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Geographic Assessment Of Permafrost Bearing Capacity In Siberia Under Warming Climate

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More than 75% of engineering structures on permafrost in Russia are built according to the ”First Construction Principle”, which relies on the freezing strength (bearing capacity) of the frozen ground to support structures. For given surface and subsurface conditions, the bearing capacity depends strongly on the active layer thickness (ALT) and the temperature at the top of the permafrost (TTOP), both of which are strongly affected by the atmospheric climate. Increases in TTOP and ALT resulting from climatic warming can significantly reduce the bearing capacity of the frozen soil and the stability of engineered structures. We have developed a set of parameterizations to estimate the bearing capacity of frozen soils as function of TTOP and ALT, according to Russian Construction Rules and Regulations. The effect of climate on TTOP and ALT was estimated by an equilibrium permafrost model. Here, we present results from a geographic assessment of changes in the bearing capacity of permafrost soils attributable to observed climatic change in Siberia. Changes in bearing capacity for the last forty years were evaluated for several large settlements and industrial centers, representing different geographical conditions of the Russian Arctic. GIS-based landscape approach was used to apply model at the regional and continental scales to spatially assess changes in the permafrost temperature, the active-layer thickness and the bearing capacity in the North of West Siberia and for the entire Russian continuous permafrost zone. Substantial (up to 25%) loss in the bearing capacity of frozen soils is evident throughout the Russian permafrost zone. This in turn undermines the stability of infrastructure built on permafrost.

Contact Information