



**Statens vegvesen**



## A description of the Trollstigen early warning pilot project

### The aim of the pilot project<sup>1</sup>

Several road and railway stretches in Norway are exposed to debris flows and flash floods that are initiated by very local precipitation systems with a relatively short duration like less than one hour to a few hours. The focus landslide prone area will be county road 63 at Trollstigen, which is highly prioritized by Norwegian authorities due to the very high exposure, particularly due to the high traffic density during the summer months. The slopes around the road are steep and the catchment areas are small and sparsely vegetated, causing quick runoff during intense rainfall. The aim is to implement a cost-effective early warning system that integrates both regional and locally monitored data.

### Innovation potential

The innovation potential lies primarily in developing the framework for an early-warning system that efficiently integrates regional and local data and that can be straightforwardly adapted to other sites with similar conditions. In the long term, the system could be automatically connected to regional or national warning services. The added value of this activity to the end-user (e.g. the NPRA<sup>2</sup>, counties or other owners of infrastructure) are early-warning systems for flood and debris flows that enable the optimal management of risk by closing infrastructure for the shortest period necessary, allowing normal use again as soon as the acute risk has passed.

### Research questions and research activities

The use of regional data has very limited, if any, applicability for early-warning systems for cases like Trollstigen where rapid mass movements (e.g. debris flows and flash floods) are prevalent. While Norwegian experience shows that the use of local data (both monitored and prognosis) has proven to be useful for early-warning for snow avalanches, this approach has not yet been applied for the types of rapid mass movements relevant for Trollstigen. The research activity will aim at establishing statistical correlations between several data sets and the occurrence of debris flows and flash floods. Data sets include:

- local metrological data and hydrological parameters and movements,

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<sup>1</sup> About Klima 2050's pilot projects and general guidelines for their establishment, see Time, B (Ed.) SFI Klima 2050 | Pilotprosjekter - Retningslinjer for etablering. Klima 2050 Note 17. Trondheim, 2016.

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- regional metrological data and weather prognoses, and
- historical observations, measurements and other background data from the pilot site.

The local metrological data will be acquired using a dedicated metrological station and supplemented by local weather radar data collected using MET's mobile weather radar system.

## The roles of the participants

- NPRA: Owner of the pilot project, with NGI and MET as research partners for the duration of Klima 2050.
- NGI: Responsible for the development of methods and techniques, in close collaboration with Met.no and the NPRA to ensure these are optimal for purpose.
- Met.no: Responsible for the supply and operation of their mobile weather radar system during the pilot and other aspects related to meteorological data.
- Other Partners
  - Partners with infrastructure that face similar challenges may choose to be involved (for example counties and Bane NOR on behalf of the Norwegian Railway Directorate)
  - Partners in the consortium with an interest in the monitoring techniques and interpretation methods may also choose to join the pilot.

NPRA will retain sole responsibility for the Trollstigen installations after the pilot is completed.

## Financial implications and agreements

The pilot project costs for Klima 2050 are primarily related to labour (hours). Direct costs are expected to be modest, as the pilot will utilise to a large degree equipment provided by Klima 2050 partners.

- Labour costs:  
Developing methods for monitoring and processing data, planning and execution of installations of temporary and/or permanent monitoring systems at the location. The time used by the NPRA and Met.no are counted as in-kind contribution to Klima 2050
- Direct costs:  
The NPRA is considering implementing permanent installations consisting of a local metrological station as well as point sensors for run-off rates. The direct costs for this would be provided by the NPRA and considered as part of their in-kind contribution.

The pilot proposes to use the mobile weather radar system owned by Met.no. Although there are no direct procurement costs for this equipment, there will be some operational costs associated with its deployment. These costs need to be identified and included in the Klima 2050 budgets.

## Publishing

The publication/dissemination related to Trollstigen must be carried out in accordance with Klima 2050's communication plan<sup>3</sup>. Through appropriate dissemination the results of this pilot study will benefit both the NPRA and other owners of infrastructure (e.g., Bane NOR). The dissemination of the experience should take place in addition to Klima 2050's own means of publishing, for example, by NPRA distributing knowledge, articles in journals, guidelines or technical handbooks.

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<sup>3</sup> Kvande, T og Time, B: *SFI Klima 2050 | Kommunikasjonsplan, versjon 3*. Klima 2050 Note 68. Trondheim, 2018