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The stohastic modeling of the thermokarst dynamics during the gas pipeline operation within a frozen peatlands (Nadym region case study)

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The widespread development of pipeline transport within the permafrost zone entails the development of risks [1] and makes us look for new methods for assessing the dangers and natural risk. The aim of the present research is a probabilistic modeling and empirical verification of anthropogenically-initiated thermokarst processes models in a pipeline stripe.
We developed stochastic model for the homogenios conditions [2], [3].
The model assumptions are:
1. The thermokarst depressions appear in a limited strip adjacent to the linear structure; the emergence of thermokarst depressions occurs independently of each other.
2. The initiated thermokarst in the zone of the linear structure can be approximately considered as an ellipse with the ratio of the semiaxes lengths.
3. Due to the thermal abrasion effect, the growth of the linear dimensions of thermokarst depressions occurs independently of other depressions, and it is directly proportional to the density of heat loss.
Implications of the model:
- the distribution of distances between the centers of thermokarst depressions along the pipeline must fit to an exponential distribution.
- the distribution of the depression areas and the distribution of the projections of the depressions on the pipeline and the perpendicular to the pipeline must fit to a lognormal distribution.
We chose two parts of gas pipeline in Western Siberia, near Nadym city. The first part of pipeline is located at a convex peat bog-moss-lichen peatlands, the second one is small topsy shrub-sphagnum-lichen peatlands. The active layer thickness is 0.5 to 2 meters thick.
To determine thermokarst depressions we use a satellite image WorldWiew 2 (06.07.2018) and field researches.
There were done detecting thermokarst depressions and fitting projections to pipeline and perpendicular to pipeline to empirical distribution.
For the most of samples, we have confirmed the initial hypothesis that the distributions of the distances between the centers of the lakes in the projection on the linear structure corresponded to the exponential distribution. The areas of the lakes and the lengths of the projections on the linear structure and perpendicular to the linear structure were confirmed to be lognormal at a significance level of 0.99.
The resulting model makes it possible to proceed to solving the problem of probabilistic risk assessment of damage to a linear structure with foci of initiated thermokarst.
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