FONNBU, A NEW (OLD) PLATFORM FOR SNOW AND AVALANCHE RESEARCH

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ABSTRACT: One of the first tasks of the newly established avalanche group at the NGI in 1973 was the selection of a suitable location for an avalanche research station. The choice was on Grasdalen, north of the Jotunheimen mountains, 1000 m asl., in a valley well known for its avalanche activity and high amounts of snow. The station was ready for use in 1973 and intensive research has been made for more than 20 years before budget constraints decreased the activity in the late 80ies. Main research interest was on snow properties, weather and avalanche relations, avalanche dynamics and snow creep in steep slopes. In connection to the research station the Ryggfonn test site was established in 1979. Two years after the 30 years anniversary party, the station burned down completely in February 2005 due to an electrical failure. Scientific data and results were safe in the NGI archive, but lots of old memorials and instruments were lost. Already on the day after the fire, it was decided to build up a new modern station on the same location. Work started the same summer and in August 2006, the new station was officially opened. The new station features accommodation for up to 15 persons, a combined seminar and living room, offices, workshop and of course a sauna. The station is equipped with a modern weather station that also measures snow temperatures and radiation balance. It is now used for NGI research in connection with the Ryggfonn test site, for avalanche courses and courses arranged by the Norwegian School of Winter Warfare and Norwegian Universities. We would like by this presentation inform about the station and invite international researchers to use the station for their research in Norway.

KEYWORDS: Field research, research platform, Norway, avalanche, snow.

1. HISTORY

One of the first tasks for the newly established avalanche group at the NGI was the selection of a suitable location for their research station. The location had to be in the middle of avalanche terrain and feature a high frequency of occurring avalanches, but nevertheless a safe place to be. The choice fell on the Grasdalen valley in Northwest Norway. The valley is located just west of the water divide at approximately 1000 masl. The area is known for its frequent avalanches and high amounts of winter precipitation. The work to build the research station was started in summer 1973 and the building was completed in October 1973 (Fig 1). The first NGI researchers reached the station on 03 January 1974 and started their research and observations.

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During the first years, transport to and from the station was the most challenging part of the research. Using a Bombardier double belted snow scooter and skies to transport people and supplies 25 km to the station in meters of new snow could take days on its own. This was eased a lot when the new highway 15 was opened in 1977 and access to the station was decreased to 800 m from the tunnel up to the station. Nevertheless, the record time needed for that distance of 800 m is more than 6 hours. With the first years a system of observation equipment was installed in and around the station. Most prominent was the wind observation station on a mountaintop close by to get at measure on the wind direction and velocity in the release areas of the avalanche tracks. As all other locations around the station, this top was named after locations in the Bible, Golgotha.

2. CLIMATE OF THE LOCATION

The climate of the location is dominated by the maritime influence of the North Sea. Main wind direction in this part of the country is from the south-west bringing warm and moist air into the

Figure 1: Picture of the old Fonnbu station in the Grasdalen valley in winter time

Norwegian mountains. This leads to highly variable temperatures in Grasdalen that can range from -20 °C to several degrees plus within 12 hours. However, the precipitation from south-west rarely reaches this area of the mountains, since the airflow is intercepted by the Jostedalsbreen glacier cap. In the same way, precipitation coming in from south and east are also decreased significantly by the surrounding mountains.

The most significant precipitation events are accompanied by winds from north-west and west. Precipitation intensities of up to 6 mm / hour over 24 hours have been observed leading to severe avalanche conditions. Table 1 gives a climatic overview over the normal conditions at the research station since 1974.

Table 1: Precipitation (mm) and temperature (°C) normals for the NGI research station in Grasdalen

	Precipitation (mm)
January	135
February	125
March	100
April	79
May	57
June	60
July	84
August	83
September	147
October	154
November	134
December	130
Annual	1 288

3. AVALANCHES

The station is surrounded by several avalanche tracks of various sizes (Fig. 2). The most prominent are Storfonn, Sætreskarsfjellet that threatens the Highway 15 and Ryggfonn where NGI conducts its full scale avalanche experiments (Norem et al., 1985.).

The dominating maritime character of the area causes the avalanches to be mainly direct action avalanches that are released during or close to precipitation storms. Heavy precipitation and strong winds are the major release cause. However, in winters with little snow early in the season weak layers of depth hoar can develop. Those may lead to the release of large avalanches later in the season.

Avalanches in the area can become huge, such as the event on 17 February 2000 that destroyed all equipment in the Ryggfonn test site or the event of 25 February 2002, when the avalanche debris went 60 m into the tunnel of Highway 15 (Moe et al, 2003). During a normal winter 1 – 3 big avalanches can be expected, reaching the road or other infrastructure in the area.

4. RESEARCH

The station has been used intensively for research and teaching purposes. Mainly three issues where addressed: a) Snow creep forces on structures, b) meteorological triggers for avalanche release and c) avalanche dynamics.

Creep forces on structures were a significant problem for the development of the Norwegian hydro power supply. Structures installed in the mountains such as transmission and radio masts were severely damaged in the first years of operation due to snow creep.

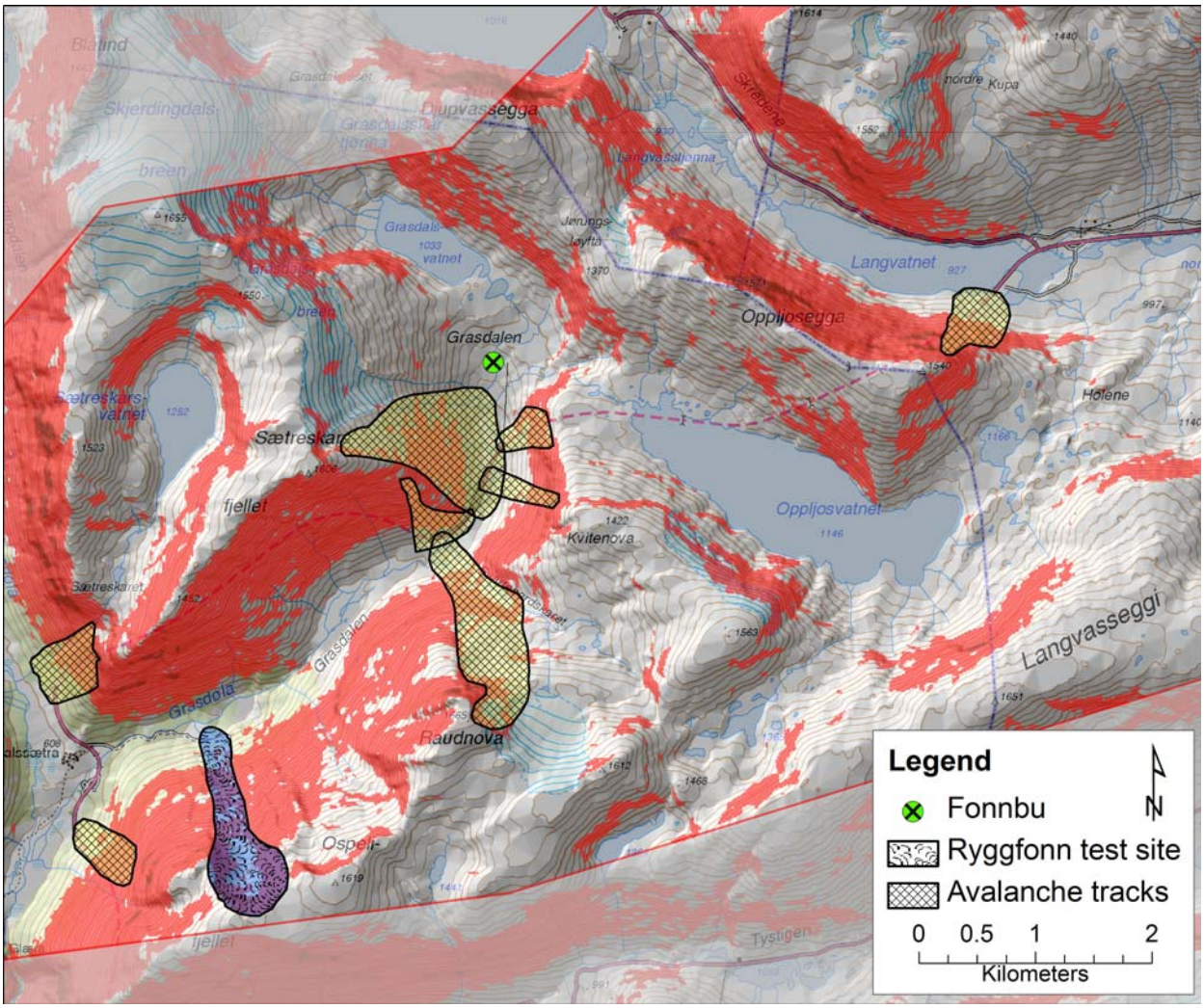

Figure 2: Map of the surrounding terrain at Fonnbu with the full scale test site Ryggfonn. All terrain steeper > 30^{o} is shaded and the most active avalanche tracks are marked in the map.

Also the station Fonnbu itself was damaged in the snow winter 1976. Results from measurements at example structures lead to better design recommendations for structures in snow (Larsen et al., 1985, McClung et al., 1984).

A major focus of the research at the Fonnbu station has been to find statistical relations between weather conditions and avalanche releases. In addition to the weather observations, all avalanches in the most important tracks around the research station were recorded. A special automatic precipitation gauge was developed to measure precipitation intensities in snow fall (Bakkehøi et al., 1985). The results of the statistical analysis give threshold values for each avalanche track and a general chart of avalanche probability versus amount of new snow precipitation (Fitzharris & Bakkehøi, 1986, Bakkehøi, 1987).

Figure 3: The ruins of the station after the fire 06 February 2005.

Figure 4: The new station with its modern architecture. The lowest of three doors is already covered by snow.

The question of how far avalanches may run, as well as how to design dams to stop avalanches was studied on the newly established full scale avalanche test site Ryggfonn from 1975.

The track releases several times in an average year, but avalanches are also released by explosives for controlled measurements. The results from measurements in Ryggfonn are the basis for many publications and the NIS model (Norem et. al 1985, 1986 and 1989, Lied et al, 2001). In later years, the effect of the dam in the Ryggfonn track has been studied in more detail by Gauer et al (2007a & b) and Faug et al. (2008).

The station has been used by many international researchers (Among others McClung, Nishimura, Perla and others) and projects such as CADZIE and SATSIE.

5. THE FIRE

During the night to the 6 February 2005, the snow plough operator on the Highway 15 noted an unusual light at the station and soon realized that the entire building was on fire. Luckily no persons were present in the station, but the house burned down to the ground. Invaluable memories and the history of the NGI avalanche group went up in smoke (Fig. 3). But all collected data and observations were safely stored in the NGI archives in Oslo. The reason for the fire was most likely an overheating in the electrical system of the station.

6. THE NEW BUILDING

Already on the day after the fire, NGI decided to rebuild the station. An architect was assigned to design a modern research station for mountains, suited for the tough conditions in Grasdalen (Fig. 4). Learning from experience at the old station, the new station was to have doors at 3 levels, which can be used successively as the snow outside accumulates. The back wall of the building was constructed in concrete to resist the snow creep. In total the new building encompasses 245 m^2 on three floors. There is a workshop, technical room, wardrobe, sleeping room and Sauna in the basement. The main living and seminar room (Fig. 5) on the first floor are accompanied by office, more sleeping rooms and bathroom. The third floor houses a dormitory for 7 persons and a storage room. In total there are sleeping places for 15 persons at the station.

Figure 5: The common room in the station with kitchen and facilities for courses and lecturing.

The building is equipped with central electrical heating and has a high speed internet connection. A snow scooter and various field equipment are available for field research around the station.

A modern weather station installed at the research station observes all meteorological elements relevant for snow and avalanche studies, such as air and snow temperatures, wind, precipitation, snow depth and a complete radiation balance.

The new station is used for NGI research, the avalanche warning service for the Highway 15, courses and education. International guests are plenty welcome. Updated weather and other information is available at www.fonnbu.no.

7. CONCLUSION

The NGI research station Fonnbu has been together with the full scale test site Grasdalen a well established platform for snow and avalanche research. The fire in 2005 opened for new possibilities in the new station. NGI and university research programs will take place in the station as well as avalanches and educational courses. The international community is encouraged to use the station for their research and teaching. All kind of cooperating projects within snow and avalanche research are welcome at Fonnbu.

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