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Inferring long-term water balance dynamics in forested watersheds: Tracing vegetation cover transitions

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The dynamics of catchment water balance remains a challenging question in hydrology especially within an environmental change context. While the temporal variability of catchment response to internal -land use- and external -climate- forcings is important for human and environmental needs, understanding the spatial variability of this response is relevant for prediction and regionalization. Among the water balance components evapotranspiration (AET) is the most difficult to measure and estimate but it is also the component that varies highly with climate and land surface conditions. Therefore, new approaches are needed that allow the attribution of variability and changes in AET through exploration of observed hydroclimatic records in watersheds. Due to an unprecedented large-scale tree epidemic, significant land use changes in natural watersheds are currently occurring in British Columbia, Canada. The aim of this work is to study the role of long-term land use history, i.e. forest harvesting or dying and subsequent regrowth, in the long-term water balance variability in forest watersheds of this region.

We first test the transferability of an ecohydrological curve suggested by Krestovsky (1980) and Kuczera (1987) that describes the landscape response of AET following forest regrowth after clear-cutting. During this recovery period a "peak" reference AET is reached approximately 60 years after the forest disturbance occurred followed by another 60 years to reach constant AET. We assume that these changes in AET will directly impact the streamflow response and apply this curve to watersheds with different patterns of forest age. We studied 8 watersheds with different size, topography, hydroclimatology and land cover history located throughout the Pacific Northwest. Since the historical land use is different in every watershed, results show a different trend and magnitude of observed and simulated actual evapotranspiration. For the 2 paired watersheds the observed and predicted streamflow changes are well reconstructed using the proposed ecohydrological curve. For the unpaired watersheds significant correlations between the simulated long-term changes in AET and simple estimates of evaporation using the catchment water balance approach (E=P-Q) were found. These correlations seem to be stronger when comparing the results to the Q/P and E/P ratios. The observed variability in the water balance in some Pacific Northwest watersheds can be explained to some extent by the forest ecophysiology at the catchment scale. Nevertheless, accurate forest disturbance data is critical to investigating water balance dynamics.