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CONTROL ID: 1472900

TITLE: Observed and projected climate change implications for urban infrastructure and society in the Russian Arctic

ABSTRACT BODY: The discoveries of mineral resources followed by an extensive economic development of the Russian North in 1960s led to a development of complex infrastructure on permafrost and urbanization of the Russian Arctic. Despite the mass migration from the northern regions, followed by the collapse of the Soviet Union and the diminishing government support, the Russian Arctic inherited massive infrastructure and remained predominantly urban. Currently, only in five districts bordering Arctic Ocean more than 1.4 million people live in urban-style buildings built on permafrost. Majority of the buildings are constructed assuming the equilibrium conditions of heat-exchange between atmosphere and permafrost underneath. This is usually achieved by construction on piles with ventilated cellars allowing ground cooling in a winter and shading in a summer. The ability of the foundations to carry structural load or foundation bearing capacity (FBC) depends on permafrost properties and changes according to permafrost temperature and active-layer depth. Climate warming observed in recent decades created conditions of diminishing FBC and resulted in deformations and failures of structures built on permafrost. This work is focused on quantitative assessment of these changes at a regional scale. In order to estimate the role of climate change on stability of structures build according to the passive principle, the permafrost-geotechnical model was developed. The historical changes were assessed by comparing model results for period associated with industrialization and construction boom in the Russian North (1965-1975) and present conditions (1995-2005) using NCEP climatic datasets. Projected changes in FBC according to A2 IPCC scenario for the mid-21st century (2041-2060) relative to baseline period (1981-2000) were assessed using output from the ensemble of MGO RCM climate change simulations. It has been found that substantial decrease in FBC will likely occur for the majority of structures built during the industrialization of the Russian North. The decrease of FBC is most pronounced in the regions of West Siberia and Chukotka. The geographic assessment shows that about 0.4 million people currently live in the areas where FBC already decreased by more than 15%. Projected changes of FBC are estimated to be even more significant by the mid 21st century considering 2-4 oC increase in mean annual air temperature in the permafrost regions of Russia. The permafrost temperature increase is modified by changes in snow cover accumulation and continentality and is less than that of the air. Despite that, the decreases in FBC are projected to be quite significant, if not catastrophic in the Russian European North and West Siberia, Western Taymyr and eastern Chukotka (40-50% and more). To mitigate the negative consequences of permafrost warming, the engineering solutions will have to adapt climate projections in construction design, introduce much higher safety coefficients and technological solutions (thermosyphons) to protect permafrost from warming. Failure to do so may result is severe economic and social consequences, as infrastructure in series of large urban settlements will be affected.

CURRENT SECTION/FOCUS GROUP: Global Environmental Change

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