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Modelling sustainability of carbon stocks in artificial soil constructions under different temperature and moisture regimes

Viacheslav Vasenev (1,3), Andrey Smagin (1,2), Bhoobun Bhavish (1), and Ramilla Hajiaghaeva (1)

(1) Peoples' Friendship University of Russia (RUDN University), Agrarian-Technological Institute, Agrobiotechnological department, Moscow, Russian Federation (vasenyov@mail.ru), (2) Lomonosov Moscow State University,GSP-1, Leninskie Gory, Moscow, 119991, the Russian Federation, (3) Institute of Forest Science, Russian Academy of Sciences (ILAN), 21, Sovetskaya, Uspenskoe, Moscow region, 143030, the Russian Federation

Urban soils are key components of urban ecosystems, supporting air and ground water quality, green infrastructure and at the end of the day comfort and life quality of city dwellers. Urban soils are exposed to severe technogenic pressures and anthropogenic disturbances. Compared to natural soils urban soils are much more vulnerable to climatic and technogenic effects and their self-restoration capacity is limited. Among the diversity of urban soils, soil constructions (replantozems and constructosomes) are of a particular interest. Soil constructions are artificial formations designed to perform certain functions, and, primarily, for air purification and urban greening. The successful performance of these functions is determined by the soil construction technology –substrate material, depth and sequence of the layers. In the absence of a clear regulation of soil construction, the currently used technologies with preferential applying of available substrates based on low peat, are not sustainable and are not able to perform the expected ecological functions. Average life time of urban topsoil based on turf with C contents above 10% is just 2-3 years, after which the major part of C stock is depleted.

This research aimed to investigate sustainability of C stocks in artificial soils construction under different temperature and moisture regimes. Considering a unique heterogeneity of materials used for urban greening, a comprehensive review of different substrates and was performed at the first step. We selected 36 soil mixtures and components, which very extremely variable in physical (texture, water retention curve), chemical (pH, total C and N) and biological (microbial biomass and basal respiration) properties. Samples were taken from each of the substrates and treated as following: 1) water saturation up to the full water holding capacity; 2) centrifuging at 200, 400, 500, 1000, 2000, 4000, 8000 and 12000 rpm; 3) applying contrast temperature regimes (5 to 40°C with 5°C step) to soils samples after centrifuging at each speed; 4) measuring CO_2 emission by IRGA and C depletion by CN analyzer. The experimental results showed that most of the substrates emitted 10-30% of initial C stocks and were not sustainable. The highest emission was shown for soil moisture 30-50% combined with soil temperature 15 to 25 °C, whereas extreme values (dry, hot, water-logged) were less favorable for CO_2 emission. Modeling confirmed that turf-based mixtures had the lowest sustainability, since depletion of more than 50% of initial C stocks was projected in 3 years. On contrast, organic-mineral mixtures didn't deplete C stocks substantially and are recommended for implementation in urban landscaping.

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