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The modeling of the channel deformations in the rivers flowing into permafrost with an increase in ambient temperature

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Global climate changes in recent decades inevitably lead to more frequent catastrophic events. Their negative effects on rivers flowing into the permafrost zone, may be exacerbated by significant changes in bed deformations caused not only the influence of water flow, but significant changes of the bed due to the influence of increasing water and air temperatures on the structure of its constituent materials.
The coastal slopes composed of permafrost will be subject to thermal abrasion.
The purpose of this paper is to investigate the influence of river flow during the increase of water temperature on the deformation of the coastal slopes, composed of permafrost rocks with the addition of ice layers.
The method of investigation is laboratory and mathematical modeling. The basis of the three-dimensional mathematical model of the coastal slopes thermoerosion of the rivers flowing in permafrost regions, and its verification is the results of the laboratory experiments conducted in the hydraulic tray.
When the water temperature in the main stream rises the ice plate begins to melt forming the cavity where small streams are formed. The soil layers lose hard icy base and begin to sag under gravity.
In the mathematical model law of the phase transition movement (Stefan condition) is determined from the heat balance equation. To determine the longitudinal velocity and the turbulent exchange coefficient we use the approach of "shallow water". The value of the transverse velocity is calculated from the equation of continuity.
Coastal slope deformation during thawing is determined primarily by deposition of rock under the influence of gravity. An erosion due to water current in the mainstream and in the cavities may play a role under sufficient looseness of the rocks.
The parameterization of the rocks deposition is almost impossible without knowing the composition of the soil, its porosity, ice content, moisture content.
The determination of the rate and amount of slipping is impossible even knowing all of these characteristics without carrying out experiments with the soil composition under a given specific mechanical and thermal loads. Mathematical modeling in combination with laboratory experiments, provides an opportunity to choose the appropriate coefficients to parameterize all the active forces without considering them separately.
One can imagine the process of sliding rocks, lying over a cavity filled with water, in the form of deflection of a beam on elastic foundation.
The magnitude of erosion of a cavity is calculated from the equation of the sediment mass conservation The model calculations permit to obtain the three-dimensional distribution of horizontal velocities in the free flow and in the cavity, two-dimensional distribution of elevation of the bottom and solid surfaces of the cavity.
Estimates of changes in the slope of the shore, obtained in the laboratory and numerical experiments coincide with sufficient accuracy.
Analysis of the of mathematical and laboratory modeling results have shown that the bed deformation of the rivers in the permafrost zone, significantly different from the deformation of river beds composed of soils not subjected to the influence of the phase transition "water-ice".
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