TOWNSVILLE STORM SURGE HYPOTHETICAL: TECHNICAL SPECIFICATIONS

Stuart Mead, Mahesh Prakash and Fletcher Woolard
CSIRO Mathematics, Informatics and Statistics,
Private Bag 33, Clayton South, VIC 3168, Australia

1 SUMMARY

This animation simulates Townsville being inundated by a four-metre storm surge created by a tropical cyclone. The storm surge peaks at the same time as the highest astronomical tide (HAT) of 2012 - forecast to peak at 3.89m on 14 December 2012. To put this in perspective, during cyclone Yasi the maximum storm surge recorded was 5.3m at Mission Beach, 2.2m above HAT (3.1m). The animation also assumes that the ground is saturated by heavy rainfall as experienced during a tropical cyclone, causing overland flooding of rivers and creeks in the area, which further increases the volume of water moving through the catchment. Rainfall in Townsville in the days leading up to Cyclone Yasi making landfall on 3 February 2011 was used as the rainfall source for the animation.

This document explains which data used to create the coastal inundation simulation and visualisation. We then explain the underlying assumptions and limitations of the model. There are some aspects that could not be included in the model either due to lack of availability or constraints of this project and these are explained in more detailed further on. In short, these are seepage and ground drainage, erosion and sediment transport, local wind and large scale weather systems.

2 DETAILED TECHNICAL SPECIFICATIONS

2.1 Study Area

The area to be visualised is the Townsville region. The figure below displays the proposed region of approximately 10 km x 18 km. Key large infrastructure within this region includes:

- two sewage treatment plants (circled),
- the Port of Townsville and

• Townsville airport.

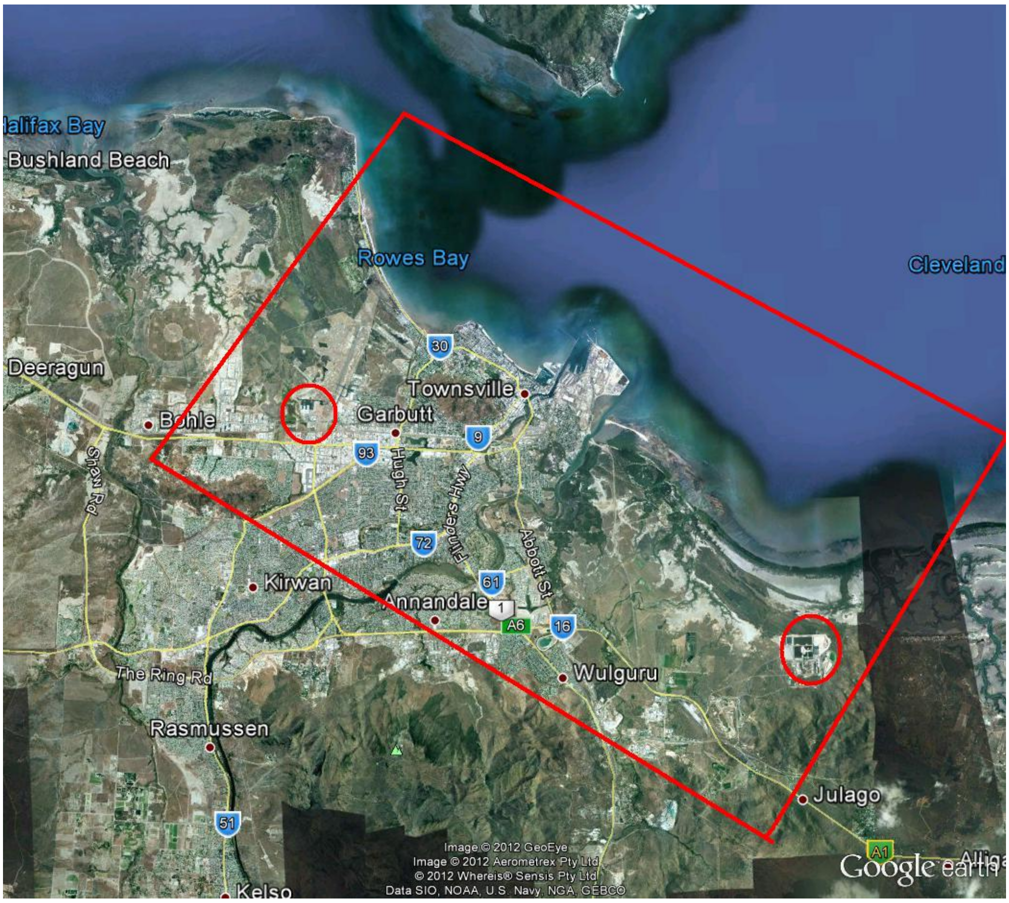

Figure 1: Townsville storm surge hypothetical study area.

2.2 Buildings

Only a small number of 3D models are publicly available for individual buildings (Casino and Holiday Inn), the rest were generated using 3D modelling software. Foreground buildings were generated in this way. Approximately 500 buildings in the CBD area (shaded red in Figure 2) were generated using a 3D model. Background buildings were generated by using a displacement map created using Photoshop (this is shown as the region shaded yellow in Figure 2).

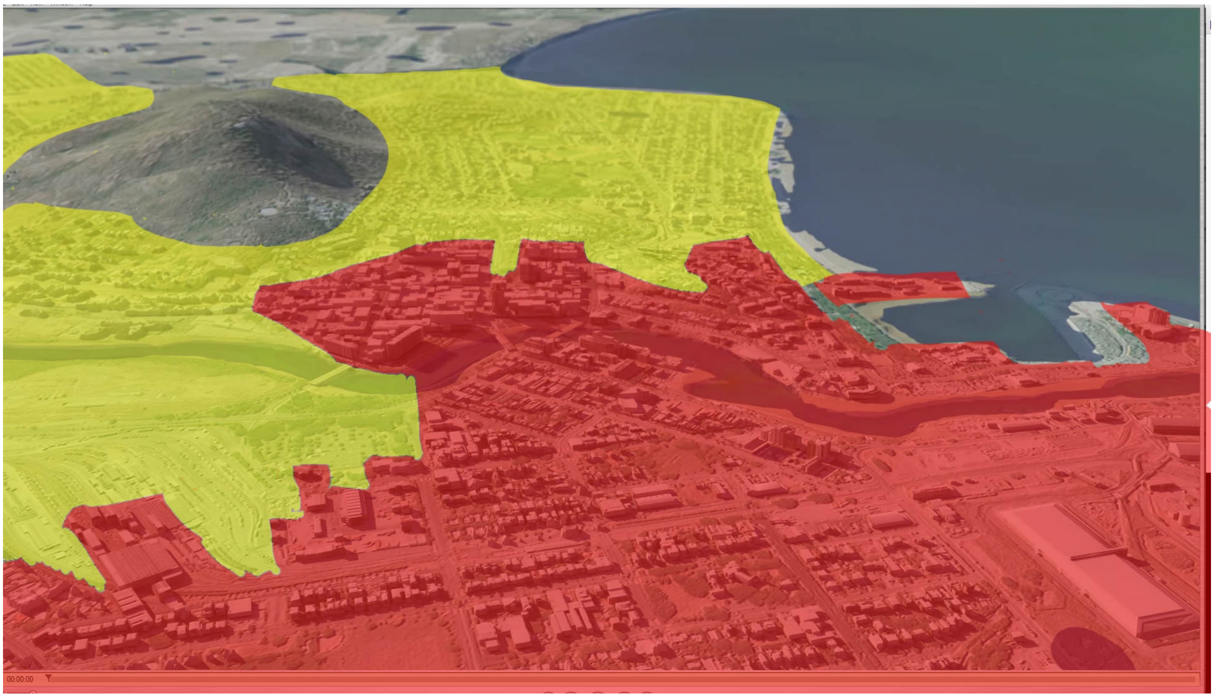

Figure 2: Townsville hypothetical region showing buildings constructed as 3D geometry in the CBD region (shaded red) and as a displacement map (shaded yellow).

2.3 Digital Terrain Model and Bathymetry

- The terrain model is a 1 second resolution (approximately 30m) hydrological digital elevation model (DEM-H), it is v1.1 of the dataset dated 2010-09-2, the data provider is Geoscience Australia.
- The bathymetry is 100m resolution, Version 2 of the GBR100 model dated the 23 June 2011[1].

Both datasets are licensed under Creative Commons-By Attribution licenses. The datasets were modified so that key features of Townsville modified or built after DEM acquisition were included in the model. The datasets were then merged and interpolated to a resolution of 15 m and used as the base for the inundation visualisation model.

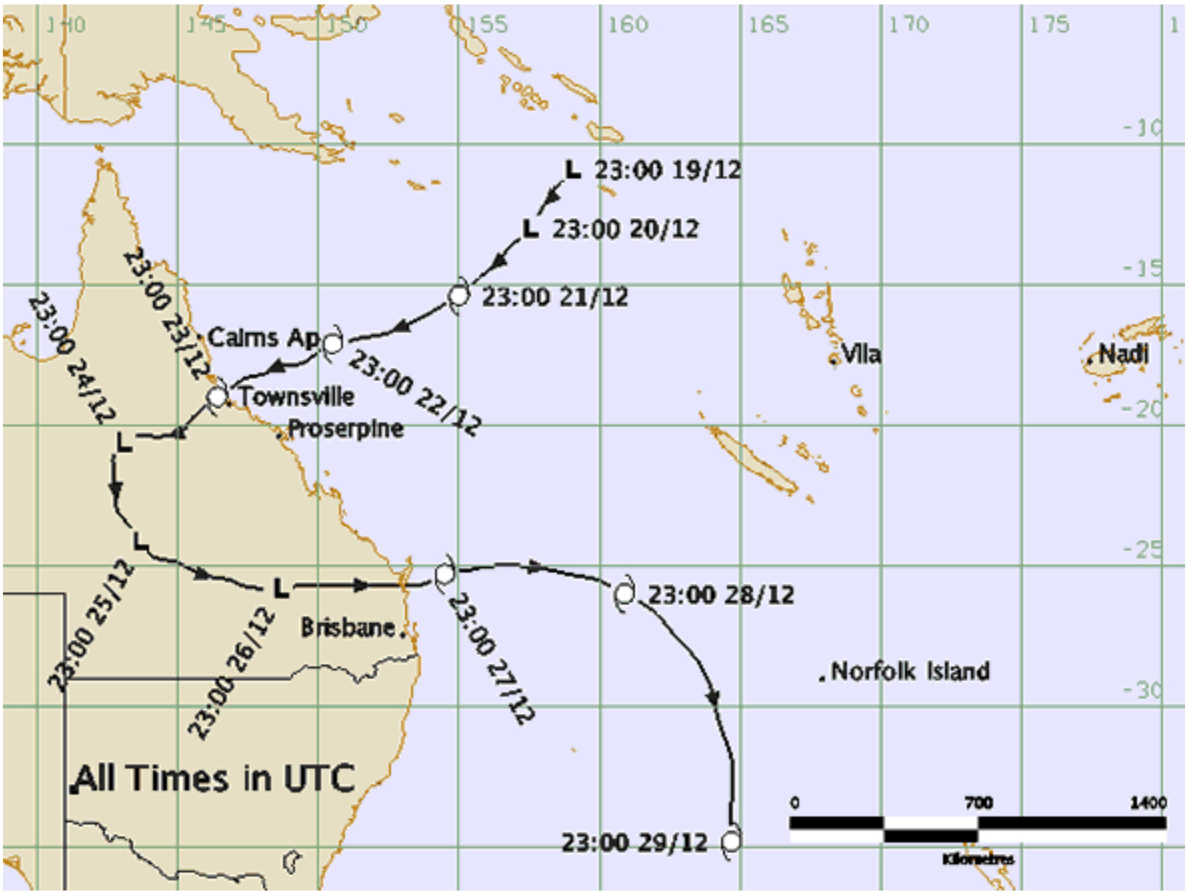

Figure 3: Path of tropical cyclone Althea. Source: BOM, 2012.

2.4 Storm surge, tidal and rainfall

The base tidal pattern was obtained from 2012 tidal tables for Townsville harbour. The highest tide for this year occurs on the 14 December and is forecast to peak at 3.89m[2]. The storm surge was assumed to peak at the same time as the peak on the 14 December. The residual surge pattern was based on Cyclone Althea[3], the path of TC Althea is shown in Figure 3. Rainfall in Townsville during Cyclone Yasi on the 3 February 2011 was used as the rainfall source during the storm surge event. The storm surge wave form shown in Figure 4, which included the tidal motion and storm surge residual, was applied to the eastern boundary shown in Figure 1.

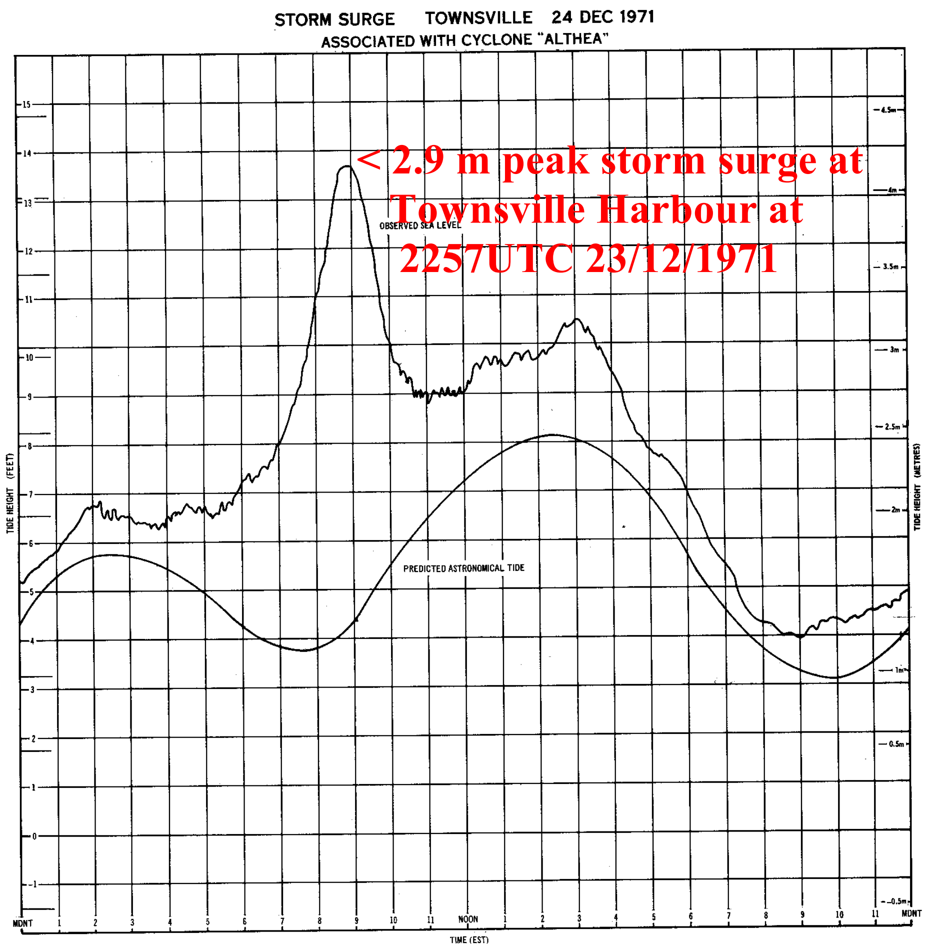

Figure 4: Storm surge wave form used in the simulation.

3. MODEL ASSUMPTIONS AND LIMITATIONS

The inundation simulation method used in this visualisation contains some assumptions and limitations, explained further below:

3.1 Zero seepage and ground drainage.

In this model, seepage of the water into the ground and drainage through storm water networks was not considered. The impact of this on the overall behaviour of the inundation is likely to be minimal, since rain before the storm surge would cause the ground to become almost saturated and the efficiency of storm water drainage systems reduces during a storm surge.

3.2 Erosion and sediment transport is not included

Erosion due to the storm surge and sediment transport is not considered in the inundation model. Sediment transport does not greatly affect flow dynamics and therefore the inundation. However, erosion during the storm surge could cause localised inundation patterns to differ.

3.3 Large scale weather systems not included

Large scale weather systems, such as prevailing currents are not included in the model. At the scale modelled, the inundation is much more sensitive to local conditions than large-scale effects. The storm surge wave direction is perpendicular to the eastern boundary.

3.4 Rainfall intensity is constant

The rainfall intensity during the event is assumed to be constant during the storm surge event. In terms of volume, the rainfall plays a minor role in the inundation event.

3.5 River inflow is based on an 2 year ARI

Inflows from the rivers were set to be similar to a 2 year ARI (i.e. 1 in 2 year) flooding event.

3.6 Local wind is not considered

The inundation model predicts water flow only, and does not consider the effect of the wind on flooding. As a consequence, there are no small scale waves in the model. These waves generally cause more damage and can cause the inundation to be more significant than what is displayed in the visualisation.

3.7 Uniform drag on terrain assumed

A uniform drag was assumed on the terrain whereas this will be variable depending on the local conditions including aspects such as vegetation cover and soil type.

3.8 3D buildings included in simulation and visualisation

The buildings and other man-made infrastructure are included in the simulation and visualisation. All buildings and infrastructure present in the visualisation have been included in the simulation. Since the resolution of the terrain in the simulation is 15 m, any infrastructure that has a size smaller than this scale is represented in two ways:

1. As a block of infrastructure that has a scale greater than 15 m if there are adjacent structures that allow this technique to be employed or
2. As a structure which has its resistance averaged over 15 m if it does not have any adjacent structure(s) surrounding it.

4 GLOSSARY

HAT (Highest Astronomical Tide)	Highest level which can be predicted to occur under average meteorological conditions and any combination of astronomical conditions.
AHD (Australia Height Datum)	Datum adopted by the National Mapping Council as the datum to which all vertical control for land based mapping is to be referred.

5 REFERENCES

1. Beaman, R.J., 2010. Project 3DGBR: A high-resolution depth model for the Great Barrier Reef and Coral Sea. Marine and Tropical Sciences Research Facility (MTSRF) Project 2.5i.1a Final Report, MTSRF, Cairns, Australia, pp. 13 plus Appendix 1. (http://www.deepreef.org/publications/reports/67-3dgbr-final-report.html)

2. Townsville Tide Guide http://www.msq.qld.gov.au/~/media/02e09ccd-1116-4226-95bf-ea1a3cbf3b1c/tide_table_townsville_12.pdf

3. http://www.bom.gov.au/cyclone/history/althea.shtml