# Progress Report No. 1-2011

for

# Norwegian National Seismic Network

## January 1st to September 30th, 2011.

Supported by

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and

University of Bergen, Department of Earth Science

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# 1 Introduction

This annual report describes the operation of the Norwegian National Seismic Network (NNSN) for the first part of 2011. The network is financially supported by the oil industry through the Norwegian Oil Industry Association ("Oljeindustriens Landsforening", OLF) and the University of Bergen (UiB). UiB has the main responsibility to run the NNSN. This report covers operational aspects for all seismic stations operated by the Department of Earth Science at the UiB and includes the financial report.

# 2 Operation

In Norway, UiB operates 32 of the seismic stations that form the Norwegian National Seismic Network (NNSN). NORSAR operates 3 seismic arrays, which also include broadband instruments, and two single seismometer stations (JMIC and AKN) (Figure 2). In total, NORSAR provides data from five broadband stations to the NNSN. The station HSPB is operated jointly between NORSAR and the Geophysical Institute, Polish Academy of Sciences, Warsaw, Poland. The seismicity detected by the network is processed at UiB, but also NORSAR integrates their results in the joint database at UiB. A seismicity map for the reporting period is shown in Figure 3.

UiB is in the process of upgrading the NNSN by changing short period (SP) to broadband (BB) seismometers and to increase the number of stations where data can be transmitted to Bergen in real time. A further effort is made to install additional high quality digitizers. The current status of this upgrade is shown in Figure 1. As of today the numbers of SP, BB stations and stations with real time transmission are listed in Table 1.

**Table 1. Overview of UiB seismic stations**

| | Short Period | Broadband | Real time |
|---|---|---|---|
| Number of stations | 14 | 18<br>(15 with natural period greater than 100 sec) | 29 |

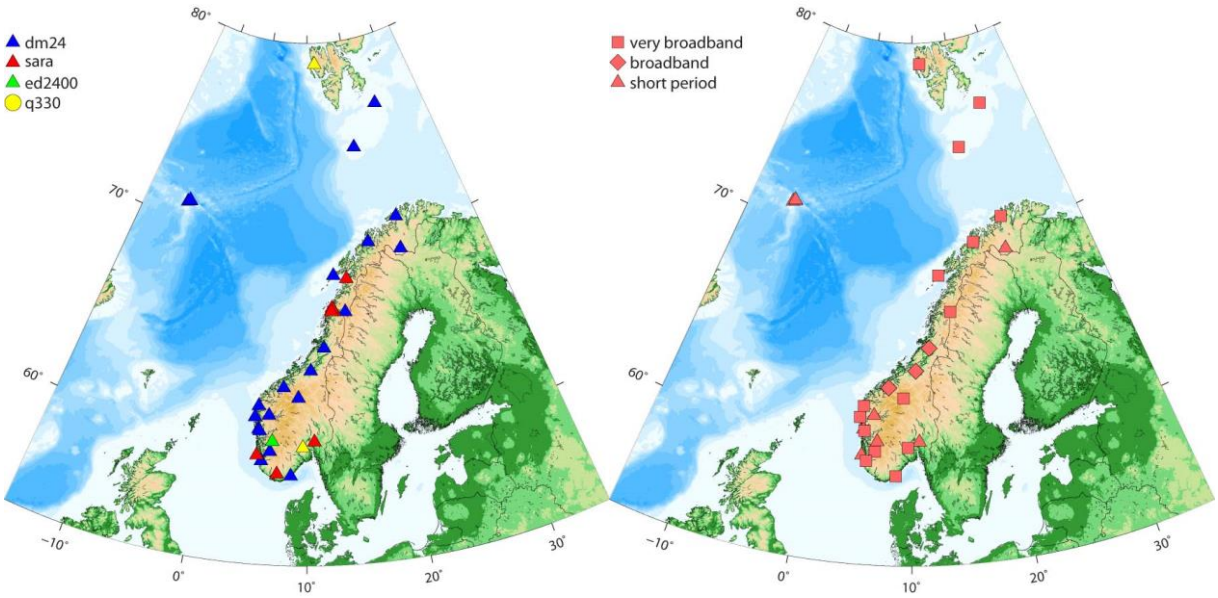


**Figure 1. Status of the NNSN stations operated by UiB as of 31 October 2011. Left: Overview of digitizers, still to be upgraded are types Sara and EarthData (ED). Right: Overview of seismometers, where 15 are very broadband.**

The operational stability for each station is shown in Table 2. The downtime is computed from the amount of data that are missing from the continuous recordings at UiB. The statistics will, therefore, also show when a single component is not working. This is done as the goal is to obtain as complete continuous data from all stations as possible. Also, communication or computing problems at the centre will contribute to the overall downtime. In the case of communication problems, a station may not participate in the earthquake detection process, but the data can be used when it has been transferred. Thus, the statistics given allow us to evaluate the data availability when rerunning the earthquake detection not in real-time.

The downtime for the majority of stations is below 5%. Larger down time were observed for the following stations: FLOS, HYA, KTK, KONS, MOR, NSS, and TBLU (see technical service overview for details).

**Table 2. Data completeness in % for January to September 2011 for all stations of the NNSN operated by UiB.**

| Station | Data completeness in % |
|---|---|
| Askøy (ASK) | 97 |
| Bergen (BER) | 99 |
| Bjørnøya (BJO) | 100 |
| Blåsjø (BLS) | 100 |
| Dombås (DOMB) | 98 |
| Florø (FOO) | 99 |
| Flostrand (FLOS) | **20** |
| Hammerfest (HAMF) | 99 |
| Homborsund (HOMB) | 100 |
| Hopen (HOPEN) | 96 |
| Høyanger (HYA) | **86** |
| Jan Mayen (JMI) | 99 |
| Jan Mayen (JNE) | 99 |
| Jan Mayen (JNW) | 99 |
| Karmøy (KMY) | 100 |
| Kautokeino (KTK) | **82** |

| Station | Data completeness in % |
|---|---|
| Kings Bay (KBS) | 99 |
| Kongsberg (KONO) | 97 |
| Konsvik (KONS) | **88** |
| Lofoten (LOF) | 99 |
| Mo i Rana (MOR8) | **Ca. 50** |
| Molde (MOL) | 98 |
| Namsos (NSS) | **69** |
| Odda (OOD1) | 100 |
| Oslo (OSL) | 100 |
| Snartemo (SNART) | 95 |
| Stavanger (STAV) | 99 |
| Steigen (STEI) | 95 |
| Stokkvågen (STOK) | 99 |
| Sulen (SUE) | 99 |
| Blussvoll (TBLU) | **90** |
| Tromsø (TRO) | 100 |

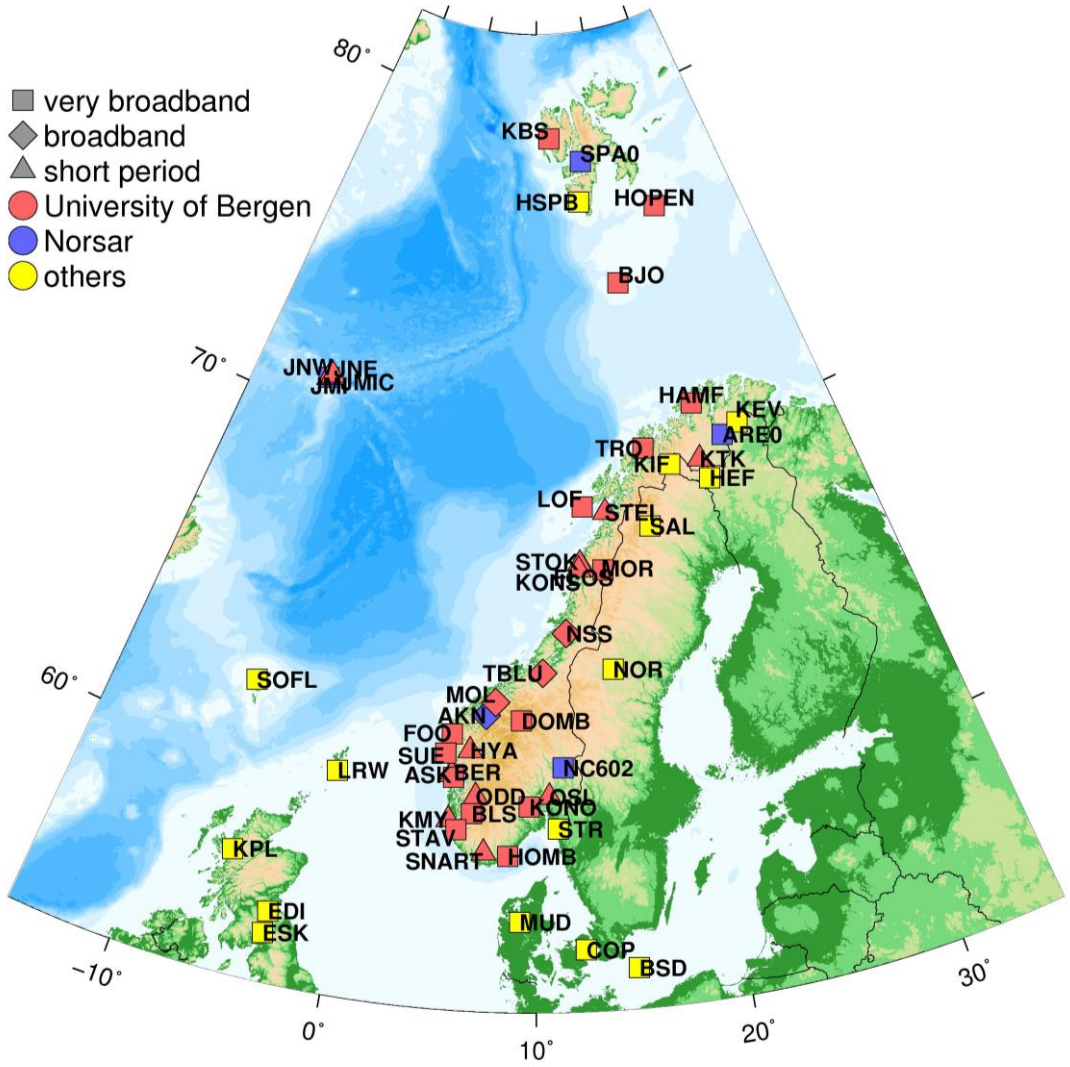


Figure 2. Stations delivering data to the NNSN database.

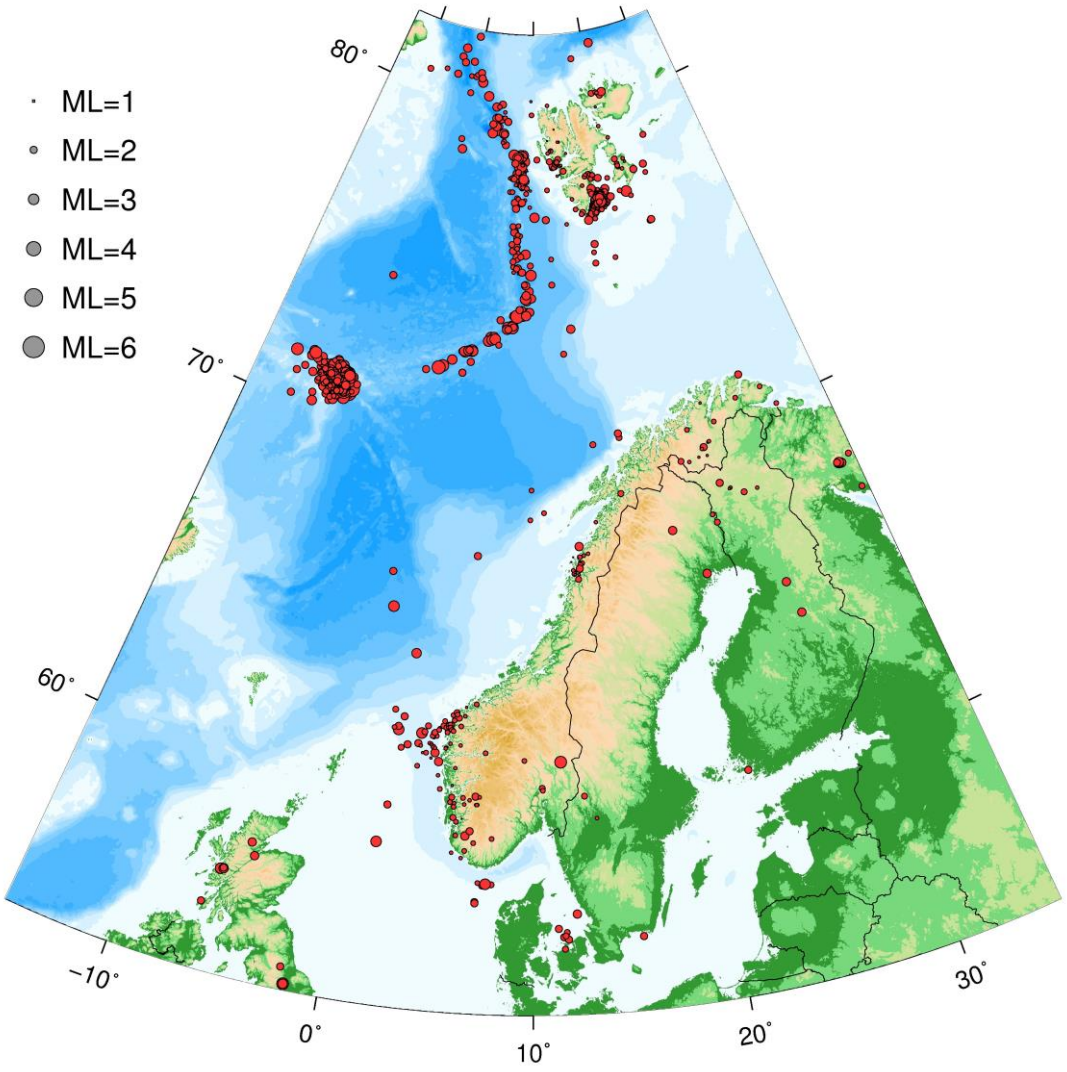


Figure 3. Seismity map showing assumed earthquakes for the period January to September, 2011.

# 3 Field stations and technical service

The technical changes for each seismic station are listed below. It is noted if these changes are carried out by the respective local contact and not by the technical staff of UiB. When a station stops working, tests are made to locate the problem. Sometimes the reason cannot be found and the cause of the problem will be marked as unknown.

Major changes during this reporting period of 2011 were:

| | |
|---|---|
| Ask (ASK) | 17.02.11: Visit. A new Guralp Digitizer (model CMG-D2M4-EAM) was installed. Unit is modified, gain has been changed from 3.2µV to 0.8µV. GPS antenna is now G-13788. Modem restarted |
| | 19.04-26.04.11: Station down, reason unknown. Restart by local operator. |
| Bergen (BER) | 18.01.11. New digitizer (CMG-D2M4-EAM) installed. |
| Bjørnøya (BJO1) | No visit or technical changes. |
| Blåsjø (BLS) | No visit or technical changes. |
| Blussvoll (TBLU) | 7.7.11-3.8.11: Station down during school holidays, eventually restarted by local operator. |
| Dombås (DOMB) | 01.02.11: A new digitizer(CMG-D2M4-EAM) was installed by the local operator. |
| | 19.08.11: Stations down 31/07/11 16:32 to 19/08/11 06:30 due to thunder storm. A new modem was installed, but station still not ok. Using ICE communication temporarily. |
| Florø (FOO) | 28.02.11: The existing Guralp sensor was replaced with a Trillium 120 sensor. |
| Flostrand (FLOS) | 05.01.11. GMS router for communication was replaced by local operator. |
| | 15:02.11: The station was down from 13.02.2011 to 15.02.2011 due to power loss. |
| | 28.02.11: Station down, possibly problem with cable. The station will not be fixed before the station configuration in the area has been evaluated. |
| Hammerfest (HAMF) | 05.03.11: Local contact checked the GPS |
| | 31.03.11: The defective GPS antenna is replaced by local operator. Timing is now OK again. |
| Homborsund (HOMB) | No visit or technical changes. |
| Hopen | No visit or technical changes. The sensor is drifting and is every second |

| | |
|---|---|
| (HOPEN) | week recentred by the local operator. This explains part of the lack of data where the instrument drifts to the limit. |
| Høyanger (HYA) | 22.07.11: Station stopped at 14:20 due to thunderstorm. Station down until 23.08. |
| | 05.08.11: New PC installed by local operator and communication is working. However, no data recorded due to problem with digitizer. |
| | 23.08.11: Visit: The existing SARA digitizer was replaced with a Guralp CMG-DM24-EAM. |
| Jan Mayen (JMI) | No visit or technical changes. |
| | The bandwidth of the satellite link has been increased, and real-time communication is becoming possible. |
| Karmøy (KMY) | No visit or technical changes. |
| Kautokeino (KTK) | 11.07.2011. 0650 UTC used SMS for remote restart. |
| | 08.07.11: Station down. |
| | 25.08.11: New PC installed by local operator. |
| | 12.09.11: Earthdata digitizer replaced by the local operator due to noise on E component. |
| | 21.09.11: Visit. New CMG-DM24-EAM digitizer installed. |
| Kings Bay (KBS) | No visit or technical changes. |
| Kongsberg (KONO) | Communication down from 26.09.11. |
| Konsvik (KONS) | Occasional communication problems. No visit or technical changes. |
| Lofoten (LOF) | 09-11.05.11: Station upgraded with a Trillium (120PA) sensor and a Guralp (CMG-DM24-EAM) digitizer. |
| Mo i Rana (MOR8) | 05.01.11: Station restarted by local operator. Down since 30.11.10. The local operator is not available for periods of time during the winter. |
| | 11.05.11: Station down. Cable was destroyed. |
| | 20.06.11: Visit. A new sensor and digitizer was installed. The cable was repaired, but the sensor still don't work. |
| | 19.07.11: Visit. It was not possible to make the sensor work at the site, so it was temporarily moved. Station is now transferring data in real time using satellite communication. A new site will be constructed. |
| Molde (MOL) | No visit or technical changes. |

| | |
|---|---|
| Namsos (NSS) | 07.07.11-26.10.11: Station down due to thunderstorm and lightning. Expected damage to PC and Digitizer.<br>25.08.11: New PC installed by the local operator. Station still down due to serial line converter or digitizer problem. |
| Odda (ODD1) | No visit or technical changes. |
| Oslo (OSL) | No visit or technical changes. |
| Snartemo (SNART) | 05.08-10.08.11: No contact with the station, due to local problems at the phone company. |
| Stavanger (STAV) | 08.02.11: Visit. Installed a new BB sensor, Trillium 120PA, new Guralp digitizer (CMG-DM24) and GPS antenna, a new industrial PC. |
| Steigen (STEI) | 18-29.05.11: Station down due to power loss. |
| Stokkvågen (STOK) | 25.07.11: Thunderstorm and lightning caused communication failure. New modem was installed by the local operator. |
| Sulen (SUE) | No visit or technical changes. |
| Tromsø (TRO) | No visit or technical changes. |

# 4 NNSN plans

The overall purpose of the NNSN is to provide data both for scientific studies, but equally important for the routine observation of earthquakes. This in principle means that broadband seismometers are desired at all sites. Of course in areas where additional stations are deployed for local monitoring, short-period seismometers are sufficient. The number of broadband seismometers in the network will be increased to replace existing short period instruments. A general goal for the future development has to be to achieve better standardization in particular with the seismometers and digitizers. The total number of stations for now should remain stable, but it is important to improve the overall network performance.

We now report achievements for 2011, and then give the plans for 2011/12.

## 4.1 Achievements in 2011

- Mo i Rana: The Mo i Rana station will be upgraded when the satellite link is sufficiently tested.
  Progress: Done. New station completed in October 2011. Trillium 120, CMG-DM24-EAM and satellite communication.

- Lofoten: the station will be upgraded by installing a new digitizer and computer; a broadband seismometer will be installed either at Lofoten or Steigen.
  Progress: Done. The station LOF was upgraded with a Trillium sensor in May 2011.
- Further upgrade: We have received funding from the department for six broadband sensors. Two of these will be used for portable deployment. The other four will be installed on current NNSN stations. The NNSN budget for new investments in 2011 will be used for digitizers.
  Progress: All available broadband sensors are installed. Five stations are being available for temporary deployment.
- New stations: planning for possible stations in the Hardangervidda area and near Bergen will start.
  Progress: The area around Geilo/Ustaoset is of interest due to easy access by train. The local 'kommune' has been contacted and the area is explored to find a good site. Noise tests are planned.
- Stokkvågen network: The network was intended to be temporary at the time of installation. With five years of recordings we will look into changing the configuration of these stations. A possible solution is to keep one of them, but to move one of them to half-way between this area and Steigen. Equipment at Stokkvågen, Steigen and the new station will have to be improved. During 2011, a noise site survey will be made.
  Progress: No progress has been made. Station FLOS is down, and will be closed at end of 2011.
- Continue with the integration of data from Ekofisk and Statfjord.
  Progress: Sample data from Ekofisk were received, and are evaluated. Real-time data transfer still needs to start. A seismometer was deployed at Statfjord was operating from 23.12.10 in the shaft of STC. However, due to unstable power supply no recordings were made.
- Establish automated routines for event based waveform data extraction from NORSAR for the associated triggers to the NNSN database.
  Progress: Beam data are now available from NORSAR and copied to UiB automatically. The beam data has been looked at in specific cases, but are not yet included in the daily processing routines at UiB.
- Procedures: earthquake response and interaction with NORSAR to be developed.
  Progress: Analyst from NORSAR has visited Bergen twice (February and June). A short document with a task list was prepared.
- NNSN website: continue development
  Progress: The menu system and content of the page is under revision. A first version of the new menu system is available. However, progress is a bit slow.

## 4.2 Plans for 2012

- New station: The station in the Hardangervidda will be installed, a site will be decided on in 2011.
- Upgrade: Stations OSL, KMY, STEI and STOK will be upgraded to a Guralp digitizer.
- Upgrade: Stations OSL and STEI will be considered for installation of a broadband seismometer.
- Ekofisk: Complete the data integration.

- Strengthen the collaboration with NORSAR on data processing through technical visits.
- Jan Mayen: Improve signal quality of the JMI station and install a broadband seismometer.
- NNSN website: continue development.