Contribution of rain on snow melt to the 2021 floods in British Columbia, Canada

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Background

A category 4-5 atmospheric river affected southwestern British Columbia (BC) on November 14-15, 2021, causing destructive floods, bank erosion and landslides, leading to five fatalities and prolonged disruption in the main transport arteries.

Extreme flood on Nov 14-15, 2021 in British Columbia, Canada

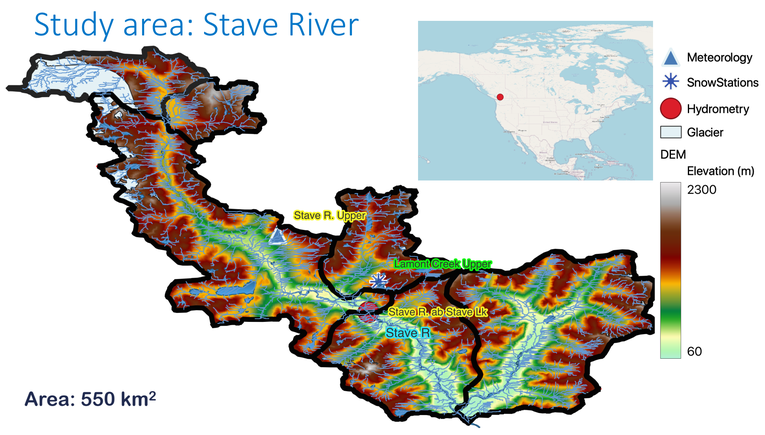
A post-fire, runoff-generated debris flow that washed out both Highway 1 and the rail line in southern BC near Tank Hill, South of Thompson River (Photo curtesy: Jeremy Venditti)

Key Research Question

What is the role of snowmelt in the extreme flood event of Nov 2021 in British Columbia?

Stave River Basin, Canada

Stave River Basin and its subbasins located in British Columbia, Canada.

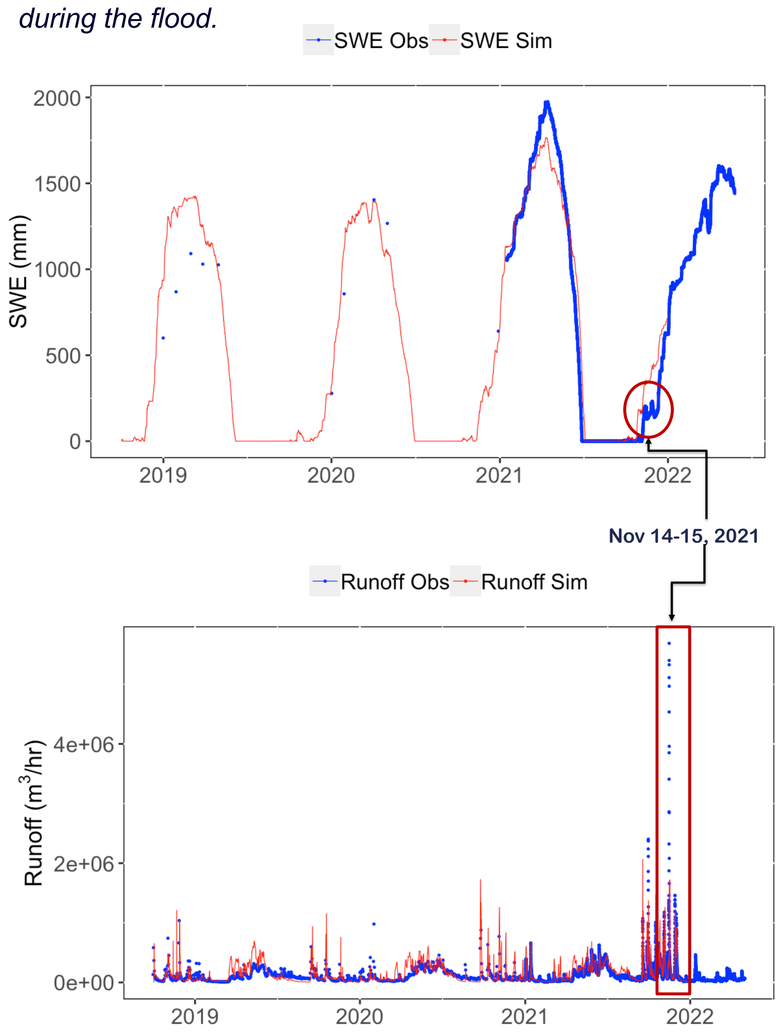


Data and Methods

We examine hydrologic processes immediately before, during, and after this extreme event in a coastal mountain watershed in BC. More specifically, we investigate snow accumulation and melt dynamics, and antecedent soil moisture conditions using a physically based cold regions hydrologic model (CRHM).

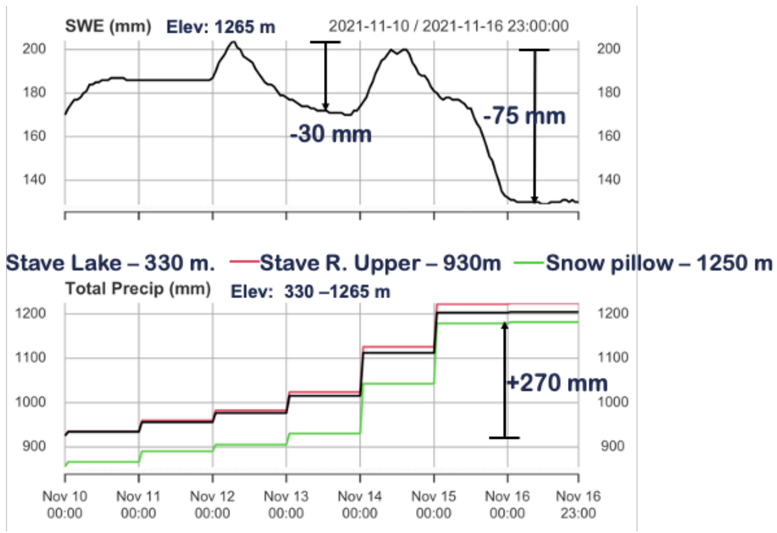
Snow water equivalent (SWE) and streamflow

Performance of the cold regions hydrological model (CRHM) in representing snow water equivalent and streamflow in the Stave River over the simulation period of 2019-2022 and during the flood.



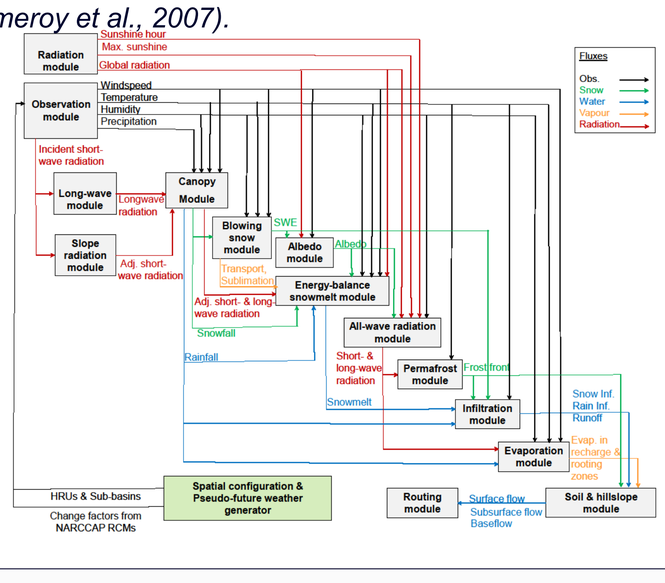
Snow water equivalent (SWE) and total precipitation before and after the event (Nov 10-16, 2021)

Snow water equivalent measured in the snowpillow showed a 105 mm decrease during the flood which caused an extreme flood event along with 270 mm total precipitation recorded in the three weather stations at different elevations.



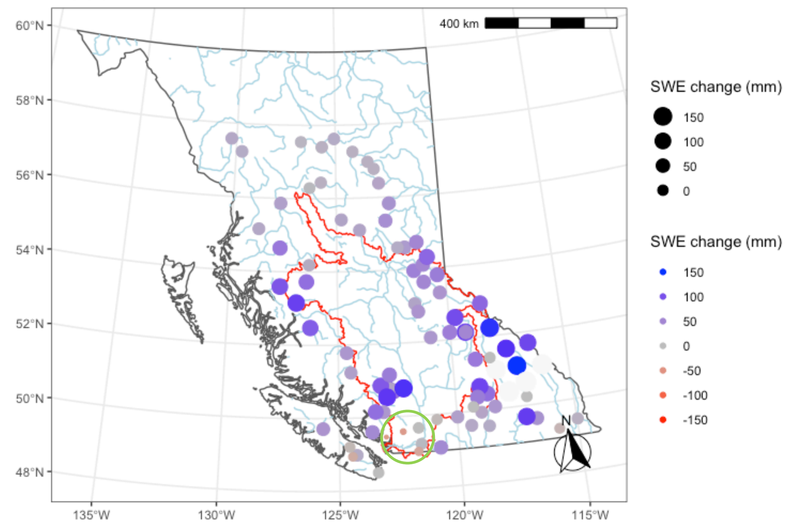
Cold Regions Hydrological Modelling Platform

We used CRHM model to represent all major hydrological processes in this snow dominated mountain watershed (Pomeroy et al., 2007).



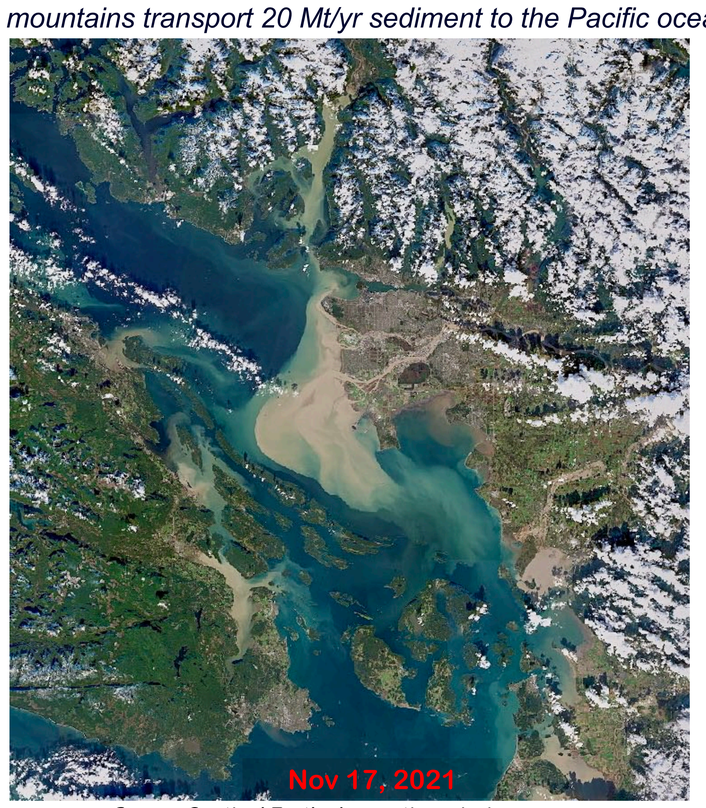
Regional snowmelt contribution to flood magnitude

Changes in the snow water equivalent during the flood in British Columbia. The southwestern areas with the negative changes between Nov 16 and Nov 11, 2021 match with the flooded zones, showing the snowmelt role in severity of the flood.



Regional snowmelt contribution to sediment transport

Rain and snowmelt runoffs generated in the coastal mountains transport 20 Mt/yr sediment to the Pacific ocean.



Source: Sentinel Earth observation mission

Conclusions

We used a physically based hydrologic model to represent the Nov 2021 flood in British Columbia.

Rain on snow and snowmelt runoff contributed to one-fourth of the extreme streamflow on Nov 14 and 15, 2021.

Acknowledgement

The authors gratefully acknowledge the financial support from the Natural Sciences and Engineering Research Council of Canada (NSERC).

Reference

Pomeroy, J.W., Gray, D.M., Brown, T., Hedstrom, N.R., Quinton, W.L., Granger, R.J. and Carey, S.K., 2007. The cold regions hydrological model: a platform for basing process representation and model structure on physical evidence. Hydrological Processes: An International Journal, 21(19), pp.2650-2667.