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Assessing Sensitivity to Forest Disturbance in Ungauged Basins

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Forest cover is a key modifier of a watershed's peak flow regime. Where forest cover is reduced due to logging or natural disturbances such as fire, insect, or disease outbreaks, peak flows are increased in most cases. Based on GIS data available for the entire province of British Columbia (BC), Canada, with its diverse climatic regimes, land cover and hydrologic processes, we developed a novel methodology that classifies the sensitivity of watersheds to peak flow modification based on input characteristics and hydrological runoff generation processes for ungauged watersheds. The input model component uses climatic data to derive mean annual snowmelt and maximum rainfall rates for BC for each month at a 400m grid resolution. It estimates the time of occurrence of snow-melt induced peak flow, and classifies watersheds into snowmelt-dominated, rainfall-dominated, and transitional precipitation regimes. This allows mapping peak flow generating input for each third-order watershed in BC. The runoff generation model component delineates dominant peak flow generating processes at the watershed level: channel interception, Hortonian Overland Flow, Saturation Overland Flow and Shallow Subsurface Flow. This delineation is based on a combination of factors such as land cover, relief, slope, aspect, drainage density, drainage pattern, and hillslope morphology. The model components have been successfully validated against provincial hydro-climatic data sets. Derived maps at 25 m resolution are used to classify the watershed into different peak flow regimes to obtain a sensitivity rating for different disturbance scenarios. This rating is incorporated into a framework to assess risks to infrastructure, drinking water, and fish habitat, and to minimize peak flow modification by optimizing timing, extent and location of logging in watersheds.

This approach provides a novel combination of spatially explicit hydrological process mapping in ungauged watersheds and scenario generation for a variety of land cover changes.