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Towards an urban soil living lab to support C-smart management of green infrastructure

Viacheslav Vasenev[1], Marya Korneykova[2], Yurii Dvornikov[2], Olga Romzaykina[2], Marcel Hoosbeek[1], and Titia Mulder[1]
[1]Wageningen University, Wageningen, Netherlands
[2]Smart Urban Nature research center, Peoples' Friendship University of Russia, Moscow, Russia

The development of urban-green infrastructures is considered an efficient nature-based solution (NBS) for C sequestration. The potential of NBS for C sequestration is often based on aboveground biomass and often overlook the contribution of urban soils. Urban soils vary from just affected by humans to fully human-made. Analysis of the spatial relationships between soil C stocks, CO_2 emissions and UGI management and maintenance is necessary to support decisions in UGI planning aiming to facilitate C sequestration and contribute to achieving C neutrality. Urban Living Lab (LL) is a relatively novel but increasingly developing concept aiming to support multi-stakeholder engagement and co-production in exploring ecosystem processes and developing nature-based solutions in a real urban setting. European Commission considers LL an efficient tool contributing to soil health analysis and improvement, and Soil Deal for Europe requires establishing at least 100 LL by 2030. So far, most of the soil LL were developed in agricultural and natural landscapes, whereas urban soil and green infrastructures remained overlooked.

The research aims to develop a prototype of an urban soil living lab (USLL) to support C-smart decisions in soil construction, planning and maintenance of urban green spaces. The USLL shall be a platform for co-creation of soil constructions to support various types of NBS units (e.g., lawns, flowering herbs or rain gardens) and for monitoring their effects on C balance. Monitoring techniques include 1) measuring soil C stocks at multiple locations with further digital soil mapping; 2) analyzing soil organic matter fraction (mineral-associated and particulate organic matter fractions); 3) continuous measurement of soil respiration during the season (e.g., by gas analyzer); 4) continuous monitoring of soil temperature and moisture at multiple points by manual and autonomous sensors with extrapolation based on remote-sensing data on surface temperature; 5) assessing C sequestration in aboveground biomass based on regular mowing or Li-Dar scanning; 6) setting up long-term experiments to study the effects of management and maintenance regimes on C balance. The prototype was tested at three university campus areas located in different climate zones: Wageningen (the Netherlands), Moscow and Apatity (Russia).

Considering topsoil C stocks, ratios between mineral associated (MaOM) and particulate organic matter (POM) C-fractions and C-CO_2 emissions/ soil C stocks ratio, soils under trees

were shown as the most efficient in C accumulation, whereas lawns were potential C sources. Moreover, lawn maintenance caused high soil CO_2 emissions which were intensified by favorable microclimatic conditions. As a result, C stocks under old lawns were lower compared to the recent ones, which was an opposite trend compared to what can be expected under natural conditions. Further development of the USLL approach will aim to support C-smart management of urban soils as a nature-based solution for climate mitigation and sustainable urban development.

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