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Mapping and spatial-temporal assessment of gully density in the Middle Volga region, Russia

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Abstract

© 2018 John Wiley & Sons, Ltd. A large-scale mapping of gully density was carried out for the Middle Volga region of the Russian Plain (188 000 km2) based on the interpretation of aerial photographs (scale 1:17 000; surveys undertaken during 1956–1970). In addition, spatial-temporal dynamic of gully density were assessed for some parts of the study area (the Udmurt Republic and the Mesha and Ulema River basins of Tatarstan), based on the interpretation of aerial photographs (survey 1986–1991) and high resolution satellite images (2012–2015). Information on factors potentially controlling gully formation and development were collected and a geographic information system (GIS) analysis was conducted. Results show the strong development of gullies in the study area over the 1956–1970 period with an average gully density of 0.21 km km−2. For the Udmurt region, we found that gully densities varied little in the period 1956–1986, during which the total active gully length reduced with only 2%. This period was characterized by low variable climatic conditions and a stable fraction of arable land with a relatively continuous crop rotation system. However, gully dynamics seems to have changed more strongly during recent decades. We found a strong (order of magnitude) reduction in active gully density for the period 2010–2015 as compared to 1986–1991. The main reason for this is likely the increasing winter air temperatures. This leads to a significant reduction in surface runoff during spring as a result of snowmelt. Nonetheless, in some regions (i.e. the Udmurt Republic in the taiga zone), the abandonment of arable land after 1991 likely plays a significant role. Likewise, a decline in the frequency of extreme rainfall events (> 50 mm) may have played a role. All of these factors contribute to a reduction of surface runoff to the gullies and their subsequent stabilization. © 2018 John Wiley & Sons, Ltd.

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Keywords

gully density, gully mapping, Middle Volga region, satellite image interpretation, snowmelt, spatial-temporal dynamic

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