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Effect of plant cover on distribution of soil organic matter pools

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Numerous studies reported that quality and quantity of primary production and also the rate of litter decomposition determine the carbon (C) content and its distribution in soils. Our objective was to examine how the type of plant cover affects C sequestration in the following pools: unprotected, spatial inaccessible, interacting with silt and clay, and biochemically protected SOM. The large lysimeters of Moscow State University allowed quantification of C stocks under broadleaf forest (Acer platanoides and Quercus robur), coniferous forest (Picea abies) and agricultural crops (9-field rotation), while other soil forming factors affecting SOC content were identical. In 1965 the lysimeters (S=9 m2, depth=1.5 m) were filled with carbonate free clay loam taken in Moscow region, originated from the Valday glaciation, and plant communities listed above were planted. We collected soil samples from the mineral horizons, from 0-5 cm depth, in spring 2012. The soils were physically separated by combination of the particle size and density fractionations (8 fractions in total), and C and N contents were analyzed.
The total C and N contents in non-fractionated soil were higher under broadleaf forest (66 and 3.1 g kg-1), than under coniferous forest (34.5 and 1.23 g kg-1) and agricultural crops (13.7 and 0.9 g kg-1). Under forests 45-50% of Ctotal and 30% of Ntotal were in the unprotected pool, in agricultural soil these percentages were in 3 times less. The greatest portions of protected C were in spatial inaccessible pool: 28, 32 and 40% of the Ctotal for broadleaf forest, coniferous forest and agricultural crops, respectively. However, the total C amount in this pool under agricultural crops was in 3 times less, than under forests. This is indicative for the loss of C-rich macroaggregates and an increase of C-depleted microaggregates in agricultural soils due to the plowing. The amounts of C, stabilized by interactions with silt and clay, were nearly the same (3-6 g kg-1) because of the identical texture of soil parent material. The portion of biochemically protected C was maximal in agricultural soil – 27%, whereas on forest plots it was 2 times less. The amount of C in this pool did not strongly differ among the investigated soils, but C/N ratio was lower under agricultural crops than under forests. This indicates deeper degradation of organics in cultivated soil, N addition by fertilization, and a growing contribution of microbially-derived C to the biochemically protected pool. Wide C/N ratio in biochemically protected pool in the forest soils reflects the accumulation of primary recalcitrant plant substances with high C/N such as lignin and cellulose.
Thus, forest vegetation contributes mainly to the SOM sequestration in the spatial inaccessible pool and is source of the high amount of non-protected C. Under agricultural crops however, the most of SOM is stabilized by interactions with silt and clay and is stabilized biochemically.