Impact of the Late Pleistocene permafrost relics on spatial patterns of linear erosion in agricultural landscapes of central European Russia

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More than 90% territory of Russia influenced by modern and relict cryolithogenesis (Velichko, 1996). Many relict periglacial features bear witness of Late Pleistocene climate oscillation events and nowadays they are widespread in Mid-Latitude Western Europe including Russian territory. It is known, paleocryogenic factor influence on soil cover’s structure on the different geomorphological position. However interrelation problem between various type of relict cryogenic features (RCF) and modern geomorphological processes, especially erosion and sedimentation, and soil degradation stays unsearched.

The goal of research – to estimate, how RCF affects modern processes and soil cover structure within the agricultural areas (Yaroslavl and Kursk regions). The research also is concentrated on evaluation relationship between different types of the relic cryogenic features and intensity and spatial distribution of soil erosion and deposition processes on cultivated slopes.

Materials and Methods

This study is based on the analysis of aerial photographs (Sentinel, BingSat, Google, Yaundex), including DEMs and aero photos from air drone, and new field surveys. Also we used a group of methods to estimate erosion rates within the small catchments areas (soil profile morphology, analysis of Cesium-137 supply in soil, empirical-mathematical models USLE/ГГИ and WaTEM/SEDEM). It is supposed to test modern methods (neuron net) for automatic decoding of paleocryogenic relief and creating an appropriate data set - contours or at least positions (centroids) of these forms.

Results

The relict permafrost-thermokarst relief prevails in the Yaroslavl Region; a polygonal relief with a block length of 40-50 m is visible almost everywhere. In new-ploughed fields inside the polygons, a second generation of blocks with a side length of 10-20 m is visible.

To the south, on the territory covered with loess-loam soil stripes or trenches can be also
detected. But on this southern territories relict cryogenic network are smaller, the relief of small knolls and depressions are widespread. They appeared due to ice-wedges melting. An analysis of the structure of the erosion-channel network in the Kursk region showed that numerous small ravines and washed-out troughs, widespread on agricultural fields, largely inherit or developed due to the RCM forms.

Conclusions

The period of transition of active cryogenic forms to the relict state is associated with numerous processes of burial, redeposition and destruction of material and microrelief alignment. RCF affects the structure and dynamics of modern erosion processes: shape and density of the erosion network; the direction, extent and complexity of the slope flows structure, the presence and alternation of redeposition and transit zones; sediment budget structure of elementary slope, gullies and small river catchment areas.

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