

Extraordinary sequence of severe weather events in the late-nineteenth century

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Abstract. Between 1883 and 1898, 24 intense tropical cyclones and extra tropical cyclones directly impacted on the southern Queensland and northern New South Wales coasts, with at least 200 fatalities in what was then a sparsely populated area. These events also caused record floods and rainfall, for example Brisbane City experienced its two largest ever floods over this period and Brisbane City set a 24-h rainfall record that still stands today. Additionally, a 24-h rainfall total of 907 mm occurred in a tributary of the upper Brisbane River resulting in a 15-m wall of water advancing down the river. Recent studies have shown that this part of Australia incurs the largest weather-related insurance losses. A major focus in this study is the seas these storms generated, leading to the loss of many marine craft and changes these waves brought to coastal areas. As a famous example of coastal erosion near Brisbane, the continual impacts from large waves caused a channel to form through Stradbroke Island to the open ocean forming two separate islands. Details of how this channel formed are described in relation to the storms. A climatology study of 239 Australian east coast storms that caused severe ocean damage between Brisbane and the Victorian border over the period between 1876 and February 2020 showed that 153 events occurred with a positive Southern Oscillation Index (SOI) trend and 86 events with a negative trend. The most active years were 1893 and 1967, both during positive SOI periods and both dominated by tropical cyclone activity. The 1893 events caused unparalleled floods and strongly contributed to the Jumpinpin breakthrough on Stradbroke Island, and the 1967 event was associated with historical Gold Coast beach erosion causing 9 billion normalised Australian dollars of insurance losses. The study also showed how direct tropical cyclone impacts in the study area decreased markedly following the June 1976 climate shift.

Keywords: coastal erosion, floods, late-nineteenth century, record rainfall, severe weather, southern oscillation, storm surge, tropical cyclones.

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1 Introduction

Despite the lack of a severe impact in Southeast Queensland (SEQ) or northeast New South Wales (NSW) from a tropical cyclone (TC) in recent decades, [McAneney *et al.* \(2019\)](#) showed that this region is subject to some of the worst insurance losses from TCs and related systems in the Australian region. For example, their study of normalised insurance losses for 1966–2017 showed that TC Dinah in January 1967 came in third with 4685 million normalised Australian dollars (AU\$), TC Wanda in January 1974 fifth with AU\$3160 million, the Brisbane hail storm of 18 January 1985 was seventh with AU\$2274 million and a tropical low which crossed the coast in January 2011 came in eighth with AU\$2260 million with a brief resumption of sustained activity. These four systems mainly impacted SEQ, and TC Dinah never actually made landfall on the mainland but came close, crossing Fraser Island where a central pressure of 944.8 hPa was read. This region's population grew dramatically from 1977 onwards as the above study shows. Some of the worst impacts in this region occurred during the latter part of the nineteenth century. Most of this region was only sparsely populated in the

nineteenth century and if such a sequence of events occurred today the results would be catastrophic.

The Bureau of Meteorology's TC data base begins in 1908. Earlier TCs have been described in [Brunt \(1958\)](#); [Callaghan and Helman \(2008\)](#); [Callaghan and Power \(2014, 2011\)](#); [Hunt \(1914\)](#); [Visher and Hodge \(1925\)](#) and [Watt \(1940\)](#). An unusually aggressive and destructive series of weather systems impacted on Australia's subtropical east coast between 1883 and 1898. Two of the biggest floods in Brisbane's history, 8.35 m on 5 February 1893 and 8.09 m on 19 February 1893, occurred during this period. The largest recorded flood in Brisbane was 8.43 m on 14 January 1841. However, there was a bar at the mouth of the Brisbane River in 1841 which is thought to have added 0.4 m to the flood and the Brisbane City Council has reduced the 1841 flood level to 8.03 m, making the two 1893 floods the biggest in recorded history. Other major floods occurred in Brisbane during January 1887, July 1889, March 1890 and June 1893. Six major floods struck Brisbane in seven years. Here we examine the meteorology of these floods, particularly in 1893 when six severe weather events produced three major floods, one moderate flood

Table 1. Brisbane City flood heights from Bureau of Meteorology, major flood is 3.5 m ??, unknown

Year	Date	Time AEST	Height (m)
1841	14 January 1841	??	8.43
1943	9 June 1843	??	2.76
1844	10 January 1844	??	7.03
1852	16 April 1852	??	2.91
1857	19 May 1857	??	3.27
1863	16 February 1863	??	3.32
1864	20 March 1864	??	3.78
1867	21 April 1867	??	2.46
1870	10 March 1870	??	2.89
1873	18 June 1873	??	2.69
1875	01 March 1875	??	2.61
1879	16 August 1879	??	2.46
1887	23 January 1887	??	3.78
1889	20 July 1889	??	3.75
1890	13 March 1890	??	5.33
1893	5 February 1893	1900	8.35
1893	12 February 1893	??	2.15
1893	19 February 1893	1000	8.09
1893	12 June 1893	1000	3.63
1896	14 February 1896	0000	2.00
1896	29 February 1896	0810	1.85
1898	13 January 1898	0130	5.02
1898	9 March 1898	1700	3.27
1908	16 March 1908	2330	3.69
1927	28 January 1927	0600	1.70
1928	22 February 1928	1105	1.67
1928	21 April 1928	2330	2.14
1929	22 January 1929	0930	1.85
1929	24 January 1929	0930	1.85
1929	21 April 1929	1100	2.10
1931	7 February 1931	1430	3.32
1955	30 March 1955	0300	2.36
1956	13 January 1956	1045	1.75
1956	15 January 1956	1142	1.75
1956	11 February 1956	1000	1.39
1956	12 February 1956	1030	1.31

and one heavy rainfall event. Another major flood struck Brisbane on 13 January 1898 – to put this into perspective, only one major Brisbane flood event occurred after this until the 1950s when large dams became operational. Table 1 shows the Brisbane City flood heights for 1841–1956.

Brisbane City recorded 465.1 mm in the 24 h ending 2300UTC 21 January 1887, which still stands as a 24-h rainfall record 132 years later. Crohamhurst (26.8°S, 152.9°E, 200.0 m elevation) recorded 907.0 mm in the 24 h to 2300UTC 2 January 1893 (Newman 1958). This was an Australian record until Bellenden Ker (40 km SSE of Cairns, elevation 1545.0 m) recorded 1947.0 mm in the 48 h to 2300UTC 4 January 1979 during TC Peter.

Floods from these 19th century storms claimed many lives and the large seas generated by their violent winds wrecked many ships, claiming many more lives, with combined totals possibly reaching as much as 200 over the period. The Supplementary



Fig. 1. Location map showing Stradbroke Islands.

Material accompanying Callaghan and Power (2014) also contains reports of severe wave and storm surge damage, and a list derived from this data for 1816–2020 is provided in Appendix 1.

Here we look at the effect of these seas on the coastal environment, and as a measure we monitor the effect on Stradbroke Island where a channel was cut by huge seas from the ocean at a place called Jumpinpin to the sheltered waters south of Moreton Bay. Brisbane lies on the western shores of Moreton Bay (Fig. 1). According to McCauley and Tomlinson (2006), Jumpinpin opened sometime late in the 19th century, breaching over a narrow section of the then Isle of Stradbroke. The exact date of breaching is unknown due to the isolation of the site. Since its formation, the inlet and nearby coastline have been highly dynamic, undergoing rapid and significant changes. The channel formed two islands, North Stradbroke Island, 38 km long and up to 11 km wide, the second largest sand island in the world and the smaller South Stradbroke Island 21 km by 2.5 km. The effect of storm surges and wave action is monitored primarily from reports at Southport which is 73 km south southeast of Brisbane and 27 km south of Jumpinpin and the Moreton Bay suburb of Sandgate which is 16 km north northeast from Brisbane and 60 km north northwest of Jumpinpin. Sandgate is sheltered from the ocean waves by North Stradbroke Island and Moreton Island. Southport in the late-nineteenth century was located on a lagoon (Broadwater) around 800-m wide with ocean waves breaking on its eastern edge. Wave action at Southport then was from reformed ocean waves moving westward across the lagoon or Broadwater.

A spit began to extend northwards east of Southport after these 19th century storms and today extends northward to South Stradbroke Island, being 200–400 m wide and 5–10 m in elevation. The average linear growth of the spit from 1910 to 1968 was 61 m per year or 6 km/century (Delft Hydraulics 1970). The supply of sand for this spit can be explained by ocean currents. The East Australian Current is a western boundary current that moves down the east coast of Australia, transporting warm water from the Coral Sea southwards. The meandering current pinches off eddies and the current speeds at the edge of these eddies can be up to 4 knots. Inshore there is a current in a northward direction, which is largely generated by wave action. This was found from the Delft Hydraulics (1970) report in their investigation into the disastrous beach erosion on the Gold Coast in 1967. In 1967, five TCs beginning with severe TC Dinah (Category 4) and then three June East Coast Lows (ECLs) produced unprecedented erosion on the Gold Coast (McCauley and Tomlinson 2006). The results from the Delft Hydraulics (1970) report showed that the littoral transport was mainly directed northwards, and this transport extended seawards out to about 900 m from the shore. South of the Tweed River, near the Gold Coast southern border, the net northward transport was calculated as 500 000 m³ per year, which is of the same order as the sediment supply of the nearest NSW rivers. To gain some idea of the power of ocean waves and storm surge, the 1967 storms removed 8 million m³ of sand from Gold Coast beaches. These storms incurred a total normalised insurance loss of more than AU\$9 billion (McAneney *et al.* 2019).

The paper is organised as follows. Section 2 records the data sources. Section 3 describes the 1893 events as well as all the Brisbane City floods and provides details of the meteorology involved. The effect of weather systems on the coastal areas of Stradbroke Island is examined in Section 4, followed in Section 5 by descriptions of weather systems additional to those in Section 3 which caused ocean damage to the east coast of Stradbroke Island. A climatology of weather systems causing ocean damage along the east coast south from Brisbane is introduced in Section 6 and further severe weather systems occurring between 1853 and 1898 over SEQ without major ocean damage follow in Section 7. A conclusion is reached in Section 8.

2 Data

Impacts and details of the weather systems were obtained from Callaghan and Helman (2008) and Callaghan and Power (2014, 2011). Weather observations and impacts were extracted from newspaper archives of the National Library of Australia (<https://trove.nla.gov.au/newspaper/>) to augment these reports. Mean sea level weather charts were also constructed manually (using nearly 50 years of experience in such an activity) from data held in the Australian National Archives before that organisation unfortunately removed weather data from their records in the 1990s. The Sir Charles Todd's weather folio from the late-nineteenth century was extremely useful for constructing weather charts for the late-nineteenth century period (http://www.charlestodd.net/Todd_Folios/). The US 20th Century Reanalyses (https://psl.noaa.gov/data/gridded/data.20thC_ReanV2.html) often showed reasonable agreement with these charts and helped with the construction of charts. Support for the Twentieth Century Reanalysis Project

dataset is provided by the U.S. Department of Energy, Office of Science Innovative and Novel Computational Impact on Theory and Experiment (DOE INCITE) program and Office of Biological and Environmental Research (BER), by the National Oceanic and Atmospheric Administration (NOAA) Climate Program Office, by the National Oceanic and Atmospheric Administration Climate Program Office, and by the NOAA Earth System Research Laboratory Physical Sciences Division. Early storm surge data for the Brisbane Roadstead was obtained from Gourlay (1981) and this was also augmented from newspaper reports. Rainfall and flooding data were obtained from Bureau of Meteorology archives and online data.

The initial impetus for this study came from Hunt (1914), in which nineteenth-century TCs and flood events along the east coast were listed. It is evident from the text in this study that it involved an enormous search through the headlines of the archived newspaper headlines. Due to limited resources, understandably, the full text of the articles was not recorded in detail and resulted in some errors. For example, some severe thunderstorms were identified as TCs and in some cases two TCs were identified when it was the one event. A later stimulus came from Blain, Bremner and Williams Pty Ltd (1985). In a massive undertaking, they researched Australian east coast ocean wave effects using Bureau of Meteorological charts at the Sydney office dating back to 1880 to determine fetch lengths and wind speeds of force 8 or greater (Beaufort Scale). The interesting events were then compared with impacts from newspaper archives. This work was built on by Callaghan and Helman (2008) using Bureau of Meteorology and shipwreck data. Archived newspapers initially helped in this latter study; however, with the National Library of Australia introducing an online service for these newspaper archives the study became infinitely more efficient for the study of Callaghan and Power (2014). This latter work studied severe weather impacts in coastal areas between Brisbane and Eden since 1860 and included a supplementary list of all impacts along the coast between Brisbane and the Victorian border from floods, intense rainfall, destructive winds and severe wave and storm surge damage. From this extensive list, Appendix 1 details the list of all such known ocean damage dating back to 1816 but more reliably since 1860 when telegraphic communication was in place along the east coast.

Power and Callaghan (2016a) reported on the frequency of severe TCs (maximum sustained winds 33 m/s or greater) affecting the east coast of Australia since 1878. The importance of ECLs to heavy rainfall and severe weather over the eastern seaboard of Australia has been noted previously, e.g. Hopkins and Holland (1997); Pepler and Rakich (2010); Pepler *et al.* (2014, 2017); Ji *et al.* (2018), Browning and Goodwin (2016) and Speer *et al.* (2009).

3 Storms during 1893 and major flooding in Brisbane City

The year 1893 was an exceptional year, with six severe events occurring, four producing floods in Brisbane City with three being major floods (see Table 1 which lists the Brisbane City floods from 1840 to 1956). The other four major floods in Brisbane City in the 1887–1898 period are examined below along with these six 1893 events.

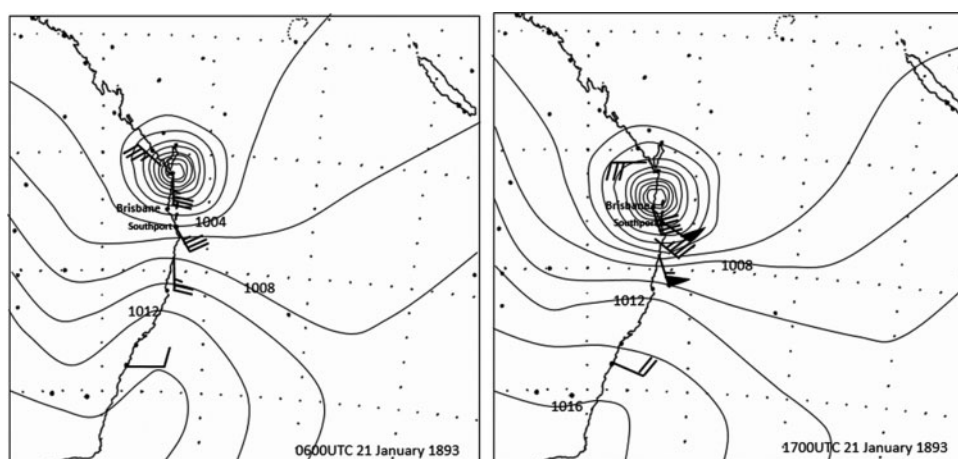


Fig. 2. Mean sea level pressure distribution and available average wind observations using conventional wind plots where a barb/half barb and flag is equivalent to 5, 2.5 and 25 m/s respectively.

3.1 Early January 1893 storm

A very severe ECL during 1–4 January 1893 formed over SEQ and moved south. Two marine vessels were lost with three bodies recovered. There was severe wind damage in Lismore, Sydney and Newcastle. Large seas affected the Gold Coast with waves breaking over Julian Rocks near Byron Bay just south of the NSW border. There were record storm surges at Ballina and Sydney. Only moderate rain occurred over SEQ. There was not sufficient data available for this event to create a meaningful mean sea level pressure (MSLP) distribution analysis.

3.2 Precursor January 1893 event to floods

A TC during 21–22 January 1893 passed just east of Brisbane where gusts reached 57 knots (28 m/s) with the MSLP down to 985.1 hPa at 1700UTC 22 January 1893 (Fig. 2). There was a large storm surge in Moreton Bay to 0.58 m (Gourlay 1981) with widespread sea damage at Sandgate, Cleveland and Southport. Heavy rain fell across SEQ with the heaviest 24-h total of 179.8 mm at Mount Tamborine. There were two deaths in northern NSW with heavy gales at Lismore, Casino, Grafton and Sydney.

3.3 First 1893 flood – possibly the worst in Australian history

The largest recorded flood in Brisbane City was 8.35 m on 5 February 1893 (Brunt 1958; Newman 1958) and the unprecedented conditions resulted in at least 30 fatalities. Early on 3 February a 15.2-m high wall of water was observed to roar down a Brisbane River gorge. The water tumbled down the Stanley River to its junction with the Brisbane River. Nearby was Caboonbah, the residence of grazier Mr. H.P. Somerset. Caboonbah (Fig. 3a) is on high ground, with a view of the Brisbane River below its junction with the Stanley River. Crohamhurst (on the Stanley River) recorded 907 mm of rain in the 24 h to 9 am 2 February 1893 and this was an Australian record for 24-h rainfall up until 1979. The location of Crohamhurst and the 96-h rainfall is shown in Fig. 3b.

Somerset (1893) described in part the flood as follows: “It was raining, though not heavily when I heard a roaring sound, and

looking west towards Mount Beppo (from which the sound seemed to come) I heard a louder noise quite different, so looking eastward I saw a wall of water fully 50 feet high coming around the bend. Astonished, I watched it pass the gum tree, and saw it submerge (i.e. exceed) the 1890 flood mark knob, and, while observing the tree, I felt the veranda floor lifting me, as the wall of water struck the cliff nearly two hundred yards away; the doors and windows rattled, the house shook as by an earthquake, and thinking my wife would be alarmed, I ran through a room, across the hall, and, on opening the door of her bedroom, she said ‘What has happened, I felt the bed shake under me’. I drew back the curtains and opened the window on the east veranda, so, from her bed, she saw the river nearing the top of the far bank, which the 1890 flood did not, and I, jumping through the window, on looking north, saw the flood not only covering the flat (nearly a mile wide) on the far side of the upper Brisbane River (whose channel it had overflowed) but also what looked like big logs racing along upstream in the distance away back from the river, so, getting my glasses, I saw clearly that they were saw-mill logs (as we found subsequently, when we saw them left high and dry near a drafting camp on a ridge in the top paddock) as being seven cedar logs bearing Mr. F. Bowman’s brand, which he got from a scrub near the head of Reedy Creek, which runs into the Stanley water on its far or eastern side, clearly showing that it was the Stanley water that had carried them to where it had left them.”

Somerset sent a horseman to Esk with a telegram addressed to the Postmaster-General in Brisbane: “Please warn inhabitants of Brisbane, Goodna, Ipswich, Lowood, other centres, of tremendous flood, 1890 level already exceeded several feet. Stanley River only, Brisbane to follow.” Somerset was correct as the flood peak when it reached Brisbane was devastating, with the Indooroopilly railway bridge swept away along with the Victoria Bridge in the Brisbane CBD. At least 150 houses were also swept down the Brisbane River with the flood peak.

During 31 January 1893, a severe TC approached land on a remote part of the Central Queensland Coast and was then steered southwards obviously under the influence of a middle to upper level trough. This deep layered trough influenced the

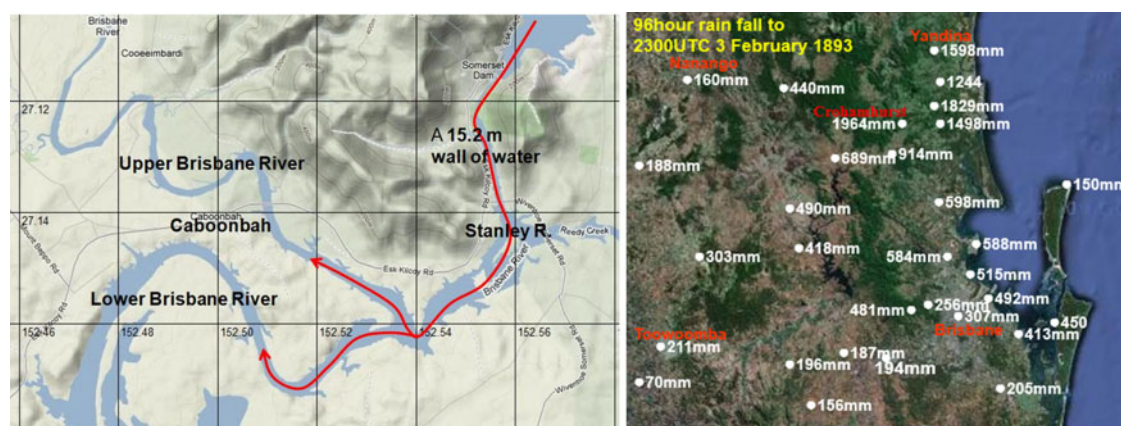


Fig. 3. (a) Location of Caboonbah, with upper Brisbane River to its north and lower Brisbane River to its south. The path of the wall of water that came down the Stanley River is shown. (b) 96-h rainfall to 2300UTC 3 February 1893, showing the location of Crohamhurst.

development of an ECL southeast of the cyclone. The development and landfall of this ECL is shown in Fig. 4 and was associated with the extreme rainfall in SEQ which occurred over the four days, with the heaviest rainfall occurring as this ECL made landfall near the Sunshine Coast with 24-h totals to 907 mm and other 24-h registrations to 739 and 639 mm.

Confirmation of the wild coastal weather produced by this ECL were the exceptionally large seas reported off Cape Moreton, with vessels having departed the Port of Brisbane forced to turn back into Moreton Bay. There were extremely high tides at Sandgate on Moreton Bay near Brisbane with seawater flooding overland and large damaging waves on the beaches. This ECL on 5 February (not shown) began to merge with the remnant circulation of the cyclone and was also responsible for the large seas and winds, which drove the vessel *Dickey* ashore on the Sunshine Coast on 5 February.

3.4 Second 1893 flood

On 11 February 1893, a short-lived TC crossed the coast near Bundaberg (see msl analysis in Fig. 5) adding to Brisbane floods where a peak of 2.15 m occurred on 12 February 1892. A schooner (150 tons) was wrecked at Inskip Point and a body of a man washed ashore. The barometer at Bundaberg fell 34 hPa in 24 h to noon 11 February, when it was 968.5 hPa (third lowest in Qld at the time). As 1100UTC 11 February, there was a 0.64-m storm surge in Moreton Bay (Gourlay 1981), and at Southport on 10 February the sea wall along the esplanade was destroyed and the baths irreparably damaged. Houses were flooded at Lismore and Grafton.

3.5 Third 1893 flood

On 17 February 1893, another TC crossed the coast near Bundaberg (see msl analysis in Fig. 6) where a MSLP of 985.4 hPa was recorded. Floods in the Brisbane River rose again and at 0020UTC 19 February came within 25 cm of the peak reached a fortnight earlier and there were four drownings with floods from Rockhampton to Grafton. There were major floods at Murwillumbah, Lismore and Grafton. The 24-h rainfall was very heavy in SEQ with Crohamhurst recording 404.2 mm, Margate

440.7 mm and Sandgate 356.4 mm all on 17 February. At 0500UTC 17 February, a 0.61-m storm surge was recorded at Moreton Bay (Gourlay 1981) and at Sandgate there was severe wave damage.

3.6 Fourth 1893 flood

There was an ECL over 10–11 June 1893 causing three fatalities and severe sea damage at Sandgate and Cleveland with a 0.58-m storm surge on Moreton Bay (Gourlay 1981). Huge waves at Byron Bay destroyed a beached steamer. A low-pressure system crossed the coast near Rockhampton as it intensified (see msl analysis in Fig. 7). It then moved south just west of Brisbane and then turned towards the east passing just to the south of Tweed Heads on the afternoon of Saturday 10 June 1893. The Brisbane River peaked with a major flood in Brisbane City at 0000UTC 12 June 1893 of 3.63 m.

Major flooding occurred at Allora, Bundaberg, Maryborough and Gympie in Qld and at Lismore, Grafton, Kempsey, Bingara and Camden in NSW. Severe wave damage occurred at Forster, Ballina, Harrington, Wollongong and Sydney.

3.7 Fifth flood (1890)

The Brisbane River peaked in Brisbane City at 5.33 m when a TC crossed the coast north of Noosa. The Superintendent of Telegraphs reported on a violent hurricane at Tewantin on the 9–10 March 1890, and at Cootharaba (25 km northwest of Noosa) houses were blown down and washed away by floods. This was the highest flood and strongest hurricane recorded in the district (see the msl analysis in Fig. 8 with the track also shown). There were 17 deaths from drowning: one at Tarampa, five in Brisbane and 11 in NSW. The vessel *Agnes* was lost north of Brunswick Heads with all hands; three bodies were washed ashore on 12 March and the other five bodies were never found.

At Southport there was a heavy gale and a heavier sea than had been observed for years. The swimming baths at the pier were completely swept away. An enormous sea broke right over the dressing boxes, a height of 3.66 m above high water mark where waves came over the swimming boxes. There were also severe storm surges at Sandgate and Redcliffe with waves breaking right

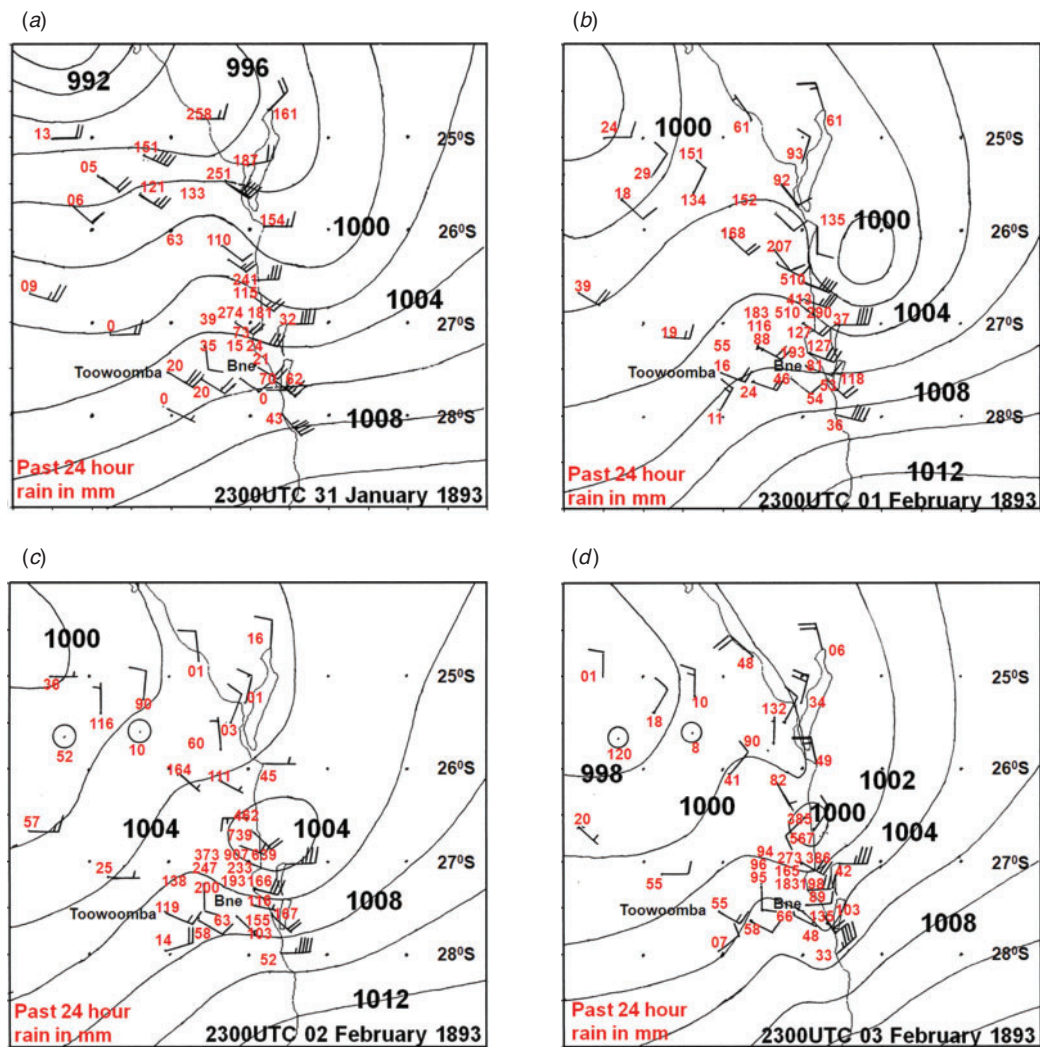


Fig. 4. As in Fig. 2 for (a) 2300UTC 31 January 1893, (b) 2300UTC 1 February 1893, (c) 2300UTC 2 February 1893 and (d) 2300UTC 3 February 1893. The rainfall over the previous 24 h is shown in red. 'Bne' marks the location of Brisbane.

over the jetties on 9 March. By 0600UTC 9 March, destructive winds struck Toowoomba. There were record floods in the Lockyer Valley, in Toowoomba and at Warwick, Moree, Coffs Harbour, Lismore, Grafton, Mclean, Taree, Port Macquarie, Camden, Mittagong, Wellington and in the Pine, Hawkesbury, Manning, Hastings and Hunter Rivers.

3.8 Sixth Flood (1887)

A TC crossed the coast north of Brisbane and there were at least 28 fatalities. There was a major flood in Brisbane City reaching 3.78 m on 23 January 1887. A ship, 43 km east-northeast of Noosa at 1000UTC 20 January 1887 reported hurricane force winds and the steamer *Culgoa* when 16 km south of Noosa encountered hurricane force winds around 1500UTC 20 January 1887 causing damage and injuring crew members (see msl analysis in Fig. 9). At Caboolture there were easterly gales from Thursday 20 January with a considerable number of trees blown down, telegraph lines smashed in all directions and the roads strewn with fallen timber.

Brisbane City recorded 465.1 mm in the 24 h ending 2300UTC 21 January 1887, which still stands as a 24-h rainfall record 132 years later. Easterly gales at Sandgate had seas breaking over the jetty, all the bathing houses were washed away and large trees were blown down in different directions. Many people were rescued from the South Pine River and 3.4 km of railway was washed away between Toombul and Bald Hills. Many people were drowned in the Logan River area. A boy was drowned near Greenmount on the Darling Downs on Saturday crossing a creek on horseback. The police at Harrisville reported a family of three were carried away by floods on Sunday night (23 January). The other members of the family were saved by trees. Two were drowned near Esk. Two people drowned in the Tenterfield area.

3.9 Seventh flood (1889)

A major flood in Brisbane City reached 3.75 m at 0830UTC 20 July 1889. An intense low was near Rockhampton on 17 July 1889, near Brisbane on 18 July 1889 then moved southeast (see

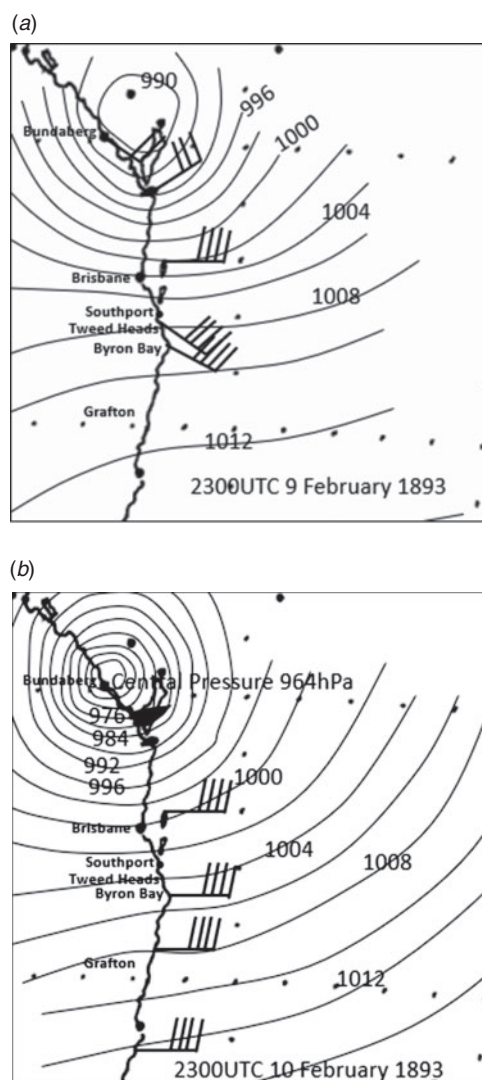


Fig. 5. As in Fig. 2 for (a) 2300UTC 9 February 1893 and (b) 2300UTC 10 February 1893.

msl analysis in Fig. 10). There were gales and heavy seas on the north and central coasts of NSW. Many deaths resulted from 13 marine vessels lost or beached. There was a major flood at Grafton, a storm surge at Sandgate and a record storm surge at Southport.

3.10 Eighth flood (1898)

A tropical low moved southwest towards Fraser Island during 8–10 January 1898 then weakened and moved northeast of Bundaberg during 11–12 January 1898 (see msl analysis in Fig. 11). Three people drowned around Brisbane in floods with a major flood in Brisbane City at 0230UTC 13 January 1898 reaching 5.02 m.

At Sandgate very strong east to southeast gales over 9–10 January reached hurricane force in the 3 h to 1700UTC 10 January and there was a large storm surge and waves at high tide that did much damage to seawalls, boats and roads etc.

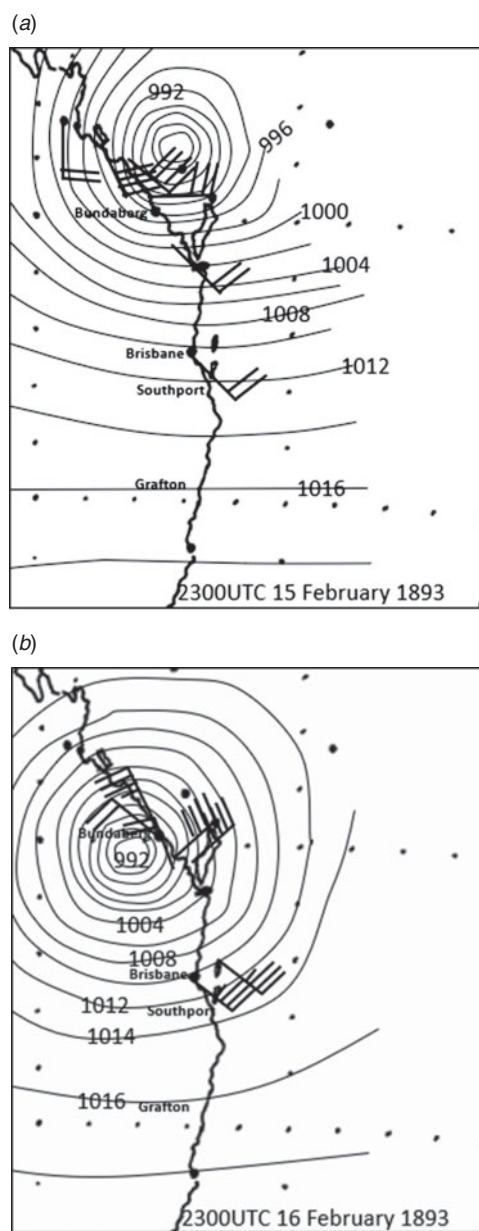


Fig. 6. As in Fig. 2 for (a) 2300UTC 15 February 1893 and (b) 2300UTC 16 February 1893.

There were also major floods in Breakfast Creek and Kedron Brook on Monday night 10 January 1898. Also, on 10 January, the steamer *Ranelagh* 836 tons was lost at Burnett Heads in a gale.

Very heavy daily rainfall totals occurred on the Sunshine Coast: Buderim 665.5 mm 10 January, 288.3 mm 11 January; Cooroy 275.6 mm 10 January, 342.9 mm 11 January; Landsborough 496.3 mm 10 January, 390.1 mm 11 January; Nambour 533.4 mm 10 January, 316.0 mm 11 January; Palmwoods 402.6 mm 11 January; and Yandina 489.0 mm 10 January, 291.3 mm 11 January.

Heavy daily totals occurred around the Stanley River: 493.3 mm 10 January, 405.4 mm 11 January; and Woodford 190 mm 10 January, 290 mm 11 January.

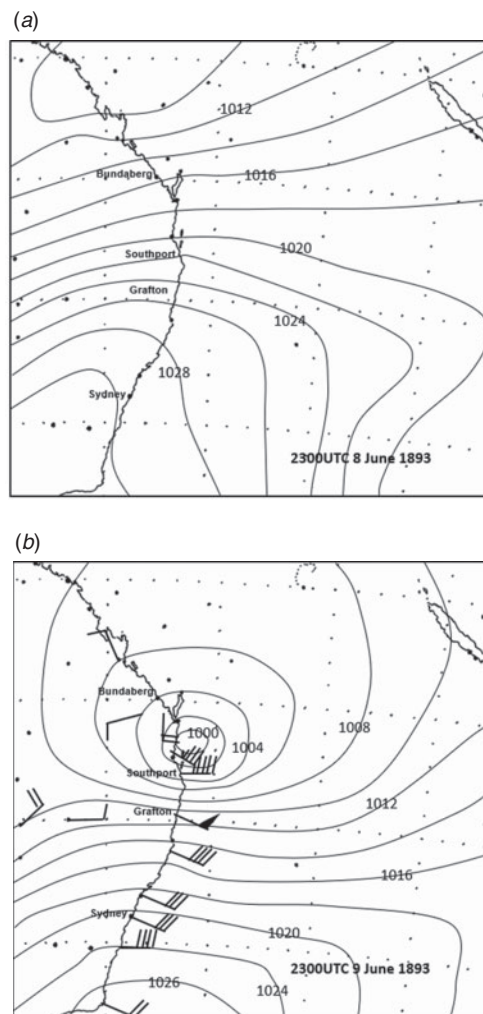


Fig. 7. As in Fig. 2 for (a) 2300UTC 8 June 1893 and (b) 2300UTC 9 June 1893.

3.11 Ninth flood (1898)

The TC Luita passed east of Brisbane and recurved towards the southeast over 6–7 March 1898 (see msl analysis in Fig. 12). There was 508 mm of rain recorded in 48 h at Crohamhurst. Gales and extremely high seas were observed along the south coast. A 3.27-m flood hit Brisbane City at 0700UTC 9 March 1898. On Monday 7 March, seas were breaking over private bathing houses at Shorncliffe. There were major floods at Lismore and Murwillumbah.

4 Weather systems and their effect on Jumpinpin

Above it was shown that the flood events also caused coastal wave and storm surge damage in SEQ. In this section are further events which impacted on this area. This coastal ocean damage focuses on the Jumpinpin (Fig. 1) region of Stradbroke Island from the observations at Southport, Sandgate and other Moreton Bay locations. The full ocean impacts of all the storms which

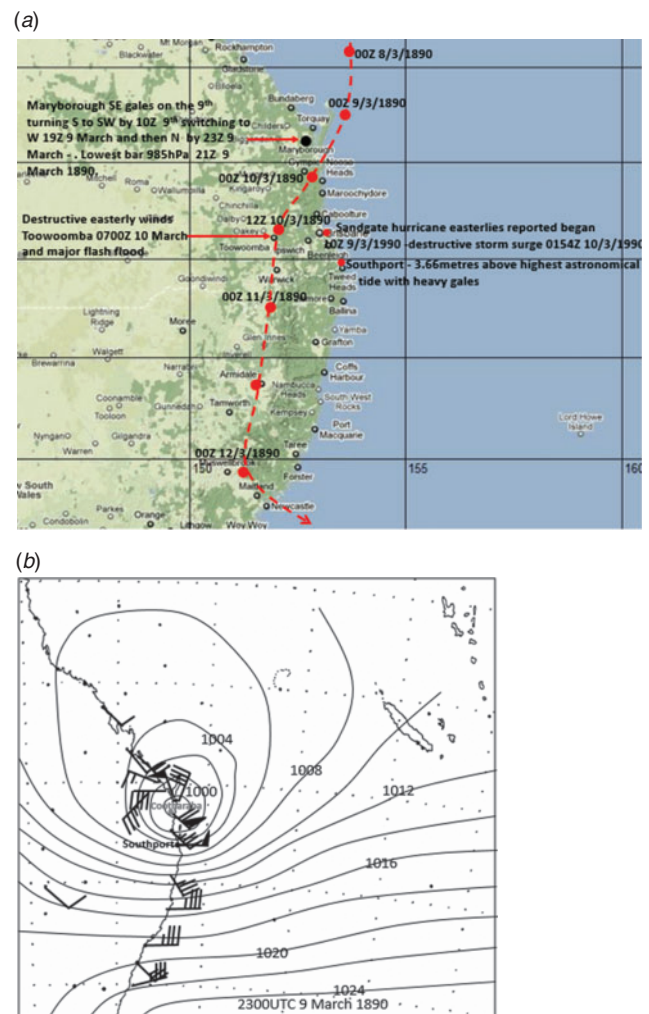


Fig. 8. (a) Shows the track of the cyclone and (b) as in Fig. 2, with isobars down to 1000 hPa and an isobar around the centre near the town of Cootharaba at 2300UTC 9 March 1890.

impacted SEQ and NSW over the study period are described in Appendix 1.

Around 1883–1885 the inner shore of Jumpinpin (sheltered waters south of Moreton Bay) was lightly fringed with mangroves with only one sandy spot to land and after this one had to pass over two sand ridges grassed with Pandanus trees to reach the ocean beach (Brisbane Courier Report 17 April 1895). Over the period to April 1895, around 400 m of the mangroves had been replaced by a clean sandy beach. Then there was only one ridge (much lower) between the bay and the ocean. Evidence that the sea has been eating into the land was that, in 1895, Pandanus trees for miles along the ocean beach were strewn with some still green, indicating recent erosion. Evidence of black mud and mangrove roots along the ocean beach indicated this was formerly the shore of the inner bay.

There was a severe weather event affecting this area during February 1883 (see below) and this may have been the first erosion episode leading into the 1883–1898 sequence of erosion.

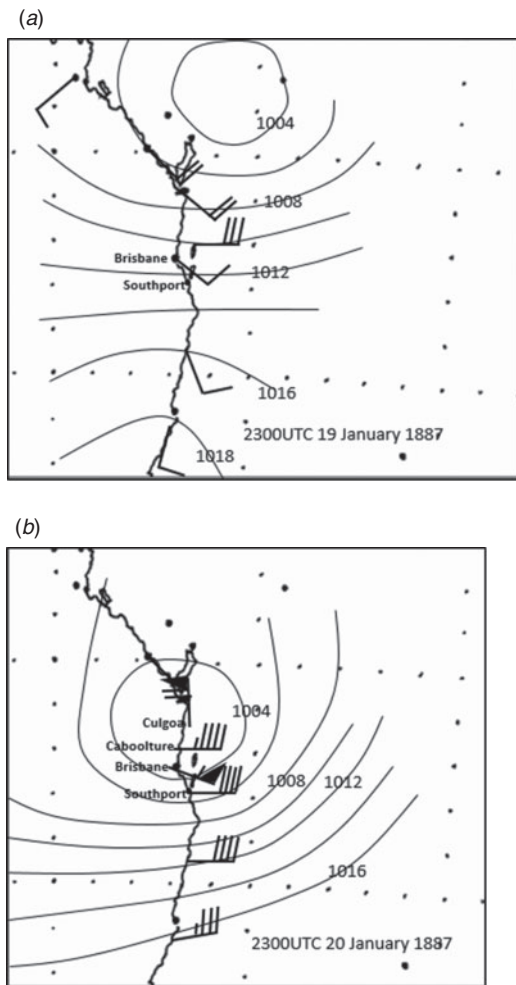


Fig. 9. As in Fig. 2, with isobars only displayed down to 1004 hPa for (a) 2300UTC 19 January 1887 and (b) 2300UTC 20 January 1887.

A report from the Boatman Pilot of Southport on 5 March 1895 (Brisbane Courier) stated that after the disturbance of TC Mu (see report below) he visited the scene of the *Cambus Wallace* wreck. After destroying one case of dynamite he went north along the beach and found, at a point 5.6 km from Jumpinpin, a break in the sand had been made by the wave action right through to Swan Bay (southern of Moreton Bay) and that ordinary spring tides washed over into the bay, the opening being about 400 m wide. The conclusion the pilot made was that there was an entrance at this spot from the ocean to the bay. He found no outflow from the bay but if the opening increased in depth and such an outflow became established the water would soon make a large channel for itself. To him it seemed likely then that the low southern part of Stradbroke would be cut off from the hilly northern part.

After three 1898 storms (see below), the Inspector of Shipping and Fisheries inspected the breakthrough which had then formed at Jumpinpin (Brisbane Courier report). The *Cambus Wallace* was then standing on a precipitous face 15.2–18.3 m high on the southern side of the channel through to the ocean. On the north side of the break, which was 800-m wide, cows and horses

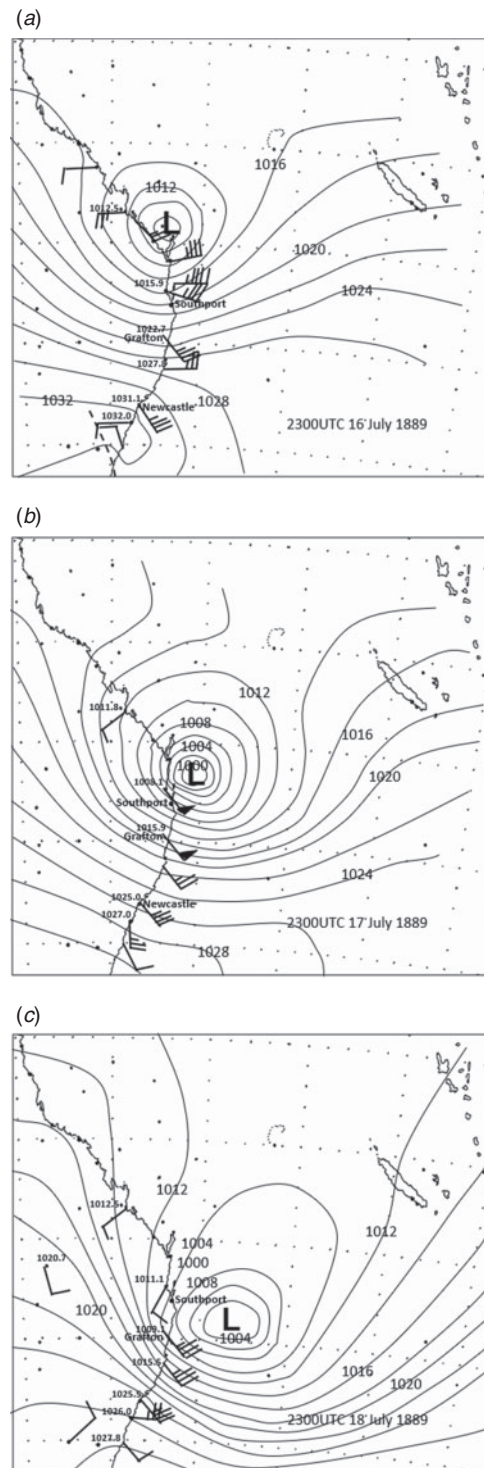


Fig. 10. As in Fig. 2, with isobars near the centre indicative only for (a) 2300UTC 15 July 1889, (b) 2300UTC 16 July 1889 and (c) 2300UTC 17 July 1889.

belonging to the oysterman at Curragee (9.7 miles from Southport) were grazing and he was happy for the time being as they had plenty of water and food. This was evidence that the large

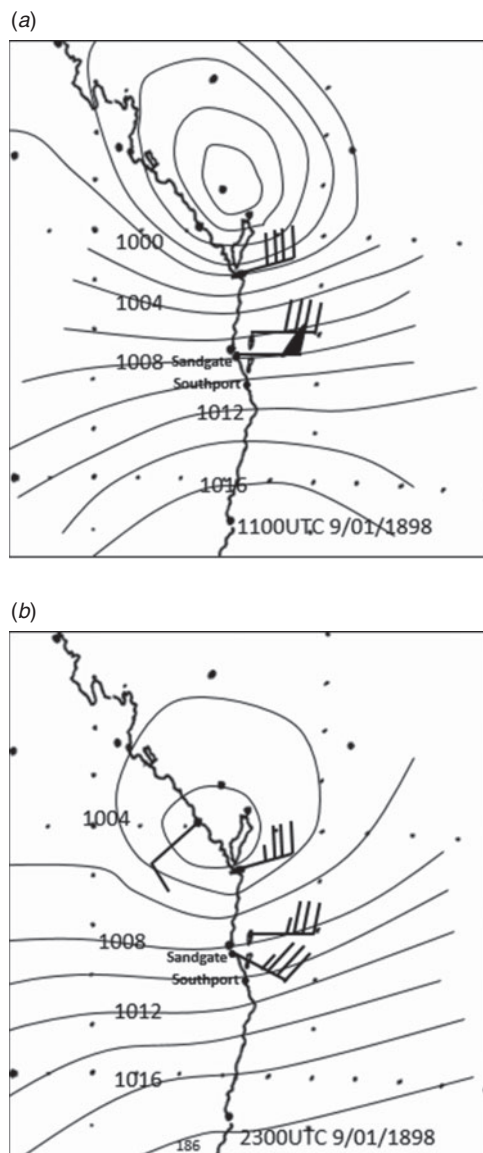


Fig. 11. As in Fig. 2 for (a) 1100UTC 9 January 1898 and (b) 2300UTC 9 January 1898.

breakthrough was a recent event, while the owner considered ways to recover his cattle. All this is evidence that after the 1895 event (TC Mu) the whole area of Jumpinpin was weakened, leaving it susceptible to a breakthrough and the three 1898 storms were the culminating events which forced the channel through at Jumpinpin rather than the location 5.6 km further north.

5 Other severe coastal damage events

Below are the additional events that caused erosion around Jumpinpin.

5.1 1883 event

An intense low developed east of Coffs Harbour on 5 February 1883 and then moved south to the east of Newcastle 7 February

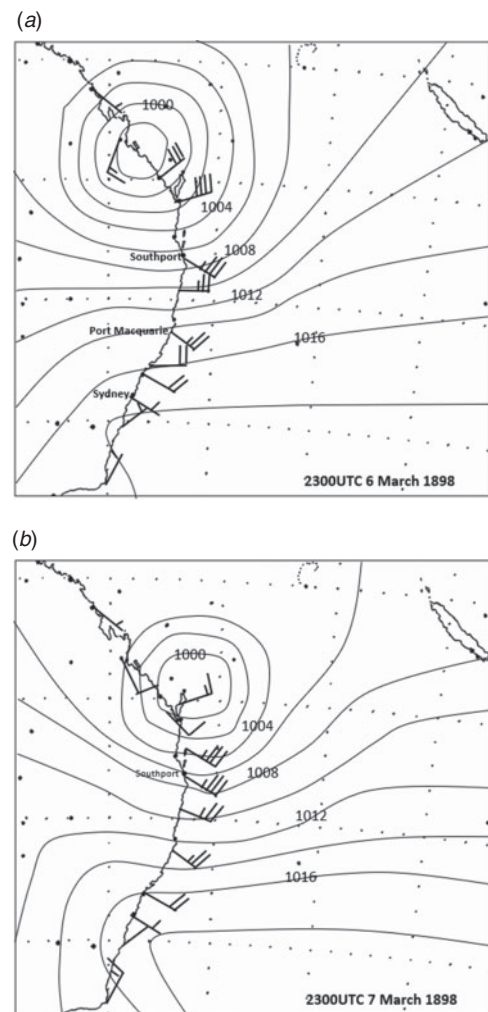


Fig. 12. As in Fig. 2 for (a) 2300UTC 6 March 1898 and (b) 2300UTC 7 March 1898.

1883 (see msl analysis in Fig. 13). Storm-force southerly winds along the NSW coast with a huge southerly swell extended up to waters near Brisbane. There was an exceptionally large high tide at Moreton Bay on 7 February 1883 and a considerable amount of low-lying land was flooded. At Southport, the tide was the highest ever known with the sea inflicting damage to the road between Labrador and Southport and washing away the boat houses on the Southport Beach. The southerly gales suggest a Kelvin wave type surge (Fandry *et al.* 1984). The ocean liner *Sorato* was irreparably damaged by tremendous seas on Friday 3 February 1883 as it left Sydney for Melbourne.

5.2 1887 event

A TC over 8–13 February 1887 passed east of Brisbane at 1830UTC 13 February 1887, where the barometer dropped to 992.9 hPa (see msl analysis in Fig. 14). Four known fatalities occurred from six foundered vessels.

Southport had an enormous tide on Saturday night (12 February), the highest for many years. The sea wall and the

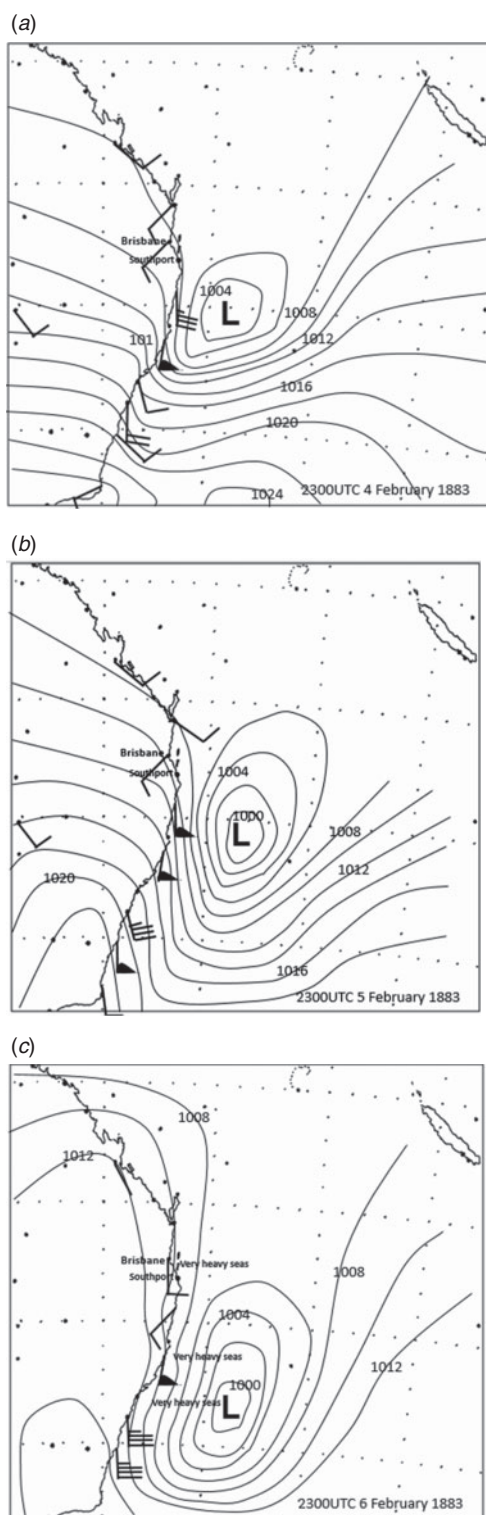


Fig. 13. As in Fig. 2, except for (a) 2300UTC 4 February 1883, (b) 2300UTC 5 February 1883 and (c) 2300UTC 6 February 1883.

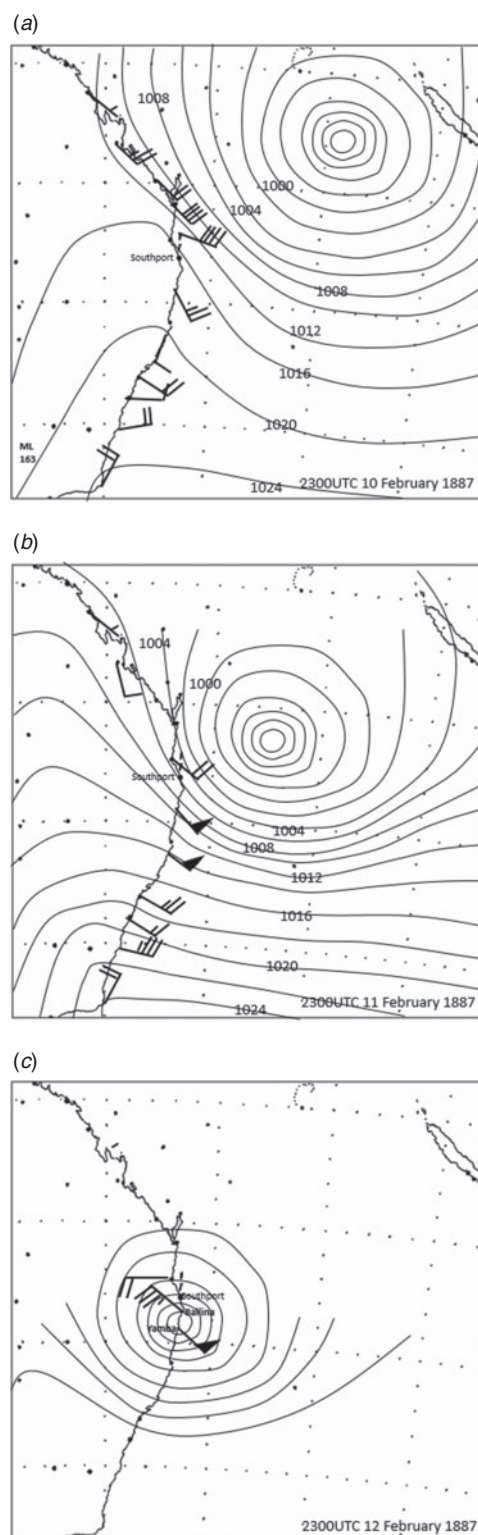


Fig. 14. As in Fig. 2, with isobars near the centre indicative only for (a) 2300UTC 10 February 1887, (b) 2300UTC 11 February 1887 and (c) 2300UTC 12 February 1887, where wind observations are from ship reports.

seaside baths were severely damaged and a dozen boats damaged. The sea washed right over the spit. Destructive winds hit Yamba and Grafton and an all-time record 24-h rainfall occurred at Warwick of 195.3 mm.

5.3 1891 event

A TC from the northern Coral Sea on 9 March 1991 moved down to the east of Fraser Island by 11 March and then moved south to the east of Southport by 11 March before turning southeast (see msl analysis in Fig. 15).

On Thursday morning 12 March, Southport reported a terrific sea on the bar, with the tide being the highest ever known. Immense damage was done to the esplanade. The sea walls and the jetty were severely damaged, and the jetty house was carried away. The barque *Don Nicolas* foundered at 0000UTC 13 March and the crew took to boats. After a long voyage, the two lifeboats made Sydney Heads on Saturday night 21 March. The *Rose M* barque 366 tons foundered on a voyage from New Zealand to Melbourne and wreckage was washed ashore on 16 March at Crowdy Head. On Lord Howe Island, on Thursday morning 12 March, the reef on the west side had enormous seas with spray whipped up by the wind. The tide was abnormally high and there was widespread wind damage, with huge trees uprooted or broken down and buildings unroofed. The violence of the gales on the coast near Forster was unprecedented. The heavy sea broke clean into the harbour and did much damage.

5.4 1892 event

A TC came close to the coast near South Stradbroke Island on 2 April 1892 (see msl analysis in Fig. 16a and its track in Fig. 16b) then turned back out to sea, causing five deaths. Wind raged from 8 am to 4 pm Saturday 2 April and the lowest bar at Brisbane (corrected to sea level) was 991.5 hPa at 2.30 pm, when Clement Wragge quoted the wind strength in Brisbane as 60–70 knots from the southwest.

There was widespread severe structural damage in the inner suburbs of Brisbane, mainly in the lee of the Taylor Range. There was also severe wind damage at Beenleigh, Redland Bay, Tweed Heads and Southport, where the sea came up over the esplanade in places and around 140 m of the seawall was washed away. The schooner *Bellringer* with cargo of cedar was driven ashore at Stradbroke Island. There was a 0.61-m surge in Moreton Bay (Gourlay 1981). There were major floods at Grafton, Lismore, Armidale, Taree and Kempsey, and at Ballina the south spit was washed away, leaving an opening of nearly 3.5 km.

5.5 1894 event

Over 18–19 February 1894, a TC passed east of Brisbane, and then moved to the Lord Howe Island area (see msl analysis in Fig. 17). A storm surge of 0.58 m was measured on the tide gauge at Moreton Bay (Gourlay 1981).

The tide in the Brisbane River Monday (19 February) rose to an abnormal height, with many of the low-lying wharves under a metre of water, and several ferry landings were unapproachable. The highest tide ever known occurred at Cleveland. At Southport, the low-lying lands along the esplanade were inundated, several

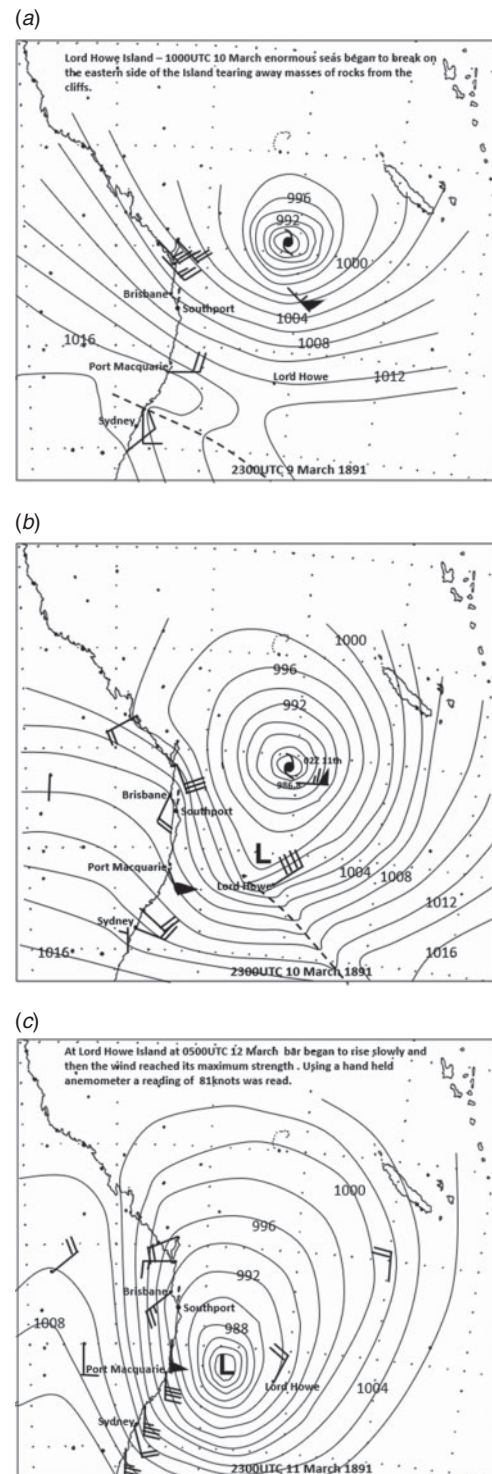


Fig. 15. As in Fig. 2 for (a) 2300UTC 9 March 1891, (b) 2300UTC 10 June 1891 and (c) 2300UTC 11 March 1891.

bathing houses were destroyed, while others were left in a tottering condition. At Ballina, a very heavy tide covered all the lower parts of town.

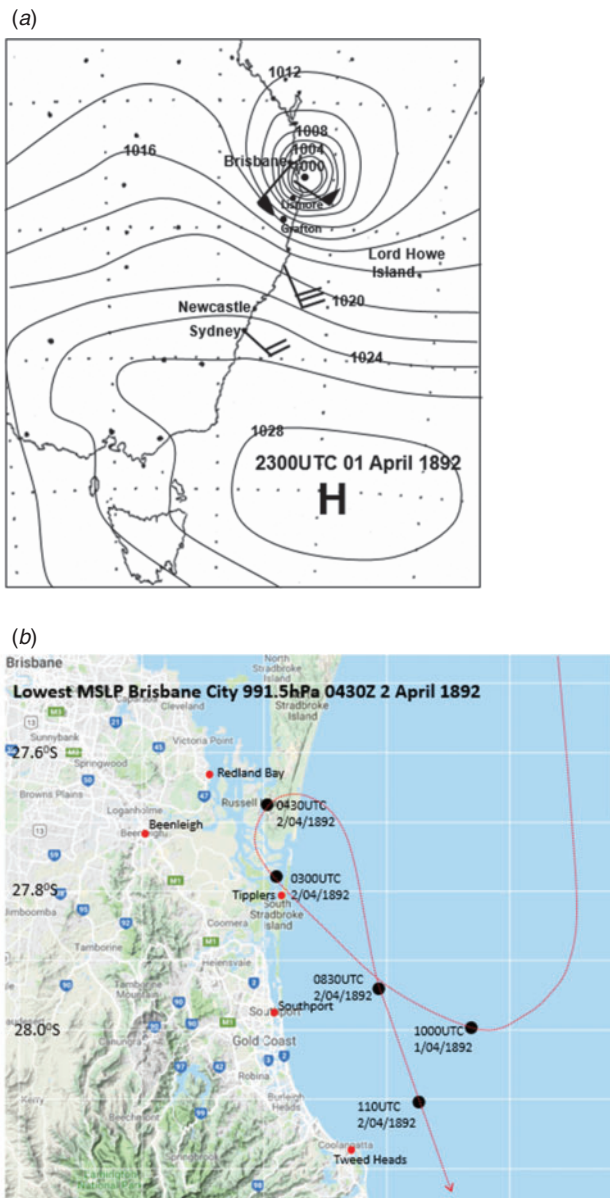


Fig. 16. (a) As in Fig. 2 for 2300UTC 1 April 1892, with isobars only analysed down to 1000 hPa. (b) The 1892 TC track showing its movement towards and away from the coast.

5.6 Second 1894 event

On 13 March 1894, a TC passed east of Cape Moreton with severe gales (see msl analysis in Fig. 18).

The Cape Moreton lighthouse experienced severe wind damage at 1300UTC 13 March. A major flood in the Tweed River reached 5.04 m at Murwillumbah. Gales damaged crops at Wynnum/Cleveland and in the Redlands areas, and floods damaged crops in the North and South Pine Rivers. The schooner *Grace Darling* was wrecked at Comboyora Point, Moreton Island, at 5.10 pm 13 March. The crew were saved.

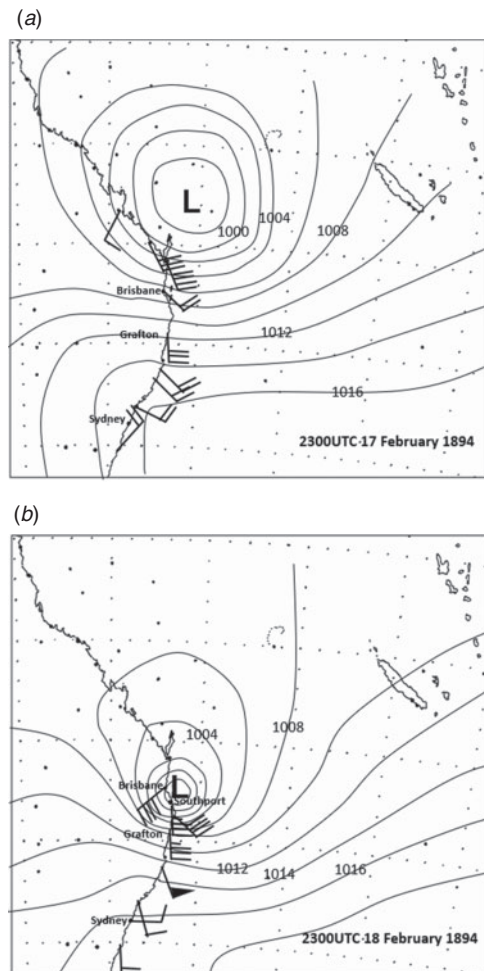


Fig. 17. As in Fig. 2 for (a) 2300UTC 17 February 1894 and (b) 2300UTC 18 February 1894.

5.7 *Cambus Wallace*

On 3 September 1894, a severe low-pressure system was well out to sea passing east of Southport. The next day, on 4 September 1894, there was severe damage from the low at Lord Howe Island with winds wrecking the school, causing severe damage to several homesteads and many forest trees were blown down. Conditions on the Gold Coast were such that Southport on 3 September 1894 had strong southeast winds with misty or foggy conditions and a heavy swell. At Tweed Heads, the observation at 1000UTC 3 September 1894 was light southerly winds and heavy seas. On 3 September 1894, the barque *Cambus Wallace* (1651 tons) thought they were 57 km off the land in misty or foggy conditions and struck the breakers 180 m off Stradbroke Island, with five seamen drowned and one dead of exposure. Residents at the Moreton Bay suburbs of Lytton and Wynnum heard the noise of the swell from the east coast of Stradbroke Island giving some idea of the size of the waves. The ship was on its maiden voyage from Glasgow to Brisbane. The low was too far out to sea to obtain observations useful for a msl analysis.

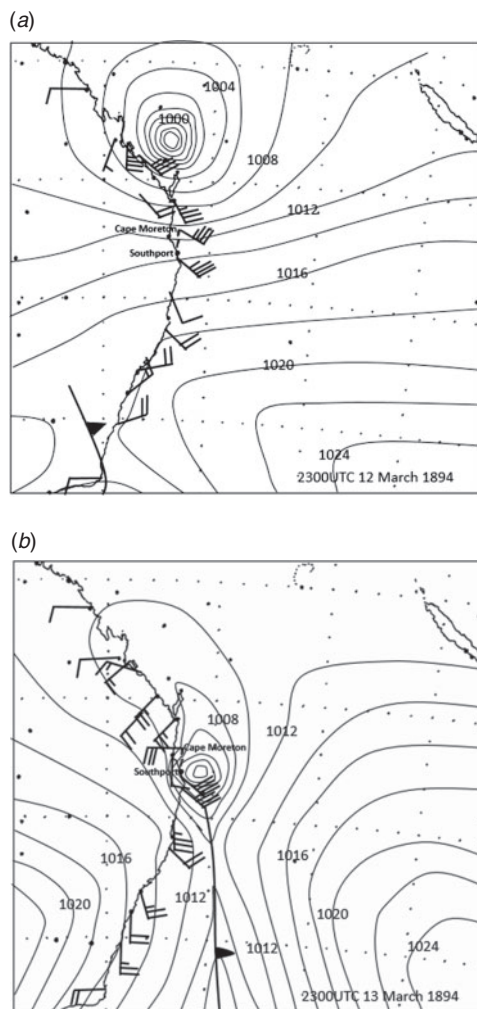


Fig. 18. As in Fig. 2 for (a) 2300UTC 12 March 1894 and (b) 2300UTC 13 March 1894.

5.8 TC Mu January 1895 (named by legendary meteorologist Clemente Wragge)

At 2300UTC 28 January, a TC was northeast of Brisbane and at 2300UTC 29 January it was 240 km east of Wide Bay, at 2300UTC 30 January the low was east of Point Danger, at 2300UTC 31 January it was moving towards Lord Howe and at 2300UTC February it was near Lord Howe Island (see msl analysis in Fig. 19).

There was much damage at Southport from the sea to jetties roads etc., with the main pier caved in. Along 5 km of the esplanade, the sea eroded the road with breaks every hundred metres or so. The toilets facing the south disappeared. About 120 m of the south spit, at the entrance to Nerang Creek on the ocean side, was eroded away (making a total of 576 m in rather less than eight years), and that point presented a steep wall of sand to the surf beating at the foot thereof. On the other side of the entrance, on Stradbroke Island, the waves were running inland among the sand hills for over several hundreds of metres. The coach with the Sydney mails was blocked by the storm surge in Currumbin Creek on Wednesday.

Double Island Point felt the full force of the hurricane on Wednesday night (30 January). The Chief Keeper's house was unroofed, and seas were mountainously high. There was severe damage to the western pier at Kiama. Immense waves were breaking right across the bay. Extremely high seas washed away a wharf at Harrington. The largest seas in memory were breaking two miles seaward. The heaviest and most dangerous sea for years hit Sydney on Saturday afternoon 2 February. Crowds of people visited The Gap to view the spectacle. There were major floods at Murwillumbah, Casino and Grafton.

5.9 ECL July 1897

During 24–26 July 1897, a low from Qld moved southeast into the Tasman Sea on Monday 26 July 1897 (see msl analysis in Fig. 20). The schooner *Heroine* was driven ashore at North Kirra near the mouth of Coolangatta Creek (30 km south of Southport) on Sunday 25th. On 26 July 1897, the breakwater was damaged at Macleay River Heads.

6 Climatology of severe ocean events

6.1 No Jumpinpin in 1846

The vessel *Coolangatta* was beached at the town which would bear its name during an ECL on 19 August 1846. It was repaired and then wrecked by another gale on 4 December 1846. The crew were then able to walk to Amity Point on the northwest tip of Stradbroke Island (Fig. 1), which was evidence that at the time Stradbroke Island was attached to the mainland with no break at Jumpinpin. There was an extensive negative Southern Oscillation Index (SOI) period from 1820 to around 1850 (Braganza *et al.* 2009), consistent with little barrier island erosion enabling the crew to walk to Amity Point.

Power and Callaghan (2016b) found a strong relationship from weather systems producing severe coastal flooding and positive phases of SOI; Callaghan and Power (2011) found the same for severe TCs affecting eastern Australia. Fig. 21 displays a time series of the cumulative SOI from 1876 to 2019. To generate this curve, the monthly values of the SOI are simply continually added. A succession of positive values causes the curve to rise and the opposite occurs for sustained negative values. Events shown in Appendix 1 are analysed using this cumulative SOI curve. Below rising (positive) SOIs are highlighted (+) with negative values (–).

Lists of event sequences during different phase of the SOI – positive (+) and negative (–)

- (+) January 1876 to September 1876, two events
- (–) October 1876 to June 1878, one event
- (+) June 1878 to April 1881, five events
- (–) April 1881 to November 1885, four events
- (+) November 1885 to December 1887, three events
- (–) December 1887 to May 1890, five events
- (+) May 1890 to February 1895, 15 events in 4 years and 9 months
- (–) February 1895 to July 1897, two events
- (+) August 1897 to May 1904, seven events
- (–) June 1904 to June 1906, one event
- (+) Jul 1906 to April 1911, six events

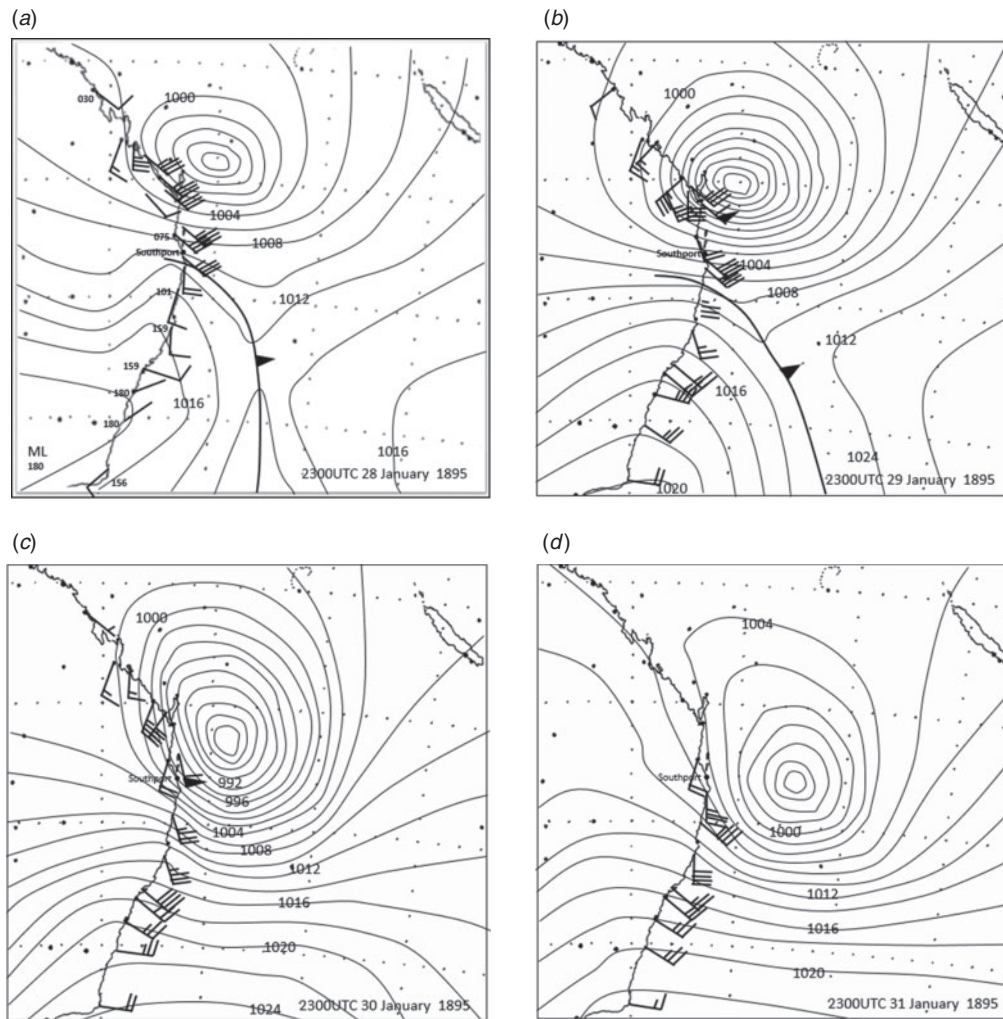


Fig. 19. As in Fig. 2 for (a) 2300UTC 28 January 1895, (b) 2300UTC 29 January 1895, (c) 2300UTC 30 January 1895 and (d) 2300UTC 31 January 1895.

- (–) May 1911 to May 1915, six events
- (+) June 1915 to May 1918, two events
- (–) June 1918 to April 1920, one event
- (+) May 1920 to April 1925, five events
- (–) April 1925 to August 1926, one event
- (+) September 1926 to Jul 1939, 20 events
- (–) July 1939 to April 1942, one event
- (+) May 1942 to February 1946, three events
- (–) March 1946 to July 1949, six events
- (+) Jul 1949 to February 1951, five events
- (–) March 1951 to December 1953, four events
- (+) December 1953 to January 1957, nine events
- (–) February 1957 to August 1959, seven events
- (+) September 1959 to November 1964, 10 events in 6 years 2 months
- (–) December 1964 to November 1966, four events
- (+) December 1966 to August 1968, seven events in 1 year 8 months
- (–) September 1968 to March 1970, one event

- (+) April 1970 to February 1972, three events
- (–) March 1972 to April 1973, nil events
- (+) April 1973 to June 1976, 11 events in 3 years 2 months
- (–) July 1976 to January 1988 13 events
- (+) February 1988 to October 1989, six events in 1 year 8 months
- (–) November 1989 to June 1995, seven events
- (+) June 1995 to February 1997, three events
- (–) March 1997 to April 1998, one event
- (+) May 1998 to April 2001, six events
- (–) May 2001 to May 2007, 13 events
- (+) May 2007 to September 2013, 20 events in 6 years 4 months
- (–) January 2014 to April 2016, four events
- (+) May 2016 to May 2018, six events
- (–) June 2018 to February 2020, four events

In total during 1876–2020 there were 153 events with a positive SOI trend and 86 events with a negative trend. This follows other studies above where stronger impacts occur during

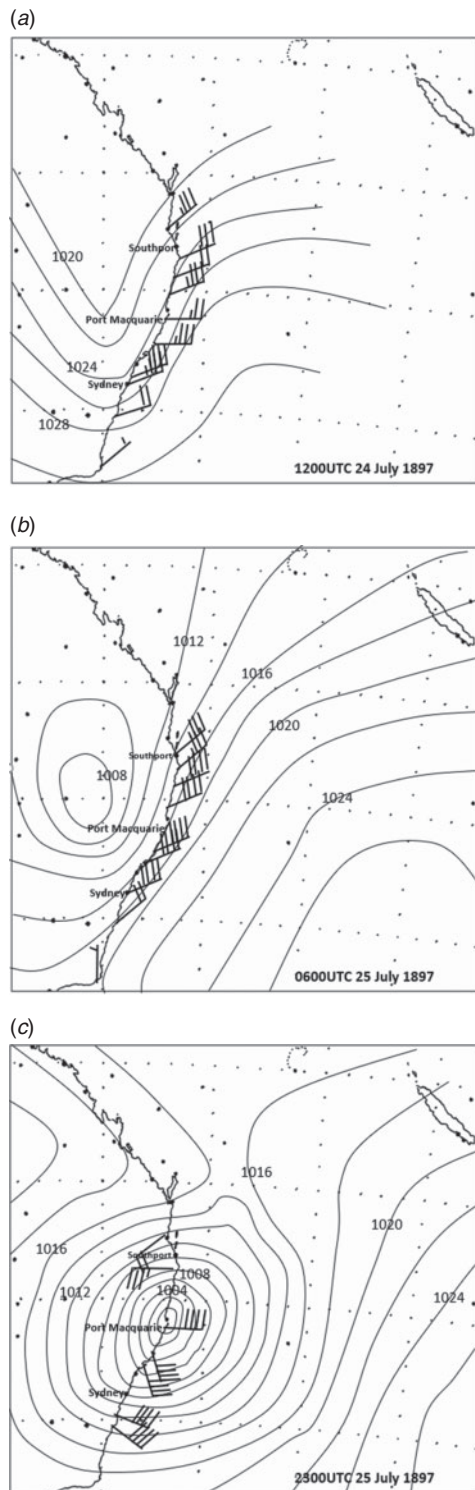


Fig. 20. As in Fig. 2 for (a) 1200UTC 24 July 1897, (b) 0600UTC 25 July 1897 and (c) 2300UTC 25 July 1897.

the positive phases of the SOI. The strongest sequences above have added to them the years and months over which the events occurred and the top three follow:

May 1890 to February 1895, 15 events in 5 years and 3 months – six of these were during 1893

December 1966 to August 1968, 7 events in 1 year 8 months – six of these were during 1967

April 1973 to June 1976, 11 events in 4 years 2 months.

Not surprisingly the most active periods were in 1893 and 1967, which led to the breakthrough at Jumpinpin and the AU\$9 billion erosion on the Gold Coast during 1967 respectively.

Before the 1976 climate shift, from May 1920 to June 1976 there were 72 positive and 24 negative SOI events. This comprised 14 TI1 events, one TI2 event, 28 TI3 events, 42 ECLs and 11 Tasman Sea lows.

Following the 1976 climate shift, from July 1976 to April 1998 there were nine positive and 21 negative SOI events. This comprised 10 TI3 events, 13 ECLs and seven Tasman Sea lows.

Following resumption of sustained positive SOIs from May 2007 to January 2014 there were 20 positive events comprising three TI3s, 14 ECLs and three Tasman Sea lows.

This shows how direct TC impacts TI 1 on the study area decreased markedly following the June 1976 climate shift.

7 Extra severe events during the 1883–1898 period without evidence of extreme wave damage at Southport

These events probably added to the seas around Stradbroke Island but more importantly they added to the enormous sequence of extreme events during 1883–1898. The TC Eline/Monsoon low Ramagh event is probably one of the worst events to hit the general Sydney area.

7.1 13–15 July 1887

Small low developed east of Brisbane. Parts of Brisbane flooded. Nerang recorded an all-time daily rainfall record for July and second highest of all time (station still open) 349.5 mm in 24 h to 2300UTC 13 July 1887, 106.2 mm next day.

7.2 26 May 1889

Tropical low crossed the coast at Fraser Island on Sunday 26 May 1889 and passed inland to Miles before recurving and passing out to sea again near Yamba on Monday 27 May. Huge seas in Sydney; some buildings were washed away by floods, houses unroofed and fences blown down. Flooding at Newcastle, Lithgow and a major flood in the Georges River of 9.7 m at Liverpool Weir, the second highest of all time. Severe wave damage at Port Stephens, Kiama and Port Kembla. There were four fatalities.

7.3 17–18 February 1888

A TC recurved just east of Mackay on 17–18 February 1888. Six fatalities. Main damage Mackay to Hervey Bay with strong gales in SEQ.

7.4 24–28 March 1890, 18 fatalities

A TC crossed the North Queensland coast near Cardwell on 24 March 1890 and recurved over Fraser Island on 28 March, bringing disastrous floods over much of Qld and northern NSW. On the Darling Downs, two policemen missing in floods

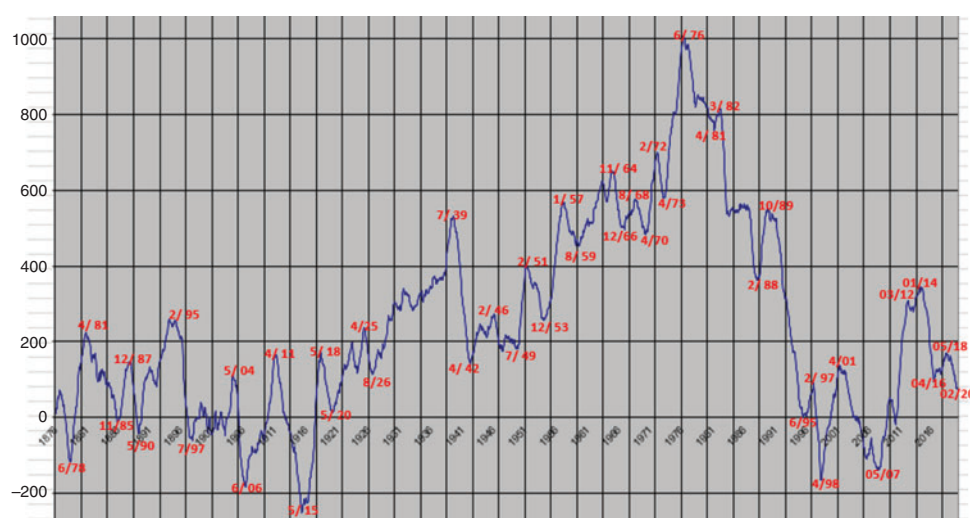


Fig. 21. Cumulative Southern Oscillation Index January 1876 to February 2020. Red numbers show the month and last two digits of the year.

near Dalby and at Roma, and 100 people were evacuated from the floods. At Beaudesert, a man drowned on 28 March and in Texas numerous buildings were washed away, a man drowned and many livestock were lost. In NSW, the Nepean River flooded with one drowning. There were major floods at Grafton, Maclean, Bingara and Moree.

7.5 12–14 February 1898 monsoon low Ramagh, 31 fatalities

On 12–14 February 1898, intense monsoon low Ramagh tracked from the continent to intensify over northeast NSW; it was probably a continuation of severe TC Eline that struck Mackay (Callaghan and Power 2011).

The brig *Amy* (220 tons) after leaving Wollongong at 9 am 14 February was driven ashore near Bulli and the eight crew all drowned. Another man died on the beach from shock. The brigantine *Malcolm* foundered at Bulli and the six crew were lost, and 500 feet of the Bellambi jetty was washed away. The ship *Atacama* was abandoned well off the NSW coast on 9 February 1898 after it began leaking. As they sailed back towards the New South Wales coast in lifeboats they encountered the intense low pressure system and 13 of the crew were drowned.

Three men drowned at Bungendore and Tumut (near Canberra) in floods on 15 February. In Sydney, trees were uprooted, verandas were carried away and the ferries were suspended. The yacht *Greyland* capsized (crew saved) in the harbour. There were 31 known deaths associated with this event.

The Georges River on Monday 14 February reached 9.0 m at Liverpool Weir (ranked third) and 5.5 m at Lansdowne Bridge. Severe flood damage at Liverpool and Bankstown.

The Bega River recorded one of its highest floods with much damage. The flood attained its highest at 2 am Tuesday 15 February.

Hunter River at Maitland on Tuesday night (15 February) reached 9.14 m, with farms badly flooded in the district.

Nepean/Hawkesbury Rivers: the height at Windsor Bridge reached 9.61 m on 15 February and caused serious crop damage.

The Nepean River at Campbelltown caused severe flooding in homesteads and on 15 February reached a height 0.91 m below the record 1843 flood. At Douglas Park (near and east of Picton) the Nepean River rose with a great rush Monday night, submerging the bridge and all the low-lying flats. It was the largest flood experienced for 25 years. At Moss Vale, at about 10.30 am Monday morning, very heavy rain fell and lasted for several hours, causing a great flood in the town, in which numerous shops and dwellings and other places of business were completely flooded, as well as a great number of fences broken down and washed away by the force of the water.

Major flood Nowra 5.0 m; major flood Moruya.

Unprecedented 24-h rainfall totals:

- West Sydney/Blue Mountains – Glenfield 31 km WSW of Sydney 186.7 mm, 14 February; Penrith 158.8 mm, 14 February; Blackheath 11 km N of Katoomba 61.7 mm, 13 February, and 170.2 mm, 14 February; Lawson 11 km E of Katoomba 132.1 mm, 13 February, and 219.7 mm, 14 February; and Springwood 23 km E of Katoomba 86.6 mm, 13 February and 220.7 mm, 14 February.
- Illawarra – Brogers Creek 22 km NNE of Nowra 57.2 mm, 13 February, and 509.3 mm, 14 February, a February record for 1890–1930; Cordeaux River 573 mm, 14 February, and 102.6 mm, 15 February, an all-time daily record on 14 February for 1871–1924; Sherbrooke 14 km N of Wollongong 63.8 mm on 12 February, 435.4 mm on 13 February, and 41.9 mm on 14 February, an all-time daily record on 13 February for 1892–1970.
- South Coast – Araluen 83.8 mm on 13 February, 267.0 mm on 14 February, and 339.3 mm on 15 February; an all-time February daily record rainfall for 1891–1970.

8 Conclusion

Twenty-five severe weather events (including the *Cambus Wallace* storm) have been described. These storms caused disastrous

flooding over SEQ and large areas of NSW. Brisbane City over this period experienced six major floods, including the two highest floods on record within a fortnight. The first of these two brought a huge wall of water from the Stanley River down the Brisbane River Valley which ultimately swept away two city bridges and 150 houses. Such an occurrence today would surely test the management of Somerset Dam and Wivenhoe Dam inflows, given the problems that occurred with managing the much weaker inflows into Wivenhoe Dam following an intense burst of rainfall during the Brisbane 2011 floods (van den Honert and McAneney 2011). Eighteen of these storms appeared to have generated ocean conditions conducive to severe beach erosion to the east coast of Stradbroke Island. Reports by experienced observers indicated the breakthrough at Jumpinpin on Stradbroke Island was a gradual process following an unusually large number of storms over a relatively short period. Popular mythology had the breakthrough created by many visitors travelling to the *Cambus Wallace* wreck to sample the Scotch whisky contained in the cargo of the Scottish wreck, thereby contributing to the erosion there. Given that the 1967 storms generated normalised insurance losses of around AU \$9 billion, it is sobering to surmise the huge losses this sequence of late-nineteenth century storms could incur today from wave erosion, storm surge flooding, fresh water flooding and severe wind gusts in the fastest growing area in Australia. Of the 24 storms that directly impacted the Australian east coast, 19 occurred during a positive phase of the SOI and five during a negative phase. A climatology study of 239 Australian east coast storms that caused severe ocean damage between Brisbane and the Victorian border over the period between 1876 and February 2020 showed that 153 events occurred with a positive SOI trend and 86 events with a negative trend. The most active years were 1893 and 1967, both during a positive SOI period and both dominated by TC activity. The 1893 events strongly contributed to the Jumpinpin breakthrough and 1967 was associated with historical Gold Coast beach erosion, which contributed to AU\$9 billion insurance losses. The study also showed how direct TC impacts in the study area decreased markedly following the June 1976 climate shift.

Conflicts of interest

The author has no conflict of interest in publishing this paper.

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Appendix 1

List of severe weather events, meteorological system responsible and associated death toll

Weather types: TI1, Tropical Cyclone (TC); TI 2, Trough extending south from a TC; TI3, Extratropical transformation of TC or low; ECL, East Coast low; TAS, Tasman Sea Low. Fatalities in last four columns: I, freshwater floods; II, over land; III, surf zone and storm surge; and IV, at sea

No.	Severe events destructive wind or ocean effects	Type	Date	I	II	III	IV
1	June 1816. Major flood and many vessels lost at sea.		15 June 1816			2	20
2	25–28 August 1834. Record easterly gale and waves Sydney. 12 fatalities.		27 August 1834			12	
3	1836. June–July, tropical storms Coral Sea affecting NSW with many lives lost at sea.		1 July 1836			8	20
4	8–12 June 1839. Storm. Three vessels wrecked Sydney Heads, Macleay River bar, and Port Stephens. Violent sea Clarence River, Yamba.		10 June 1839				
5	14 January 1841. Evidence of severe erosion Gold Coast.		14 January 1841				
6	18–19 May 1842. Two vessels lost with crew and part of crew.		19 May 1842				10
7	8–9 July 1848. SE gales, three vessels lost with at least 14 lives lost.		9 July 1848			9	5
8	5–6 May 1849. Severe low with eight vessels lost Gold Coast to Coffs Harbour.		5 May 1849				
9	3 March 1850. Gales Ballina to Newcastle, four vessels driven ashore.	TI3	3 March 1850				
10	28 September 1850. Severe low, three vessels lost with at least eight fatalities.	ECL	28 September 1850			7	1
11	Tropical low 24–30 March 1851, six fatalities, three vessels lost.	TI3	30 March 1851	1		5	
12	ECL 15–16 May 1851. Twenty fatalities in the Bega and Twofold Bay region. Vessels lost at sea.	ECL	15 May 1851	18		2	
13	25–26 August 1851. Massive low Tasman Sea with severe gales Lady Elliot Island to Sydney. Three vessels wrecked.	T3	26 August 1851	1			
14	21–24 June 1852. Severe ECL. Twelve vessels wrecked or blown out to sea and never seen again.	ECL	22 June 1852	89		12	20
15	11 July 1853. Storm-force easterlies Sydney, bar down to 995.3 hPa and signal station unroofed. Brig 134 tons broke up in heavy swell South Head, ketch ashore Shoalhaven River.	ECL	11 July 1853				
16	11–14 August 1854. Intense low below 990 hPa. Schooner <i>Isabella</i> lost with 20 passengers and crew. Wind damage in Sydney and vessels damaged between Nowra and Port Macquarie.	ECL	12 August 1854				20
17	6–10 November 1856. ECL. Large loss of life. Eight vessels, between central NSW to Bass Strait, lost in violent gale.	ECL	8 November 1856			2	20
18	17 May 1857. <i>May Rose</i> light ship broke free off Moreton Island and disappeared, 16 lost.	TI3	18 May 1857				16
19	15–18 June 1857. ECL near Newcastle. Three vessels lost.	ECL	16 June 1857	7			
20	26–28 July 1857. ECL near Newcastle at least 13 lives lost at sea.	ECL	27 July 1857				13
21	20 August 1857. The <i>Dunbah</i> storm. 121 lives lost from the <i>Dunbah</i> .	ECL	20 August 1857	15		121	
22	29 July–6 August 1859. long lived storm N NSW and vessels lost Tweed to Newcastle. Around 12 lives lost Tweed Bar.	ECL	3 August 1859			12	
23	22–25 July 1860. Low passed east of Sydney. Huge waves came through the Heads. Three vessels wrecked.	ECL	23 July 1860	1			
24	16–18 November 1860. ECL strong ESE to SE gales Sydney. Two vessels wrecked and immense trees torn up from roots.	ECL	17 November 1860	1		2	
25	13–17 February 1863. Severe TC moved into NSW. Severe beach erosion, ships and breakwater damaged.	TI3	14 February 1863	16			
26	15–21 March 1863. Severe TC passed east of Brisbane. Two vessels lost and one drowning in Moreton Bay.	TI1	17 March 1863			1	10
27	8–12 February 1864. TC off Central Qld coast. Many fatalities, at least 17 in floods and three in ocean.	TI2	10 February 1864	17		3	
28	17–20 March 1864. TC close to SEQ, 24 fatalities at sea.	TI1	18 March 1864				24
29	2–3 June 1864. Low near Newcastle. Coastal wave damage and six ships lost.	ECL	3 June 1864			10	7
30	10–12 June 1864. Measured winds 65 knots, Sydney Observatory. Severe wave damage and four ships wrecked.	ECL	11 June 1864				
31	30 September–1 October 1864. Southerly gales Central and South Coast, very heavy seas and swells. Many vessels lost.	TAS	30 September 1864			17	6
32	13–15 January 1865. Unusually intense low developed off Tweed Heads. Steamer and punt lost.	T3	14 January 1865				31

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No.	Severe events destructive wind or ocean effects	Type	Date	I	II	III	IV
33	12 July 1866. Great gale. Many vessels lost.	ECL	12 July 1866				100
34	19–21 June 1867. The Catherine Hill Gale.	ECL	20 June 1867	36		4	1
35	ECL 14–17 February 1868. Enormous seas breaking right across Sydney Heads, many vessels wrecked.	ECL	15 February 1868			10	33
36	ECL 12–13 February 1869. Five ships lost Newcastle to Wollongong.	ECL	13 February 1869				19
37	8–9 May 1869. Severe ECL with eight vessels lost.	ECL	8 May 1869	2			20
38	4–10 March 1870 A TC crossed the coast near Maryborough with five shipwrecks in Qld/NSW.	TI1	8 March 1870	2			20
39	18–21 March 1870. ECL developed north coast NSW and moved south to Sydney.	ECL	20 March 1870	8			6
40	25–26 April 1870. The Walter Hood Storm. An intense ECL developed near Ulladulla.	ECL	26 April 1870	7			20
41	24–26 December 1870. Slow moving ECL near Kempsey with five vessels lost.	ECL	25 December 1870	1			3
42	4–6 October 1872. Low developed near Sydney. Two vessels wrecked and a schooner disappeared with the crew.	ECL	5 October 1872				8
43	9–12 January 1873. Four vessels lost with about 20 fatalities.	TI2	10 January 1873				20
44	Gothenberg Cyclone 23 February–2 March 1875. Vessels suffered severe damage in seas Sydney to Brisbane.	TI3	26 February 1875	1			
45	St Magnus Gale 15–19 March 1875. Six vessels lost between Northumberland Island (Central Qld) and Sandon River (NSW).	TI3	17 March 1875			8	20
46	ECL 15–19 July 1876, six vessels wrecked.	ECL	17 July 1876	9			6
47	Dandenong Gale of 10–12 September 1876. All-time record wind speed measured in Sydney and unprecedented storm surge in Manly.	TI3	11 September 1876				50
48	11–15 July 1877. Yarra Yarra Gale ECL. Five vessels lost – severe wind damage in Sydney.	ECL	13 July 1877				18
49	1–3 June 1878. ECL, three vessels lost with all on board in one schooner.	ECL	3 July 1878				6
50	ECL 14–16 February 1879. Two vessels wrecked and barquentine disappeared after leaving Newcastle for NZ.	ECL	15 February 1879				8
51	23–25 June 1879. ECL. Two schooners wrecked Trial Bay.	ECL	24 June 1879	1			
52	ECL 6–8 August 1879. Ocean came over Solitary Island (25 m high).	ECL	7 August 1879				
53	27–28 September 1880. Three schooners left Sydney for N NSW coast and disappeared in severe gale and ship broke up near Newcastle.	ECL	28 September 1880				20
54	ECL near Port Macquarie 22–24 September 1881. Three vessels wrecked.	ECL	23 September 1881				
55	18–20 October 1881. Many lives lost at sea. Measured 78 knot gust in Sydney with much damage.	ECL	19 October 1881				31
56	24–29 October 1882. Seventeen fatalities in steamer off Botany Bay, enormous easterly seas.	ECL	27 October 1882				17
57	5–7 February 1883. Huge southerly swell, record storm tides SEQ and ocean liner severely damaged off Sydney.	ECL	6 February 1883				
58	26–29 July 1886. Two vessels wrecked from huge seas travelling from Sydney to Brisbane.	ECL	28 July 1886				
59	23 January 1887. Brisbane TC seas breaking over the jetty and at Sandgate, all the bathing houses were washed away	TI1	23 January 1887	28			
60	TC 8–13 February 1887. Seven vessels wrecked.	TI1	10 February 1887				4
61	8–11 October 1888. At Yamba, wind unroofed many houses. Three vessels wrecked.	ECL	10 October 1888			4	
62	26 May 1889. Ocean damage, Manly and Kiama.	TI3	26 May 1889	3		1	
63	17–20 July 1889. Twelve vessels lost with many casualties.	TI3	18 July 1889				14
64	24 January to 4 February 1890. Two men drowned and unknown number drowned in three lost vessels.	TI2	1 February 1890	2			10
65	10–13 March 1890. Ship lost with eight on board. Major storm surge Southport.	TI1	12 March 1890	26		8	
66	9–13 March 1891. Gold Coast and Forster – immense damage to coastal infrastructure. One ship abandoned and another was wrecked.	TI1	8 March 1891				12
67	8–9 June 1891. Large storm surge Sandgate, Cleveland, Wynnum and Redland Bay caused much damage. Four vessels wrecked.	TI3	9 June 1891				
68	26–27 February 1892. Crew of schooner <i>Queen</i> lost near Port Macquarie.	ECL	27 February 1892				6
69	1–4 April 1892. Severe wind damage Brisbane and Gold Coast, tornado at Tweed Heads. Schooner <i>Bellringer</i> driven ashore at Stradbroke Island. 0.61 m surge at Moreton Bay. At Southport, seven chains of the seawall were washed away. At Ballina, the south spit was washed away, leaving an opening nearly two miles wide.	TI1	2 February 1892	4	1		

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No.	Severe events destructive wind or ocean effects	Type	Date	I	II	III	IV
70	23–24 September 1892. Sydney, 104 knots with many buildings damaged or unroofed. Schooner disappeared. Man drowned in harbour.	ECL	24 September 1892		1	1	8
71	11–12 November 1892. Huge waves crashed over steamer near Sydney, sweeping seaman to his death and another steamer lost in heavy seas.	ECL	12 November 1892				1
72	1–5 January 1893. Large storm surge and waves inundated Ballina with great damage. Ketch disappeared. Seas broke over Julian Rocks, Byron Bay.	TI2	3 January 1893	2			6
73	21–22 January 1893. Severe sea damage Sandgate and Cleveland with 0.58 m storm surge. Huge waves destroyed a beached steamer, Byron Bay.	TI1	22 January 1893	1	1		
74	1–4 February 1893. Steamer <i>Dicky</i> (226 tons) was wrecked in heavy seas near Caloundra.	TI3	3 February 1893	30			
75	18 February 1893. TC 0.61 m surge, Moreton Bay	TI1	18 February 1893	6			
76	8–10 March 1893. Immense damage in Newcastle from wind and flash flooding.	ECL	9 March 1893	10			
77	10–12 June 1893. Three fatalities. Wollongong harbour works severely damaged. Beacons and buoys were washed away by large waves at Forster, Ballina and Harrington. In Sydney, huge waves dashed high against the rocks of North, South and Middle Heads, and Dobroyd Point.	TI3	11 June 1893	3			
78	18–19 February 1894. Large storm surge with severe damage and erosion, Southport. Storm surge inundated Ballina.	TI1	19 February 1894				
79	Tropical low moved from Coral Sea into Tasman Sea 11–15 March 1894. Three vessels wrecked.	TI3	13 March 1894	1			
80	TC Mu severe erosion, Southport.	TI1	2 February 1895				
81	31 May–1 June 1897. Sydney Tornado. Very heavy seas Tweed to Illawarra with four vessels wrecked.	ECL	31 May 1897				
82	25–26 July 1897. Vessels driven ashore Coolangatta, Byron Bay and South West Rocks where part of breakwater swept away.	ECL	26 July 1897	1			
83	13–14 February 1898. Monsoon low Ramagh. Three coastal vessels and a ship wrecked.	TI3	14 February 1898	3	1	14	13
84	The Maitland Gale 5–7 May 1898. Fifteen vessels lost, NSW coast. Destructive wind damage at Newcastle.	ECL	6 May 1898			24	26
85	3–5 April 1899. Gusts measured to 62 knots Sydney and ship wrecked at Newcastle.	ECL	4 April 1899				
86	Low developed over Sydney 6–8 June 1900. Three vessels lost including 1499-ton ship.	ECL	7 June 1900				
87	4–6 July 1900. Exceptionally large waves Kiama and Wollongong.	ECL	5 July 1900				
88	23 July 1900. ECL. Three drowned in rescue attempt of wrecked schooner in huge seas at Forster Bar.	ECL	23 July 1900			3	
89	24–27 May 1903. Oakland storm. Steamship lost at Port Stephens. Mountainous seas severely damaged breakwater at Port Kembla, Wollongong and Newcastle.	ECL	26 May 1893				11
90	<i>S.S. Nemesis</i> tragedy 8–11 July 1904.	ECL	9 July 1904				32
91	ECL 30–31 August 1906. Schooner broke up in big seas.	ECL	31 August 1906				7
92	1–2 February 1908. Cruise ship damaged off Sydney Heads and ferries damaged in harbour. Wind damage, Watsons Bay.	ECL	01 February 1908				
93	ECL 25–28 September 1909. Breakwater severely damaged at Newcastle. Man swept off breakwater at Port Kembla and drowned. A ship abandoned.	ECL	25 September 1909			1	
94	ECL 18–19 July 1910. Waves at Manly broke over the sea walls. Waves caused serious damage to breakwaters at Port Kembla. Severe wind damage Sydney.	ECL	19 July 1910				
95	TC from Gulf to Sydney 11–13 January 1911. Record easterly gust Sydney 72 knots; three ships wrecked.	TI3	12 January 1911				
96	Exceptionally large fetch southerly gales 15–16 September 1911. Three ships lost.	TAS	16 September 1911				50
97	14–17 July 1912. Exceptional beach erosion even inside Sydney Harbour 3-m erosion scarps. Massive sea damage Kiama, Manning Heads and Newcastle.	TAS	16 July 1912				
98	8–9 March 1913. Wind, flood and sea damage to houses in Sydney. Tornado at Manly. Yacht <i>Thelma</i> (25 tons) wrecked by very large waves on the bombora at Dobroyd Point in Sydney Harbour and one drowned. Small boats broken up by the violence of the sea at Manly, with one drowned. At Verrell's Beach, several boats were wrecked, and in one case boats were lifted bodily from the beach to the scrub 20 ft above. Man drowned, Botany Bay. Many weekender cottages with ocean and harbour frontages were wrecked.	TI3	9 March 1913	2	1	3	
99	13–15 May 1913. One fatality. Heavy swell in Sydney through the Heads grounded a steamer.	ECL	14 May 1913	1			

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No.	Severe events destructive wind or ocean effects	Type	Date	I	II	III	IV
100	17–19 June 1914. Vessel disappeared and two others wrecked. Extensive damage and shoreline erosion Coffs Harbour. Wind caused extensive damage in Sydney.	ECL	18 June 1914			6	4
101	18–20 October 1914. <i>Rozelle</i> schooner (98 tons) wrecked near Cape Three Points. Sudden storm destroyed all six fishing boats Coffs Harbour.	ECL	19 October 1914				
102	21–23 June 1917. Coffs Harbour, severe damage in the harbour from heavy seas, at Nambucca damage to the jetty, training wall and breakwater.	ECL	22 June 1917				
103	19 September 1917. Steamer wrecked Norah Head in mountainous seas. Extensive severe structural wind damage in Sydney.	ECL	19 September 1917		1	3	
104	15–21 May 1919. Six fatalities. <i>S.S. Tuggerah</i> foundered near Port Hacking.	TI3	18 May 1919			6	
105	9–12 December 1920. Newcastle recorded wind gusts of 67 knots. Enormous damage at Newcastle and two ships driven ashore. The sea came into the sand hills at Stockton. South Head at Sydney recorded 61 knots when the velocity recording caps blew off. In Sydney houses were unroofed. Property damage from waves, Collaroy and Narrabeen.	ECL	11 December 1920		1		
106	6–8 April 1921. Steamer in distress in heavy seas off Jervis Bay (navy to aid). Launch driven ashore, Gunnamatta Bay. Severe wind damage, Cronulla.	TI3	7 April 1921				
107	14–16 May 1921. Major landslide, Byron Bay. A ship and a large fishing boat wrecked at Byron Bay.	ECL	15 May 1921		2		
108	25–27 June 1921. Intense bomb low off N NSW coast. Two ships foundered, wreckage was from Smoky Cape to Curl Curl.	ECL	26 June 1921				36
109	<i>S.S. Sumatra</i> low 25–26 June 1923. Iron screw steamer, 584 tons foundered off Port Macquarie and a ship was driven ashore at Cronulla.	ECL	26 June 1923				46
110	16–19 May 1926. Severe infrastructure damage by waves at Kirra. Two ships adrift for a week.	TI3	18 May 1926				
111	TC 1–2 April 1927. Heavy seas severe erosion Gold Coast/Tweed. Record high tide, Gold Coast.	TI1	2 April 1927		1		
112	15–18 April 1927. Severe structural wind damage, Sydney suburbs. Eleven people died in a launch disaster in Botany Bay.	ECL	17 April 1927		2	5	11
113	Weather bomb 13–15 June 1928. Two ships wrecked near Newcastle and severe structural wind damage there. Houses were unroofed, Sydney and surrounds. Large tides caused damage to jetties etc at Gosford. Storm surge (0.58 m) Moreton Bay 1000UTC 16 June 1928.	ECL	14 June 1928		1	5	5
114	ECL 7–9 February 1929. A collier foundered off Sydney Heads.	ECL	8 February 1929	4	1		6
115	27–29 February 1929. Waves caused severe erosion and infrastructure damage at Coolangatta and Byron Bay. Passenger ship disabled off Brisbane.	TC1	28 February 1929				
115	29–30 June 1929. Steamship severely damaged. Waves breached the Southport Spit, road at Currumbin and Tweed. Severe wind damage Brisbane to N NSW.	TI3	30 June 1929		3		
117	9–12 September 1929. Launch wrecked on Seal Rocks. Wind damage in Newcastle.	ECL	10 September 1929		1		
118	31 May–2 June 1930. Wind and storm surge damage at Cronulla. Vessels driven ashore harbour and Cronulla.	TI3	02 June 1930		1		
119	1–8 February 1931. Storm surge of 0.76 m on Moreton Bay tide gauge. Severe beach erosion Gold Coast and N NSW.	TI2	5 February 1931				
120	5–7 July 1931. In Sydney, houses and shops were unroofed.	ECL	6 July 1931		7		
121	23–24 June 1933. Collier disappeared with 18 seamen.	ECL	24 June 1933				18
122	30 January–2 February 1934. Record storm surge Moreton Bay tide gauge 1.16 m. Bar Sydney down to 989.8 hPa. Exceptionally large waves Sydney (reported 40 feet high at Bondi). A fishing boat overturned in the heavy surf at Cronulla and one man drowned.	TI3	31 January 1934		1	1	
123	14–19 June 1935. Unprecedented waves and storm surge at Coogee with clubhouse (30 feet above sea level) severely damaged. General damage along the whole coast to buildings, promenades, sea walls and roads. Scores of small launches and sailing boats in coastal harbours were severely damaged. The Balmoral Baths in Sydney Harbour were smashed to pieces.	TAS	17 June 1935			5	
124	22 March 1936. Very large waves and storm surge damage Brisbane to Tweed Coast. Severe beach erosion with buildings and crops damaged.	TI1	22 March 1936				
125	23–25 June 1936. Severe structural wind damage to houses at Moruya with huge trees uprooted. Launches severely damaged, Sydney Harbour.	ECL	23 June 1936				
126	17–21 February 1937. Woolgoolga Jetty, Byron Bay Pier and Coffs Harbour Breakwater severely damaged by large waves. Boy drowned at Bondi with many rescues, NSW coast.	TI1	19 February 1937		5	1	

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No.	Severe events destructive wind or ocean effects	Type	Date	I	II	III	IV
127	15–16 March 1937. Steamer <i>Haiping</i> abandoned. The sea broke over a retaining wall at Manly, Brisbane.	TI3	16 March 1937	1			
128	17–20 January 1938. Flooding from storm surge, Brisbane and Moreton Bay. Large waves and storm surge, Gold Coast, with waves breaking a mile off Kirra Point.	TI1	18 January 1938	1			
128	Black Sunday 6 February 1938. A 965-hPa low east of Bass Strait 4 February moved to NZ. Large southern swell hit Bondi, Newcastle and Surfers Paradise 6 February. At Bondi, 200 lives saved but five lost. One drowned at Newcastle Beach.	TAS	6 February 1938			6	
130	4–6 March 1939. Large waves and storm surge damaged coastal installations in SEQ and Coffs Harbour. Ships at sea suffered damage.	TI3	5 March 1939	1			
131	27–28 March 1942. Exceptional wave heights from 400 nm fetch of gales. In Sydney houses were unroofed.	ECL	28 March 1942	6			
132	12–15 October 1942. Thirty boats destroyed at The Entrance. At Bronte seas broke over the Beach Park. Severe wave damage, Balmoral Beach and in the harbour.	ECL	14 October 1942	1			
133	7–9 April 1945. Many homes unroofed in Sydney. Brighton-le-Sands Life-saving Club was demolished by waves.	ECL	8 April 1945				
134	10–11 June 1945. Destructive waves, storm surge. Tornado at Mona Vale. A man was swept off the esplanade at Manly, Sydney. Two ships driven ashore. Houses destroyed by waves, Collaroy and Narrabeen.	TI3	11 June 1945	5	2	2	1
135	23–26 March 1946. Storm surge on main Gold Coast highway. Storm surge (0.73 m) Moreton Bay tide gauge.	TI3	24 March 1946	5			
136	23 January 1947. Tug wrecked Clarence River bar. Waves broke into beach pavilion and flooded campers at Kirra.	TI1	23 January 1947	2			
137	28–30 January 1948. Ocean damage to properties and beaches Maroochydore to Tweed. Sydney, 185 rescues. Gust of 96 knots recorded at Lord Howe Island.	TI3	29 January 1948				
138	14–16 June 1948. Six deep-sea fishing launches lost at Byron Bay.	TI3	15 June 1948				
139	20–23 February 1949. Ship <i>Bombo</i> sank in huge seas 8 km off Wollongong with crew of 12 lost.	TAS	22 February 1949				12
140	3–5 June 1949. Seas described as the largest in 40 years; 71 knot gust, Sydney Airport. Houses and buildings unroofed in Sydney.	TAS	4 June 1949		2		
141	25–26 August 1949. Nine fishing launches and two valuable yachts were washed ashore at Coffs Harbour.	ECL	25 August 1949	6			
142	16–19 January 1950. Tornado at Hendra. Large destructive waves and storm surge between Brisbane and Sydney with a girl swept off the esplanade at Cronulla to her death.	TI3	18 January 1950	6	3	1	
143	21–26 June 1950. Two ships lost. Cronulla surf club collapsed into sea and extensive damage to other foreshore installations along the NSW coast.	ECL	23 June 1950	11			17
144	17–19 January 1951. Collier foundered off The Entrance. Large waves damaged craft, Sydney Harbour.	ECL	18 January 1951	6			6
145	20–26 January 1951. Severe erosion Gold Coast with spit breached, storm surge Mermaid Beach, Burleigh, and large boulders hurled across the road at Currumbin.	TI3	23 January 1951				
146	7–8 June 1951. Heavy seas and gales, craft damaged, Sydney Harbour. Ferries suspended.	ECL	8 June 1951				
147	24–26 September 1951. Large storm surge Jerry Bailey (Shoalhaven River).	ECL	25 September 1951	1			
148	14–16 June 1952. Three-metre waves, Balmoral Beach, and many craft damaged in the harbour. Wave caused fatality at Whale Beach. Gusts exceeding 71 knots caused widespread damage around Sydney and suburbs.	ECL	15 June 1952	3		1	
149	24–28 July 1952. Near Sydney. Large seas with shipping delayed, and beach erosion.	ECL	26 July 1952				
150	19–22 February 1954. Large storm surges, Gold Coast and N NSW, and severe beach erosion. Large storm surge, Byron Bay, jetty swept away with entire fishing fleet.	TI1	21 February 1954	30			
151	11–13 July 1954. Gust of 74 knots recorded at Redland Bay. Major sea damage Moreton Bay. Ship reports 21 m waves off Gold Coast.	TI3	12 July 1954				
152	16–17 February 1955. Massive SE fetch 'seas worst seen in harbour'.	ECL	17 February 1955				
153	26 March–4 April 1955. Prolonged period of large waves and beach erosion.	TI1	27 March 1955	1			
154	30 April–1 May 1955. Two men swept out to sea and drowned after capsizing their boat, Sydney Harbour.	ECL	1 May 1955	1			2
155	24 February–1 March 1956. Mountainous seas.	TI3	27 February 1956				

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No.	Severe events destructive wind or ocean effects	Type	Date	I	II	III	IV
156	10 June 1956. Severe damage Sydney and gusts reached 135 km/h (73 knots) at Sydney Observatory. Record high tides Sydney. One hundred small boats damaged in the harbour. A man was swept into the sea along the cliff road at Tathra.	ECL	10 June 1956			1	
157	24–26 June 1956. Mountainous seas South Coast and Bass Strait, and ship sunk near Wilsons Promontory.	ECL	25 June 1956				8
158	2 August 1956. Steamer, 640 tons lost at Avalon when struck by a huge wave.	TAS	2 August 1956				10
159	19 February 1957. Waves inundated Pacific Highway at Kirra. Beachfront home undermined at Tugun. Extensive damage to shipping, harbours and foreshores N NSW.	TI3	19 February 1957				
160	22–24 August 1957. Damage in Sydney and to ships in harbour.	ECL	23 August 1957				
161	9–11 March 1958. Heavy seas and erosion Central Coast NSW. Landslides and shipping delayed.	ECL	10 March 1958				
162	8–12 June 1958. Waves over 10 m reported off SEQ and NSW Coasts out to 640 km. Ships sustained damage. Severe Beach Erosion. Floods in SEQ.	TI3	10 June 1958				
163	29 June–1 July 1958. Intense low. Newcastle shipping delayed and coastal damage.	ECL	30 June 1958				
164	21–22 January 1959. ECL Newcastle, severe beach erosion and coastal damage.	TI3	21 January 1959				
165	21 July 1959. Widespread wind damage, shipping damage and storm surge, Sydney, with 57 knot gust.	ECL	21 July 1959				
166	4–5 October 1959. Sea wall lost at Dee Why and many yachts lost.	ECL	5 October 1959				
167	24–26 May 1960. Extensive sea damage to Gold Coast and Tweed Beaches and interruptions to shipping.	TI3	25 May 1960				
168	3–4 December 1960. Small boats wrecked. Storm surge Sydney. Heavy swell NSW coast.	ECL	4 December 1960			3	
169	3–6 May 1961. Ships in difficulty at Port Kembla. Very heavy swell 7 May. Road to Kurnell damaged by waves.	TAS	5 May 1961				
170	6–9 April 1962. Heavy seas damaged the breakwater at Port Stephens.	TI3	7 April 1962				
171	9–12 July 1962. Small craft were lost or damaged at North Coast harbours. Extensive beach erosion. Two tornadoes at Port Macquarie.	ECL	11 July 1962	3	3		
172	1 January 1963. Huge seas and beach erosion, Gold Coast and Tweed.	TI3	1 January 1963				
173	24–29 April 1963. A US Navy ship suffered damage off the South Qld Coast in 13 m waves.	TI3	26 April 1963				
174	7–9 May 1963. Large storm tide, Gold Coast. Waist deep water in Sutton St, Redcliffe, and other streets were under 5 feet of water.	ECL	8 May 1963				
175	23–25 August 1964. Severe tornado at Smithtown near Kempsey. Heavy seas NSW South Coast.	ECL	24 August 1964				
176	18–21 July 1965. Many small craft damaged, Moreton Bay.	ECL	20 July 1965				
177	17–19 February 1966. Considerable damage to small craft and beaches, NSW coast.	TI3	18 February 1966				
178	20–22 May 1966. Storm surge of 0.38 m at Sydney. The dredge <i>WD Atlas</i> foundered 18 km SE of Jervis Bay.	TAS	21 May 1966				13
179	9–13 June 1966. Storm surge at Sydney of 0.51 m. Brighton Beach, Botany Bay, badly eroded.	ECL	11 June 1966				
180	28–31 January 1967. Massive waves and storm surge damage SEQ and N NSW.	TI1	30 January 1967				
181	18–19 March 1967. Severe beach erosion.	TI1	18 March 1967				
182	2–4 April 1967. Gold Coast and Tweed beaches completely eroded by large waves.	TI1	3 April 1967				
183	10–14 June 1967. Severe beach erosion, Gold Coast and N NSW.	TI3	11 June 1967	3	1		
184	26–28 June 1967. Culminating erosion event on the Gold Coast with buildings and houses lost to the sea and many houses damaged. Volunteer army of 5000 people placed around 100 000 sandbags along the foreshore, helping to prevent many houses being lost to the sea. Severe erosion N NSW coast.	ECL	27 June 1967		1		1
185	4–6 September 1967. Property damage from waves Collaroy and Narrabeen. Hsig estimated greater than 6 m.	ECL	5 September 1967				
186	13–15 May 1968. Huge waves hit Sydney. Extensive erosion, Botany Bay. Sydney Airport southerly gust 62 knots 15 May.	TAS	14 May 1968				
187	24–25 August 1969. <i>Noongah</i> , steel motor vessel, freighter, (1465 tons) foundered in a gale off Smoky Cape.	ECL	24 August 1969				21
188	8–10 December 1970. Swells of 9 m at Bass Strait oil rigs. Exceptionally large swells NSW South Coast and beach erosion.	ECL	9 December 1970				
189	25 July 1971. Severe winds caused damage at Coffs Harbour and Mid North Coast. Significant wave heights greater than 6 m.	TAS	25 July 1971				

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No.	Severe events destructive wind or ocean effects	Type	Date	I	II	III	IV
190	11–13 February 1972. Storm surge and severe erosion, Gold Coast and Tweed.	TI1	12 February 1972				
191	12–16 June 1973. Severe beach erosion, Bengello Beach, Moruya.	TAS	13 June 1973				
192	5–8 July 1973. Mean winds of 40 to 55 knots along the Tweed–Gold Coast, exceptionally large waves and severe erosion.	TI3	7 July 1973	4			
193	25–29 January 1974. Severe beach erosion, Gold Coast and Tweed.	TI3	27 January 1974	10	8		
194	6–9 February 1974. Buildings and houses damaged by waves, Gold Coast, Tweed, Botany Bay and Tathra.	TI1	8 February 1974				
195	9–13 March 1974. Prolonged large waves and erosion.	TI3	12 March 1974				
196	26 May 1974. Gust to 92 knots, Nobbys, and severe structural wind damage, Newcastle. Severe coastal erosion along Central Coast and in Sydney Harbour. Ship <i>Syigna</i> wrecked. Seven fatalities and hundreds of homes wrecked.	ECL	26 May 1974			3	4
197	8–11 June 1974. Continuation of severe coastal erosion from large waves.	TAS	6 June 1974				
198	4–6 August 1974. Hsig Botany Bay 5.2 m.	TAS	6 August 1974				
199	21 June 1975. Max gusts Nobbys 77 knots, Nowra 62 knots, Sydney City 59 knots; 0.44 m storm surge, Sydney. Hsig 7.0 m Botany Bay Buoy.	ECL	21 June 1975				
200	19 January 1976. Large waves and storm surge Yeppoon to N NSW.	TI1	19 January 1976				
201	1–5 March 1976. Houses damaged by winds, Swansea. Large waves Qld/NSW penetrated Botany Bay, destroying launches and swept person off a cliff at Tathra.	TI3	29 February 1976			1	
202	15–18 May 1977. Boat lost in exceptionally large waves Sandon River. Storm surge of 0.49 m, Coffs Harbour. Coffs Harbour Hsig 5.5 m peak 9.3 m Tp 12.1 s from SE. Byron Bay Hsig 5.6 m peak 9.5 m Tp 11.2 s from 112 ESE.	ECL	17 May 1977				5
203	17–21 March 1978. Claimed six lives. Gusts to 71 knots, Nobbys. Sydney Airport gusts to 95 km/h (56 knots). Long fetch gale to storm-force winds Central Coast.	TI3	19 March 1978	6			
204	1–3 June 1978. Waves South Coast NSW. Houses undermined. Eden, significant wave height 6.5 m. Peak period 13.0 s from ESE. Kingfish B Bass Strait, Hsig 9.2 m.	ECL	2 June 1978				
205	14–19 June 1978. Houses undermined by sea, 0.43 m storm surge at Sydney and 0.44 m at Coffs Harbour. Gust 62 knots.	ECL	16 June 1978				
206	Low 6–10 May 1980. Six houses at Labrador, Gold Coast, flooded by 1 m of water (6 May). Brisbane Hsig 5.7 m Tp 11.7 s, Byron Bay Hsig 5.8 m peak 9.8 m Tp 11.2 s from 90 E.	ECL	8 May 1980				
207	3–5 June 1983. Gusts to 70 knots at Cape Byron. Brisbane Hsig 5.6 m Tp 11.0 s. Beach erosion, Gold Coast.	ECL	4 June 1983				
208	7–9 April 1984. Gold Coast, 250 houses unroofed and 2000 damaged. Similar damage at Tweed. Extensive beach erosion Gold Coast, Kirra groyne damaged. Five helicopter rescues of stricken yachts. Coffs Harbour Hsig 6.2 m Tp 10.1 s from 112 ESE.	TI3	8 April 1984				
209	28 July 1984. Structural wind damage, Sydney. Yacht wrecked NSW S Coast, where ship read gusts to 82 knots.	ECL	28 July 1984			1	
210	8–10 July 1985. Coffs Harbour Hsig 6.6 m peak 12.2 m Tp 9.3 s from 157 SSE.	TI3	9 July 1985				
211	21–26 October 1985. Eden. Hsig 6.1 m peak 10.4 m Tp 11.0 s from SE. Hsig 4.9 m from SE, Coffs Harbour, and 4.7 m from ESE, Byron Bay. A waterspout came ashore in the Redcliffe, Margate area and damaged 21 buildings.	ECL	24 October 1985				
212	5–8 August 1986. Severe beach erosion Sydney with large saltwater inundation. Sydney's significant wave height 7.5 m peak period 15.1 s. Coffs Harbour Hsig 6.4 m peak 11.1 m Tp 12.7 s from 135 SE.	ECL	6 August 1986	6			
213	19–21 November 1986. Low in the SW Tasman Sea. Gusts to 63 knots, Nobbys. Peak wave heights on Botany Bay buoy exceeded 12 m.	TAS	20 November 1986				
214	11–13 November 1987. Rapidly developing Lord Howe low. Nobbys gusts SSE 68 knots, Sydney Hsig 6.75 m and peak 11.34 m from the SSE.	TAS	12 November 1987				
215	9–11 February 1988. Coffs Harbour Hsig 6.4 m peak 12.2 m Tp 12.7 s from 180 S.	TAS	10 February 1988				
216	5–7 July 1988. Nobbys gusts 75 knots, Extensive wind damage Sydney beach suburbs. Eden Buoy Hsig height 5.9 m (peak 10.0 m) from east.	TI3	7 July 1988				
217	14–16 Sep 1988. Large swells, Gold Coast and N NSW. Byron Bay buoy Hsig 6.0 m from SE.	ECL	15 September 1988				
218	24–25 April 1989. Severe beach erosion Sunshine, Gold and Tweed Coasts. Hsig to 6.11 m. Byron Bay Hsig 5.9 m peak 10.3 m Tp 10.5 s from 90 E.	TI3	25 April 1989	2			
219	19–23 June 1989. Record wave heights Coffs Harbour Buoy. Hsig 7.4 m peak height 13.5 m Tp 11.2 s from SE.	ECL	21 June 1989				

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No.	Severe events destructive wind or ocean effects	Type	Date	I	II	III	IV
220	11–14 July 1989. Eden. Hsig 6.7 m peak 10.2 m Tp 12.3 s from south. Little erosion, Moruya.	TAS	12 July 1989				
221	1–3 August 1990. Sydney, 0.38 m storm surge, Hsig 7.19 m from SE; 62 knot gust, Sydney Airport.	ECL	2 August 1990				
222	25–27 August 1990. Sydney, significant wave height 6.28 m; Hsig > 3 m for 64 h.	TAS	26 August 1990				
223	11–13 October 1990. Eden Hsig 6.4 m peak 11.1 m Tp 11.2 s from S. Batemans Bay Hsig 6.0 m peak 10.9 m Tp 12.6 s from SSE. Significant erosion, Moruya.	TAS	12 October 1990				
224	17 March 1993. Hsig to 7.5 m Brisbane Buoy (record) and large storm surges, Gold Coast and N NSW. Severe beach erosion. Byron Bay Hsig 5.5 m peak 8.8 m Tp 9.9 s from 45 NE	TI3	17 March 1993	1			
225	11–15 March 1994. Hsig 6.7 m peak 12.4 m Tp from 180 S. Start of erosion, Moruya.	ECL	12 March 1994				
226	14–16 February 1995. Hsig to 6.42 m (Brisbane Buoy). Byron Bay Hsig 5.6 m peak 9.1 m Tp 10.7 s from 90 E.	TI3	15 February 1995				
227	1–7 March 1995. Severe beach erosion, N Coast NSW. Hsig Coffs Harbour 6.2 m from E. Sydney Hsig 5.1 m Tp 10.7s from E. 3–8 March 1995 Byron Bay Hsig 5.8 m 10.7 m Tp 11.2 s from 112 ESE.	TI3	6 March 1995				
228	14–17 February 1996. Storm surge of 0.59 m, Gold Coast. Injuries from waves <i>QEII</i> off Yamba. Hsig 6.19 m (Brisbane Buoy). Byron Bay Hsig 5.4 m peak 9.4 m Tp 11.4 s from 135 SE.	TI3	15 February 1996				
229	1996 Mayday Weekend. Long-period waves (12–14 s) battered Gold Coast and Tweed with Hsig to 6.9 m and the worst beach erosion since 1989. Coffs Harbour Hsig 5.2 m Tp 10.6s from 67 ENE.	TI3	2 May 1996	5			
230	30 August–1 September 1996. Gusts to 64 knots near Wollongong. Batemans Bay record wave heights, Hsig to 7.2 m Tp 11.5 s from E. Eden 6.8 m Hsig Tp 11.6 s from ESE. Severe erosion, Moruya. Sydney Hsig 6.1 m Tp 10.5 s from SE.	ECL	30 August 1996	3			
231	9–11 May 1997. Record Sydney Hsig 8.43 m Tp 11.5 s from 151° SSE. Serious damage to Breakwater at Coffs Harbour Tp to 17 s. Severe erosion Moruya. Byron Bay Hsig 6.0 m peak 10.2 m Tp 11.8 s from 180 S.	TAS	10 May 1997				
232	23–26 June 1998. Huge seas NSW S Coast. Max gust 82 knots, Nobbys. Much damage to houses and marine craft, Newcastle. Eden Hsig to 6.4 m from S.	TAS	23 June 1998				
233	7–8 August 1998. 62 knot gust Sydney and 71 knot gust Nobbys. Ports of Botany Bay and Port Jackson closed. Hsig to 5.6 m (Eden) from SE. Sydney Hsig 5.0 m SE.	ECL	8 August 1998	4	1		
234	20–25 May 1999. Four helicopter rescues to stricken yachts off Brisbane and Port Macquarie. Long-period large waves Tp 14.2s Hsig 5.0 m from ENE at Eden. Sydney Tp 14.9 s Hsig 4.5 m from ENE. Coffs Harbour Hsig 5.3 m peak 10.6 m Tp 11.6 s from ESE. Byron Bay Hsig 5.0 m peak 8.8 m Tp 13.3 s from 112 ESE.	TI3	23 May 1999				
235	14–16 July 1999. Hsig 6.8 m Tp 11.7 s from SE, Coffs Harbour; and 6.0 m from ESE Tp 11.9 s, Sydney. Byron Bay 4.7 m Hsig Tp 11.7 s from 135 SE.	ECL	15 July 1999				
236	23–25 October 1999. Bateman Bay buoy Hsig 6.6 m peak 11.8 m from ESE.	ECL	24 October 1999				
237	8–9 March 2001. Serious beach erosion Gold Coast and N NSW. Storm surge of 0.45 m, Gold Coast, with scarping on the northern beaches of 0.5–1.5 m. Coffs Harbour Hsig 5.1 m Tp 10.2 s from 135 SE. Byron Bay Hsig 5.1 m Tp 10.2 s from SE.	ECL	9 March 2001	2			
238	27–29 July 2001. Wind gusts of 115 km/h (62 knots) were recorded Sydney (harbour closed) Hsig to 7.0 m Tp 12.6 s from S. Rescues to sailors and surfers. Hsig Batemans Bay 5.4 m Tp 10.9 s from SE.	TAS	28 July 2001				
239	18–22 November 2001. Sydney Hsig 6.2 m peak 11.5 m Tp 10.8 s from 145 SE.	ECL	19 November 2001				
240	28–30 June 2002. Large 981 hPa Tasman Sea low. Eden Buoy 28–30 June Hsig 7.1 m mean Hsig 4.5 m peak height 13.1 m Tp 11.7 s Tp from S. The large southerly swell dismasted a yacht 300 km east-northeast of Fraser Island on the 30 June.	TAS	29 June 2002				
241	25–26 June 2003. Two helicopters carried out rescues east of Cape Byron. Six major rescues off the NSW coast by lifeguards, large NE swells caused saltwater inundation at South Steyne. Sydney Hsig 5.0 m Tp 12.9 s from 086° E. Coffs Harbour Hsig 5.4 m peak 9.9 m Tp 10.7 s from 135 SE.	TI3	26 June 2003				
242	24–26 February 2004. Large long-period waves, Coffs Harbour. Hsig 6.5 m (peak 10.8 m) Tp 12–14 s.	ECL	25 February 2004				
243	4–6 March 2004. Hsig 7.1 m peak 14.3 m, Brisbane; 67 knot wind gust Cape Moreton. Large storm surge, Currumbin.	TI3	5 March 2004	3			

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No.	Severe events destructive wind or ocean effects	Type	Date	I	II	III	IV
244	Low 18–20 July 2004. Significant wave height Sydney 6.66 m peak height 10.28 m from SSE ranked 5th since 1987.	TAS	19 July 2004				
245	18–20 October 2004. SE gusts 48 knots at Coffs Harbour 20 October and gusts greater than 60 knots reported in area, with widespread wind damage. Coffs Harbour Hsig 5.7 m peak 10.0 m Tp 9.5 s from 90 E.	ECL	19 October 2004				
246	22–24 March 2005. Hsig 6.6 m peak 11.4 m Tp 10.4 s from SE Sydney. Ferries suspended, Gust to 54 knots Sydney.	ECL	23 March 2005				
247	9–11 July 2005. Tasman low 24 h rainfall to 155.0 mm, Eden (Timbillica) July record. Eden buoy significant wave heights to 6.3 m peak height 11.3 m from ESE.	TAS	10 July 2005				
248	15–17 November 2005. Coffs Harbour, significant wave heights to 6.0 m from 135° SE.	TAS	15 November 2005				
249	27–29 November 2005. Low NSW N Coast intensified east of Sydney and then tracked back towards Nowra. Bateman Bay buoy 27–29 November 2005 significant wave height 6.6 m, 11.2 m (peak) from 153 SSE.	ECL	28 November 2005				
250	3–5 March 2006. Hsig to 7.2 m (Brisbane buoy) from ESE and all-time record peak wave height of 16.8 m. Saltwater inundation, Gold Coast and Tweed.	TI3	4 March 2006				
251	8 June 2007. Sydney Hsig 6.9 m (max 14.13 m record on buoy) Tp 11.1 s. Ship aground, Nobbys. Severe beach erosion, Sydney and harbour.	ECL	8 June 2007		10		
252	17–20 June 2007. Eden Buoy Hsig 6.0 m waves from SE. Batemans Bay Hsig 5.4 m peak Tp 11.4 s from SSE. Sydney Hsig 6.0 m peak 10.3 m Tp 10.4 s 128 SE.	ECL	19 June 2007				
253	26–28 June 2007. ECL South Coast of NSW. Eden buoy 26–29 June 2007 Hsig 7.1 m peak 11.9 m Tsig 10.3 s Tp 11.6 s waves from 157° SSE.	ECL	27 June 2007				
254	27 December 2007–5 January 2008. Severe beach erosion, Gold Coast and Tweed, with Hsig to 6.2 m (Brisbane buoy). Coffs Harbour Hsig 5.0 m peak 9.6 m Tp 11.4 s from 90 E.	TI3	4 January 2008				
255	13–17 February 2009. Hsig 6.6 m Tp 10.2 s Byron Bay from E.	ECL	15 February 2009				
256	March–April 2009. Crowdy Heads Hsig to 6.0 m, Tp 12 s. Sydney Hsig 5.9 m, Tp 11.4 s from E. Coffs Harbour 30 March–2 April 2009 Hsig 5.5 m peak 9.0 m Tp 10.7 s from 135 SE.	ECL	31 March 2009				
257	19–24 May 2009. Gusts 72 knots Cape Byron and 63 knots Gold Coast Seaway. Record Hsig 7.6 m at Byron. Severe Beach erosion NSW North Coast and Manly. Coffs Harbour Hsig 6.5 m peak 11.8 m Tp 12.0 s from 099 E.	ECL	22 May 2009		1	1	
258	7–9 October 2009. Sydney Hsig 6.2 m peak 12.2 m Tp 11.7 s 183 S.	TAS	8 October 2009				
259	30 May 2010. Hsig Eden reached a record 7.3 m from the SE. Extensive beach erosion on the South Coast. Gusts 73 knots Montague Is. Batemans Bay Hsig 5.5 m Tp 11.0 s from ESE.	ECL	30 May 2010				
260	2–3 June 2010. Lennox Head, tornado caused widespread damage.	ECL	3 June 2010				
261	2–3 August 2010. Sydney Hsig 6.4 m peak heights 13.3 m Tp 11.2 s from S; gusts 75 knots, Wattamoll, and 66 knots, Jervis Bay.	TAS	3 August 2010				
262	13–15 June 2011. Tornado at Red Rock (Mid N Coast), Hsig to 5.7 m Crowdy Head. Coffs Harbour Hsig 5.3 m peak 10.2 m Tp 10.2 s from 135 SE.	ECL	14 June 2011				
263	19–22 July 2011 Hsig at Sydney buoy 3 m for 96 h (a record) (since 1987). Hsig 6.3 m peak 11.3 m Tp 11.7 s from S. Eden Hsig 5.9 m peak 10.0 m Tp 11.6 s from SE. Batemans Bay 5.6 m Hsig Tp 11.6 s from ESE.	ECL	21 July 2011				
264	5 June 2012. Sutherland Shire, severe wind damage. Sydney severe beach erosion. Sydney buoy Hsig 7.7 m Tp 14 s from S at 1600UTC 5 June. Batemans Bay promenade washed away and Hsig 6.0 m Tp 13 s from SE.	ECL	5 June 2012				
265	11–12 June 2012. Brisbane Hsig 6.3 m (max height 11.9 m) Tp 13 s from ESE. Peak heights of 11.3 m at Byron. Severe beach erosion.	ECL	12 June 2012				
266	20–28 January 2013. Waves reached peak heights of 15.0 m on the Gold Coast and 12.6 m at Coffs Harbour (Hsig 6.9 m).	TI3	28 January 2013		3		
267	18–24 February 2013. Large wave heights Byron Bay and Coffs Harbour exceeded 12 m. Severe storms Ballina and Sydney (gusts to 73 knots) and a series of devastating tornadoes struck the Kiama region.	TI3	23 February 2013		2		
268	18–20 April 2013. Low east of Gabo Island. Sailor rescued Eastern Bass Strait. Coffs Harbour buoy, significant wave height 5.5 m peak height 9.9 m peak period 16 s from SSE. Sydney buoy, significant wave height 5.7 m peak height 10.3 m peak period 14 s from S. Eden buoy, significant wave height 5.7 m peak height 12.1 m peak period 12 s from S.	TAS	19 April 2013				

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No.	Severe events destructive wind or ocean effects	Type	Date	I	II	III	IV
269	23–25 May 2013. ECL. One fatality. A woman was knocked unconscious by a shore-dumping wave and killed inside the heads at Port Stephens, just north of Newcastle. The significant wave height on the Crowdy Head buoy reached 5 m. A storm surge moved up the coast as follows: Coffs Harbour 0.48 m 0315UTC 24 March; Yamba 0.422 m 1545UTC 24 March; Ballina 0.405 m 0230UTC 25 March; Tweed Heads 0.435 m 0115UTC 25 March. There was severe erosion on SEQ beaches.	ECL	24 May 2013				1
270	16–17 September 2013. Batemans Bay Hsig 6.1 m, peak 10.8 m and Tp 11 s from E. Eden Hsig 7.2 m peak 12.8 m Tp 12 s from E. Port Kembla Hsig 5.0 m peak 9.7 m Tp 9 s from ENE.	ECL	17 September 2013				
271	18 August 2014. Batemans Bay Hsig 5.4 m 7 pm 18 August, Hmax 9.8 m 5 am 18 August Tp 11 s from the SE. Eden Hsig 5.2 m 11.30 pm 18 August, Hmax 9.8 m 9 pm 18 August Tp 12 s from SE. Sydney Hsig 5.0 m 1 pm 18 August, Hmax 9.6 m 8 pm 18 August Tp 10.5 s from S.	ECL	18 August 2014				
272	15 October 2014. 0130 am Hsig 6.1 m Sydney Tp 15 s from S.	ECL	15 October 2014				
273	Sydney buoy Hsig (2nd highest on record) 8.1 m from 149° at 0600UTC 21 April. Peak wave heights were 14.9 m 147° at 0500UTC 21 April.	ECL	21 April 2015		3		
274	1 May 2015. Tweed buoy Hsig 6.0 m 10 pm 1 May Hmax 12.5 m Tp 11 s from 050°. Brisbane buoy Hsig 5.5 m 8 pm 1 May Hmax 10.5 m Tp 12 s from 045°. Gold Coast buoy Hsig 5.0 m 11 pm 1 May Hmax 8.8 m Tp 11 s from 070°. Byron Bay buoy Hsig 5.3 m 11 pm 1 May Hmax 9.0 m Tp 11 s from 075°.	ECL	1 May 2015		5		1
275	4–5 June 2016. People were evacuated from about seven houses and a unit block in Collaroy, as large waves crossed 50 m over the coastal road. Several properties had their ocean front yards washed away. One of the properties along that strip lost an entire in-ground pool, which had moved above 5 m out to sea. Sydney's eastern suburbs were also badly hit, with Coogee's historic surf club suffering extensive damage. Coffs Harbour 6.44 m (Hsig) and 10.99 m (max) with waves from 061° Tp 10.83 s. Brisbane 5.5 m (Hsig) at 10 pm 4 June coming from 060° and with a peak period of 12 s. Sydney 6.46 m (Hsig) and maximum height reached 9.72 m, 5 June. Peak period was 13.8 s and waves came from 097°.	ECL	5 June 2016		5		1
276	2–4 August 2016. Coffs Harbour Hsig 7.8 m and peak heights to 12.56 m with waves from 174°, 3 August. Top storm tide Coffs Harbour 2.42 m (surge 0.58 m) on 3 August.	ECL	3 August 2016				
277	7 March 2017. Crowdy Heads 9.67 m peak 5:00 pm; 4.96 m Hsig 6:00 pm Tp 13.82s Coffs Harbour storm surge 0.38 m 4 am; Port Macquarie storm surge 0.34 m 4:45 am; 0.5 m surge Scarborough 0800UTC 8 March.	TAS	7 March 2017				
278	18 March 2017. Coffs Harbour buoy, significant wave heights reached 5.22 m at 0200UTC 18 March and peak heights 9.66 m at 11:00 am 18 March with waves from ESE and peak period around 10 s.	ECL	18 March 2017		1		
279	20–21 August 2017. Large storm surge southerly flow on east coast augmented by coastally trapped wave emanating from southern Australia. Surges Shorncliffe (Moreton Bay) 0.5 m 0900UTC 21 August. Scarborough (Moreton Bay) 0.5 m 4:00 pm 21 August. 0.5 m surge Ballina 1300UTC 20 August. 0.51 m surge Coffs Harbours 1400UTC 20 August. Large waves much of east coast, largest at Port Kembla Hsig 5.52 m (Hmax 13.1 m) from SE Tp 14 s 1700UTC 20 August.	Large NZ High	20 August 2017				1
280	0000UTC 16 January 2018 Crowdy Head Hsig 5.73 m from 150° Tp 15 s. Brisbane 0700UTC 16 January 2018 Hsig 6.0 m from 160° Tp 15 s Hmax 13 m.	TAS	16 January 2018				
281	Eden 0300UTC 29 August 2018 Hsig 6.6 m from SE Hmax 10.6 m Tp 14 s. Sydney 0900UTC 29 August 2018 Hsig 5.2 m from SSE Hmax 9.6 m Tp 15s.	TAS	29 August 2018				
282	TC Oma – Storm surge Gold Coast Sand Pumping Jetty 0.8 m. Gold Coast Seaway 0.5 m. Brisbane 22 February Hsig 7.0 m from SE Hmax 13.0 mm Tp 12 s; Byron Bay 23 February Hsig 6.35 m from SSE Hmax 11.41 m. Significant beach erosion.	TI3	22 February 2019				1
283	0200UTC 4 June 2019 Sydney Hsig 7.37 m from the south Hmax 12.54 m Tp 14 s. 2300UTC 3 June 2019 Port Kembla Hsig 7.4 m from S Hmax 13.2 m Tp 13 s.	TAS	4 June 2019				
284	0000UTC 9 February 2020 Sydney Hsig 6.6 m from ESE Hmax 13.9 m Tp 11 s. Crowdy Head 0500UTC 9 February 2020 Hsig 5.0 m from East Hmax 9.3 m Tp 11 s. Batemans Bay 1000UTC 9 February 2020. Hsig 5.0 m from ESE Hmax 9.6 m Tp 12 s.	ECL	9 February 2020				