down into the water flow resulting in cliff formation at the convex bank. Blocks of frozen wet sand melting in water becomes the material for sand waves formation at the bottom. Deep niches of thawing are formed at the concave bank, which also lead to breakdown of large pieces of the bank. Thus, riverbanks of laminated structure in cryosphere are susceptible of spasmodic erosion. The thawing of the frozen ground at the shoreline is practically independent of the velocity of the flow in the range used in experiments.

The influence of snow cover on the thawing of frozen ground was investigated. Snow cover decelerates the thawing of the banks from above, but accelerates formation of deep niches under the cover. Crack separates the snow cover above the frozen bank from the snow cornice above the water, which breaks down at some moment carrying along blocks of ice and frozen sand. Modeling of processes of frozen grounds thawing could be useful for forecast the reaches of riverbanks crushing depending on composition of the frozen banks.

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Modelling Thermal Regime of an Intrapermafrost Talik in Central Yakutia

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Intrapermafrost taliks widely occur in sandy deposits of the Lena River alluvial terraces on the right bank of the Lena River, in central Yakutia. Most such talik strata host intrapermafrost groundwaters, discharging in small creeks cutting the valley sides and feeding multiple icings throughout winter. While the source areas of the groundwater flow can be traced at most locations, the question of the origin of non-frozen intrapermafrost layers remains open. Are they a product of the current climate, or of the warmer Holocene optimum conditions? In both cases, is there a significant thermal imprint from the groundwater flow capable of maintaining the non-frozen state of the deposits? Our study aimed at addressing these questions with the means of heat transfer modelling.

Our study site is the well-studied Ulakhan-Taryn valley, at the right bank of the Lena River ca. 50 km from Yakutsk. Local geology is fine to medium sands from the surface Boreholes and ERT surveys provide sufficient details on the permafrost distribution: a topmost frozen layer from surface to 16 m, a top of permafrost at ca. 80 m, and an intrapermafrost talik between the two. Mean monthly ground temperatures vary from -18.6°C (January) to +16.8°C (August) at the ground surface, from -9.3°C (January) to +9.8°C (August) at 1m, and are slightly positive at zero annual amplitude depth (18 m). The active layer depth averages 2.8 m.

Our modelling exercises involved two numerical models, QFrost (Moscow State University) and PFLOTRAN (Sandia National Laboratories, USA), both open-source and distributed under GNU GPL license. QFrost is a conductive heat transfer model with phase changes, and PFLOTRAN is a fully coupled convective-conductive heat and water transfer model. At the current stage of our study, only 1D calculations were performed and only conductive heat transfer was accounted for in both models. Initial conditions were assigned based on borehole descriptions and published thermal properties of central Yakutian sands. Calibration and verification runs were used to test and adjust, if necessary, the major input parameters, of which the most important were the thermal properties of local sands in both frozen and non-frozen state. A uniform temperature distribution (1 °C) was applied, and geothermal flux was neglected in both model settings, based on previous studies.

The variations in thermal properties of frozen and non-frozen sands were found to control the thermal regime of the upper part of the cross-section. Calibration runs have proven that the 'positive temperature shift' effect controls ground temperature distribution in the active layer, where the thermal conductivity in non-frozen state exceeds that of the frozen sands. Our preliminary results from a series of 1D simulations in QFrost, running for 100 y, show that under current climate, permafrost develops to a depth at least 40m in an initially non-frozen profile of sandy deposits. In PFLOTRAN, however, the bottom of permafrost depth limits to ca. 20 m, but further freezing is expected in longer model runs. Therefore, a certain thermal impact from groundwater flow may be assumed sustaining the intrapermafrost talik in its present dimensions.

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Hydrological modelling of the maximum runoff characteristics at small rivers in the permafrost zone

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The reliability of extreme flow characteristics assessments is associated with non-stationary nature of the environment when statistical approaches become