

Q&A: Real-time flood forecasting

#	Question	Answer
1	What do T and U mean in TUFLOW	TUFLOW was initially an acronym for Two dimensional Unsteady FLOW. Funnily enough, these days TUFLOW is 1D, 2D and quasi 3D (2D layered)
2	If the embankment was mainly breched due to erosion and scouring rather than overtopping, was any morphological models done to identify the vulnerable locations of the embankments based on erosion/scouring?	Good question Imran. Ben will outline how the breach information was identified and communicated to the operation center in 10 slides time. If he doesn't I'll circle back to address the question during Q&A after the presentations are concluded.
3	I saw two Input Rainfall Rasters were they both Radar the 12 Hour and 30 minute GPM? or was it an interpolation of gauged rainfall and radar or something else?	They were global rainfall forecast model product outputs, not radar data recordings
	Would that be GPM and another forecast model output? Just I heard missing gauges were removed, which I thought meant recorded data of some kind.	The system was configured to receive datasets from a variety of different sources. For example, hindcast information was available from recorded pluviograph information (that was subsequently gridded in DELFT FEWS). The system was also configure to read in recorded satellite data (GPM) in gridded form, though the accuracy of that data was found to be too poor in the Himalayan region to be used.
	Thanks Chris. So was GPM not used at all? Or simply not in the Himalayan region? Also, would this mean that the rainfall inputs in the Himalayan region were only rainfall gauges?	
4	Were the 2D breach scenarios run in real time?	Yes. The breach simulations were run in real-time. TUFLOW HPC, using GPU hardware acceleration, made the hydraulic model simulation speed fast enough to support the real-time simulation.
5	Was the forecast from the model compared to site data to see how reliable the results from TUFLOW were?	live answered Yes (FEDSS), one of the postprocessing results that is published to web is WL plots comparison at alert stations withing the Hydraulic model domain which compares TUFLOW results versus measure data
6	Did the the model in India automatically show the breaches when and where they occurred, or did these have to be manually run, based on where the breach/es were likely to occur?	It does not identify the location automatically. Catchment observers in the field report to the operation center when and where a breach is expected. The operation centre enter the breach metrics (eg, chainage location) into DELFT FEWS, which automatically updates the TUFLOW inputs to reflect the breach details, runs the model simulation and extracts the results for the operator to interpret.
7	Thanks Ben for great presentation. It is glade to know the performance is wrking well. Does the hydologic model also wroks well at bend part of rivers? have you considered the types of materials (e.g., soil, concrete)?	
8	types of materials of river banks	
9	Thanks for the presentation Ben. Could you provide an idea of the spatial resolution of the 2D inundation models and their runtimes?	live answered
10	How has real-time data hydro-meteorological improved the calibration process ?	live answered
		Appreciate the reply.
11	Can we flood forecasting using AI, and its result is reliable?	I doubt that based on the short historic record especially for gridded rainfall
		This is a developing field. The quality of AI is heavily dependent on the quality of data used to train it. TUFLOW models are being used in numerous locations to train AI for flood forecasting systems. If the TUFLOW modelling is of high quality and accuracy, you can have greater confidence in the AI system too. Mott MacDonald have presented on such system at numerous conferences
12	Can you see any advantages in using Rain on Grid with TUFLOW moving forward?	Cons: 1. Rain on grid leaves a lot of speckles which make cleaning map in the post processing more time consuming, 2. With including rain on grid all the storm water netwok is required to be added to the model, otherwise the model will show flooding in the areas and properties that are actually being drained by storm water network. With adding all the storm water network to the model run time increase substantially Pros: Flooding by overland flow path will be included in the resultant flood extent
13	What are the challenges identified in the FEDSS2, and what steps should be taken to enhance the system further?	Have you had any consideration of utilising a fully dynamic rain on grid approach like Royal Haskoning's FLASH System? This would remove many sources of error including those related to interpolation involving products like WaterRide
		live answered
14	Two inflow boundaries are used in in 1D HD model. One for Bagmati and other one Adhawara at tranboundary location. Are you taking forecast inflow from hydrological model and hindcast part are generated from rating curve?	
15	Is this model using any organization presently?	
16	Does FEDSS capture variability in rainfall forecasts, historically, bom rainfields products provide a 10 ensemble members. Also - does GIS post processing include analysis against building footprint data and inundation of floor levels? and reconciliation with actual road closure locations?	live answered
17	Was there a trend in either over predicting or underpredicting the flooding?	live answered
18	Mahnaz: is mesh size 10 meters?	Grid size varies between catchments - they have been optimised to run in the required time of one hour. It varies between 8m and 20m for different catchments

19	How are forecasted impacts translated into the community through warnings via Queensland Fire and Emergency Services website? Thanks Steve Muncaster - Victoria State Emergency Service	Natural Hazard team provide the produced information to DEMU (Disaster and Emergency management Unit) during a flood event to help them make an informed decision
20	what are the alert stations and what generates this information? is it a sensor?	Yes, they are sensors which record Water level or rain or both
21	Is it possible to generate IFD curves considering real time short-duration rainfall data to check the design floods and take appropriate flood emergency measures?	For short duration events/ flash flooding events what you mentioned is normally the process, and then using pre-cooked maps and overland flow path map available based on that
22	what is the level of effort needed to set up a real time system with few and tuflow?	live answered
23	FEDDS modelling - can it be used to predict 1% AEP flood extents? Also, I wanted to know the reliability of the modelling results? Is there any sensitivity check that we can do to support the results?	The FEDSS models were developed from higher resolution models which were used for design runs such as the 1% AEP. These were calibrated to multiple historic events
23	FEDDS modelling - can it be used to predict 1% AEP flood extents? Also, I wanted to know the reliability of the modelling results? Is there any sensitivity check that we can do to support the results?	Thanks Katrina :) Thanks for the opportunity. FEDSS will be vital in the coming years for flood extent mapping here in Australia. Looking forward to learning the software (when available).
24	Which topography data is used for 2D inundation modelling?	For FEDSS, we use topography data based on LIDAR data, and bathymetry based on surveyed data
25	What type of information is needed to identify realtime or forecasting breach location without any human interaction?	
26	How to select number of rainfall depth variations in river basin?	
27	It's embankment breaching.	
28	Mahnaz, the model in Gold Coast uses gauge input data only? Or do you include radar or other type of rainfall inputs?	Forecasting includes the ADFD (Meteye) forecasts as well as the 12hr and 2hr radar forecasts, plus measured and forecast tide data, and gauge data for recorded rain
29	Thank you for the opportunity. Please Mahnaz SEDIGH, can I get a free and good resolution of global flood extent map of different return periods.	We only produce flood maps for the Gold Coast area, which next generation is on its way. For any data request you can contact City of Gold Coast customer service
30	In both of the models you presented, is rainfall the sole meteorological feature taken into account, or have additional meteorological factors been considered? Furthermore, are there any hydrological factors integrated into the models to enhance their predictive capabilities?	For FEDSS, for tailwater level we are using forecasted tide from BOM which will include any possible storm surge to my knowledge
31	when using one-way coupled models by feeding hydrograph from one model to another.e.g. from hydrological to routing models, do you think that momentum conservation is omitted in such one-way coupling?	
32	Is there any background data assimilation/ML oning into the developed process based models?	
33	How do you evaluate snow-melt data particularly for those rivers having their catchment areas originating in the Himalayas?	
34	Was the cell size consistent throughout the model? If so, how well did it capture the downstream catchments especially where there's medium - moderate development	For FEDSS: The cell size is variable in different catchment based on their extent, but constant in each catchment. One of the postprocessing steps is remapping the results on a 1 m resolution topography to decrease the resolution of the final extent that is being published as final output. The next stage of development would be using quadtree.
35	Are there any example projects that were carried out using advanced measuring techniques for pore pressure or seepage in the stop banks for predicting the width of the breach?	
36	How to model small cloudburst floods between 10-20km2 in a data scarce area?	
37	Thank you for your response. How many catchment observers did you need for this project to get a sense of where and when breaches occurred? Also, to date, did any people need to be evacuated based on the results suggested by the forecast extents?	
38	What are the likely annual costs of implementing a FEWS and TUFLOW System. What level of internal IT Resources would be required?	
39	Thanks for the presentation. For either project, was the hydrological modelling component automated, or do they require manual estimates of input parameters (e.g. losses)	For FEDSS, there are default parameters used for the automated part of the system, however during an event the system is operated by an engineer who calibrates against recorded data and knowledge of antecedent conditions.
39	Great question. Would love to know the answer to that	
40	in a data sparse condition if we have insufficient data for river tributaries how much minimum no. of stations discharge data required for modelling any river stretch	Quadtree could be applied for reduced speed of running
41	Just curious, were the IL's and CL's applied variable? say on rainfall depth? I have seen some councils use varying roughness factors based on depth	The initial IL and CL used are the ones based on calibrated hydrological models for the past major events, which are different for each catchment. During an event they can be adjusted relatively quickly by the user based on the comparison of modelled and measured WL at alert stations, which rating curves are available, in URBS

42	<p>How many catchment observers did you need for this project to get a sense of where and when breaches occurred?</p> <p>Also, to date, did any people need to be evacuated based on the results suggested by the forecast extents, and did they actually get flooded?</p>	
43	<p>Thank you all for this great webniar. I understand that the accurate forecasts are difficult due the limit of data and the performance of the models. Continue your good work!</p>	
45	<p>Check out RHDHV's FLASH System</p>	
46	<p>FLASH is a real-time cloud-based Flood Forecasting and Warning System that incorporates state of the art rainfall forecasting with rapid hydro-dynamic (TUFLOW) modelling.</p> <p>The key point of difference with FLASH is that it incorporates the Bureau of Meteorology's Rainfields product suite and enhanced algorithms now incorporated within TUFLOW(Quadtree) to allow near real-time hydraulic modelling.</p>	