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Genesis and Diversity of Cryosols of the Northeast Siberian Lena River Delta

Sebastian Zubrzycki, Eva-Maria Pfeiffer, and Lars Kutzbach
Universität Hamburg, Hamburg, Germany (sebastian.zubrzycki@uni-hamburg.de)

The North-Siberian Lena River Delta (LRD) is the largest Arctic delta and an important interface between the Arctic Ocean in the North and the large Siberian land masses in the South. LRD consists not only of Holocene deltaic sediment deposits as a river terrace and the modern active floodplains but also of remnants of the former Pleistocene mainland including large islands of ice-complex sediments and the Arga-Muora-Sise Island, which is composed of pure sand sediments of still debated origin. The highly diverse landscape structure of LRD is reflected by a great variety of permafrost-affected soils (cryosols). This study aims at describing this great cryosol diversity and at analysing the dominant soil-forming processes in this comparatively scarcely studied soil region. The soil development in the investigated continuous permafrost region is limited by the short thawing period of around three months (June to September) and takes place in the shallow (below 1 m) seasonally thawed active layer. The geological parent material plays an important role for the development of soils in the LRD region. The distribution of the various soil types closely follows the pattern of the geomorphic units characterised by differing sedimentation conditions. The properties and genesis of the soils on the Holocene river terrace and the modern floodplains are strongly affected by the enormous amounts of fluvial sediments (about 12 x 10^6 tons per year) brought by the Lena River into its delta. The fluvial sedimentation together with the also pronounced aeolian sedimentation results in a fast vertical growth of soils. The upward rise of the soil surface leads to an upward movement of the permafrost table resulting in fast incorporation of soil material formed in the supra-permafrost zone into the permafrost. Due to the morphodynamics of ice-wedge polygons and resulting formation of patterned ground with elevated rims and depressed and water-saturated centres, the Holocene river terrace of the delta is in its main extent covered by a soil complex of Glaci-Turbic Cryosols and Hapli-Histic Cryosols. The active floodplain levels are dominated by sandy or gleyic Fluvi Gleyic Cryosols or Areni Fluvic Cryosols. The surfaces of the Arga-Muora-Sise Island are frequently reshaped by aeolian sedimentation and erosion. The soils on these scarcely vegetated landscapes are dominated by cryoturbated and sand-rich soils with high moisture contents, e.g., various Areni-Turbic Cryosols and Aqui-Turbic Cryosols. The modern soils covering the older Pleistocene ice-complex plains are influenced by wide ice-wedge net structures and consist of a soil complex of Glaci-Turbic Cryosols and Gleyi-Histic Cryosols. The widespread thermokarst depressions within the ice-complex are covered by Histi-Turbic Cryosols and Gleyi-Histic Cryosols, whereas the slopes are dominated by Aqui-Turbic Cryosols and Gleyi-Cryic Cryosols. For the largely unexplored hinterland of LRD it can be assumed that the active genesis of the soils lasts longer than in the active delta regions due to a much lower sedimentation and more stable surface conditions. In these regions widespread cryoturbated and peat-rich soils like Histi-Turbic Cryosols and Histic Cryosols. An increased understanding of spatial variability and genesis of permafrost-affected soils is essential for meaningful predictions of climate change consequences in Arctic permafrost regions.