

Coastal impacts of the June 2016 East Coast storm for Sydney

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The east coast storm event of 4 – 5th June affected the entire eastern seaboard region producing heavy rain, strong winds and powerful surf. In particular, the coastal zone was impacted by an uncommon combination of large wave heights and very long period, north-easterly swell waves, strong onshore winds and some of the highest tides of the year. This resulted in significant beach erosion, overtopping and some structural damage at the extreme southern ends of beaches.

The Black Nor'easter

The primary weather system that developed in the northern Tasman Sea was a result of a strong Anticyclonic Intensification (AI), producing a steep pressure gradient and strong wind field that ran the length of the east coast (Figure 1 a).

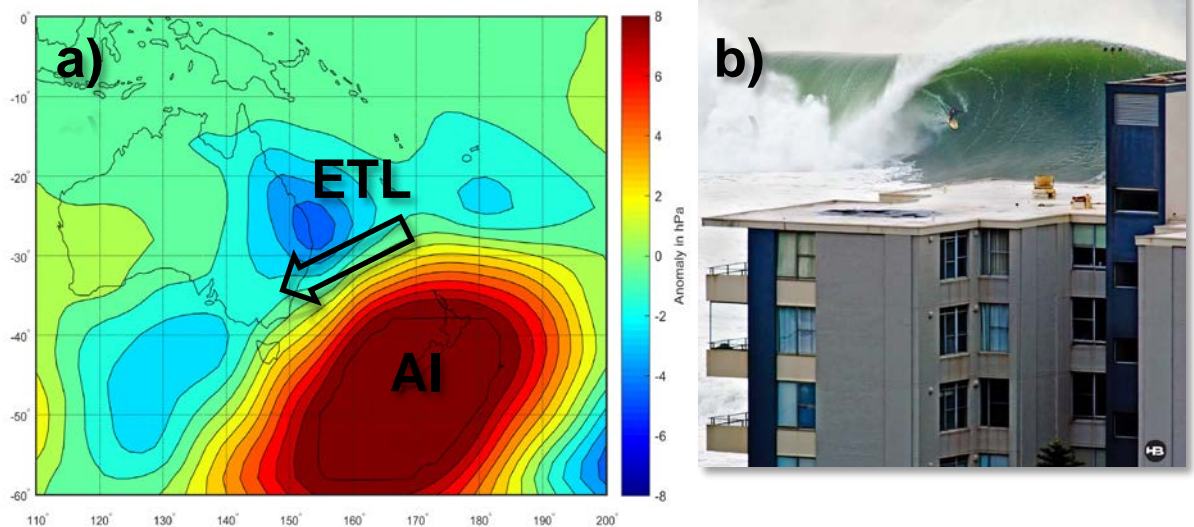


Figure 1 a) the composite sea level pressure pattern for all east-northeast anticyclone intensification events over the past 30 years, with approximate wave direction and, b) the resulting inshore wave conditions on the Northern Beaches (photo: Mark Onorati).

An Easterly Trough Low (ETL) developed between the anticyclone (high pressure system over New Zealand) and tracked south parallel to the coast. Numerous low pressure cells were spun out of the ETL along the length of the coast. Historically, this type of pattern is referred to as a 'Black Nor'easter' and was first described during the 1800s. Recent research suggests that this type of event was much more frequent during the 1600 and 1700s (Goodwin and Browning, *in prep*).

Unusual wave conditions

While offshore wave heights gradually increased as they travelled south down the coast, they were largely unremarkable, ranging from around 4.5 m at Byron Bay to 8.4 m at Eden (buoy-observed significant hourly wave heights, H_{sig}).

However, the very long periods (over 13 s for three consecutive days) and north-easterly direction of the waves are highly unusual (occurring less than 1% of the time over the past 30 years), and caused higher-than-normal wave power along the NSW shelf and coast. This ultimately led to very energetic inshore wave conditions focused on the southern ends of exposed beaches (Figure 1 b) and large quantities of sand movement.

Erosion in the wrong places

In general, the long wave period of this storm caused waves to shoal and break far offshore. This limited beach erosion impacts. Also, prior to this event an extended period of calm, fine weather ensured beaches across NSW were in good condition which provided a buffer to storm impacts.

The north-easterly direction of the storm, coupled with a storm surge and anomalous high tides on Sunday evening (5th June), caused erosion and overtopping of primarily north-east facing beaches. This was compounded by a second high tide and powerful surf on Monday morning. The south end of Collaroy-Narrabeen on Sydney's Northern Beaches was particularly affected (Figure 2).



Figure 2 (clockwise from left) severe structural damage to the Collaroy Beach Club; beach lowering at South Narrabeen (sewage pipe is usually buried under beach); cliff failure and car park damage at Fisherman's Beach.

The vulnerability of Collaroy-Narrabeen is as much a result of construction of the built environment on the active beach and foredune. The beach is an erosion hotspot because of inappropriate development, rather than a natural sand supply problem. Our previous surveying efforts have shown that the 200 year ARI erosion line at Collaroy to be ~60 m landward, close to the current Pittwater Road alignment (Goodwin et al., 2015).

The good news

Although not much consolation to those who lost property, the sand hasn't moved far away. The numerous rock reefs along Sydney's coast act as sub-aqueous barriers to sand loss - meaning each embayment (i.e. the beach sitting between two headlands) is effectively 'closed', and sand can only move on- or off-shore.

Since the destruction on Sunday night, wave conditions are now more favourable and the recovery process has already begun.

Full storm recovery, however, takes months. The danger to places like Collaroy is that a similar event comes along before recovery can take place. The temporal ‘clustering’ of storm events (i.e. one storm hitting shortly after another) can further lengthen beach recovery times.

A sign of things to come?

The occurrence of one storm does not indicate a trend – these type of events are still relatively rare. Recent research (Goodwin *et al.*, in press) suggests, though, that this hybrid ETL/AI storm type may become a more frequent feature along the NSW coast in the future.

One of the most robust signatures of global warming is a poleward expansion of the tropics (Lucas *et al.*, 2014), which is most pronounced during the equinoxes – a period of high storm genesis and very high tides. Goodwin *et al.*, (in press) suggest that tropical-origin storms will track further south with an expanding tropics, in place of extra-tropical storms.

References

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