Storm Surge: Know your risk in Queensland!

Storm surge is a rise in sea level above the normal tide usually associated with a low pressure weather system such as a tropical cyclone. Storm surge develops due to strong winds pushing water towards the coastline as well as the low atmospheric pressure drawing up the sea surface.

The Queensland coastline is highly vulnerable to storm surge. This is due to the frequency of tropical cyclones, the wide continental shelf and relatively shallow ocean floor in both the Great Barrier Reef lagoon and in the Gulf of Carpentaria, as well as the low lying nature of many coastal cities and towns.

While the highest storm surges are more likely to occur in North Queensland and the Gulf of Carpentaria, they can also develop in southeast Queensland affecting the Sunshine Coast, Moreton Bay and the Gold Coast. Storm surges may reach magnitudes of 1 to 10 metres above the tide depending on the intensity of the cyclone, its size and the local characteristics of the coastline.

Impacts

Storm surge can be very dangerous and poses a critical risk to human life during tropical cyclones.

The length of coastline affected by a storm surge can be tens to hundreds of kilometres wide. The rise in sea level can be rapid and high in velocity, inundating the ground floor of buildings, even up to the roof.

Storm surge has the power to easily move cars, even houses, can damage roads and buildings and can be almost impossible to manoeuvre through. Additionally, the storm surge can carry dangerous debris, which can cause structural damage to buildings and pose a high risk to life.

This information booklet was prepared by Griffith Centre for Coastal Management to educate Queensland’s coastal communities about storm surge.
Total Water Level
The total water level experienced on land during a cyclone is made up of contributions from the storm surge, tide, freshwater flooding and wave run-up.

Total Water Level = Storm Surge + Tide + Freshwater Flooding + Wave Run-up

What is a storm tide?
Storm tide is the water level resulting from the combination of the storm surge with the astronomical tide, and is referred to a vertical datum such as Lowest Astronomical Tide, Highest Astronomical Tide or Australian Height Datum, AHD (equivalent to Mean Sea Level at major ports).

Flooding
Storm surge can travel many kilometres inland and rising waters may come from estuarine waterways as well as the open coast. Low lying areas surrounding estuaries are vulnerable to the combination of storm surge and upstream flooding from heavy rainfall. Properties on the beachfront are also at risk from sea water inundation due to storm surge as well as wind–induced waves.

Storm Tides
The impact of a storm surge is highly dependent on the phase of the tide and the surge will have greater impact if it arrives during a high tide. This may result in extremely high water levels. When forecasting the cyclone, the timing of cyclone landfall is uncertain, making it difficult to predict an exact water level. The peak of the storm surge may occur prior to or after the cyclone making landfall. It can also occur without the cyclone crossing the coast.

Waves
Storm surge is usually accompanied by extreme ocean waves created by hazardous winds during the cyclone event. These add to the total water level through wave run-up.

Wave run-up is the maximum height of the waves rushing up on the beach. This is due to both wave set-up as well as the swash of broken waves on the shoreline.

Wave set-up is the elevation of sea level above the storm tide level as a result of water piling up against the shoreline due to the momentum of the breaking waves.

These conditions can lead to beach erosion and add further impact to beach front properties.
Tropical Cyclones

A tropical cyclone is a violent storm characterised by a calm low pressure eye surrounded by strong winds rotating clockwise in the Southern Hemisphere. They form over tropical waters of temperatures greater than 26.5°C and can persist over oceans with lower temperatures, although the energy tends to dissipate over cooler waters and land. A cyclone’s intensity is categorised based on the severity of its wind (see below).

Forecasting

Every cyclone is unique in its behaviour resulting in a high level of uncertainty when it comes to forecasting where and when they will cross the coast. A cyclone can travel for hundreds of kilometres, may move erratically, even making sharp turns or loops, and change intensity rapidly. In Queensland, a cyclone may form in the Coral Sea and cross Cape York into the Gulf of Carpentaria or vice versa, and can track parallel to the coastline either north or south.

The Australian cyclone season extends from November through to April with an average of 10 cyclones per year, although not all make landfall.

Tropical Cyclone Categories

<table>
<thead>
<tr>
<th>Cyclone Category</th>
<th>Sustained Wind Speeds (km/hr)</th>
<th>Wind Gusts (km/hr)</th>
<th>Typical Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tropical cyclone</td>
<td>62-88</td>
<td>90-125</td>
<td>Negligible house damage; damage to crops, trees and caravans.</td>
</tr>
<tr>
<td>2. Tropical cyclone</td>
<td>89-117</td>
<td>125-164</td>
<td>Minor house damage; significant damage to crops, trees and signs.</td>
</tr>
<tr>
<td>3. Severe tropical cyclone</td>
<td>118+</td>
<td>165-224</td>
<td>Roof and structural damage; power failure likely</td>
</tr>
<tr>
<td>4. Severe tropical cyclone</td>
<td>118+</td>
<td>225-279</td>
<td>Significant roof loss and structural damage; widespread power failure; dangerous airborne debris</td>
</tr>
<tr>
<td>5. Severe tropical cyclone</td>
<td>118+</td>
<td>280+</td>
<td>Extremely dangerous with widespread destruction</td>
</tr>
</tbody>
</table>

Source: www.bom.gov.au/cyclone/about/intensity

Most severe cyclones in Queensland

1. Tropical Cyclone Monica (2006) was the highest intensity cyclone on record to impact the east coast of Australia, making landfall as a Category 5 system close to Lockhart River in Far North Queensland. The storm surge magnitude for this event is unknown given the remote nature of the impact area.

2. Tropical Cyclone ‘Mahina’, occurring in 1899, caused the largest death toll of any natural disaster in Australian history. Over 400 people were killed on shipwrecks in Bathurst Bay in Far North Queensland due to extreme waves and storm surge.

Nott et al., 2013 The world record storm surge and the most intense southern hemisphere tropical cyclone – new evidence and modelling. Bulletin of the American Meteorological Society.
Tropical Cyclone Yasi

In 2011, Severe Tropical Cyclone Yasi made landfall over South Mission Beach as a marginal Category 5 system with maximum wind gusts of 285 km/hr. It produced a storm surge peaking at 5.3 m at the town of Cardwell. TC Yasi made landfall at close to low tide, and the storm tide was 4.5 m relative to mean sea level (AHD). If TC Yasi crossed the coast at high tide, the storm tide could have reached over 7 m AHD.

TC Yasi was a large cyclone and storm surge over 1 m affected the Queensland coast from Port Douglas to Bowen. Waves over 9 m high were recorded in Townsville. In the towns of Tully Heads, Hull Heads, Cardwell and Port Hinchinbrook, houses were inundated and in some cases completely destroyed or washed away. Robust evacuation strategies meant that no fatalities occurred.

Tropical Cyclone Oswald

Tropical Cyclone Oswald developed in the Gulf of Carpentaria in January 2013 and tracked as an ex-tropical cyclone down much of the east coast of Queensland. This brought gale force winds, high swell, intense rainfall and some storm surge. The persistent northerly wind direction caused storm surge of over 1 m in southern Moreton Bay. While the storm surge alone did not cause appreciable flooding on the open coast, when combined with flooded estuaries and high waves, it contributed to inundation in small urban catchments and significant beach erosion along the Sunshine Coast and Gold Coast beaches.

Recent Storm Surge Events in Queensland

For more information

Bureau of Meteorology
www.bom.gov.au/cyclone/about

Queensland Fire and Emergency Services

Department of Environment and Heritage Protection

See your local Government website for local details regarding storm surge.