Modelling the vulnerability of the active layer features and water fluxes of Russian boreal zone catchments to the climate change

Lebedeva L., Semenova O., Sazonova D., Tananaev N.

State of the freshwater ecosystems in the boreal zone is closely related to the permafrost properties such as active layer depth, and ground ice conditions. Hydrological processes strongly influence geomorphological feedback, biochemical pathways, greenhouse gas fluxes, and the export and transport of the dissolved and particulate organic material. Understanding of the physical drivers of the permafrost/hydrology interaction in a changing climate should be a starting point for further environmental studies in boreal regions. The goal of our ongoing research is quantifying the vulnerability of the active layer properties and flow patterns in different boreal forest (taiga) and tundra ecotones. Data from the Igarka monitoring site, located in the transition zone between the taiga and tundra ecotones in northern Krasnoyarsk Krai, are extensively employed in our studies.

The modelling experiment is to be performed in the following steps: 1) validation of the process-based Hydrograph model against the observed active layer depths in bogs and coniferous forest landscapes in the Little Graviyka catchment (CALM R40 site); 2) simulation of the water discharge records for the Little Graviyka (0.44 km^2) and the neighbouring Graviyka River catchments (323 km^2); 3) model runs with the artificial meteorological inputs assuming temperature/precipitation increase by a constant value; 4) vulnerability assessment of the active layer features and water fluxes in various landscapes to the introduced (hypothetic) climate change.

Applied distributed process-based Hydrograph model describes the majority of land hydrological cycle processes and includes the coupled algorithms of heat and water dynamics in the soil. Employment of soil and vegetation properties as the model parameters, controlling active layer dynamics and flow formation, requires no calibration efforts. Thus the model could be employed in non- stationary climate change conditions. Verification of the results besides river runoff against soil and snow variable states as the model metrics allows reducing the uncertainty of the model parameters. Potential change of soil thawing rates and flow regime projections can be used for thermokarst and related geomorphic processes forecasts in the boundary (taiga/tundra transition) region.