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Assessment of soil erosion rate trends in two agricultural regions of European Russia for the last 60 years

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Abstract

Purpose Forest–steppe and the southern forest ecotones of European Russia (ER) are the most productive agricultural areas in Russia. Both climate and land use changes have occurred within the ER during last 30 years. These changes can lead to changes in the timing, magnitude, and spatial distribution of soil erosion rates on cultivated lands. The objective of this research was to assess the trends in soil erosion rates since the 1960s for two agricultural regions of ER.

Materials and methods Rates of soil erosion were estimated for two time windows (1963–1986 and 1986–2015) within the two agricultural regions. Both regions are characterized by a high proportion of cropland (> 60%), and within each region, one river basin and one 1st–3rd-order agricultural catchment were selected for a detailed assessment of soil erosion rates. Erosion models and visual interpretation of satellite images were used for the evaluation of the erosion rates for the river basins. Sediment budget assessments, ^{137}Cs dating, geomorphologic mapping, and erosion models were used for the evaluation of the sediment redistribution for the two time windows in agricultural catchments.

Results and discussion At the river basin scale, the mean annual erosion rate did not change in the western part of forest–steppe ecotone; however, there was a weak negative trend in the mean annual erosion rate for the eastern part of the southern forest ecotone. A large negative trend in the erosion rate was found for both small agricultural catchments. In all cases, the reduction in the erosion rates was mainly associated with a decrease of surface runoff during snowmelt, as a result of an increase in both the air and soil temperatures during winter season. The soil loss reduction during snowmelt was counteracted by an equal increase in rainfall erosion due to increase of rainfall intensity in western part of forest–steppe ecotone.

Conclusions Reduction of surface runoff during spring snowmelt was the main reason the erosion rates declined on cultivated lands within the forest–steppe and southern forest ecotones of ER. Evaluation of ephemeral gully erosion rate was not incorporated into State Hydrological Institute erosion model used for the evaluation of the soil losses during snowmelt. This has led to an underestimation of the total soil losses for the 1963–1986 time window for all study sites.

Keywords ^{137}Cs technique · Deposition · European Russia · Mapping · Sediment · Soil erosion

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