EGU22-5971, updated on 17 Aug 2022
https://doi.org/10.5194/egusphere-egu22-5971
EGU General Assembly 2022

Intra- and intercity variability of urban soil-C stocks along a climatic gradient

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Urban soils have a high capacity to accumulate C, whereas urban soil-C stocks are exposed to multiple direct or indirectly anthropogenic effects and therefore very variable and dynamic. The intracity variability of soil-C stocks is affected by functional and historical zoning, land management and mesoclimatic anomalies (e.g., urban heat island). The intercity variability is likely explained by the difference in regional climate conditions. The current research aimed to analyze variability in urban soil C stocks by a comparative analysis of six settlements following the climatic gradient in Central European Russia.

In 2019-2021 urban soil-C stocks were observed in the residential areas of six settlements representing different bioclimatic zones: Murmansk (68N, 33E; forest-tundra), Apatity (67N, 33E; north taiga), Moscow (55N, 37E; south taiga), Pushchino (54N, 37E; mixed and deciduous forests), Kursk (51N, 36E; forest-steppe) and Rostov-on-Don (47N, 39E; dry steppe). In each settlement, total 50 locations were selected following a random stratified scheme and mixed soil samples from the depths 0-10, 10-20, 30-30 and 30-50 cm were collected in each location. Soil organic (SOC) and inorganic (SIC) C stocks (all the depths) as well as microbial (basal) respiration and half-life time (only 0-10 cm) were analyzed in the collected samples. The intracity variation was investigated and mapped by digital soil mapping techniques linking field data to conventional (i.e., vegetation, relief and parent materials) and urban-specific (i.e., historical zoning and distances to infrastructures) covariates. In result, spatial variability and profile distribution of SOC and SIC were analyzed.

Total C stocks ranged from 15 kgC m^{-2} in Pushchino to over 30 kgC m^{-2} in Rostov-on-Don and Kursk. The highest contribution of subsoil (below 30 cm) layers was shown for the south settlements, where urban soils were often formed on top of the buried Chernozems, whereas in the polar climate the role of subsoil in total urban C stocks was much smaller. The outcomes confirmed that for topsoils urban C stocks were higher than in the natural zonal soils for the northern sites (Moscow and Apatity), whereas the opposite was shown for the settlements to the

south from Pushchino. Half-life time of organic matter decreased from almost 30 years in Murmansk to less than 5 years in Rostov-on-Don. This illustrates law resistance of urban soil-C stocks to microbial decomposition under warm climate conditions. The contribution of organic and inorganic C to the total C stocks also clearly followed climate gradient and SIC share in Rostov-on-Don was 7 times higher than in Murmansk and Apatity. Historical zoning and land-cover were the major predictors of urban soil-C intracity variability with high C stocks in the historical centers and under trees and shrubs compared to the recently developed lawns. Land cover mainly explained variability in topsoil C stocks, where subsoil C stocks were more dependent on the urban history.

Acknowledgments The field and laboratory analysis of C stocks was performed with the support of Russian Foundation for Basic Research project № 19-29-05187. Spatial analysis and modeling was supported by Russian Science Foundation project № 19-77-30012.