# Does the weather stop the traffic?

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**Abstract**

Natural hazards in Norway, the most important being avalanches, landslides, and floods, are often triggered by extreme weather events (EWEs). According to recent studies winter precipitation in Norway has increased by 5-25% between the two 30-year periods 1961-90 and 1979-2008. Climate models indicate that this trend will continue in the future, and EWEs are expected to become more frequent and intense. These changes are likely to threaten important infrastructure that are designed along the guidelines based on known historical precedence.

The current study is carried out under the Norwegian project InfraRisk (Module A) which aims to improve the understanding of past and future variability of EWEs in Norway and its connection to natural hazards affecting Norwegian transport infrastructure. The focus is on major roads, railways and related buildings. The main objectives are to identify EWEs that are most relevant in the triggering of natural hazards, and to analyze past and future changes in frequency and intensity of these events, as well as their spatial distribution. In this study we have assessed changes in the past, between 1961 and 2010, with particular focus on climate elements relevant in the triggering of avalanches. Among the climate variables studied are intense and/or prolonged precipitation events, episodes of heavy snowfall, especially those followed by strong winds, and freeze-thaw events known to cause instability in the snow pack and triggering rock fall.

## Data and methods

Estimates of daily temperature and precipitation obtained from observations are interpolated
to a 1x1 km2 grid covering the Norwegian Daily grids are available for the period 1957 until today and are presented at www.seNorge.no.

A simple trend analysis is performed using the rank-based nonparametric Mann-Kendall trend test. Trends are computed for different time periods and evaluated for statistical signicance at the 95% confidence level. Long-term trends are computed for the period; 1957-2010, and short-term trends are computed for three 30-year periods; 1961-1990, 1971-2000, and 1981-2010. Figures 2 – 5 shows maps of Norway with max levels and trends. Figure 1 is a set of maps showing the annual mean percipitation, annual temperature, and topography.

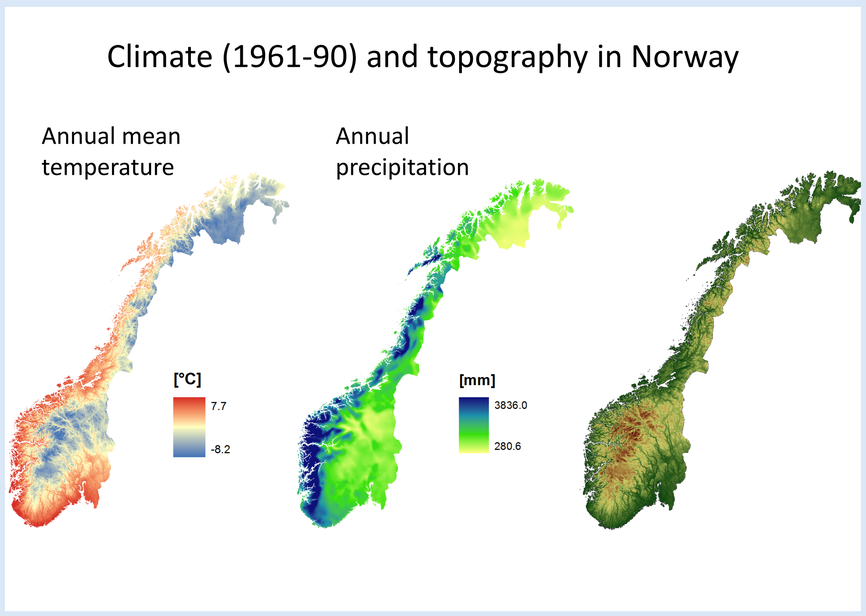


**Figure 1:** The norwegian anual climate and topography

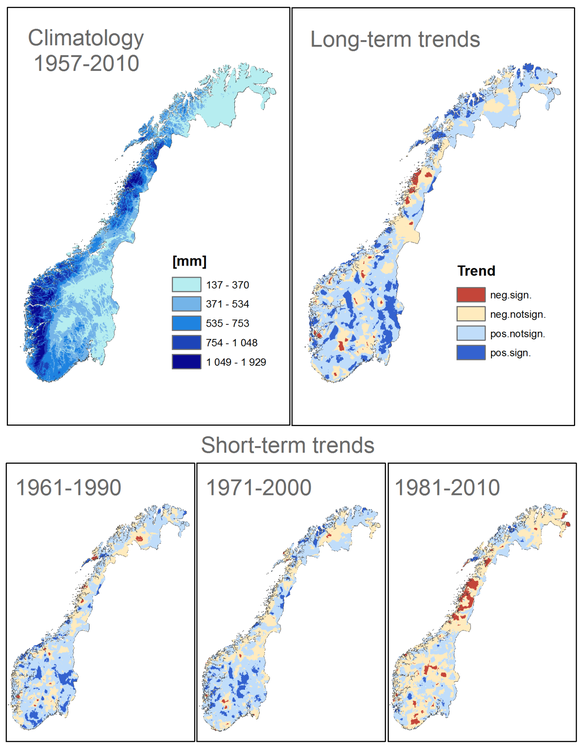


**Figure 2:** Annual maximum 1-day precipitation, with linear trend over various time periods. The longterm trends show a pattern og increased 1 day percipitation, wich is also evident in the periods of 1961 – 1990, and 1971 – 2000.

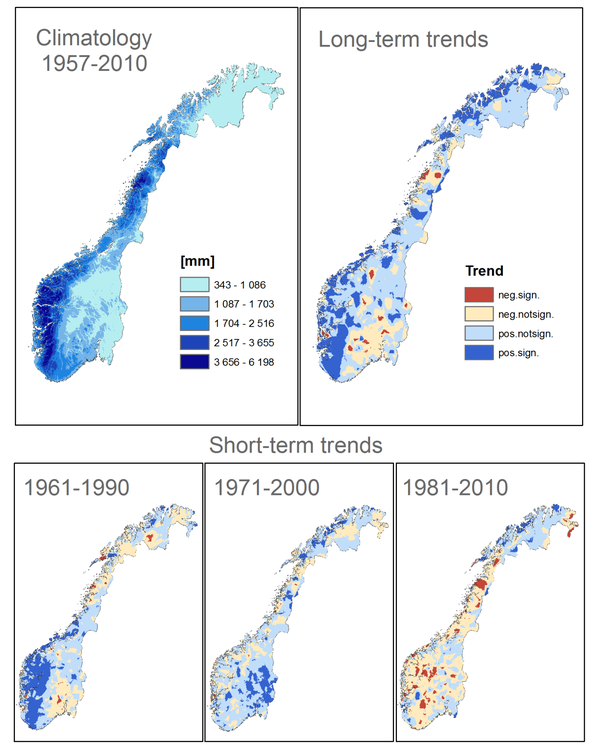


**Figure 3:** Annual maximum 10-day precipitation, with linear trend over various time periods. The longterm trends show a pattern og increased 10 day percipitation, wich is also evident in the periods of 1961 – 1990, and 1971 – 2000.

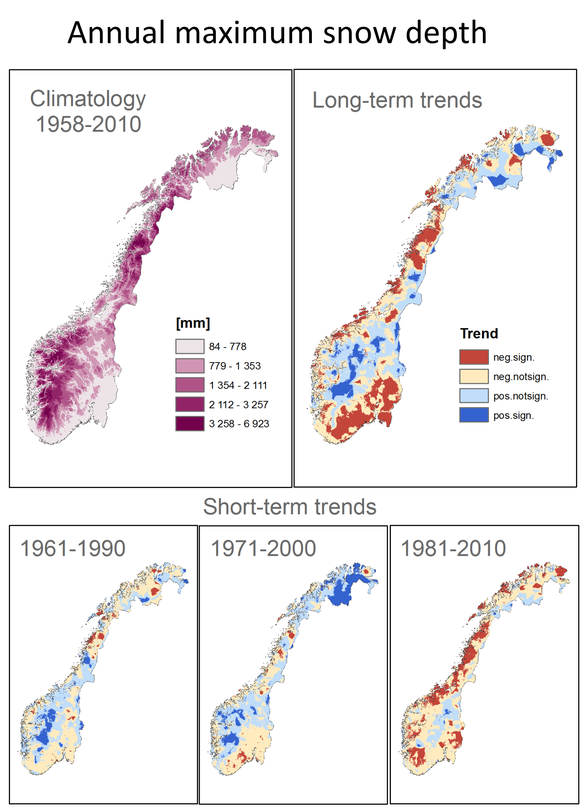


**Figure 4:** Annual maximum snow depth, with linear trend over various time periods. There is a clear distinction between highland and lowland regions in the max snow depth: The max. snow depth is still increasing in the mountains, and decreasing in the lowlands.

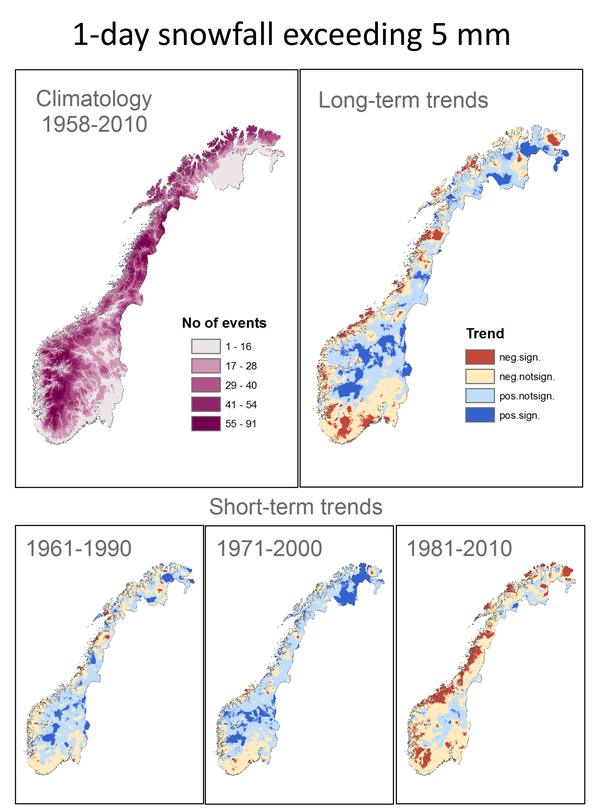


**Figure 5:** Annual number of days with snowfall exceeding 5, with linear trend over various time periods. The longterm trends show a pattern og increased days with hevy snowfall in the mountains and decreased heavy snowfall in the lowlands.

## Conclusions

- Since observations are limited in many areas, especially in higher elevations, the national climate grids are a valuable supplement in the analysis of past climate
- Trends in annual maximum daily precipitation sums for the entire period 1957-2010 are generally positive, except in some regions in the southeast and in central Norway. Trends are stronger and show a more distinct pattern for longer duration precipitation
- The frequency of moderate to strong precipitation events has increased in most parts of the country since 1957
- Annual maximum snow depth reveals positive trends in cold areas, which might be explained by increased winter precipitation, and negative trends in warm areas due to increased winter temperatures

Acknowledgements
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More information: http://www.ngi.no/en/prosjektnett/infrarisk