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Development of carbon stocks in post-agrogenic, self-restorating soils of different climatic zones of Russia

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The focus of this chronosequential study was on dynamics of soil organic carbon (SOC) stocks of post-agrogenic soils under self-restoration of Russia: Podzols and Stagnic Albeluvisols of the taiga, Chernozems of the forest-steppe, Calcisols and Solonetz of the dry steppe. The sites of each chronosequence were comparable in climate, texture, and land-use history, but differed in duration of self-restoration. In the Podzol and Stagnic Albeluvisol chronosequences, the carbon stocks showed a distinct redistribution within different soil sections. Hence, during 170 years of a Podzol chronosequence, the carbon (C) accumulated in the organic surface layers up to 3.3 kg m-2, but C decreased in 0 – 0.2m of the mineral topsoils from 4.3 to 3.1 kg m-2 and in 0.2 – 0.5m of the mineral topsoils from 4.6 to 2.1 kg m-2. Decreasing SOC stocks of the mineral soils were overcompensated by increasing SOC stores of the organic surface layers, thus showing an increasing SOC sink functioning. During 68 years of a Stagnic Albeluvisol self-restoration, C accumulated in the organic surface layers up to 0.8 kg m-2 and in 0 - 0.2m of the mineral topsoils from 2.2 to 3.2 kg m-2, but C decreased in 0.2 – 0.5m of the mineral topsoils from 2.2 to 0.7 kg m-2. Decreasing SOC stocks of 0.2 – 0.5m sections of the mineral soils were compensated by increasing SOC stores of the organic surface layers and 0 – 0.2m section of the mineral topsoils. This indicates a tendency of an increasing SOM sink functioning at long terms. An increasing C sink was determined for the other chronosequences. Hence, during 59 years of Chernozem self-restoration, SOC stocks increased from 6.2 to 9.4 kg m-2 in the upper 0.2m and from 17.7 to 24.2 kg m-2 in the upper 0.5m and reached 76% and 95% of the C stocks of the natural Chernozem, respectively. During 42 years of Calcisol chronosequence, SOC stocks increased from 1.1 to 1.3 kg m-2 in the upper 0.2m and from 2.0 to 3.5 in the upper 0.5m and reached 42 and 79% of the C stocks of the natural Calcisol, respectively. During 42 years of Solonetz chronosequence, SOC stocks increased from 0.9 to 1.6 kg m-2 in the upper 0.2m and from 1.7 to 3.1 kg m-2 in the upper 0.5m and reached 80 and 89% of the C stocks of the natural Solonetz, respectively.

The study shows in conclusion, that self-restoration of post-agrogenic soils of Russia induced the development of a carbon sink independently of the climatic zones. Calculated for the upper 0.2m, the SOC accumulation rate increased from the taiga (ca. 7 – 30 g C year-1 m-2) to the forest steppe (ca. 52 g C year-1 m-2) and decreased in the dry steppe (ca. 3 – 18 g C year-1 m-2).