CONCEPT TO OPTIMIZE ROAD CLOSURES DUE TO AVALANCHE HAZARD ON LOW TRAFFIC ROADS IN NORWAY
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ABSTRACT: The Norwegian road network connects remote communities to central parts of the country. These communities are often vulnerable to isolation due to avalanche hazard on the road and no detour possibilities. The roads are often low traffic roads, but with high value transport such as schoolchildren and fresh fish for the European market.

To optimize road closures and reduce the risk to road users due to avalanche hazard in a cost effective approach on low traffic roads, the Norwegian Public Road Administration (NPRA) utilize different methods. The methods and equipment often need to be adapted especially to the extreme arctic climate and lack of daylight in winter.

The use of these methods do not eliminate the avalanche hazard for the road users, and will not prevent the threat of an avalanche blocking the road. However, it will reduce the risk of avalanche accidents and give the possibility to reduce the duration of a road closure due to avalanche danger. Using low-cost methods also give the opportunity to secure more roads, either temporary or permanent, than expensive avalanche protection.

KEYWORDS: Monitoring, Warning, Observation, Avalanche Control, Hazard evaluation.

1. INTRODUCTION

The Norwegian Public Road Administration (NPRA) is responsible for about 55 000 kilometers of public road in Norway, and 11 000 of these are in the northern region. Most of the region is north of the Arctic Circle (Fig. 1), and has more than 500 locations exposed to avalanches, ice- and rockfall. Securing the most important locations has an estimated cost of more than 2 billion USD.

Avalanches and avalanche hazard cause several road closures every winter, lasting from a few hours to several days. Many roads offer no detour possibility, and communities get isolated. On roads with low traffic volume, it is not always of public utility to build expensive avalanche protection, and the NPRA pursue cost-effective methods to reduce the risk for the road user as well as the duration of the road closure.

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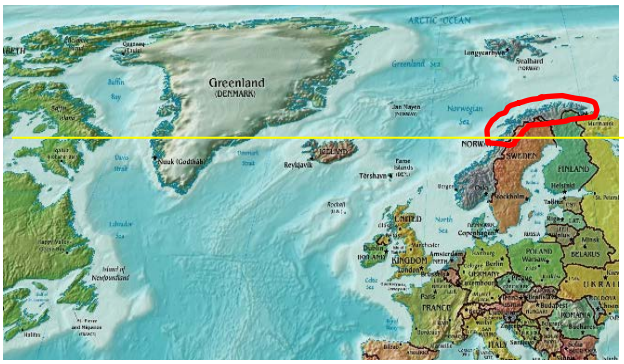

Fig. 1: The northern region of the NPRA encircled in red, Arctic Circle marked by yellow line.

The concept consists of a toolbox that include observation, evaluation and systems for active control, monitoring and warning.

2. THE CONCEPT

2.1 Observation and hazard evaluation

In 2003, the NPRA outsourced the snow clearance function to the private market, and most of the experience and local knowledge vanished. To compensate for this effect the NPRA developed avalanche contingency plans and began to educate the snow-clearing contractors in 2005.

Contractors have to attend a 2-day course where they are introduced to the contingency plan and learn about several topics including basic meteorology, snow physics and avalanche hazard evaluation. The contingency plans include information about climate and precipitation threshold values, topography and avalanche paths.

During each winter, the contractors will observe the weather and snow conditions, and perform a daily avalanche hazard evaluation. If necessary, they can discuss the hazard level with the avalanche staff in the NPRA. The evaluation provides the basis for whether a road should be closed or not.

In 2013, the Norwegian Water Resources and Energy Directorate (NVE) initiated the Norwegian Avalanche Center that produce regional avalanche bulletins and forecast, www.varsom.no. The NPRA and our contractors are contributors and end-users of the forecast. The contractors report observations from the road, and the avalanche staff in the NPRA do observations in the mountains. The NPRA also contributes with building weather stations in the lowland and the mountains, and with forecasters to adapt the forecast to road applications.

The produced regional forecast is a useful tool for the contractor when they evaluate the avalanche danger on a local scale.

2.2 Avalanche monitoring and warning systems

To warn motorists about avalanches the NPRA have used a wired geophone system since the 1980's. According to Haaland (2013), the lack of maintenance and outdated technology have resulted in only three of the systems still in operation.

Monitoring and warning systems are still one of the solutions the NPRA use for low trafficked roads. New monitoring systems mainly use radar technology, but the NPRA is also testing other methods.

An ongoing pilot project for a wireless geophone system on county road 472 at Sandneslia south of Bodo seems promising. Sandneslia has several avalanche paths and annual avalanches (Fig. 2). One of the old, analog geophone systems is here. It has been out of service for more than 15 years. An inspection revealed that cables were torn and the circuit board destroyed.

The new digital system will be less vulnerable to damage due to the wireless transmission of signals, and has the possibility to filter the signals to avoid false alarms. It will also be established a radar monitoring installation in Sandneslia to compare the two methods.

Fig. 2: Sandneslia has several avalanche paths. (Photo: Dag Theodor Andreassen)

2.3 Active avalanche control systems

The use of explosives is strictly regulated in Norway, and methods such as heli-bombing is prohibited. To reduce the number and size of naturally triggered avalanches, and to reduce the time of road closures due to avalanche hazard, the NPRA is testing modern systems for active avalanche control. Systems in use in the northern region are the gas-based Gazex and DaisyBell.

Gazex is a fixed system with a limited range, but not affected by weather conditions, such as strong wind and poor visibility. This system is in use on county road 883 in Skillefjord north of Alta (Fig.3).

Fig. 3: Skillefjord Avalanche Area and road 883, Gazex exploder installed 2014. (Photo: Ole-André Helgaas)

An alternative system is the Wyssen Avalanche Tower, also with positive test results in Southern Norway recent years.

The DaisyBell give more range and flexibility as it is a helicopter carried system (Fig. 4). This system make it possible to operate in a large area, testing several avalanche paths. One of the drawbacks is that the weather conditions must be right to fly helicopter. The NPRA own three DaisyBell-systems, two of them in the northern region.

Fig. 4: Active avalanche control with Daisybell, here used near the city of Tromso, Northern Norway. (Photo: Ole-André Helgaas)

3. CASE

January 8 2015, an avalanche from the Gjovarden Mountain hit two cars driving on county road 866 to Skjervoy in Northern Norway (Fig. 5). It happened in a well-known avalanche area that until the 1990s had avalanches annually. Over the last 20 years, however, there are almost no reported incidents, and therefore this accident was surprising and unpredicted.

The road have no detour possibilities, and more than 2500 inhabitants in the coastal village of Skjervoy were completely isolated (Fig. 6). This could also cause a serious problem for an important transport of fresh fish planned with a tight time schedule to Southern Europe.

Fig. 5: Gjovarden Avalanche Area and road 866, in the middle of photo two abandoned cars that were hit by an avalanche January 8 2016. (Photo: Ole-André Helgaas)

Fig. 6: Overview map with the location of Gjovarden Avalanche on county road 866 to the coastal village of Skjervoy, Northern Norway.

Due to snowy weather, it was difficult to open the road after such an accident with people and cars involved. It is also a typical challenge to evaluate avalanche risk for rather low frequent avalanche areas e.g. 20-30 year's frequency.

Several neighboring avalanche paths were also a great concern for the local contractor. Due to high demand for security, this is also an important issue

before starting the work to clear the road and remove the avalanche snow under Gjovarden Mountain. High media interest and increasing problems for the affected users of the road 866 was the background for planning an avalanche active control action as soon as possible.

Monday January 11 the avalanche staff in the NPRA used the DaisyBell to test the avalanche danger. In midwinter, it is only 3-4 hours of daylight on clear days at 70 degrees north. After several attempts without triggering any avalanches, the danger level was evaluated to be acceptable. The road opened JUST IN TIME – only a few minutes before the departure of the truck convoy loaded with fresh fish! Afterwards the DaisyBell triggered avalanches before opening a road on the Arnoy Island, 10 km north of Gjovarden (Fig. 7). Active avalanche control with helicopter is a useful tool, but the time window is short with scarce daylight in midwinter.

The avalanche staff in NPRA together with the contractor used several “items from the toolbox” to reduce the duration of road closure.

4. EXPERIENCE SO FAR

The concept is constantly evolving by improving the tools and testing new ones. Commercial systems often have to be adapted to the harsh climate of the Arctic, and some methods have proved to be inadequate.

The lack of daylight during the Polar Night is a problem to the installations that need a power supply, such as warning and active avalanche control systems. They are often far from commercial power supply, and the alternative is often solar energy. The systems have to be adapted with an improved solution, with either increased backup or an alternative source.

The harsh climate is also challenging for sensors and equipment, and cause problems such as icing of wind gauges in the mountains.

Evaluating the local avalanche danger can often be difficult, especially with the lack of daylight. By education and contribution through observation, the contractors seem to increase their awareness and skill to evaluate the danger level.

5. CONCLUSION

The use of the methods in the concept do not eliminate the avalanche hazard for the road users, and will not prevent the threat of an avalanche blocking the road. However, it will reduce the risk of avalanche accidents on the road and give the possibility to reduce the duration of a road closure due to avalanche danger. Using low-cost methods also give the opportunity to secure more roads, either temporary or permanent, than expensive avalanche protection.

Fig. 7: DaisyBell used to trigger avalanches prior to opening the road on the Arnoy Island, just before daylight fades. (Photo: Ole-André Helgaas)

REFERENCES

Haaland, G, 2013: *Evaluering av geofonanlegg for detektering av skred*. NPRA *report No. 204*, 17 pp, URL: http://www.vegvesen.no/fag/Publikasjoner/Publikasjoner/Statens+vegvesens+rapporter/_attachment/561046?_ts=142e73795a8&fast_title=SVV+rapport+204+Geofonanlegg+for+skred.pdf

Norwegian Avalanche Center (2016): Avalanche bulletin, Accessed 26 August 2016. [Available online at http://www.varsom.no/en/Snow-avalanche/]