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Poster No. 53

Effect of land-use and elevation on microbial biomass and water-extractable carbon in soils from Mt. Kilimanjaro ecosystems

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Abstract

Microbial biomass carbon (MBC) and water-extractable organic carbon (WOC) – as sensitive and important parameters for soil fertility and C turnover – are strongly affected by land-use changes all over the world. These effects are particularly distinct upon conversion of natural to agricultural ecosystems due to very fast carbon (C) and nutrient cycles and high vulnerability, especially in the tropics. The objective of this study was to use the unique advantage of Mt. Kilimanjaro – altitudinal gradient leading to different tropical ecosystems but developed all on the same soil parent material – to investigate the effects of land-use change and elevation on MBC and WOC contents during a transition phase from dry to wet season. Down to a soil depth of 50 cm, we compared MBC and WOC contents of 2 natural (Ocotea and Podocarpus forest), 3 seminatural (lower montane forest, grassland, savannah), 1 sustainably used (homegarden) and 2 intensively used (maize field, coffee plantation) ecosystems on an elevation gradient from 950 to 2850 m a.s.l. Independent of land-use, both MBC and WOC strongly increased with elevation on Mt. Kilimanjaro corresponding to ecosystem productivity and biodiversity. Through the agricultural use of ecosystems MBC and WOC contents decreased – especially in surface layers – on average by 765 mg kg^{-1} for MBC and 916 mg kg^{-1} for WOC, compared to the respective natural ecosystems. The decrease with depth was highest for forests > grasslands > agroecosystems and also was positively correlated with elevation. We conclude that MBC and WOC contents in soils of Mt. Kilimanjaro ecosystems are highly sensitive to land-use changes, especially in topsoil. The MBC and WOC contents were considerably reduced even in sustainable agricultural systems. Since MBC and WOC are very fast reacting and sensitive C pools, we expect a decrease in other soil C pools accompanied by a strong decrease in fertility and productivity due to changes in land use from natural to agricultural ecosystems.

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Effect of land-use and elevation on microbial biomass and water-extractable carbon in soils of Mt. Kilimanjaro ecosystems

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Introduction

To understand impacts of climate and land use changes on biodiversity and ecosystem stability at Mt. Kilimanjaro, detailed information of the current biotic and abiotic controls on carbon and nutrient fluxes are needed.

Microbial biomass C (MBC) and water-extractable C (WOC) are strongly influenced through climate and land-use practices. To get an insight of these effects, different ecosystems were investigated during a dry-to-wet transition from March to May 2012.

Objectives

1) Land-use change from natural to agricultural ecosystems affects contents of MBC and WOC
2) Seasonal changes of MBC & WOC are affected by elevation (→ climate)
3) Stronger seasonal changes in MBC and WOC are expected in the topsoil as compared to deeper soil layers

Conclusion

➔ Seasonal changes of MBC and WOC are more distinct in lower than in higher elevated ecosystems (**Figures 2 and 4**)

➔ Soil MBC & WOC contents of Mt. Kilimanjaro increase linearly with elevation (**Figure 3**)

➔ Land-use has a strong influence on ecosystems: MBC and WOC in agricultural ecosystems are ~3 times decreased compared to semi-natural ecosystems (**Figure 5**)

Outlook:

➢ Investigation of twelve ecosystems
- MBC & MBN stocks
- Soil greenhouse gas exchange
- Activity of the microbial biomass

Methods

Sampling:

✔ Monthly samples (March – April – May 2012) of eight ecosystems (**Figure 1**)

✔ Five mixed samples per plot and sampling / depths of 0-10, 10-20, 20-30 & 30-50 cm)

Analysis:

✔ chloroform-fumigation-extraction method → MBC & WOC

Statistics:

✔ Two-way mixed-effect ANOVA, Tukey's Post-Hoc Test

✔ R statistical environment

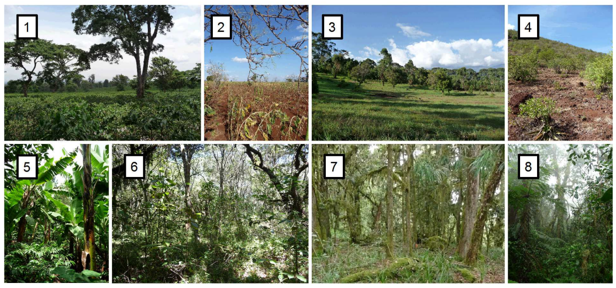

Figure 1: Investigation sites: (1) Coffee plantation, (2) Maize field, (3) Grassland, (4) Savannah, (5) Homegarden, (6) Low montane forest, (7) *Podocarpus* forest, (8) *Ocotea* forest

Results

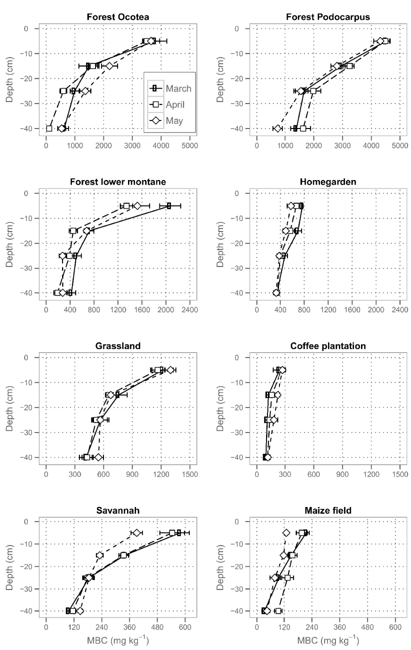

Figure 2: MBC depending on soil depth & sampling date. Standard errors as black lines. Note different X scales for ecosystems at different elevation.

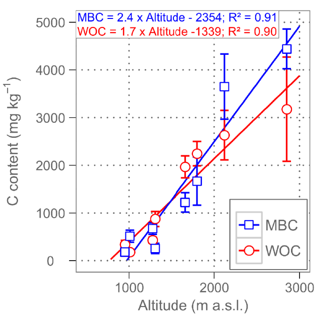

Figure 3: Regression between altitude and MBC or WOC in the 0–10 cm layer of soils of Mt. Kilimanjaro.

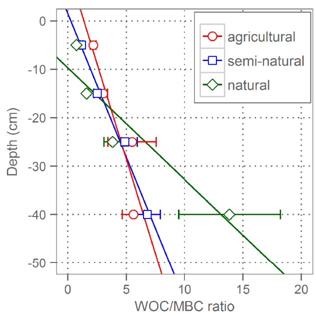

Figure 5: WOC/MBC ratio in agriculturally used (R^2 = 0.77), semi-natural (R^2 = 0.98) and natural (R^2 = 0.80) ecosystems.

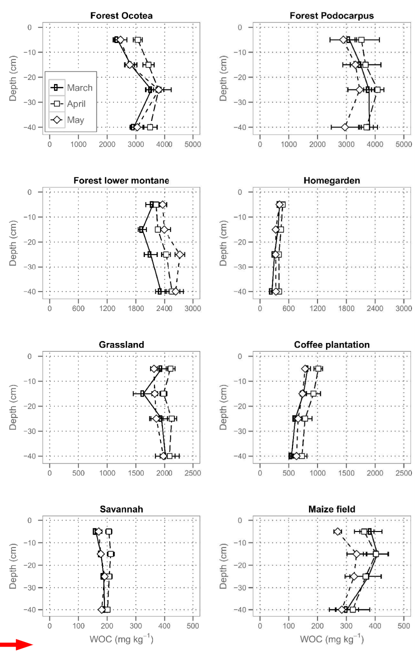

Figure 4: WOC contents depending on soil depth and sampling date. Standard errors as black lines. Note different X scales for ecosystems at different elevation.

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Reference:
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