

Economic Assessment of Permafrost Degradation Effects on Road Infrastructure Sustainability under Climate Change in the Russian Arctic

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Russian regions containing permafrost play an important role in the Russian economy, containing vast reserves of natural resources and hosting large-scale infrastructure to facilitate these resources' exploitation. Rapidly changing climatic conditions are a major concern for the future economic development of these regions. This study examines the extent to which the transport infrastructure are affected by permafrost in Russia. Three model scenarios of changes in road infrastructure sustainability under permafrost thawing and degradation due to global climate change in nine Russian Arctic regions are considered. Until the current mid-century, economic assessment of the aftermath of climate change in these regions was physicogeographically based on six model climate assessments of cryogenic conditions, reflecting the most negative (scenario RCP8.5) option of the IPCC global climate change forecasts, which best fits the conditions of the Russian Arctic. The data of Russia's Transport Strategy until 2035, updated by the authors, serve as the basis for predicting road infrastructure development. An inertial (conservative) scenario of road infrastructure development in 2020–2050 shows that capital costs to maintain road infrastructure sustainability and reduce damage risks under permafrost thawing and degradation will average at least 250 m US dollars a year and will exceed 350 m. and 470 m. respectively, under the moderate and modernization scenarios. The maximum indicators will be relevant for the Republic of Sakha (Yakutia), Magadan oblast, and the Chukotka Autonomous Okrug. The implementation of the modernization scenario will require revision of the existing standards, technologies, and entire economy of the road infrastructure and capital construction favoring the development of innovative standards and construction technologies, as well as the improvement of the proposed methodology and methods of cost estimation for these purposes.

Keywords: climate change, permafrost degradation, road infrastructure, risks, development scenarios, russian arctic