Geophysical Research Abstracts
Vol. 13, EGU2011-10524, 2011
EGU General Assembly 2011

Wildfire effects on stream hydrochemistry within the zone of continuous permafrost distribution in Central Siberia

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Forest fires, the main disturbance factor in the boreal biome, are tended to increase in frequency and severity under "dry warming" (Conard et al. 2002). Shorten fire-return interval in larch dominated permafrost terrains of Central Siberia (Kharuk et al., 2008) exert significant control on ecosystem element cycling throughout the complex interaction between deforestation, ground vegetation and organic layer combustion as well as deepen soil active layer. Integral impact of fires on biogeochemistry of basins underlain by permafrost might be traced through an analysis of element release into riverine systems from watersheds affected by fire events.

To analyze the effect of fires on chemical composition of surface waters in permafrost zone and its temporal changes, fourteen small forested watersheds (3-25 km2) have been selected in mid-stream of Nizhnyaya Tunguska River (Yenissey basin, Central Siberia, Russia). Analysis of larch trees in forest stands of the area demonstrated that presumably all basins were affected by wildfires in the past. Selected watersheds have been severely influenced by ground fires (>90% of watershed area) ca 110, 60 and 20 years ago. Water sampling campaign has been conducted from snowmelt (mid-May) to the start of freezing (mid-October) on weekly and/or monthly interval in 2006-2010. In this study, we analyzed the dissolved loads for major and trace element concentrations.

In terms of concentration changes in the course of the year, concentrations of dissolved organic carbon (DOC) as well as associated elements like Fe, Al, Y and REE and inorganic ions (e.g. DIC, Cl, Ca, Na, Mg etc.) demonstrated opposite tendencies during frost-free seasons in all streams. However, basins with recent fire effect exhibited generally lower DOC concentrations in streams along with much more pronounced seasonal increase in inorganic loads. The increased active layer thickness and major element leaching from mineral soil is the most likely cause of inorganic component concentration increase in watersheds affected by fire events. The larger watersheds have also shown talik (permanently unfrozen zones) formation resulting in deep solute appearance in the surface runoff (high concentrations of Na and Cl ions). Decreased discharge and reduced DOC export in fire-affected watersheds have been suggested to result respectively from larger water-holding capacity of the deepen active soil layer, which developed after the fire events, and the combustion of the organic layer, which is the main DOC source. Thus, under a drier climate, fires impose two limitations of DOC release from watersheds: (1) decreasing mobile C-source (combustion of organic layer), and (2) decreased volume of draining water (increased water-holding capacity of soil). Comparable concentrations of elements in streams draining from watersheds burnt 50 and 100 years ago corroborate earlier estimates of a recovery time of 50 years for ecosystem structures of larch forests of the region.