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Small scale variability of soil parameters in different land uses on the southern slopes of Mount Kilimanjaro

Christina Bogner (1), Anna Kühnel (2,3), Johannes Hepp (2,4), and Bernd Huwe (2)

(1) University of Bayreuth, BayCEER, Ecological Modelling, Bayreuth, Germany (christina.bogner@uni-bayreuth.de), (2) Soil Physics Group, BayCEER, University of Bayreuth, Bayreuth, Germany (bernd.huwe@uni-bayreuth.de), (3) Soil Science, Department of Ecology and Ecosystem Management, Center of Life and Food Sciences, Weihenstephan, Technical University of Munich, Germany (anna.kuehnel@wzw.tum.de), (4) Soil Biogeochemistry, Martin-Luther-University of Halle-Wittenberg, Germany (johannes-hepp@gmx.de)

The Kilimanjaro region in Tanzania constitutes a particularity compared to other areas in the country. Because enough water is available the population grows rapidly and large areas are converted from natural ecosystems to agricultural areas. Therefore, the southern slopes of Mt. Kilimanjaro encompass a complex mosaic of different land uses like coffee plantations, maize, agroforestry or natural savannah. Coffee is an important cash crop in the region and is owned mostly by large companies. In contrast, the agroforestry is a traditional way of agriculture and has been sustained by the Chagga tribe for centuries. These so called homegardens are organised as multi-level systems and contain a mixture of different crops.

Correlations in soil and vegetation data may serve as indicators for crop and management impacts associated to different types of land use. We hypothesize that Chagga homegardens, for example, show a more pronounced spatial autocorrelation compared to coffee plantations due to manifold above and belowground crop structures, whereas the degree of anisotropy is assumed to be higher in the coffee sites due to linear elements in management. Furthermore, we hypothesize that the overall diversity of soil parameters in homegardens on a larger scale is higher, as individual owners manage their field differently, whereas coffee plantation management often follows general rules.

From these general hypotheses we derive two specific research questions: a) Are there characteristic differences in the spatial organisation of soil physical parameters of different land uses? b) Is there a recognizable relationship between vegetation structure and soil physical parameters of topsoils? We measured soil physical parameters in the topsoil (bulk density, stone content, texture, soil moisture and penetration resistance). Additionally, we took spectra of soil samples with a portable VIS-NIR spectrometer to determine C and N and measured leaf area index and troughfall as an indicator of vegetation patterns. First results support our general hypotheses. In the coffee plantation anisotropic variation of soil parameters clearly showed the anthropogenic influence like compaction due to agricultural machinery. However, soil bulk density and penetration resistance in the homegarden were also quite variable at the sites. The larger variability of throughfall in the homegarden is reflected in the patterns of soil moisture. Regarding the larger scale, where we compared different homegardens and coffee plantations along the southern slope of the mountain, soil parameters of the coffee plots were less diverse than those of the homegardens.