EGU21-9355
https://doi.org/10.5194/egusphere-egu21-9355
EGU General Assembly 2021

Effect of Climate and Geochemistry on Organic Carbon Pools in Top and Subsoils of Tropical Volcanic Regions

Han Lyu[1], Tetsuhiro Watanabe[2], Ruohan Zhong[3], Method Kilasara[4], Arief Hartono[5], and Shinya Funakawa[6]

[1]Graduate School of Global Environmental Studies, Kyoto University, Kyoto, Japan (lyuhan1993@gmail.com)
[2]Graduate School of Agriculture; Graduate School of Global Environmental Studies, Kyoto University, Kyoto, Japan (watanabe.tetsuhiro.2m@kyoto-u.ac.jp)
[3]Graduate School of Agriculture, Kyoto University, Kyoto, Japan (zhong.ruohan.76w@st.kyoto-u.ac.jp)
[4]Stella Maris Mtwara University College, Mtwara, Tanzania (kilasaramethod@gmail.com)
[5]Faculty of Agriculture, Bogor Agricultural University, Bogor, Indonesia (aharton2002@yahoo.com)
[6]Graduate School of Agriculture; Graduate School of Global Environmental Studies, Kyoto University, Kyoto, Japan (funakawa.shinya.2w@kyoto-u.ac.jp)

Clarifying the controlling factors for soil organic carbon (SOC) stabilization is a primary issue in mitigating climate change. However, the mechanisms controlling soil carbon cycle are not well-understood, especially in tropical regions. Furthermore, the mechanisms are expected to differ between topsoil and subsoil. The objectives were to clarify the controlling factors for SOC pools partitioned by their stabilities, then to compare the differences in pools and controlling factors between topsoil and subsoil.

Both top (0–15 cm) and subsoil (20–40 cm) samples were collected at volcanic regions of Tanzania and Indonesia along an elevation gradient under mostly undisturbed vegetation (23 sites). A kinetic model, including labile, intermediate, and stable pools, was fitted to accumulative SOC mineralization curve obtained from 343-day incubation to determine the sizes of the labile and intermediate SOC pools (C_L and C_I) and their mean residence times, where the size of the stable SOC pool (C_S) was measured as non-hydrolyzable carbon by fractionation. Correlation and path analyses were conducted to determine the controlling factors for each SOC pool, using the results of the model fitting and SOC fractionation and the data on climate, geochemistry, and biology (e.g., mean average temperature and precipitation, nanocrystalline mineral content (Al_o+1/2Fe_o), and microbial biomass, respectively).

The intermediate pool (56.2 ± 10.4% of SOC) predominantly contributed to the storage and stability of total SOC (10 to 157 g kg^{-1}) for both topsoil and subsoil with the mean residence time of years to decades (3400 to 31500 days). For both topsoil and subsoil, Al_o+1/2Fe_o was strongly correlated with C_I and C_S, suggesting that organo-mineral complexation is a predominant factor that controls the intermediate and stable SOC pools, rather than soil pH or texture. Also, temperature negatively affected the sizes of all three pools, which indicates the low temperature retards the decomposition of all parts of SOC. The labile SOC pool was more controlled by biotic and climatic factors (i.e., microbial biomass and excess precipitation). Concerning differences between topsoil and subsoil, SOC was more in the intermediate than in the stable pool, and the effect of temperature on C_S was more substantial in the subsoil. Moreover, Al_o+1/2Fe_o controlled the mean residence time of the intermediate SOC pool, indicating the stability of subsoil SOC that had a labile nature would be more dependent on nanocrystalline minerals.

While temperature widely influences all SOC pools, geochemical factors control more stable pools and total SOC storage, whereas biotic factors and moisture mainly alter relatively labile SOC pools. The subsoil SOC would be more sensitive to climate change than topsoil SOC. The findings helped to understand SOC stabilization mechanisms for both top and subsoils in tropical volcanic regions.