Geophysical Research Abstracts
Vol. 20, EGU2018-10454-1, 2018
EGU General Assembly 2018

Influence of urbanisation on pH, carbonate and soil organic matter stocks of arable soils of Kumasi (Ghana)

Stephen Boahen Asabere (1), Thorsten Zeppenfeld (1), Kwabena Abrefa Nketia (1,2), and Daniela Sauer (1)

(1) Georg-August Universität Goettingen, Institute of Geography , Physical Geography , Göttingen, Germany (stephen-boahen.asabere@geo.uni-goettingen.de), (2) Centre for Scientific and Industrial Research - Soil Research Institute, Kumasi, Ghana

Soil organic matter (SOM) stock is an essential indicator of urban ecosystem performance due to its effects on soil fertility, biogeochemical cycles and its potential mitigation of climate change. For the rapidly growing West-African cities, it is important to understand the influence of urbanisation on SOM stocks and other soil fertility indicators of arable soils, because in these cities urban farming plays a critical role for food security and urban sustainability. However, such information is rare. Therefore, in this study we analysed pH, carbonate and SOM contents in arable soils of the city of Kumasi (Ghana), from the inner city to its periphery, also representing an urbanisation chronosequence.

We took topsoil samples (0-10 cm) from 210 maize fields (3 replicates = 630 samples) on Acrisols of the same local soil series. Thus, the factors land-use and soil series were kept constant. The sampling was carried out in 2016. Based on historical satellite images, we included (1) the inner Kumasi area, which was urban already in 1986 (thus for $>$ 30 years = long-term urban soils), and (2) the periphery that became urban after 1986 (thus being urban for $<$ 30 years = short-term urban soils). The soil samples were analysed for pH, carbonate content, loss on ignition (LOI), and total C (TC) and N (TN). All element contents were transformed to element stocks per m^2.

Soil pH was acidic to moderately alkaline with significantly higher values in long-term compared to short-term urban soils. Correspondingly, mean carbonate stocks in long-term urban soils exceeded those of short-term urban soils. Mean bulk density was similar in both long- and short-term urban soils (1.4 g cm^{-3}). It showed a negative relationship (r^2=0.42) with SOM stocks, calculated from soil organic carbon (SOC). LOI and TC stocks were significantly greater in long-term urban soils, whereas SOC stocks and C:N ratios were similar in both long- and short-term urban soils. A possible explanation for this different behaviour may be that LOI in urban soils most likely includes additional combustible materials other than SOM, and TC may include also inorganic carbon (e.g., egg shells) from household waste. SOC stocks and C:N ratios of these soils may be influenced by charred material (black carbon). Element stocks of urban soils as calculated per m^2 are further influenced by the abundance of coarse fragments, which showed higher mean contents in the long-term urban soils (16%) compared to the short-term urban soils (10%). This difference is mainly caused by solid non-degradable household waste that generally accumulates in soils of West-African cities over time. The outcomes of this study show that soils used for urban farming in Kumasi receive considerable amounts of ashes and (mostly organic) waste from households, leading to increased TC stocks and pH of these soils on one hand, but also accumulation of non-degradable waste on the other hand. As Kumasi is a typical expanding West-African city, we conclude that these outcomes are transferable to most other rapidly growing West-African cities.