Observed hydrological changes in partially glacierized catchments

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HYDROLOGY

Motivation

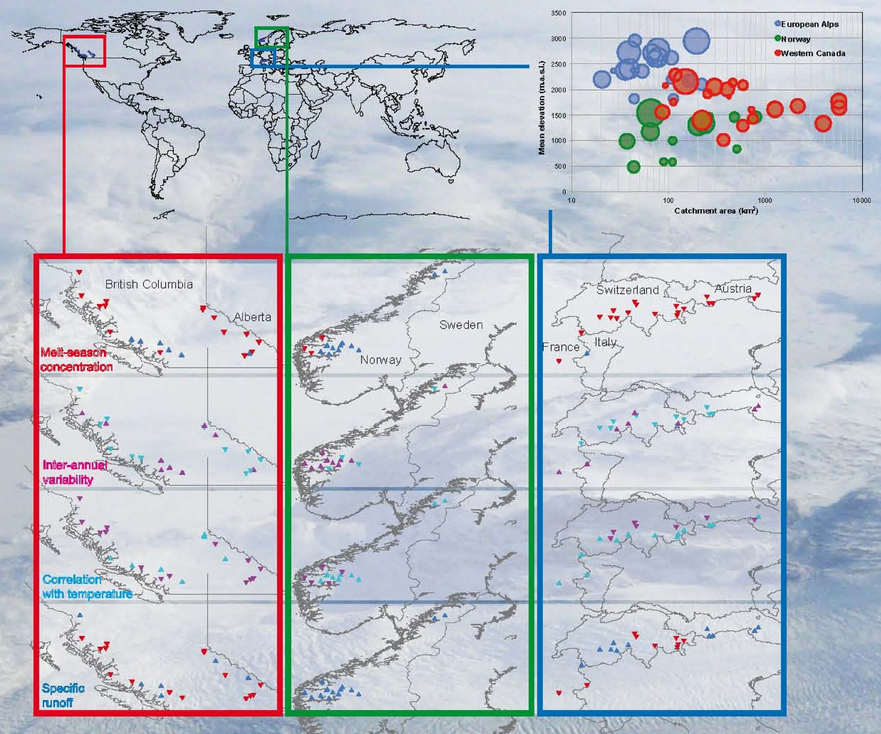
Timing and quantity of streamflow changes from partially glacierized catchments as a response to climate warming can vary widely and are difficult to quantify.

Measures of change

Some typical response signatures exist. Hock et al. (2005) summarize glacier runoff characteristics that may be observed in streamflow from glacierized catchments, separating initial response and long-term response to warming:

Signature	Initial - Later response
Melt-season runoff concentration	▲ Decrease ▼
Inter-annual runoff variability	▼ Increase ▲
Runoff correlation with Temperature	Increase ▲ - Decrease ▼
Specific runoff	Increase ▲ - Decrease ▼

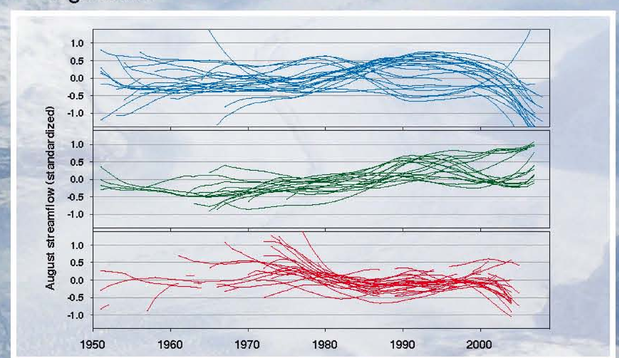
Changes in these signatures were mapped as the difference in streamflow characteristics between an earlier period and a later period, *S*(1968-1988) : *S*(1989-2008)

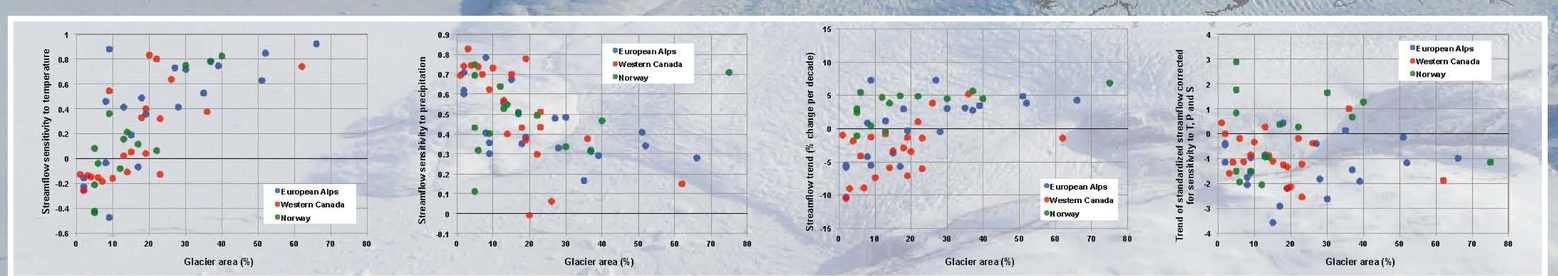


Dataset

The assembled dataset of catchments from Canada, Norway and the European Alps reflects general differences in data availability in these regions. While all countries monitor partially glacierized catchments,

- catchment areas for gauges above the first reservoir or major regulation are much larger in Canada than in Europe,
- mean catchment elevations are higher in the Alps than in Norway and Canada,
- European records are longer, but more likely influenced by regulation.





August streamflow sensitivity (graphs above) to climate was used in a Trend analysis of August streamflow corrected for the influence of temperature, precipitation and carry-over storage (through regression) to filter out the signal of change due to glacier loss (Stahl and Moore, 2006) .

August streamflow trends (graphs above) are mostly negative in Canada, mostly positive in Norway, and mixed in the Alps.
After correction for climate sensitivities, most trends in the Alps and some in Norway become negative, indicating progressed influence of glacier loss.

Conclusion

Results of trends and changes largely confirm known directions of recent changes: in Canada and the Alps glacial rivers show changes towards prolonged melt seasons, increasing variablity and decreasing specific discharge in August. Norwegian glacial rivers, however, show increasing trends in summer streamflow, though some catchments with low glaciation show decreases when correcting for the direct effects of climatic variability. The dataset provides opportunities to elucidate the complex drivers of change across a range of conditions.

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Hock,R., Jansson P., Braun L. (2005). Modelling the Response of Mountain Glacie r Discharge to Climate Warming. In: Huber et al. (Eds). Global Change and Mountain Regions. Springer/Dordrecht.
Stahl K. and Moore R.D. (2006). Influence of watershed glacier coverage on summer streamflow in British Columbia, Canada, Water Resour. Res., 42, W06201.