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Spatial distribution of SOM parameters during paddy soil evolution

Angelika Kölbl (1), Cornelia Müller-Niggemann (2), Lorenz Schwark (2), Zhihong Cao (3), Jianrong Fu (3), and Ingrid Kögel-Knabner (1)

(1) Lehrstuhl für Bodenkunde, Ökologie und Ökosystemmanagement, 85350 Freising, Germany (koelbl@wzw.tum.de), (2) Institut für Geowissenschaften, Christian-Albrechts-Universität Kiel, 24118 Kiel, Germany, (3) The Institute of Soil Science, CAS Chinese Academy of Sciences, Nanjing 210008, PR China

During the past 2000 years new farmland was created through consecutive land reclamation by protective dikes in the Zhejiang province (Yangtze River Delta, PR China). The consecutive construction of dikes provides a unique chronosequence of soil formation under agricultural use. Parts of the land are used for paddy rice, other parts for a variety of non-irrigated crops (control sites). These soils document the effect of soil redox conditions on the evolution of soil organic matter (SOM) parameters and their spatial distribution during pedogenesis.
We hypothesised that the spatial pattern of SOM parameters will change with increasing duration of paddy soil use, leading to a spatial homogenisation due to frequent puddling of topsoils. The subsoils are assumed to be characterised by a higher spatial heterogeneity due to an increased number of redox cycles and ongoing transport processes in the undisturbed subsoil layers.
We sampled three plots within the chronosequence (50, 300 and 1000 years of paddy cultivation) to investigate the development of the spatial dependence of SOM parameters. A regular, orthogonal grid with a size of 25 x 25 m and consisting of 70 sampling positions was used at each plot. Three soil depths were sampled, including the puddled topsoil, the plough layer, and a mixed subsoil layer. The measurements included total C and N as well as organic C (OC) concentrations, soil colour and magnetic susceptibility.
In each soil layer of the 50 and 300 y old paddy plots, no spatial dependencies of the SOM parameters were found, but a significant spatial dependence was found in each soil layer of the 1000y old paddy site. The spatial distribution of OC and N in the topsoil showed a higher range, a higher (semi-)variance and a stronger spatial dependence compared to the subsoil. Furthermore, the spatial pattern of OC and N is considerably different between top- and subsoil, indicating that OC distributions below the plough layer are controlled by different processes compared to the puddled topsoil. We conclude that paddy soil formation is associated with the development of the spatial distribution of SOM. This process takes at least several hundred years. The spatial pattern of SOM in paddy topsoils is assumed to be management controlled, whereas pedogenic processes are most likely responsible for SOM distributions in subsoils. We assume the compacted plough layer to be responsible for the decoupling of the SOM distribution between topsoil and subsoil.