Vulnerability assessment of the Russian Arctic zone to natural hazards on municipal level.

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We offer a technique for assessing the social and economic vulnerability of the municipalities in the Russian regions to natural hazards.

This technique based on two integral indexes:

1. The index of the social and economic density of the territory. It shows the probable direct and indirect damage from natural hazards per unit area only the economically exploited part of total municipal territory. Index parameters: the population, the value of fixed assets and the volume of gross production, which divided into the built-up area of municipality.

2. The index of socio-economic spatial vulnerability of the territory. It shows the probability of a concentrated social and economic into the disaster zone. Index calculated as the product of the population, the fixed assets value and the gross production volume and the spatial vulnerability coefficient. This coefficient is equal to the share of built-up area in the total area of municipal land.

The technique tested on the Arctic zone of Russia, where the sizes of the municipalities are extremely high. On this case it is particularly important to exclude "empty" spaces for assessing the society and economy vulnerability on a small-scale level. We created the databases of the necessary socio-economic parameters on the municipal level and proposed methods for estimating the important missing parameters. The municipal level in Russia is very poorly provided with statistical data. For example there is no information about fixed assets on the municipal level, but we offer the way how to solve this problem. In addition, we considered promising investment projects in the Russian Arctic zone and calculated the changes in the social and economic vulnerability (and the overall level of risk) given that they will be implement. We identify the types of municipalities with different level of vulnerability using cluster analysis.

In Russian Arctic we compared the results of indices calculations with trends of permafrost degradation, which is very relevant problem in connection with the trends of modern global climate change. Based on our calculation and cryolithological forecasts, we identify the highest risk areas on the ratio of three parameters: maximum positive permafrost dynamics and the maximum density and spatial vulnerability of the society and economy.

Conclusions.

1. In Russian Arctic the areas of maximum rapid permafrost degradation, concentration and spatial vulnerability of the society and economy are generally overlap. This means an increase the level of natural risk in the medium and long term in the most developed parts of Russian Arctic.

2. According to the proposed technique, the same level of vulnerability may have municipalities, which have a lot of difference of socio-economic development level.

3. The maximum risks of permafrost degradation we identified in: the south and southeast territories of the Yamalo-Nenets Autonomous District, Vorkuta, Norilsk, Anadyr, the northern part of the Murmansk region (including Murmansk itself), Naryan-Mar. For these territories it is first necessary to create measures and scientifically approaches to adapting the society and economy to the changes in permafrost.