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The Norwegian Tide Gauge Network : National report of Norway

June 2017

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Introduction

The Norwegian Tide Gauge Network is operated by the Norwegian Mapping Authority, Hydrographic Service (NHS). There are 23 digital tide gauges along the Norwegian coast, one gauge in Ny-Ålesund at Svalbard and one gauge at Jan-Mayen (currently out of order) (see Figure 1 and Table 1).

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Figure 1 The Norwegian Tide Gauge Network, May 2017.

Station	Latitude	Longitude	Continuous GNSS	Digital data available from
Viker	59°02' N	10°57' E	No	1990
Oslo	59°54' N	10°44' E	No	1914
Oscarsborg	59°41' N	10°37' E	No	1953
Helgeroa	59°00' N	09°52' E	No	1965
Tregde	58°00' N	07°34' E	Yes, since 2001	1927
Stavanger	58°58' N	05°44' E	No	1919
Bergen	60°24' N	05°18' E	No	1915
Måløy	61°56' N	05°07' E	No	1943
Ålesund	62°28' N	06°09' E	No	1961
Kristiansund	63°07' N	07°45' E	No	1952
Heimsjø	63°26' N	09°07' E	No	1928
Mausundvær	63°52' N	08°40' E	Yes, since 2007	1988
Trondheim	63°26' N	10°24' E	No	1989
Rørvik	64°52' N	11°15' E	No	1969
Bodø ³	67°18' N	14°24' E	No	1949
Kabelvåg	68°13' N	14°30' E	No	1988
Narvik	68°26' N	17°25' E	No	1931
Harstad	68°48' N	16°33' E	No	1952
Andenes	69°19' N	16°09' E	Yes, since 2000	1991
Tromsø	69°39' N	18°58' E	No	1952
Hammerfest	70°40' N	23°41' E	No	1957
Honningsvåg	70°59' N	25°59' E	Yes, since 2006	1970
Vardø	70°20' N	31°06' E	Yes, since 2005	1947
Ny-Ålesund	78°56' N	11°57' E	Yes, since 1993	1976
Jan-Mayen (currently out of order)	70°55' N	08°43' E	Yes, since 2007	2014

Table 1: List of stations in the Norwegian Tide Gauge Network.

³ The tide gauge in Bodø was moved to a new location in February 2016

The tide gauge network

Until 1985 there were two tide gauge networks in Norway, but between 1986 and 1992 the gauges were modernized and merged into one network operated by the Norwegian Mapping Authority, Hydrographic Service (NHS). The new system used stilling wells and sampled the water level with 15 second intervals. These data were filtered and decimated to 10 minute values and automatically transferred to NHS.

A new modernization was completed in 2002. The data loggers were changed to Sutron 8210 and the 10 minute values were obtained by making 3 minute averages of one second samples.

In 2007 the sampling and filtering procedures were changed. The sampling frequency is still 1 Hz but now one-minute averages are stored in the data logger, transferred to NHS at regular intervals (every 20 minutes) and stored in a database. The one-minute values are filtered (Butterworth filter) and decimated to produce ten-minute values. The ten-minute values are presented on the internet in near real-time if they comply with an automatic quality control. Software developed at NHS is used for manual editing on the data.

All the permanent tide gauges are of the stilling well type, except in Hammerfest where a radar gauge (Miros SM-094) is used (since August 2007) and at Jan-Mayen where a pressure gauge has been used.

The tide gauge at Mausundvær was renewed in 2010, and is now part of the network.

In August 2014, a permanent tide gauge was successfully installed on the island of Jan Mayen. Unfortunately, the tide gauge was damaged by the rough weather in 2016 and is currently out of order. The installation of a new tide gauge is planned but the time frame for this is uncertain. There is approximately 2 years of data from this tide gauge but the reference levels are still uncertain.

In February 2016 the tide gauge in Bodø was moved to a new location nearby the old tide gauge. Existing data series have been transferred to the new tide gauge position.

The majority of the gauges are mounted on solid rock and are levelled with about three years intervals. A few gauges are located on slightly unstable ground and are levelled more frequently. The Norwegian Mapping Authority, Geodetic Institute (GI) is responsible for the levelling.

GNSS measurements

By October 2015, eight continuous GNSS receivers (CGPS) are installed at seven Norwegian tide gauges. In Vardø, Andenes and Tregde the antennas are installed directly at the tide gauge, on the other stations the GNSS receivers are some hundred meters away. In Ny-Ålesund the GNSS receiver is installed near the VLBI-station (Very Long Baseline Interferometry), which is located about 1.5 km from the tide gauge.

In May 2009 the GNSS receivers in Ny Ålesund (NYA1, NYAL) was renewed.

In May 2012 the receiver in Tregde was renewed.

In October 2014 the receiver in Honningsvåg was renewed.

Station	Continuous GNSS from	GNSS receiver type	Serial nr.	Firmware version	Sampling rate	Antenna type	Ra-dome
Tregde TGDE	2001	Trimble NetR9	5128K 76924	4.70	1 sec.	AOAD/ M_T	None
Andenes ANDE	2000	Trimble NetR5	4649K 03383	3.84	1 sec.	Trimble Zephyr TRM5597 1.00	None
Ny-Ålesund NYA1	1997	Trimble NetR8	4843K 33429	4.41	1 sec.	ASH 701073.3	Snow
Ny-Ålesund NYAL	1993	Trimble NetRS	44392 39123	1.1-5	1 sec.	AOAD/M_ B	Dome
Vardø VARD	2005	Trimble NetRS	44122 32898	1.1-5	1 sec.	Trimble TRM 29659.00	Dome SCIS
Mausundvær FROC	2007	Trimble NetR5	4649K 03429	3.84	1 sec.	Trimble Zephyr TRM5597 1.00	None
Honningsvåg HONS	2006	Trimble NetR9	5351K 48957	5.01	1 sec.	TRM5980 0.00	Dome SCIS
Jan Mayen JANS	2007	Trimble NetR9	5349K 48322	5.01	1 sec	TRM4124 9	None

Table 2: An overview of status of the continuous GNSS receivers per Oct 2015.

The Norwegian Mapping Authority, Geodetic Institute is responsible for the continuous GNSS measurements and analyses of the data.



Figur 2: Tide gauges with continuous GNSS receivers at Tregde (to the left) and at Andenes

Data availability

By the end of 2016, the Norwegian water level database contained water level data from more than 220 temporary tide gauges and 1425 years of water level observations from the permanent tide gauges. All data have been through a quality control, and all corrections are flagged and documented. Figure 3 gives an overview of the available digital time series from the permanent tide gauges in operation.

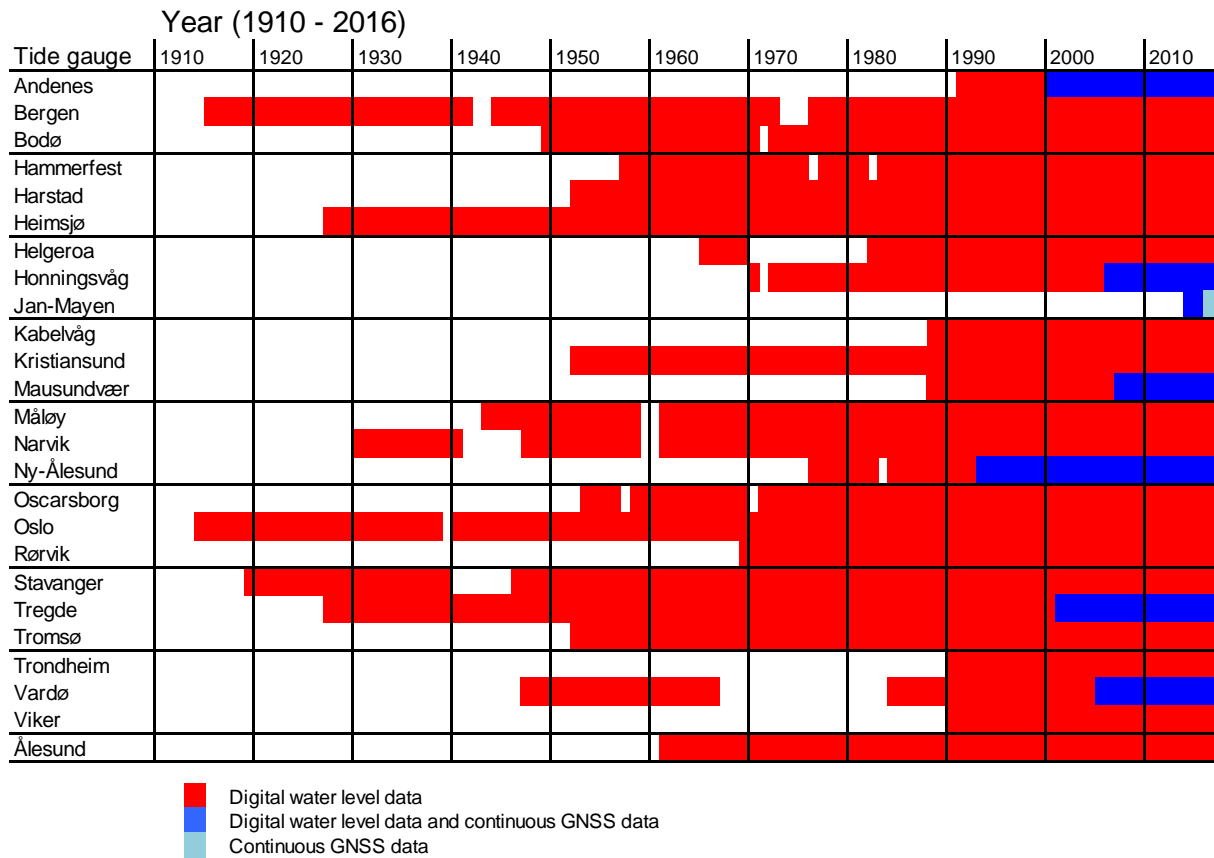


Figure 3: An overview of available digital time series from the stations in the network.

International data exchange

Quality controlled sea level data are routinely made available through the following international programmes:

- PSMSL : Monthly and annual means
- GLOSS : Fast delivery data to UHSLC
Delayed mode data to BODC

Internet

The following quality checked sea level data is available for free download on our web site www.kartverket.no/en/sehavniva, from all the permanent tide gauges except Mausundvær and Jan-Mayen. Some of the data is also available for other positions than the tide gauge:

- Water level observations (from around 1990 to now)
- Tidal predictions
- Residuals
- Water level prognosis for 5 days (model-data from the Norwegian Meteorological Institute)
- Monthly and annual means (from start of measurements to now)
- Vertical datums (Tidal levels, reference levels, storm surge return levels)
- Projections of future sea level change in Norway

The same data is also available through our API (Application programming interface), www.kartverket.no/en/sehavniva/Open-Data/API/, which makes it possible to integrate the sea level data in external systems and applications.