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Connections between winter snowpack and subsequent spring floods in Norway

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In Norway many inland and mountainous catchments have a hydrological regime where snow accumulates during winter. The runoff is delayed until the snow melts during spring. These processes are important for flood forecasting and water resource management, such as operation of hydropower reservoirs. It is commonly assumed that spring flood volume and peak linked to antecedent conditions such as winter snowpack, i.e. a large winter snowpack results in a high spring flood. The aims of this study are (i) to identify for which catchments a high correlation between snow water equivalent (SWE) at the end of the snow accumulation season and the subsequent spring flood, and (ii) establish regression models for these catchments to be used for seasonal flood forecasting.

Daily runoff data from 43 distributed catchments all over Norway, each with at least 50 years of observations and a flood regime which is significantly influenced by snowmelt, were used. For each of these catchments we extracted SWE, precipitation and temperature on daily resolution from the on gridded data of Senorge.no.
A peak-over-threshold approach was used to select independent flood events above the 90-th percentile. Maximum discharge, duration and volume were calculated for each event. The contribution of rain and snowmelt to each flood was additionally determined, based on snowmelt, precipitation and temperature data.
The spring flood was defined as the first flood event that occurs after the date of maximum SWE, and the snowmelt contribution of at least 70%.
The contribution of rain to a spring flood is independent of maximum SWE, resulting in a weaker correlation between maximum SWE and spring flood size. We therefore scaled the flood with the percentage of snow contribution to the flood event in order to adjust for the contribution from rain. The correlations between SWE and the spring flood were higher for scaled spring floods than for the unscaled ones.

The results show for half of the stations a correlation coefficient of 0.5 or higher. Flood volume had the highest correlation to SWE, followed by flood duration and peak. The geographical distribution of correlation shows that the correlation is the highest for inland catchments and in Northern Norway. Lower correlations were observed for catchments near the west coast.
Regression models were established for these stations in order to predict the spring flood peak, duration and volume based on SWE data.

In summary, we have (i) identified for which catchments SWE might be used to predict spring flood and (ii) established regression models for predicting spring flood peak, duration and volume based on the winter snowpack.