EGU General Assembly 2016
Vienna 17–22 April 2016

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

Christina Bogner[1], Anna Kühnel[2,3], Valeska Scharsich[1,2], Johannes Hepp[4,2], Bernd Huwe[2]

[1]Ecological Modelling, BayCEER, University of Bayreuth, DE [2]Soil Physics Group, BayCEER, University of Bayreuth, DE [3]Soil Science, Department of Ecology and Ecosystem Management, Center of Life and Food Sciences, Weihenstephan, Technical University of Munich, DE [4]Soil Biogeochemistry, Martin-Luther-University of Halle-Wittenberg, DE

Introduction

The Kilimanjaro region is characterised by
- a rapidly growing population and
- conversion from natural to agricultural ecosystems.

Agricultural area is a complex mosaic of different land uses, mainly: coffee, maize, homegardens and natural savannah.

Homegarden (agroforestry) is a traditional way of farming:
- a multilevel system (Fig.1) with
- a brought mixture of plants and high productivity.

Coffee plantations in monoculture, owned mostly by large companies, are increasingly replacing the homegardens.

Figure 1 : A typical homegarden.

Research Questions

- Are there characteristic differences in the spatial organisation of soil physical parameters in the four land uses coffee, homegarden, maize and savannah?
- Is there a recognizable relationship between vegetation structure and soil physical parameters of the topsoil?

Research Area

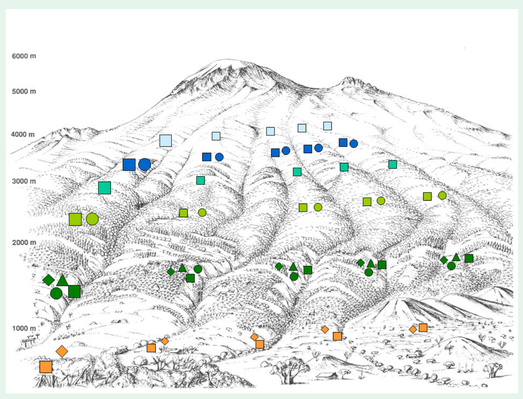

Figure 2 : Position of study plots at the southern slopes of Mt. Kilimanjaro.

- Location: southern slopes of Mt. Kilimanjaro (Tanzania)
- Four land uses considered: maize and savannah (peach in Fig.2), homegarden and coffee (dark green in Fig. 2)

Methods

Vis–NIR spectroscopy for analysis of soil properties:
- Content of C, N and texture
- One soil profile per land use
- Acquisition of Vis–NIR spectra in the field (Fig. 3)
- Chemical/physical analysis of soil samples for calibration/validation of partial least squares models
- Models for each land use and soil parameter separately
- Yields detailed distribution of soil properties (Fig. 4)

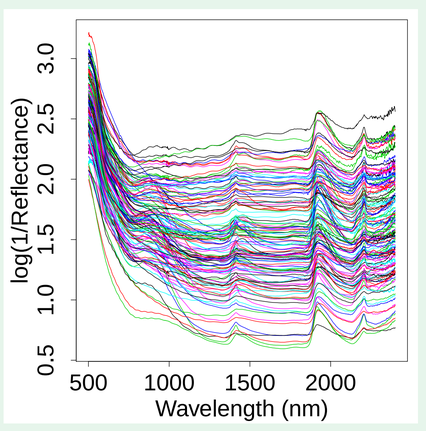

Figure 3 : Spectra of soil samples.

Coffee and homegarden plots (20 × 50 m):
- Bulk density, stone content, texture, penetration resistance and soil moisture
- LAI and throughfall
- Variogram analysis to quantify spatial correlation
- Correlation between soil and vegetation parameters

Results and Discussion

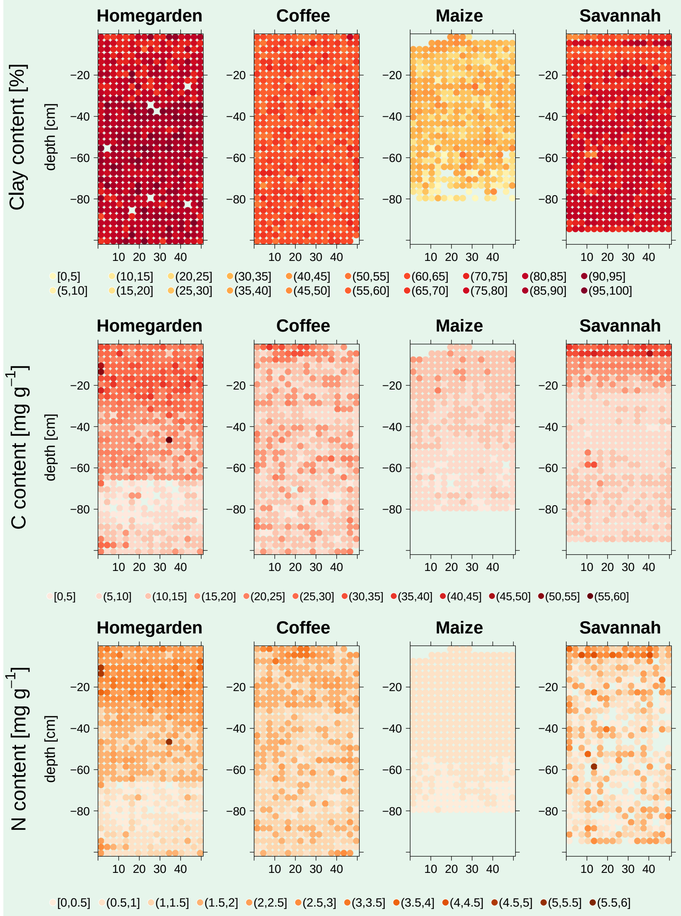

Figure 4 : Predicted clay, C and N content for soil profiles in different land uses.

Texture
- In general, good agreement between measurements and predictions
- Large clay content in homegarden, partly prediction of more than 100% (excluded)
- Coffee: Texture remains constant with depth
- Maize: Low clay, but sand content up to 65%

C content
- In general, good agreement between measurements and predictions
- Decrease of C with depth in all profiles (Fig.4).
- Some isolated points of high C content, especially in homegarden and savannah
- Largest C content in homegarden, lowest in maize
- Large C content in upper horizons in savannah

N content
- Patterns of N content similar to C, except for savannah
- Model for N content in savannah possibly not suitable (empty segments in Fig.4 correspond to negative predictions)
- Predicted and measured values for maize did not match → probably poor N model, due to a small number of samples

Figure 5 : Studied coffee plantation.

Coffee
- Geology: large clay content, bulk density and penetration resistance
- Anthropogenic influence: strong anisotropy due to rows, large variability (Fig.5)
- LAI more variable and on average smaller

Homegarden
- Throughfall and soil moisture more variable (multilevel system)
- Penetration resistance low and spatially homogeneous

References

[1] J. Hepp, "Analyse der bodenphysikalischen Standortheterogenität in zwei verschiedenen Landnutzungssystemen des südlichen Kilimanjaro", in German, Bachelor Thesis, University of Bayreuth, 2011.

[2] A. Kühnel, "Variability of physical, chemical and hydraulic parameters in soils of Mt. Kilimanjaro across different land uses", PhD thesis, University of Bayreuth, 2015.

christina.bogner@uni-bayreuth.de anna.kuehnel@wzw.tum.de valeska.scharsich@uni-bayreuth.de
johannes-hepp@gmx.de bernd.huwe@uni-bayreuth.de

www.bayceer.uni-bayreuth.de/mod/ www.bayceer.uni-bayreuth.de/bophy/

www.bayceer.de