Report from the first operational winter of the Norwegian Avalanche Centre

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ABSTRACT: The Norwegian Avalanche Centre had its first operational season from mid-January until the end of May 2013. We report on the experiences from the first operational winter. The Norwegian Avalanche Center assesses the avalanche danger based on the European Avalanche Danger Scale for 24 regions on mainland Norway. In addition we assess the meteorological conditions for all of Norway and issue a warning if the danger level exceeds 3-considerable outside the predefined forecasting regions. Avalanche bulletins were issued four times a week for each region and published on www.varsom.no. Most of the regions are situated in a maritime climate along the west coast of Norway, while a handful is situated in a more continental climate. A network of professional field observers provides a local danger assessment 2-3 times a week for each region. In general we have sparse data for vast regions. In addition the forecast is issued for the next 48h making it very dependent on the regional weather forecast and uncertainties in there. Despite some challenges the first season was rated a success by users and operators. User surveys and two workshops at the end of the season gave valuable input for further development. Daily updated bulletins will be issued from next season and more regions will be included within the coming two years.

KEYWORDS: Avalanche forecasting service, avalanche bulletin, Norway, winter conditions, varsom.no.

1 INTRODUCTION

The Norwegian Avalanche Centre was opened on the 14th of January 2013. We will herein report about its first operational season. Details about the establishment and general operation of the service are given in Engeset, 2013 (this issue). We briefly repeat facts relevant to the understanding of this article. The service is collaboration between the Norwegian Water Resources and Energy Directorate (NVE), Norwegian Meteorological Institute (MET), The Norwegian Public Roads Administration (NPRA), The Norwegian National Rail Administration (JBV) and the Norwegian Geotechnical Institute (NGI). NVE is responsible for the service.

1.1 Work schedule for forecasters and observers

Forecasting regions range in size from 1500 km^2 to 8500 km^2 and stretch over 11 degrees of latitude (Figure 1). Field observations were available twice a week through a staff of 52 professional observers distributed over the 24 forecasting regions. Although more than 400 precipitation gauges and even more temperature sensors are available, automatic weather stations in the Alpine are not available in most regions.

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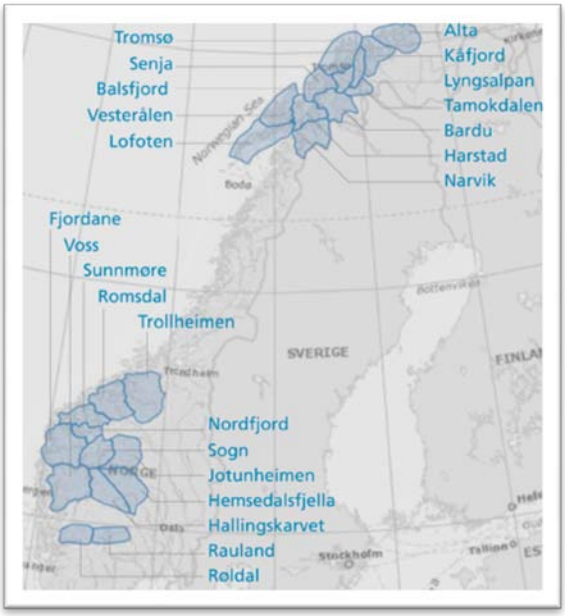

Figure 1: Map showing the 24 forecasting regions where an avalanche bulletin was available during the first operative season 2012/2013.

Therefore the forecaster had mainly to rely on numerical weather prediction and snow pack models and the uncertainties there in to assess the meteorological conditions. The observation database regobs.no (Ekker et al, 2013) and the map-centric tool xgeo.no (Barfod et al, 2013) are the main forecasting tools.

An avalanche bulletin for each day is issued. However, bulletins were only published four times a week on Mondays, Wednesdays, Fridays and Saturdays. On these days, a full assessment of the regional avalanche danger was

made for that day and the following two days. E.g. on Monday the bulletin for Monday, Tuesday and Wednesday are issued. Four forecasters, including one dedicated meteorologist were on duty. Normally two were responsible for Southern Norway and two were responsible for Northern Norway. The meteorologist on duty issued an alpine weather forecast for each region. Based on previous conditions and the expected meteorological situation he/she compiles a list of regions where a high danger level might be reached. Those regions were then assessed first by the forecasters and published as soon as possible to alert preparedness. During the non-forecasting days one person was monitoring the situation and was only updating the bulletins for regions where a major divergence from the previously assessed situation occurred. This setup lead to the situation that some days only a 48h old bulletin was available to the public. Though imperfect, this setup was thought to give best value to the user with the available resources.

2 GENERAL AVALANCHE CONDITIONS IN NORWAY DURING THE FORECASTING SEASON

The coastal regions had generally little snow in the beginning of the forecasting season, while the drier inner parts of Southern and Northern Norway had above average snow depth (Figure 2; www.senorge.no). A long cold spell lead to development of depth and surface hoar in the southern regions. At the end of January several warm fronts passed Northern Norway. Rain on snow events kept the danger level between considerable and high.

Northern Norway received a lot of snow in the beginning of February on a weak snowpack, which kept the avalanche danger at a considerable level. At the same time a strong low pressure system hit the west coast in the South. More than a meter snow in 24h triggered many natural avalanches. In regions where the surface hoar was still intact conditions were very unstable for over a week. During most of February stable weather gave moderate avalanche danger throughout the country.

Towards the transition to March, Northern Norway was hit by several low pressure systems in short succession, leading to many shorter avalanche cycles over the cause of a week. In the South the west coast received half a meter of snow on top of a weakly bonded snow pack leading to a short avalanche cycle.

All of Norway received new snow in the second half of March. Danger levels varied between moderate and considerable in the South, while high avalanche danger was reached in the North where most of the snow fell.

Around Easter, Northern Norway received heavy snowfall. Avalanche danger varied between considerable and high for almost two weeks. During this period five persons died in avalanche accidents in the district of Troms. A stable high pressure system caused stable conditions in the South during the same period.

In the second half of April temperatures rose and conditions became very elevation depended. At lower elevations solar radiation and rain events caused several natural avalanches throughout the country, while wind slabs remained the main problem in the Alpine.

We had mostly moderate avalanche danger throughout May. However, daily temperature variations caused the danger level to vary between low to considerable in several regions. The only exceptions were the regions Røldal and Voss. Here, two meter snow fell within a week giving considerable avalanche danger. Towards the end of May and our forecasting season the avalanche danger was low in all forecasting regions.

3 EVALUATION

3.1 Feedback and user surveys

Our first season gave us valuable experience and new insights, which we will use to improve the service utterly towards the coming seasons. Besides the experience of the groups of observers and forecasters we also gained valuable input through external experts, two user questionnaires and two workshops towards the end of the season. The major points from a one week evaluation of the daily bulletin by C. Pielmeier from SLF and G. Statham from Parks Canada are

- Bulletins are well structured and the website provides easy navigation
- A danger map on the homepage would give a better overview
- Flash/header and main text are too general, more facts about the current situation are requested
- Symbols for the avalanche problem are difficult to understand or misleading

Results from the user questionnaires are generally encouraging. One questionnaire was geared towards recreational users and one towards professional users such as mountain guides, the police or road preparedness. In addition a workshop including the professional users was held in June 2013.

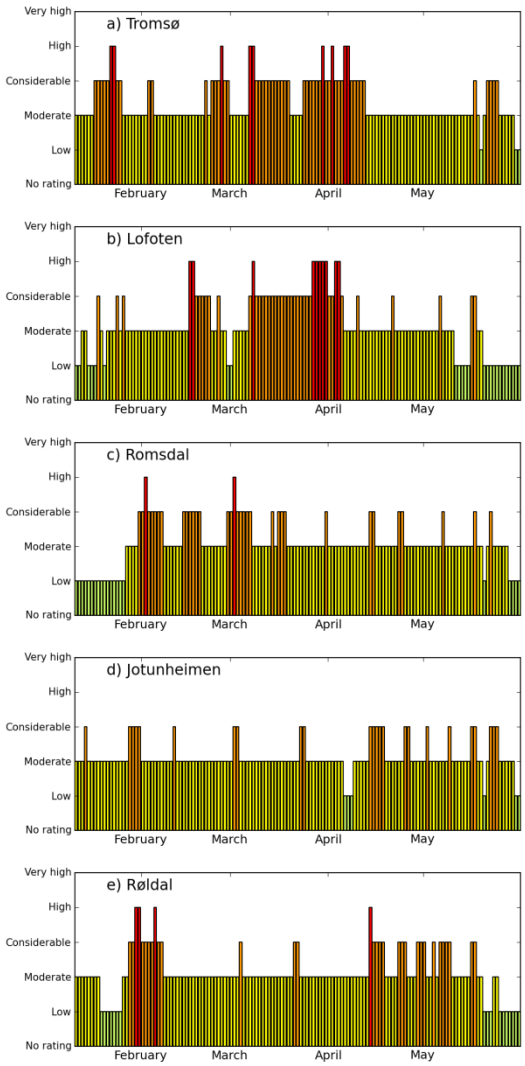

Figure 2: Avalanche danger level during the forecasting season 11th January to 31st of May 2013 for selected regions representing the areas of coastal Northern Norway a) and b), coastal Southern Norway c) and e), and the continental inner parts of Southern Norway d). Tromsø and Lofoten show a period of high avalanche danger around Easter. Jotunheimen never reached level high, varying mainly between moderate and considerable. Romsdal and Røldal had generally moderate danger with occasional snow storms in February, March and April leading to short avalanche cycles.

The main feedback from the professional users was

- Generally pleased with the product
- Bulletins are an aid in the their work
- Daily updates is requested
- More information geared towards professional users is requested
- Online material is very useful for teaching, but could be more extensive
- Public information of current avalanche danger could be better coordinated

The Norwegian Red Cross and the Norwegians Peoples Aid use the bulletins as an aid to set their preparedness level and for educational purposes.

The main feedback from recreational users was

- The avalanche bulletin was long missed and provides useful information
- Daily updates requested
- Educational/awareness effect is huge
- Useful trip planning tool
- Avalanche problems should be presented better
- Online learning material should be extended.

The generally positive feedback is a sure sign that avalanche forecasting is demanded in Norway. The lack of major criticism might therefore be attributed to the fact that the users are generally happy to get a needed product. We expect that expectations will be higher and criticism will increase over the coming seasons.

3.2 Performance of the service

Forecasted danger levels agreed well with actual danger levels according to observer feedback and feedback from two user surveys. The forecasters observed a tendency to downgrade danger ratings from high to considerable when the forecasting lead time decreased (Figure 3). This was mainly the case when the 48h precipitation prognosis had large uncertainty or too much precipitation as compared to what was observed. On the other hand forecasters often waited with raising the level to high until the actual day of the event (Figure 3).

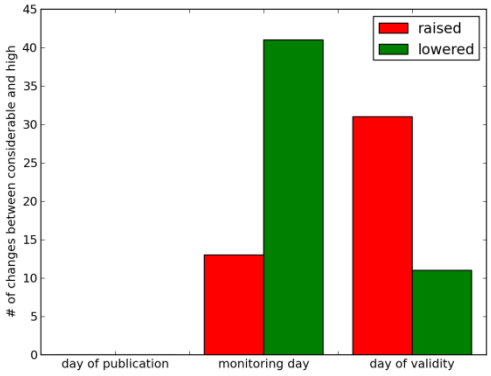

Figure 3: Number of changes between danger levels considerable and high. High danger levels issued two days in advanced due to expected new snow was often lowered during the monitoring day, when an updated weather forecast was available. A total of 6234 bulletins were

issued during the season, thus relatively few changes were necessary compared to the total number of bulletins issued.

The correct prognosis of high avalanche danger was validated by reports on natural avalanching by the road and rail authorities. Road closures due to avalanching or potential avalanching are automatically reported to the forecasters via xgeo.no.

Work load for the forecasters was high, especially in the beginning of the season. Though, several members of the forecasting crew had to some extent been involved in regional avalanche danger forecasting previously, new routines, regions, tools and colleagues needed time to get accustomed with.

The combination of high avalanche danger in Northern Norway, public holidays and five fatalities due to avalanches around Easter (Jaedicke, 2013), clearly pointed out the weaknesses of our system. Forecasters had to evaluate the complex and fast changing conditions in 12 of the 24 forecasting regions, while simultaneously being available to the media and public who had large interest due to the accidents and high amounts of new snow. Though observations from the field came more rapidly than usual the vast size of the forecasting regions and the fact that the forecasters were not familiar with all the regions posed clear challenges. Validation was hard to assess afterwards. The meteorological conditions were dominated by snow showers acting very locally, such that the 48h and 24h precipitation prognoses failed to place the zones of highest precipitation correctly. Only daily contact to people in the area enabled us to assess the conditions.

The lack of automatic weather stations in the Alpine is another challenge. Especially, information on wind was missed by the forecasters. The Norwegian Avalanche Centre and its partners will install 40 new stations over the next four years. This will be a tremendous improvement compared to today's situation, but hardly provide a full overview in all regions.

Ideally, more field observations, temporally and spatially, need to be available. Here, information form recreationist combined with professional observations can be beneficial. Over time all forecasters need to become familiar with the special conditions in each forecasting region. This requires a permanent and dedicated stuff (Kosberg et al., 2013). A decentralized system, where the forecaster is only responsible for one forecasting regions is an option, but too costly to maintain. We chose a more centralized system where most of the forecasting is done from the NVE headquarter in Oslo. However, all tools and data a forecaster needs are available online and forecasting can be done from any place with a good internet connection. This was made use of in some forecasting regions. The advantages of a centralized system are that it is easier to implement changes in the system and a better knowledge transfer between the forecasters.

4 OUTREACH

Varsom.no, our main publishing platform for the avalanche bulletin, had close to 100,000 independent visits over the cause of the season (Johnson, 2013). Thus, indicating clearly a strong interest in the product in a country with around 5 million inhabitants. Social media, such as Facebook, was used to present add-on material and updates to the user. Backcountry skiing has seen an upward trend over the last years in Norway. Several festivals and workshops for backcountry skiing and avalanche awareness courses are offered during the season by various organizations. Staff from the Norwegian Avalanche Centre was present at many of the major events. The general impression by presenting or teaching at these events is that the interest in the new service is huge and expectations are high.

5 CONCLUSION AND FURTHER DEVELOPMENT

The start of the Norwegian Avalanche Centre was a success. Feedback from users, media and professionals working in the field of avalanche forecasting states that clearly. However, many improvements can be made.

The main focus is on increasing the usefulness and quality of the bulletin. Starting out with the forthcoming season 2013/2014 the Norwegian Avalanche Centre will issue updated bulletins daily. Four forecasters will be on duty daily, such that the development of the avalanche conditions is monitored more closely and availability to users and media is guaranteed. We will further improve communication between forecasters and field observers.

It is planned that forecasting regions become more dynamic and that avalanche terrain that is not included today will be covered. This is thought to be implemented by the season 2014/2015. Teaching material will continuously be extended and improved. Efforts to include communities, organizations and ski resort in delivering data to the service will be continued.

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