

## TECHNOLOGY FOR HANDLING OF NATURAL HAZARDS IN THE NORWEGIAN PUBLIC ROADS ADMINISTRATION

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**ABSTRACT:** The Norwegian government requested in their long-term plan for national transportation in Norway (2025 – 2036), the use and development of technology to enhance road safety and accessibility. This meant for the Norwegian Public Roads Administration (NPRA), to put an effort into using technological solutions for natural hazard mitigation. The rationale behind this government request is two-fold: Following the general trend in society towards more technology and digital solutions and of course saving money. The NPRA is thus required to reduce avalanche risk at 20 – 25 exposed road sections by developing site-specific mitigation concepts using RACS, avalanche detection systems, and site-specific avalanche forecasting. All these systems should support each other, and data should be readily available for our natural hazard preparedness system. As a supporter of the avalanche community, we are interested in sharing data and experiences from this project with other road owners in Norway and the avalanche community worldwide.

**KEYWORDS:** RACS, warning systems, road management.

### 1. A GOVERNMENTAL CALL FOR USING TECHNOLOGY FOR ROAD SAFETY

The Norwegian network of national highways consist of ca 10 000 km of roads. As to date, 354 road sections are defined to need mitigation measures against snow avalanches and slush flows. The Norwegian Public Roads Administration (NPRA) is responsible for the national highway network and our mission is to develop and facilitate an accessible, safe, and green transport system.

The NPRA is an administrative body subordinate to the Ministry of Transport. In 2023, the Norwegian Parliament asked the government to investigate how new technology can be used to detect avalanches as well as prevent avalanches from hitting the road. Further, technology should be used to prevent cars from driving into avalanche deposits on the road. An answer was expected in 2025.

To answer the call from the Norwegian government, the NPRA established the project: “Technology for handling of natural hazard” in 2024.

In the coming five years the project’s main goal is to reduce the risk from avalanches and/or slush flows at 20 – 25 exposed road sections. The project is a

research and development project, where new technology should be used and developed around well-established remote avalanche control systems (RACS) and avalanche warning/detection systems.

The NPRA has been using RACS since 2010 (Farestveit and Skutlaberg, 2010), and we have continuously developed how these systems can be best integrated in our natural hazard preparedness system (Farestveit and Skutlaberg, 2012, Tveit and Farestveit 2023). The same is true for avalanche detection systems where we have more than forty years of experience, with technology ranging from geophones to doppler radars and interferometric SAR (Humstad et al. 2024).

RACS and avalanche detection systems are only a part of our use of technology for natural hazard management. We have established site-specific avalanche forecasting for one road section in the winter 2021/2022 (Haddad et al. 2023) and will start a forecast for another road section in the winter 2024/25, where several RACS will be built. There is a good chance that several of the 20 – 25 road sections to be secured, will also need site-specific avalanche forecasting. As for all these sites, we are and will follow EAWS recommendations (Jaedicke et al. 2023). We further see the need to do research on flood and slush flow activity and how to implement warning systems for these types of natural hazards. We have done testing of avalanche mitigation from UAS (Tveit and Bøckman, 2024), and will use this methodology further both within NPRA as well as in collaboration with TARP (Stimberis et al. 2018).

Last, we have developed RESPONS our own web portal for real-time monitoring and reporting of all

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natural hazards on and close to our road network in Norway (Orset and Frekhaug, 2024). So far, the web portal shows warning bulletins, avalanche registrations, webcams, snow observations, known avalanche paths and contingency plans. We also use the portal to write, show, and distribute the national warning bulletins covering all natural hazards for roads (Orset and Frekhaug, 2024). Further development of RESPONS to handle and show more natural hazard data is planned. This could include a tool for site-specific avalanche warning and AI-generated prognoses for avalanche danger per road section.

## 2. PROCUREMENT PROCESS AND PROJECT PREPARATION

As a public agency, the NPRA must follow the rules of the Norwegian public procurement act. This means that acquisition of technology over a certain value must be done by tender. Releasing these tenders is time consuming and since we receive yearly funding, the procurement process is highly ineffective. With the goal of reducing avalanche risk at 20 – 25 road sections in the coming five years, this ineffectiveness must be mitigated. We have done so by establishing a framework agreement for acquisition, building, and maintaining RACS.

Project preparation is done in two different working groups. A group of avalanche specialists establishes a priority list based on professional assessments. Professional assessments include both summer and winter fieldwork, collecting surface models by UAS photogrammetry. We also carry out geomorphological mapping and dynamic avalanche modelling.

A group consisting of persons trained in land acquisition, landscape architecture, cultural monuments / archaeology and project management takes prioritized projects over and develops them further, making these projects ready to be built.

All the other development of new technology and implementation of related projects, as described in the paragraph above is done in subgroups, obviously relating to our main work on reducing risk for 20 – 25 avalanche prone road sections.

## 3. RESULTS FROM THE FIRST YEAR OF THE PROJECT

We have signed contracts with two companies under the framework agreement for RACS. The companies are Wyssen Norge AS and MHM Entreprenør & Service AS. The latter company is the Norwegian supplier for the O`Bellx system. The framework agreement is valid for two + one + one years with a maximum of 50 systems. The subcontracts signed under the framework agreement are valid for five + five + five + five years and include service, support, explosives or gas, and all other things needed to have the

system running, expect helicopter costs. For each sub-project within the framework agreement, we decide the contractor mainly based on price, which we agreed upon in the agreement beforehand. Other deciding factors are for example that we want to have the same type of system in a limited area or that we want to have a gas-system if the system is to be placed very close to an inhabited area where people easily have access. The county road owners, being responsible for over 40 000 km of roads and 1231 registered avalanche prone road sections can also make use of the framework agreement.

In 2024 we will deploy one O`Bellx + as a supplement for an already existing O`Bellx + at Rv 7 in Southern Norway (Figure 1). Rv 7 is a frequently used road over the mountain plateau Hardangervidda, connecting the west coast of Norway to the eastern part of the country. We further intend to install six Wyssen towers at Ev 134, a road over another mountain pass in southern Norway. These towers will supplement three existing Wyssen towers (Figure 2). To support the use of new RACS at Ev 134, we will establish site-specific avalanche forecasting from the winter 2024/25.

In total these newly deployed systems will reduce avalanche risk on four road sections. In addition to these two road sections, several sites in northern Norway have been field mapped and assessed using avalanche simulations to find the optimal number of RACS and their placement in the starting zones. We furthermore work on placement of weather masts and avalanche detection systems such as radars at these sites.

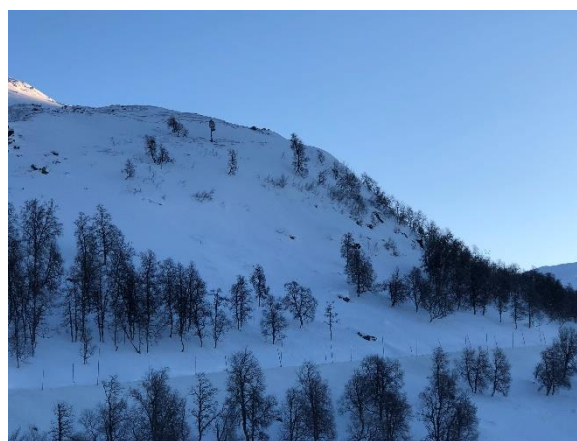


Figure 1: Rv 7 in Southern Norway was instrumented with an O`Bellx + the winter of 2022/2023 (photo: Njål Farestveit, NPRA). The site will be supplemented with one O`Bellx + in 2024 as the first sub-project in the “Technology for handling of natural hazards” project.



Figure 2: Existing Wyssen tower at Ev 134 after a release in 2022 (photo: Jens Tveit, NPRA).

#### 4. DISCUSSION AND THE WAY AHEAD

With this paper we intend to introduce our current approach to reducing risk from natural hazards on Norwegian roads. With the Norwegian Government being interested in the use of established and new technology for avalanche risk reduction, we feel a large responsibility in finding the best solutions for each exposed road section. This is a challenging task, however, also an academically exciting one, which forces us to be up-to-date on new developments within the avalanche industry.

We are lucky to have dedicated avalanche professionals in our team and a good and open avalanche community around us, with the Norwegian Water Resources and Energy Directorate as a close partner, together with a handful of consulting agencies. The signing of a framework agreement for RACS in the first year of the project was an important step towards reducing avalanche risk at 20 – 25 road sections.

Besides good cooperation within the Norwegian avalanche community, close cooperation with the Norwegian counties that own the county road network, as well as close cooperation with the road contractors is absolutely vital for the success of this project. As the project develops, we are happy to share both data, methods and results to facilitate community building and safer roads.

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