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Holocene history of boreal forest landscapes of the Central European Russia

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Recent detailed investigations of landforms, soils and surface deposits of the Borisoglebsk Upland northeastern slope within the Nero Lake basin (Central European Russia, Yaroslavl Region) allowed deciphering co-evolution of the major landscape components of the case study area since the Late Pleistocene. The Late Pleistocene to Holocene transition in the gully network was represented by relatively short but high-magnitude (up to 12 m) incision phase followed by significant infill till 6.5 ka. Absence of the well-developed early Holocene paleosols in the studied sections and cores suggests dominantly negative sediment budget. There is so far limited evidence of sedimentation over the first half of the Holocene. Discontinuous deposition with certain interruptions (but without distinct buried soil formation) occurred only within closed depressions and on gully fans. The second part of the Holocene prior to the widespread human settlement left more substantial traces in soil and sediment record. Despite the common perception of the pristine boreal forest landscapes to be geomorphologically stable due to erosion-protective role of woodland vegetation, several phases of dramatically increased soil and gully erosion rates have been identified. It is identified in soil bodies and sediments, both at locations dominated by denudation (evidences of multiple topsoil truncation in Atlantic and Subatlantic) and at zones of alternating incision and infill of small linear erosion features. Such extremes were most likely associated with combination of several triggers including natural forest fires and high-magnitude rainfall or snowmelt runoff events. There are several ¹⁴C dated layers of pyrogenic charcoal indicating pre-anthropogenic wildfire-induced incision and infill cycles during the middle and late Holocene.

The last phases of increased hillslope and fluvial activity within the study area can be related to increased human interference, starting from about 1600-900 years ago. The onset of cut-and-burn cultivation is independently established from available archeological evidences, dating of cut and burnt tree logs remnants, organic material buried by agrogenic colluvium and gully fans. Latest period of intensive gully growth can most likely be attributed to the XIXth Century land tenure reform, when most of the study area gullies experienced significant linear growth, bottom incisions and appearance of several new gully branches. The most recent trend of soil and gully erosion has been evaluated by ¹³⁷Cs sediment tracing, soil empirical modeling and comparison of historical and modern maps, airborne photos and satellite images. Rates of soil redistribution on slopes decreased significantly over the last several decades due to combination of natural and

anthropogenic impacts: 1) decreased spring snowmelt runoff caused mainly by generally lowered thickness of seasonally frozen topsoil layer; 2) arable land abandonment or shift from row crops and cereals to perennial grass-dominated crop rotations in the post-Soviet period. In addition, local short-term (from several years to within-year) cycles of relatively low-magnitude (not exceeding ± 1 m range) incision and infill in gullies are often triggered by biogenic activities, namely beaver dam constructions and breaches and local log jams.

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