National Report of New Zealand

Prepared for
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1. Introduction

New Zealand does not have a formal, nationally administered, network of sea-level gauges. Instead, sea level gauges are mostly operated independently by various agencies, with some national coordination of daily downloads of data, post processing and archiving undertaken through voluntary partnerships with either Toitū Te Whenua Land Information New Zealand (LINZ) or National Institute of Water and Atmospheric Research Ltd (NIWA).

LINZ continues to regularly receive tide gauge data, maintain the national archive of sea level data and act as the primary national contact for the international archives held by the Permanent Service for Mean Sea Level (PSMSL) and the University of Hawaii Sea Level Center (UHSLC). As New Zealand's Hydrographic Authority, LINZ uses this data to produce official tide predictions and other tide-related information to meet its safety of life at sea obligations. LINZ is responsible for overseeing the operation of the tsunami monitoring network (Section 2.3). LINZ manages the operation of two gauges in the Ross Dependency, Antarctica, one of which (Scott Base) is a GLOSS Core Network station.

NIWA is in the process of reviewing how to optimally disseminate its coastal, environmental monitoring and modelling data via their website. This will have a particular focus on sea level data (tides and storm surge), SLR projections and in situ wave measurements.

The following brief report outlines activities in New Zealand associated with sea level gauges and availability of data. The main developments since the last report have been:

a) Six permanent sea-level gauges have been established by two local/regional councils since the last report. The map on the last page has been updated accordingly.

b) A network of 12 DART buoys (Deep-ocean Assessment and Reporting of Tsunami) has been established at strategic locations in the Southwest Pacific close to the Hikurangi, Kermadec, Tonga and Vanuatu trenches, and northwest of Norfolk Island (see Sec. 3.3 for further detail).

2. Sea Level Stations

A large number of organisations own and operate sea level stations in New Zealand. These stations can be grouped into four categories:

a) Sites at major ports operated by the local port company or regional council (Sec. 2.1)

b) An open coast network coordinated by NIWA, which includes some regional and local council owned sites, (Sec. 2.2).

c) A tsunami monitoring network established by LINZ in partnership with Crown-owned research organisation GNS Science's GeoNet Project (Sec. 2.3).

d) Other sites (Sec. 2.4).

2.1 Stations at Major Ports

Station	Latitude	Longitude
Marsden Point	35° 50′ S	174° 30' E
Auckland	36° 51′ S	174° 46' E
Onehunga	36° 56′ S	174° 47' E
Tauranga	37° 39′ S	176° 11' E
Gisborne	38° 40′ S	178° 02' E
Port Taranaki	39° 03′ S	174° 02' E
Napier	39° 29′ S	176° 55' E
Nelson	41° 16′ S	173° 16' E
Wellington	41° 17′ S	174° 47' E
Picton	41° 17′ S	174° 00' E
Westport	41° 45′ S	171° 36' E
Lyttelton	43° 36′ S	172° 43' E
Timaru	44° 23′ S	171° 15' E
Port Chalmers	45° 49′ S	170° 39' E
Dunedin	45° 53′ S	170° 30' E
Bluff	46° 36′ S	168° 21' E

Table 1
Sea level stations whose data is used to produce daily tide predictions

2.2 Open Coast Network

NIWA coordinates an informal nation-wide network of open-coast sea level gauges in partnership with some regional and local councils and, for one installation, the National Tidal Unit, Bureau of Meteorology (Australia). There are 14 gauges coordinated and/or archived by NIWA, five of which are operated by NIWA. This network of stations complements the gauges operated by individual ports (Section 2.1) and other local/regional councils (Section 2.4). Details on sites and the characteristics of the 14 stations in the open-coast network are listed in Table 2.

Station [Agency]	Latitude	Longitude	Start date of NIWA archive	Record interval (min)	Gauge Type
Poutu Point [NRC]	36° 22′ S	174° 11′ E	21-Apr-2002	5	B
Whitianga [WRC]	36° 50′ S	175° 43′ E	13-Jul-1999	5	R
Thames [WRC]	37° 08′ S	175° 31′ E	1-Nov-1992	5	US
Moturiki Is. [NIWA]	37° 38′ S	176° 12′ E	27-May-1971	1, 5	B+SW
Raglan Wharf [WRC]	37° 48′ S	174° 53′ E	1-Jul-2008	1	R
Kawhia Harbour [WRC]	38° 04′ S	174° 49′ E	29-Aug-2008	1	B

Tarakohe [TDC]	40° 49′ S	172° 54′ E	28-Jan-2005	1	B
Little Kaiteriteri [TDC]	41° 03′ S	173° 02′ E	17-Jun-2000	1	B
Mana [GWRC]	41° 06′ S	174° 52′ E		1	SW
Sumner Head [NIWA, ECan]	43° 34′ S	172° 46′ E	3-Jun-1994	1	B
Jackson Bay [NTU]	43° 58′ S	168° 37′ E	13-Dec-1996	1, 6	SEAFR
Green Island [NIWA, ORC]	45° 57′ S	170° 23′ E	4-Dec-2002	1	B
Dog Island [NIWA]	46° 39′ S	168° 25′ E	2-Feb-1997	1	B

Table 2
Sea level gauges in the open-coast network

Gauge type abbreviations: B = gas bubbler with ParoScientific PS2 pressure sensor; SW = still-well float/counter weight + digital logger; US = ultrasonic in air; SEAFR = SEAFRAME acoustic gauge; R = radar.

Agency abbreviations: ECan [Environment Canterbury]; GWRC [Greater Wellington Regional Council]; NRC [Northland Regional Council]; NTU [National Tidal Unit, Bureau of Meteorology, Australia]; ORC [Otago Regional Council]; TDC [Tasman District Council]; WRC [Waikato Regional Council].

2.3 Tsunami Monitoring Network

LINZ has partnered with GeoNet to operate and maintain a network of sea level recorders around New Zealand and its off-shore islands to allow better detection and confirmation of tsunamis.

The data from these sites is transmitted to GeoNet which is responsible for monitoring New Zealand's geophysical hazards (earthquakes, volcanoes, landslides and tsunamis). Real time data from this network is available via the Global Telecommunications System (GTS) and plots of the observed and de-tided data are updated every 5 minutes on the GeoNet web-site http://www.geonet.org.nz/tsunami. Data is also archived and made freely available from the GeoNet and LINZ web-sites.

In addition, the open coast site at Jackson Bay, listed in Table 2, operated by Australia's Bureau of Meteorology also contributes to that country's tsunami network.

Station	Latitude	Longitude	Start date
Boat Cove (Raoul Island)	29° 17′ S	177° 54′ W	29-May-2009
Fishing Rock (Raoul Island)	29° 55′ S	177° 55′ W	29-May-2009
North Cape / Otou	34° 25′ S	173° 03′ E	24-Dec-2008
Korotiti Bay (Great Barrier Island (Aotea Island))	36° 11′ S	175° 29′ E	31-Jul-2010
Devonport	36° 50′ S	174° 47′ E	26-Mar-2009
Manukau	37° 03′ S	174° 31′ E	28-Jul-2010
Lottin Point / Wakatiri	37° 33′ S	178° 10′ E	10-Oct-2008
Tauranga	37° 39′ S	176° 11′ E	6-Jul-2008
Gisborne	38° 40′ S	178° 02′ E	11-Mar-2008
Napier	39° 29′ S	176° 55′ E	20-Sept-2007
Castlepoint	40° 55′ S	176° 13′ E	7-Oct-2009
Wellington	41° 17′ S	174° 47′ E	23-Mar-2007
Charleston	41° 54′ S	171° 26′ E	14-Jul-2015
Kaikōura	42° 25′ S	173° 42′ E	27-May-2010

Owenga (Chatham Island)	44° 02′ S	176° 22′ W	7-Dec-2007
New Brighton Pier*	43° 30′ S	172° 44′ E	26-May-2021
Port Chalmers	45° 49′ S	170° 39′ E	25-Feb-2010
Puysegur	46° 05′ S	166° 35′ E	14-Dec-2009

* New Brighton Pier replaced Sumner (43°34′S, 172°46′E) which closed 1-Apr-2022.

Table 3
Operational sea level stations in the tsunami monitoring network

Dates indicate when the sites commenced operation.

2.4 Other Sea Level Gauge Sites

In addition to the sites described above, continuous sea level measurements are also taken at sites at minor ports, supplementary gauges at major ports and several estuaries. Most of these stations are owned and operated by either local/regional councils or port companies.

Station	Latitude	Longitude
Rangaunu Harbour (Ben Gunn Wharf) [NRC]	35° 00′ S	173° 15' E
Whangaroa [NRC]	35° 03′ S	173° 45' E
Opua [NRC]	35° 19′ S	174° 07' E
Opononi [NRC]	35° 30′ S	173° 24′ E
Town Basin [NRC]	35° 43′ S	174° 20′ E
Dargaville [NRC]	35° 56′ S	173° 52' E
Weiti River [AC]	36° 39′ S	174° 44' E
Helensville [AC]	36° 40′ S	174° 27′ E
Tamaki River [AC]	36° 55′ S	174° 52′ E
Tauranga Harbour (Ōmokoroa) [BRC]	37° 40′ S	176° 03' E
Tauranga Harbour (Sulphur Pt.) [POT]	37° 41′ S	176° 10' E
Tauranga Harbour (Oruamatua) [TCC/BRC]	37° 42′ S	176° 13' E
Tauranga Harbour (Hairini Bridge) [TCC/BRC]	37° 43′ S	176° 10' E
Kaituna River [BRC]	37° 45′ S	176° 25' E
Manu Bay [WRC]	37° 49′ S	174° 49′ E
Rangitaiki River [BRC]	37° 55′ S	176° 52' E
Whakatāne Town Wharf [BRC]	37° 57′ S	177° 00' E
Ohiwa Harbour (Port Ōhope Wharf) [BRC]	37° 59′ S	177° 06' E
Ōpōtiki Wharf [BRC]	38° 02′ S	177° 14' E
Manawatū River [HRC]	40° 28′ S	175° 14′ E
Motuara Island [MDC]	41° 06′ S	174° 16′ E
Ōkukari Bay [MDC]	41° 12′ S	174° 19′ E
Te Weka Bay [MDC]	41° 15′ S	174° 11′ E
Havelock [PMNZ]	41° 17′ S	173° 46′ E
Bridge Street (Christchurch) [CCC]	43° 31′ S	172° 43′ E
Avon/Heathcote (Ferrymead) [CCC]	43° 33′ S	172° 43' E
Milford Sound [Environment Southland]	44° 40′ S	167° 56' E

Spit Wharf (Otago Harbour) [POL]	45° 47′ S	170° 43' E
Cape Roberts (Antarctica) [LINZ]	77° 02′ S	163° 12' E
Scott Base (Antarctica) [LINZ, AntarcticaNZ]	77° 51′ S	166° 46′ E

Table 4
Other sea level gauge sites

Agency abbreviations: AC [Auckland Council]; BRC [Bay of Plenty Regional Council]; CCC [Christchurch City Council]; MDC [Marlborough District Council]; NRC [Northland Regional Council]; PMNZ [Port Marlborough New Zealand]; POT [Port of Tauranga]; POL [Port Otago Ltd.]; TCC [Tauranga City Council]; WRC [Waikato Regional Council].

2.5 GLOSS Stations

Five stations in the GLOSS Core Network are located within New Zealand.

GLOSS stations 101, 127 and 129 appear in Table 1 and station 134 is in Table 4. See Sec. 5.1(c) for further comment about GLOSS 128.

GLOSS ID	Station
101	Wellington
127	Auckland
128	Waitangi (Chatham Island)
129	Bluff
134	Scott Base (Antarctica)

Table 5
New Zealand's GLOSS Core Network stations

3. Sea Level Measurement Technologies

3.1 Stations at Major Ports

Sea level data at all major ports (Table 1) is recorded digitally.

A variety of sea level measurement technologies are used, including sub-surface pressure transducers, float and stilling well, downward-looking radar and ultrasonic systems.

Data is recorded once every minute at 12 gauges, two at 5-minute and the remaining two at 10-minute intervals.

3.2 Open Coast Network

As listed in Table 2, most of the sites operated by NIWA use a bubbler gauge technology (with shrouds over the orifice head to reduce wave effects) with PS2 ParoScientific pressure sensors, while other installations use either radar, acoustic, ultrasonic or float/counter weight systems.

All sites record data in digital form, mostly at 1 minute recording intervals, with the remaining gauges recording at 5 minute intervals.

3.3 Tsunami Monitoring Network

Each of the LINZ/GeoNet tsunami monitoring sites listed in Table 3 incorporates a pair of Druck PTX 1830 pressure sensors. The vented sensors have a range of 0 – 20 metres and output a 4

– 20mA signal. Sea level is measured at a rate of 10Hz and a record is output at 1 minute intervals.

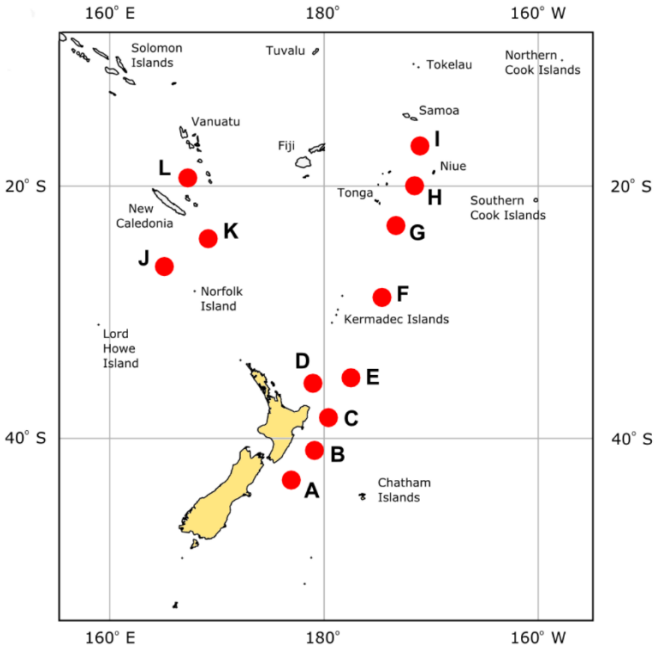
New Zealand has installed a network of 12 DART buoys (Deep-ocean Assessment and Reporting of Tsunami) at strategic locations in the Southwest Pacific close to the Hikurangi, Kermadec, Tonga and Vanuatu trenches, and northwest of Norfolk Island. This network installation was led by NEMA (National Emergency Management Agency) in partnership with GNS Science and NIWA with funding provided by MBIE (Ministry for Business, Innovation and Employment) and MFAT (Ministry for Foreign Affairs and Trade).

The network also provides monitoring and detection information for Tokelau, Niue, the Cook Islands, Tonga and Samoa.

Station	Latitude	Longitude
NZA	42° 22'S	176° 55'E
NZB	40° 36'S	179° 05'E
NZC	38° 12'S	179° 48'W
NZD	36° 06'S	178° 36'E
NZE	36° 03'S	177° 42'W
NZF	29° 41'S	175° 01'W
NZG	23° 21'S	173° 24'W
NZH	20° 05'S	171°52'W
NZI	16° 53'S	171° 11'W
NZJ	26° 40'S	163° 57'E
NZK	24° 19'S	169° 30'E
NZL	19° 19'S	166° 47'E

Table 6

The NZ DART Network Stations



Locations of the NZ DART buoys, annotated with their station ID suffix

3.4 Other Sea Level Gauge Sites

Details of equipment used at these sites (Table 4) has not been collated, however pressure sensors, ultrasonic, bubbler and float/counter weight technologies would be most likely.

4. Continuous GPS (CGPS)

CGPS observations have been made at the major ports (Wellington, Lyttelton and Dunedin since late 1999 and Auckland since 2009). These stations are operated by GNS Science.

Discussions are underway amongst interested parties to increase the number of GNSS sites co-located at tides gauges.

5. Data Availability

5.1 Hourly Data for GLOSS Core Network stations:

a) Wellington (101) and Bluff (129):

Fast delivery of data for these GLOSS stations is forwarded to UHSLC each month.

b) Auckland (127):
The port company operating this site refuses to make this data available to the international community free of charge. Auckland Council are in discussions with the port company, but if the stance doesn't change it may be time to remove Auckland from the GLOSS Core Network and include Moturiki (Table 2).

c) Chatham Island (128):
This site stopped recording 15 February 2016 when wharf redevelopment commenced. No organisation is known to be responsible for maintaining this station.

d) Scott Base (134):
PSMSL currently holds monthly and annual data to the end of 2016. LINZ will submit data for subsequent calendar years during 2023, and submit same to UHSLC.

5.2 Hourly Data, Daily, Monthly and Annual Means

a) Hourly data:
LINZ provides hourly data for Bluff and Wellington to UHSLC each month, and once each year submits to UHSLC and PSMSL hourly data for the other stations listed in Table 1 (except for Auckland, as explained in Sec. 5.1(b)).

b) Daily and monthly means:
Once each year LINZ provides daily and monthly mean datasets to PSMSL and UHSLC for the stations listed in Table 1 (except for Auckland).

c) Annual means:
LINZ publishes, on its website, annual mean sea level datasets at 7 locations for which long-term records are available. These sites are Auckland, Dunedin, Lyttelton, Nelson, Port Taranaki, Wellington (all from Table 1) and Moturiki (Table 2). These timeseries, which go back at least to 1951 and as far as 1891 will be updated annually and are available for download at https://www.linz.govt.nz/products-services/data/types-linz-data/sea-level-data/long-term-annual-mean-sea-level-data .

5.3 Open Coast Network

The open-coast network data (Table 2) is uploaded, for most sites, 3 to 6-hourly to the internet in the form of plots from tide, storm surge and long-wave/tsunami analyses. The web site is: http://www.niwa.co.nz/our-services/online-services/sea-levels.

Processed and quality-assured datasets for the NIWA-operated gauges (five active sites and six closed sites) are available by email request to sealevels@niwa.co.nz.

Requests for information or data from this network not covered above can be made to the first author of this report – contact details shown on the first page.

5.4 Tsunami Monitoring Network

Data recorded by the tsunami monitoring sites is available for free download in the form of daily files. Metadata about the sites and the data can be accessed via https://www.linz.govt.nz/products-services/data/types-linz-data/sea-level-data/sea-level-data-downloads .

Data recorded by the DART buoy network is available for free download, see: https://www.geonet.org.nz/tsunami/dart

5.5 Other requests

Metadata for Antarctica gauges at Scott Base and Cape Roberts and the data can be accessed via https://www.linz.govt.nz/products-services/data/types-linz-data/sea-level-data/sea-level-data-downloads .

Requests for information or data not covered above can be made to the authors of this report – contact details shown on the first page.

SEA LEVEL SITES IN NEW ZEALAND

Major port sites (Table 1) are shown in **red**
Open coast sites (Table 2) are shown in **green**
Tsunami monitoring sites (Table 3) are shown in **brown**
Other sites (Table 4) are shown in **blue**

Names of GLOSS Core Network stations are appended with their GLOSS ID number