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Drought and Snow: Analysis of Drivers, Processes and Impacts of Streamflow Droughts in Snow-Dominated Regions

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Around the world, drought events with severe socio-economic impacts seem to have a link with winter snowpack. That is the case for the current California drought, but analysing historical archives and drought impact databases for the US and Europe we found many impacts that can be attributed to snowpack anomalies. Agriculture and electricity production (hydropower) were found to be the sectors that are most affected by drought related to snow.
In this study, we investigated the processes underlying hydrological drought in snow-dominated regions. We found that drought drivers are different in different regions. In Norway, more than 90% of spring streamflow droughts were preceded by below-average winter precipitation, while both winter air temperature and spring weather were indifferent. In Austria, however, spring streamflow droughts could only be explained by a combination of factors. For most events, winter and spring air temperatures were above average (70% and 65% of events, respectively), and winter and spring precipitation was below average (75% and 80%). Because snow storage results from complex interactions between precipitation and temperature and these variables vary strongly with altitude, snow-related drought drivers have a large spatial variability.
The weather input is subsequently modified by land properties. Multiple linear regression between drought severity variables and a large number of catchment characteristics for 44 catchments in Austria showed that storage influences both drought duration and deficit volume. The seasonal storage of water in snow and glaciers was found to be a statistically important variable explaining streamflow drought deficit.
Our drought impact analysis in Europe also showed that 40% of the selected drought impacts was caused by a combination of snow-related and other drought types. For example, the combination of a winter drought with a preceding or subsequent summer drought was reported to have a large effect on reservoir levels and, consequently, on drinking water and electricity production. Snow storage therefore, is an important factor to consider in drought monitoring, prediction and management.