INFORMATION SHEET

Busselton storm surge and inundation modelling

What causes a storm surge?

A storm surge is a storm-induced rise above tidal sea level. Storm surge is caused by strong onshore winds and reduced atmospheric pressure related to low pressure weather systems, such as tropical cyclones or winter storms.

This build-up of water can be more than 100 kilometres wide and may surge up to five metres above normal sea level. Storm surges can exceed five metres in exceptional circumstances, such as during a category 5 cyclone, and is exacerbated if the storm coincides with a high tide (Figure 1). These elevated sea levels may last for several hours to over 24 hours, depending on the storm behaviour.

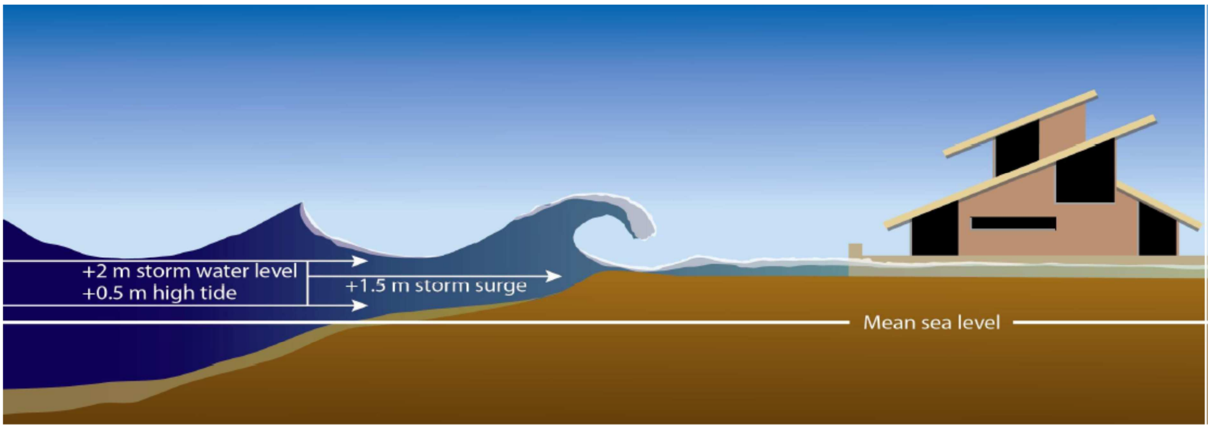

Figure 1: A storm surge results in water levels on the coast being higher than normal, leading to inundation and destruction of buildings and infrastructure

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Rising sea levels caused by climate change pose a risk for many low lying countries around the world and for some coastal communities in Australia.

The risk of coastal inundation is increased under sea level rise and storm surge conditions because sea water levels rise higher than normal on the coast.

Some of the Western Australian coastline is particularly vulnerable to the impacts of storm surges because it is low-lying and because the urban environment is in close proximity to the coast.

To improve our understanding of the present and future vulnerability of the south west coast, the Department of Planning and the Western Australian Planning Commission engaged Geoscience Australia to undertake storm surge and inundation modelling for Busselton.

Methodology

For this project, Geoscience Australia integrated outputs from two existing models to simulate the combined effects of regional-scale storm surge and riverine flooding. The two models used were GCOM2D (for storm modelling) and ANUGA (for coastal inundation).

The storm modelling was based on Tropical Cyclone Alby, which occurred on 4 April 1978 and was one of the most intense cyclones experienced in the area on record.

In order to investigate the worst case impact of Tropical Cyclone Alby, its track was shifted in space and time so that the cyclone's maximum wind speeds directly impacted Busselton and coincided with a spring tide of 1.5 metres, thereby increasing the rarity of the event (Figure 2).

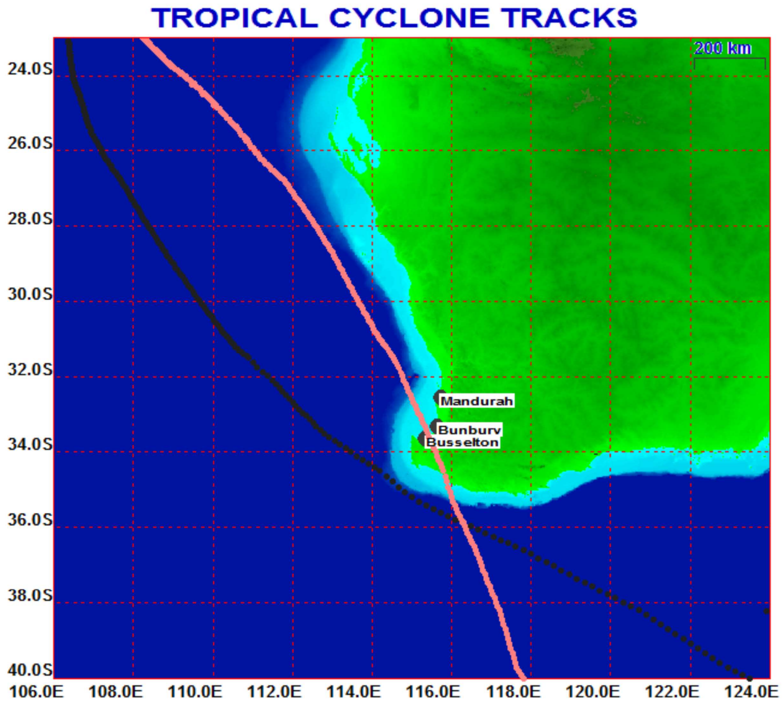

Figure 2: The route of Tropical Cyclone Alby was shifted from the actual track (black line) to the 'worst case track' (pink line) for verification and prediction purposes (Hubbert et al., 2012).

Table 1 shows the sea level and river flooding scenarios that were modelled. The modelling was undertaken to identify the potential inundation arising from a hypothetical worst case track of a storm similar to Tropical Cyclone Alby, under four different sea level rise scenarios – current sea level, 0.4 metre sea level rise, 0.9 metre sea level rise and 1.1 metre sea level rise.

Table 1: Storm surge and flood modelling scenarios

ID	SCENARIO DESCRIPTION	SEA LEVEL	RIVER FLOOD
B0	Base Case (TC Alby)	Current	None
B1	Worst Case (TC Alby, track and time shift)	Current	None
B2	Worst Case + sea level rise (SLR)	+ 0.4 m	None
B3	" "	+ 0.9 m	None
B4	" "	+ 1.1 m	None
B5	Worst Case + Coincident Flooding	Current	25 year ARI[1]
B6	" "	Current	100 year ARI
B7	Worst Case + Coincident Flooding + SLR	+ 0.9 m	25 year ARI
B8	" " "	+ 0.4 m	100 year ARI
B9	" " "	+ 0.9 m	100 year ARI
B10	" " "	+ 1.1 m	100 year ARI

Results

The results of this study provide an understanding of the potential impacts of coincident cyclonic storm surge and riverine flooding events on the region.

Figure 3 shows the potential ocean inundation arising from a hypothetical worst case track of a storm similar to Tropical Cyclone Alby under four different sea level rise scenarios – current sea level, 0.4 metre sea level rise, 0.9 metre sea level rise and 1.1 metre sea level rise.

[1] Average Recurrence Interval

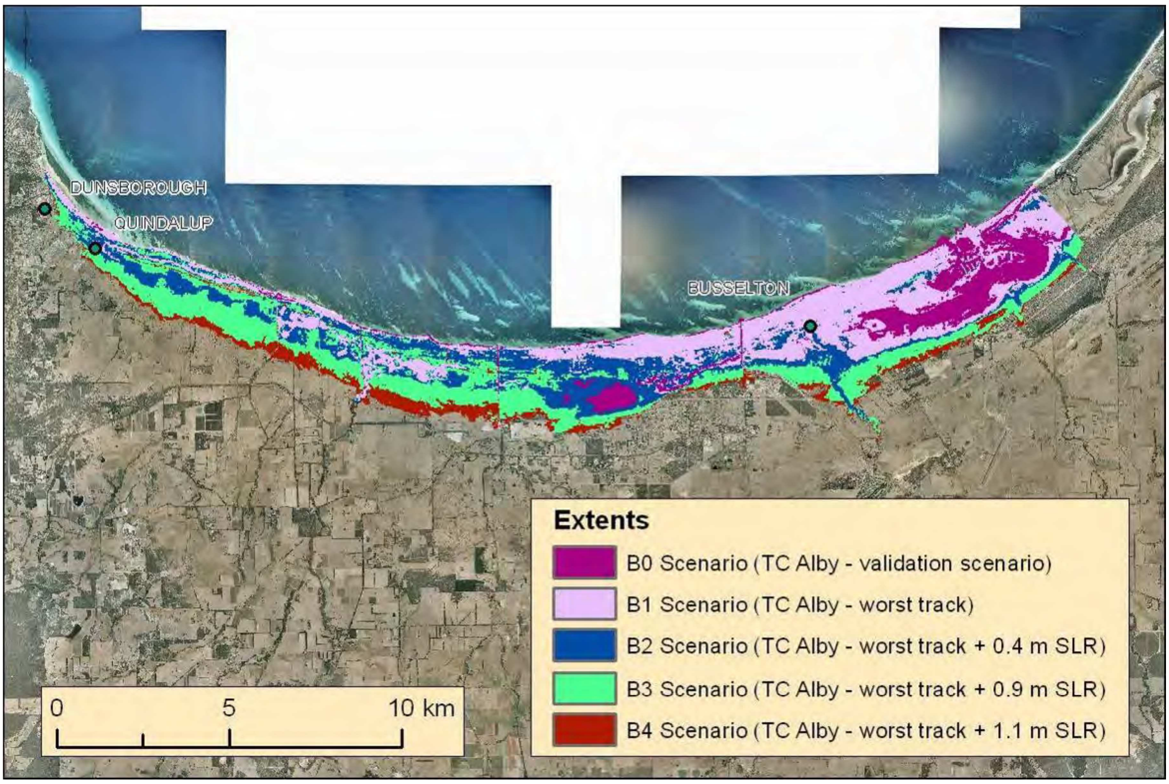

Figure 3: Ocean inundation extents for validation (B0), Tropical Cyclone Alby worst track (B1) and sea level rise scenarios (B2-B4)

Figure 3 shows that increasing the sea level increased the inundation extent.

Figure 4 shows the potential inundation from a hypothetical worst case track of a storm similar to Tropical Cyclone Alby, with coincident flood events (25 and 100 year ARI).

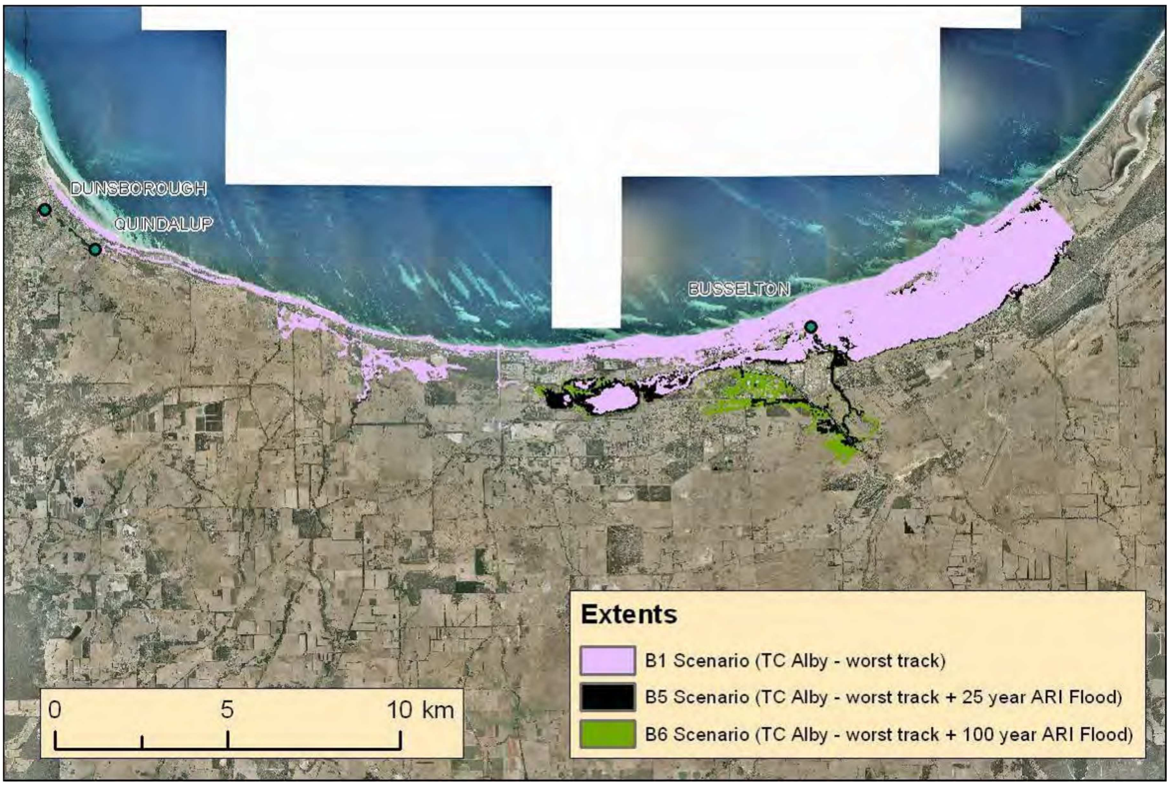

Figure 4: Riverine inundation extents for worst track Tropical Cyclone Alby (B1) and flooding 25 year ARI (B5) and 100 year ARI (B6)

Figure 4 shows that riverine flooding had little impact on the extent of inundation, compared to the storm surge associated with the worst case Tropical Cyclone Alby.

The key observations of the modelling were:

- The greatest difference in storm surge and inundation was observed when the track of Tropical Cyclone Alby was changed to produce the worst case scenario (B1).
- After that, the worst case plus 0.9 metre sea level rise (B3) caused the next most significant increase in the inundation extent, with large areas of Dunsborough now being inundated.
- In general, increasing the sea level increased the inundation extent. Areas that were already inundated under scenarios with lower sea levels may experience higher water velocities with further sea level. An example of this is the Busselton Jetty area. In this way, further sea level rise can increase the destructive potential of storms.
- The effects of coincident riverine flood were largely confined to an increase in the water levels within the estuaries. However, additional inundation occurs when the Vasse Diversion Drain spills out. In the event of coincident storm surge, sea level rise and riverine flooding, the effect of the riverine flooding will be reduced if the Vasse Diversion Drain can be prevented from spilling out above the Busselton Bypass.
- The general practice of maintaining the Vasse estuary level at 0.4 metres Australian Height Datum is very important. The impact of an event similar to Tropical Cyclone Alby on Busselton when the estuary levels are significantly higher than 0.4 metres would be far more severe than the sea level rise scenarios presented in this report.

Modelling limitations

Due to the nature of the modelling process and the data and information underpinning this project, a number of qualifications must be placed on all the results produced.

It should be noted that while the modelling uses the best available data, bare earth elevation was used in this study. The model does not include surface structures such as buildings, earthworks or vegetation, or protection structures, which may interact with waves and inundation flow.

At the completion of the study, Geoscience Australia recommended:

- that the results are to be used as an indicative guide only; and
- decisions should not be made solely based on this information.

In addition:

- the study is not suited to inform day to day planning determinations;
- the model used was the best available at the time of modelling;
- the results do not necessarily represent all possible scenarios in which a storm may occur – Tropical Cyclone Alby is the worst tropical cyclone on record impacting south west Western Australia and the track change modelled increased the possible inundation extents. However there could be probable storm scenarios that are unmatched in the available historical record and that have a worse impact than that modelled in this study; and
- further work is needed to increase the level of accuracy at which these scenarios represent a real event, such as calibrating the model outputs against a more recent storm event.