Topic:
EFN science and applications

Title:
The effects of forest disturbance and climate change on hydrology in the Deadman River Watershed: implications for environmental flow needs

Forest disturbance impacts many aspects of the flow regime including flow timing, flow magnitude, rate of change, flow frequency and variation. These changes in-turn affect the extent and condition of aquatic ecosystems. It is difficult to quantify how forest change affects streamflow because of the concurrent influence of climate. Understanding how these two drivers affect streamflow separately can help determine environmental flow needs (EFNs). The 878 km^2 Deadman River watershed, near Kamloops British Columbia provides water supply, fish, and other aquatic resources. Long-term annual data (1960 - 2012) on streamflow, climate, and forest change were used with multiple complementary statistical methods to separate the effects of forest change and climate variability in the study watershed: modified double mass curves, sensitivity–based method, time trend analysis and the paired-year approach. Equivalent clear-cut area (ECA) was used to represent watershed-scale cumulative forest disturbance and subsequent growth through space and time. The ECA reached 56% in 2012, confirming that the watershed has been severely disturbed.

Analysis of daily flow data reveals a significant change in the magnitude of annual streamflow and low flows. The effects of forest disturbance on mean annual flow became statistically significant in 1989, at an ECA of 12.4%. Since this breakpoint, from 1990 – 2012, we found that forest disturbance led to an average increase in mean annual streamflow +12.7mm/year. Additionally, we found that climate change has also lead to an increase in mean streamflow of a similar magnitude over the same time. Low flow was found to increase significantly by 0.15 m^3/s or 79%. Up until now the increasing levels of disturbance have meant that the effects of forest and climate change have been additive, both increasing streamflow. The implications of those results for EFNs are discussed in the context of future forest recovery and climate change.

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