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The study of soils and vegetation transformation due fire disturbances in remote areas through scenario modelling of observed hydrological response to fire impact

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Large territories of Siberia and Russian Far East are the subject to frequent forest fires. Often there is no information available about fire impact except its timing, areal distribution and qualitative characteristics of fire severity. Observed changes of hydrological response in burnt watersheds can be considered as indirect evidence of soil and vegetation transformation due to fire impact.

In our study we used MODIS Fire products to detect spatial distribution of fires in Transbaikal and Far East regions of Russia in 2000 – 2012 period. Small and middle-size watersheds (with area up to 10000 km2) affected by extensive (burn area not less than 20 %) fires were chosen. We analyzed available hydrological data (measured discharges in watersheds outlets) for chosen basins. In several cases apparent hydrological response to fire was detected.

To investigate main factors causing the change of hydrologic regime after fire several scenarios of soil and vegetation transformation were developed for each watershed under consideration. Corresponding sets of hydrological model parameters describing those transformations were elaborated based on data analysis and post-fire landscape changes as derived from a literature review. We implied different factors such as removal of organic layer, albedo changes, intensification of soil thaw (in presence of permafrost and seasonal soil freezing), reduction of infiltration rate and evapotranspiration, increase of upper subsurface flow fraction in summer flood events following the fire and others.

We applied Hydrograph model (Russia) to conduct simulation experiments aiming to reveal which landscape changes scenarios were more plausible. The advantages of chosen hydrological model for this study are 1) that it takes into consideration thermal processes in soils which in case of permafrost and seasonal soil freezing presence can play leading role in runoff formation and 2) that observable vegetation and soil properties are used as its parameters allowing minimal resort to calibration. The model can use dynamic set of parameters performing preassigned abrupt and/or gradual changes of landscape characteristics.

Interestingly, based on modelling results it can be concluded that depending on dominant landscape different aspects of soil and vegetation cover changes may influence runoff formation in contrasting way. The results of the study will be reported.