field data measuring. This was conducted by HAII. (NB. We haven't asked them yet.)

32. There is a quite large bathymetry in the model domain. Is running in 2D a reliable choice in this case?

We are not sure what 'quite large bathymetry' means. Definitely, to simulate water levels and depth-averaged currents, a 2DH application is most indicated. See webinar presentation for results obtained during validation.

33. What parameters, if any, you use from the ROMS portion of the WRF-ROMS input? Is it ocean currents, perhaps?

This should be asked to HAII, Deltares just used the output from their meteorological model, WRF-ROMS. In this application, they set up an atmospheric – ocean model to improve meteorological forecasts by taking into account surface ocean results.

34. Is your nearshore bathy data in 250mx250m?

Several data sources were used. See slide 15 of Webinar presentation. At some locations, bathymetry data density was higher than 250m; in some areas it was lower.

35. Your flooding model looks like it is a bathtub model, this has been shown to be incorrect in the literature, hydrodynamics are important, Are you concerned you are overpredicting flooding?

See also question 27 above. The overland flooding in the upper Gulf of Thailand was indeed obtained static, 'bath tub' approach (within FEWS, based on coastal hydrodynamic and wave setup results). In this method, unless a 'landward attenuation' factor is used, then flooding will be overestimated. Limitations are well-known. Future development of the FEWS-GoT system will improve this component.

Questions about the software:

36. Has Delft3D FM linux version has been released? Where can I get the linux version of Delft3D Flexible Mesh?

Yes, but the access to the D-Flow FM code is limited to a small group of Partners in Development. We anticipate having D-Flow FM in open source and on Linux for everyone in 2017, but it could become 2018.

37. Is the Courant grid generation a tool part of Delft3D Flexible Mesh or is it an external progamme?

It is part of an internal tool which is not available for users. RGFGRID is our standard tool for grid generation of (un)structured grids. However, the Courant grid functionality has to be added yet.

38. Is Delft3D Flexible Mesh currently available to users?

Yes, see https://www.deltares.nl/en/software/delft3d-flexible-mesh-suite/.

39. Which programming system (Matlab/C#?) will be more convenient in the forecasting process?

Delft-FEWS has been developed in using Java^{TM} technology, and is fully configurable through open XML formatted configuration files. In the J2EE compliant Client-Server application, JMS is used to provide resilient communication between distributed system components. Delft-FEWS allows the additional java libraries to be accessed by the software giving organisations the opportunity to create their own import routines and connections to external data sources. From the IT perspective, the development in Java has proven to offer several benefits. One such benefit is that the system is plat-form independent. Additionally, the flexibility of java allows the system to integrate well in existing IT infrastructure Environments, this includes Oracle, Microsoft SQL Server and PostgreSQL for the database, and JBoss and Oracle Weblogic for the application server.

40. Is the FEWS module available for the public?

The Delft-FEWS software is freely available to the public. The user can download the Research and Demonstration version of FEWS via the link: https://oss.deltares.nl/web/delft-fews/download.

Remaining questions:

41. The adapter of HEC-HMS and HEC-RAS is currently not online. How can we access this?

More information on HEC-HMS and HEC-RAS can be found at the Deltares public wiki: https://publicwiki.deltares.nl/display/FEWSDOC/HEC-RAS+Model+Adapter.

42. Are there plans to have FEWS as a web-based application?

In the near future there is no plan to migrate FEWS to a fully web-based application. However, the FEWS data and output can be displayed in a web-based platform (e.g. web viewer) in real time. This web viewer can be available for various public groups.

43. Will these slides be available in PDF format for distribution?

Yes; they are available on http://oss.deltares.nl/web/delft3dfm/webinars.