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## DEGRADATION, REHABILITATION, AND CONSERVATION OF SOILS

# Contemporary Trend in Erosion of Arable Southern Chernozems (*Haplic Chernozems Pachic*) in the West of Orenburg Oblast (Russia)

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**Abstract**—The contemporary trend in the degradation of arable southern chernozems (Haplic Chernozems Pachic) in the steppe zone of south-eastern European Russia under the impact of water erosion has been evaluated based on a field study of changes in the deposition rate of eroded products on the bottoms of the currently stable negative landforms within a small catchment (1.92 $km^2$ in area) with almost completely tilled slopes in the west of Orenburg oblast, in the basin of the Samara River (a left tributary of the Volga River). The dating of deposited sediments and the analysis of their temporal dynamics have been performed using the radioactive isotope $^{137}Cs$ as a chronomarker. The results of a thorough analysis of catchment topography, grain size distribution data on soils and sediments, hydrometeorological observations, and satellite data have been used. It is found that the mean accumulation rate of chernozem erosion products on the bottom of a small catchment valley was 1.9–2.0 cm/year (16.5–28.4 kg/$m^2$ annually) during the period of 1959–1986 (4.2–4.8 cm/year, or 30.4–83.5 kg/$m^2$ annually in 1959–1963) compared to only 0.52–0.68 cm/year, or 6.6–11.9 kg/$m^2$ annually, during the period of 1986–2016; i.e., the thickness of deposited sediments decreased at least by 3.0–3.6 times, and their mass decreased by 2.0–4.3 times (2.9 times on the average). It is shown that the main reason for the presumed significant decrease in the erosion rate of southern chernozems in the region during the last decades was the reduction in surface water runoff from slopes during the spring snowmelt period, as well as the probable change in the structure of crop rotation toward some increase in the share of perennial grasses, and erosion control measures.

*Keywords:* southern chernozem (Haplic Chernozem Pachic), erosion, sediment, sedimentation, stratozem (Fluvisol), caesium-137, dry valley, catchment, climate change, surface water runoff, steppe, Russian Plain

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## INTRODUCTION

The water erosion (hereafter, erosion) of soils, which is the most common type of soil degradation, is one of the most important environmental problems of humanity, which causes deterioration in quality and frequently loss of soil resources on the Earth. The tillage of catchment slopes activates erosion by 3–4 orders of magnitude on the average compared to the natural landscapes [8]. On the other hand, the rate of soil loss from arable lands is significantly variable in time, which is primarily due to varying hydrometeorological conditions (changes in the amount of precipitation, heterogeneous distribution of their fallout layer and intensity among the seasons, different soil freezing depths in winter, types of spring snowmelt, etc.) and economic activities (changes in the areas of cultivated lands and their crop rotations, tillage practices, erosion control measures, etc.).

The last decades in European Russia were characterized by notable climatic and hydrological changes [25, 26, 32], which should affect the rates of erosion and accumulation of its products in all links of the regional fluvial network. Frolova et al. [25] note a significant degradation of spring flood as a water regime phase on rivers in the most part of Russian Plain, which was due to the rise in winter air temperatures and the increase in the number and duration of thaws reducing the reserve of water in the snow during the snowmelt period and the maximum water discharge during the spring flood. On the other hand, the changes in land use (reduction in the cropland area, especially during the period of 1991–2005; alternation of crop rotations; etc.) most significantly affected the southern regions of the forest zone [28]. In the steppe zone, the area of cropland decreased less significantly, although noticeably, by 27.5%. According to the erosion models calculations [28], the total soil loss in the steppe zone decreased by 14% on the average during the period from 1980 to 2012. Unfortunately, no results of field studies are available to confirm the presence and intensity of the reduction trend in the mean annual erosion rate of chernozemic soils in the south-eastern