EGU21-11093, updated on 05 Jul 2022
https://doi.org/10.5194/egusphere-egu21-11093
EGU General Assembly 2021

Dynamics of soil organic carbon during natural forest succession in the Polish Carpathian Mountains

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The main driver of the Carpathian landscape is the process of natural forest succession, which causes the overgrowing of the unique semi-natural meadows. Land-use changes influence the balance of organic carbon in the soil, simultaneously may cause carbon sequestration or CO_2 emission. Whereas, there is still a lack of knowledge covering the impact of natural forest succession on organic carbon cycling. The purpose of this study was to investigate the dynamics of organic carbon in the different land-use soils. The selected properties showing the rate of mineralization process as well as soil biological activity were taken into account.

This study was located in three selected Carpathians' national parks. Soil samples were taken from 0-10 cm and 10-20 cm soil layers of ten transects each consisting three different land use: semi-natural meadow, succession (30-75 aged trees), and old-growth forest (more than 150 years). Measurements of microbial biomass carbon (MBC), dissolved organic carbon (DOC), dehydrogenase (DHA) and invertase (INW) activity and microbial respiration were made on fresh soil samples. Based on the first-order kinetic model of microbial respiration the cumulative respiration was calculated. Additionally, the metabolic quotient (qCO_2), the microbial quotient (qMIC), and the mineralization quotient (qM) were calculated.

The mean C_{org} content ranged from 17.6 g kg^{-1} in the 10-20 cm layer of succession to 41.5 g kg^{-1} in the 0-10 cm layer of forest. Considering the individual land use variants in the 0-10 cm layer meadow characterised the highest MBC, DHA and qM, and the lowest qCO_2 values. In the succession, the highest cumulative respiration and qCO_2 and the lowest MBC and INW were noted. Whereas the forest characterised the highest INW and the lowest cumulative respiration, DHA, qMIC and qM. Similarity, in the 10-20 cm layer meadow the highest MBC and DHA as well as qMIC were found. The succession characterised the highest cumulative respiration, qCO_2 and qM and the lowest qMIC. However, in the forest the highest INW and the lowest qCO_2, qMIC and qM were noticed.

Overall, for all investigated soils the positive correlations between C_{org} and MBC, DHA and negative correlations C_{org} with qMIC, qCO_2 and DOC were shown. Whereas, when we take into consideration the individuals land use variants and depths can be stated that the content of organic carbon was shaped by different properties. In the 0-10 cm content of C_{org} in meadow and forest positive correlated with cumulative respiration and DHA, and negative with qM. Additionally,

in forest negative correlations C_{org} with DOC, INW and qCO_2 were found. While in succession the positive correlations C_{org} with MBC and INW and negative correlations C_{org} with DHA, qMIC and DOC were noted. In the 10-20 cm layers of meadow and succession C_{org} positive correlated with MBC, INW, qCO_2 and negative with qM and DOC. Additionally, the qMIC positive correlation with C_{org} in meadow and negative correlation in succession was found. Whereas, in forest C_{org} positive correlated with qM and MBC, while negative correlations between C_{org} and qMIC, DOC and qCO_2 were noticed.