Impacts of land-use change on organic carbon storage in highly weathered soils of tropical Sub-Sahara Africa

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1. Previous study (Kirsten *et al.* 2016, 2018)

- The objective was to identify the impact of land use on soil organic carbon (SOC) storage in acid, highly weathered soils, *i.e.* Acrisols (E Usambara Mts., NE Tanzania)
- We excavated soil pits to 100 cm soil depth on 10 study sites (Fig. 1)
- Three different agricultural land uses were compared with near-natural forest
- Additional samples taken in 10 cm depth increments down to 40 cm (satellite samples) with an auger

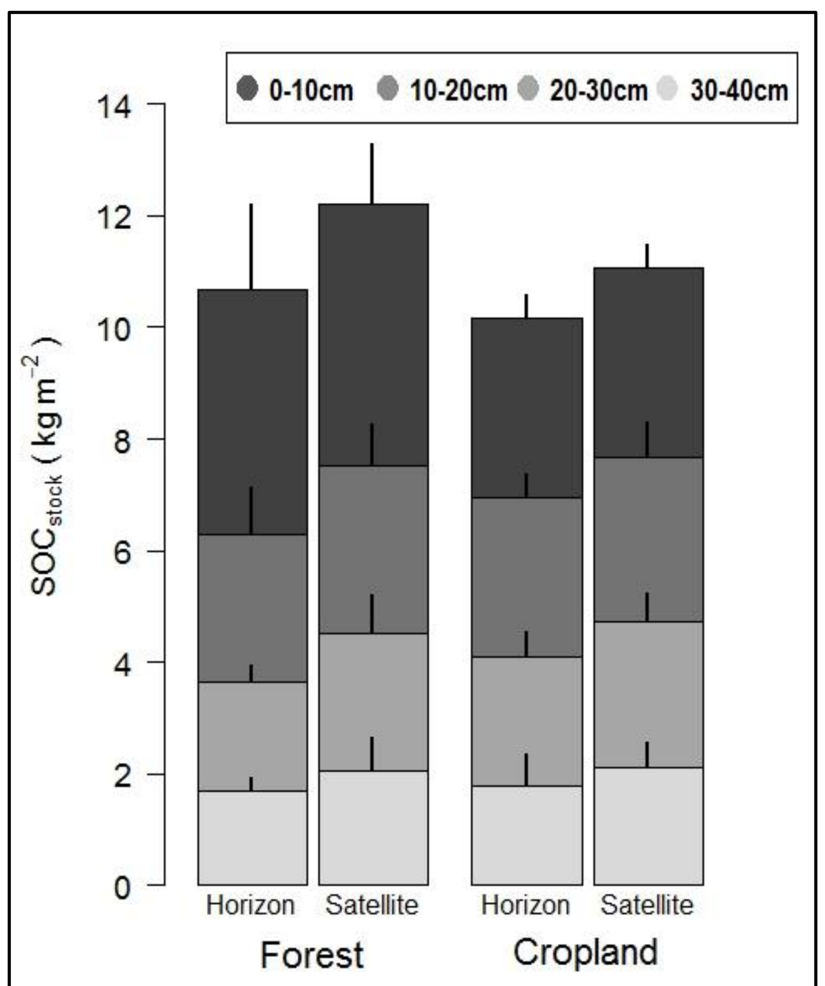

Fig. 2: Soil organic carbon stocks to 40 cm (horizon- and satellite based sampling approaches). Satellite samples comprise n = 8 samples per site and depth interval. Land-use types analyzed: forest (*n* = 4), cropland (*n* = 3). Error bars show the standard deviation.

2. Results and assumptions based on previous study

- SOC stocks to 100 cm: similar range between forest, cropland, and tea plantation 17.5, 16.9, and 16.8 kg m^{-2}, respectively
- Mean SOC stock of croplands (0-10 cm; satellite samples) significantly decrease by 27 % compared to forest soils (Fig. 2)
- Land use impact was much smaller compared to data provided by the review study of Don *et al*. (2011)
- Positive relation between oxalate-extractable Fe and Al with SOC detected only for cropland topsoils but not for forest soils
- Contribution to SOC storage through mineral associations may be superimposed under forest by a high and variable litter input → causing differences in particulate organic matter
- Generally the soils had high SOC stocks independent of the established land uses (efficient SOC stabilization)

3. Ongoing project

- **Aim: <u>Identify the contribution of pedogenic iron oxides and clay minerals on SOC storage and stabilization</u>**
- Focusing on topsoils under forest and annual crops → strongest impact on SOC storage assumed (previous study)
- Resampling and extension of the previous study sites (forest *n* = 6: Kirsten *et al*. (2016), cropland *n* = 6)
- Adjusted sampling scheme to catch possible slope variability (Fig. 4)
- Significant different SOC stocks detected between land uses, as well as within the same land use (Fig. 5)
- Application of a combined dithionite and texture analysis (oxide free clay content) to the same soil sample (Fig. 6)
  a. Necessary for determination of the desired gradient
  b. First view how SOC storage will be affected by pedogenic oxides and clay content

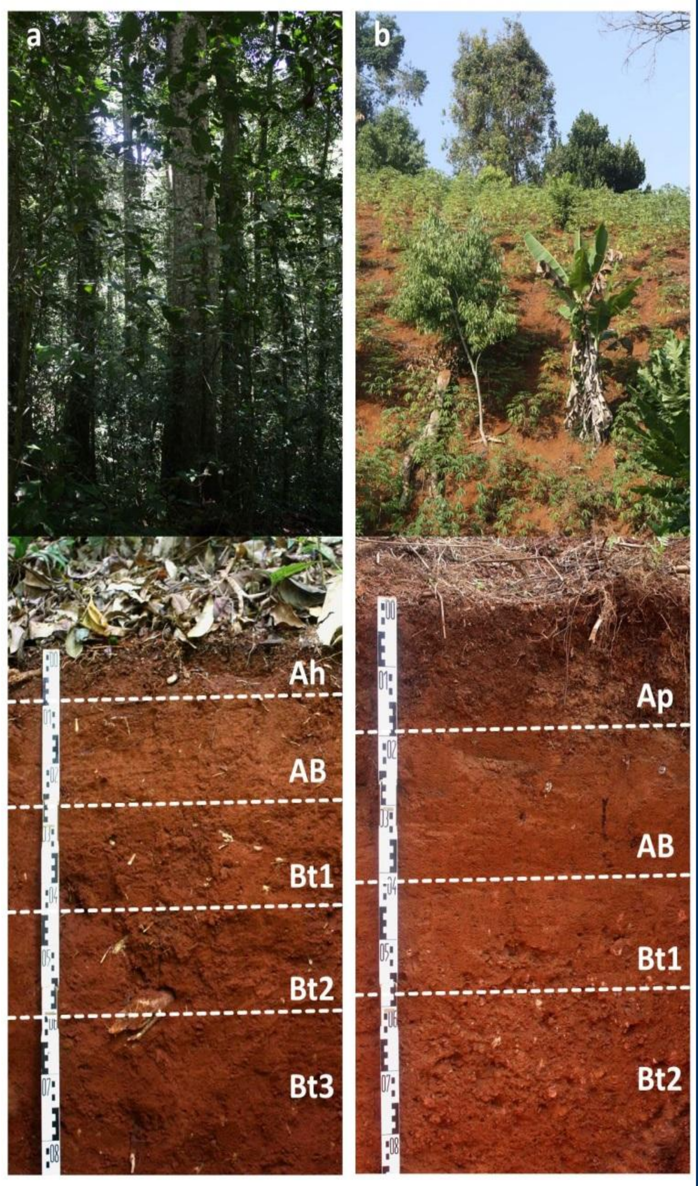

Fig. 1: Forest (a) and cropland(b) plot with typical soil profiles.

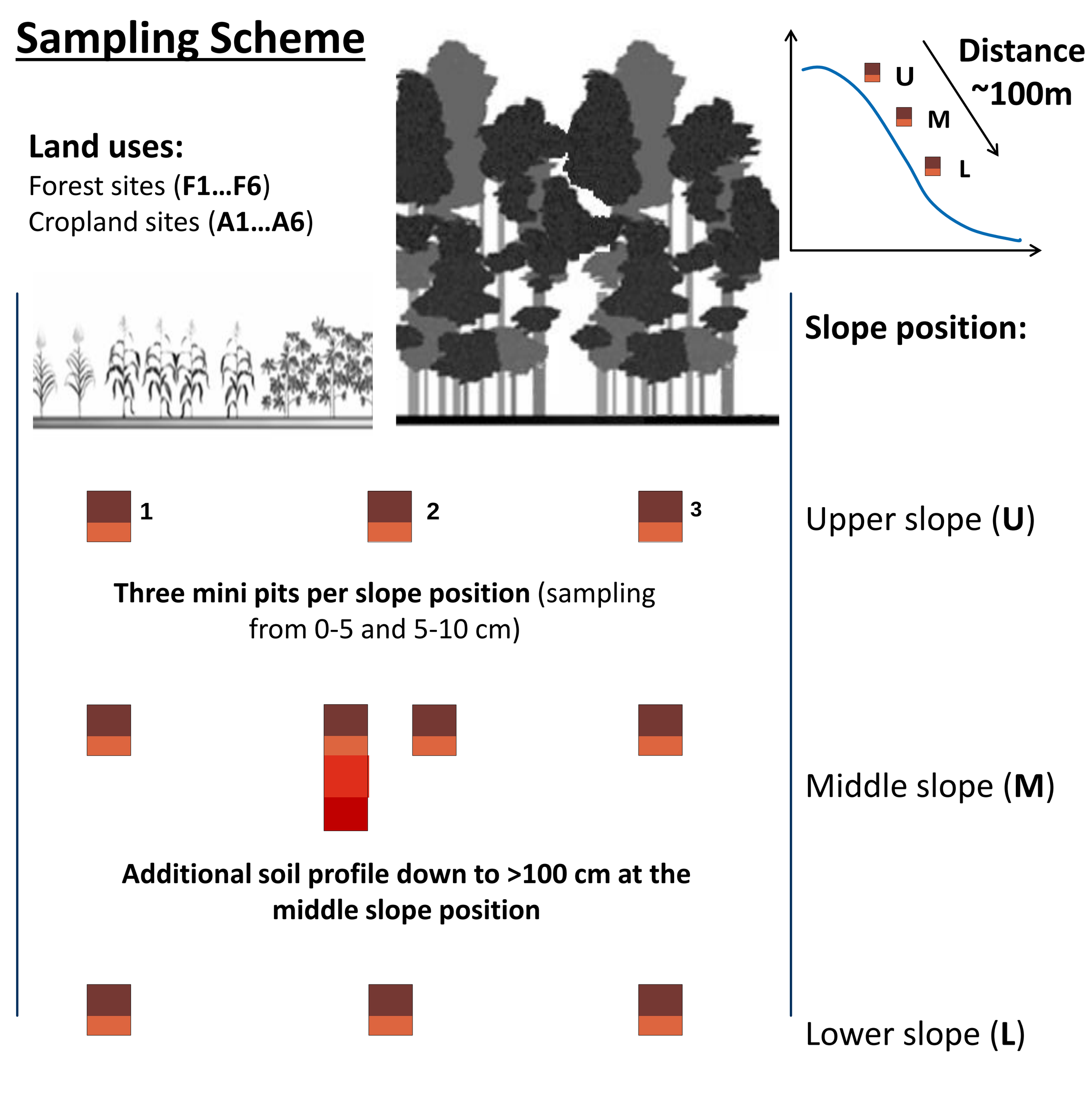

Fig. 4: Applied sampling scheme.

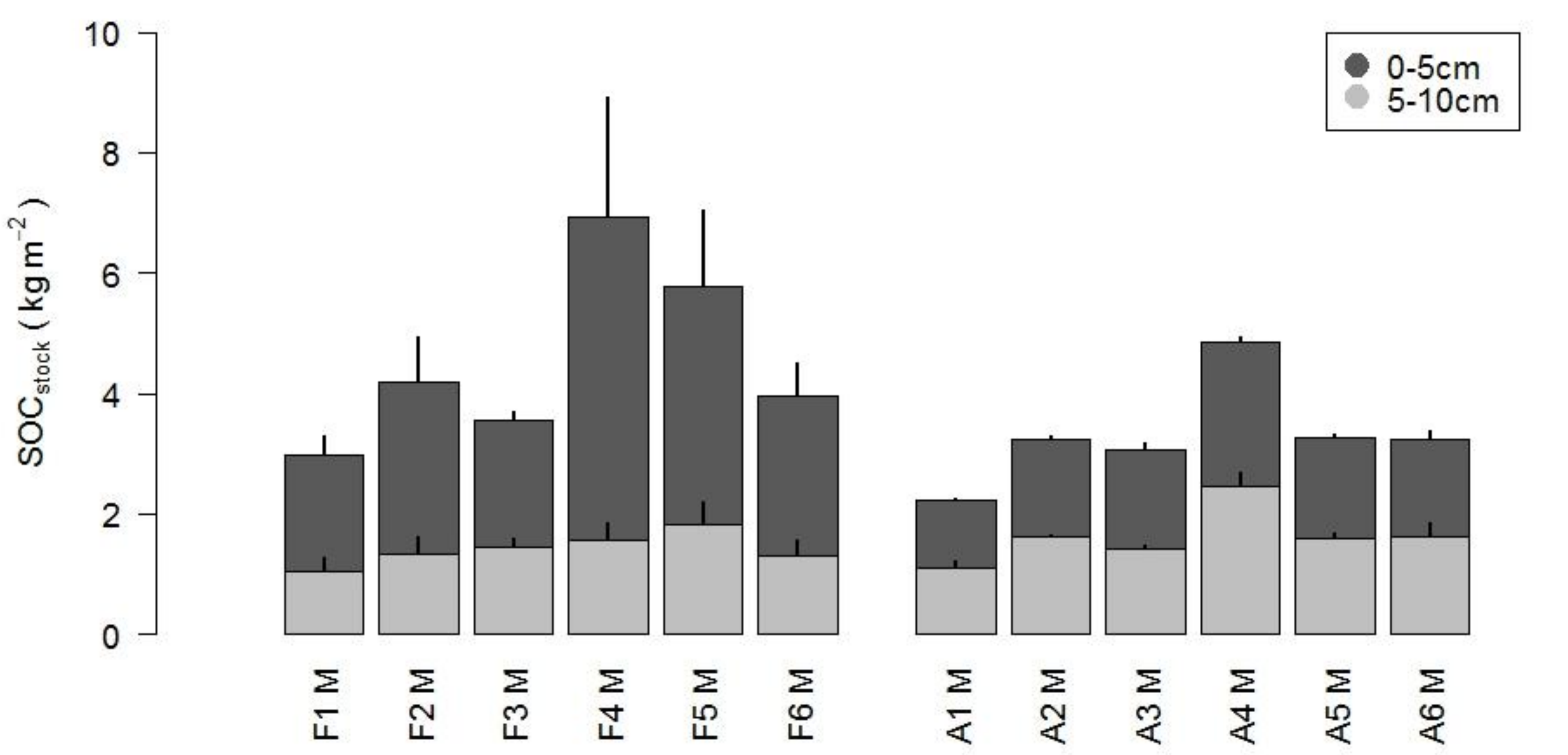

Fig. 5: Soil organic carbon stocks of the six forest (F1-6) and the six arable (A1-6) sites at middle slope position down to 10 cm based on mini-pit sampling (*n* = 3). Error bars showing standard deviation.

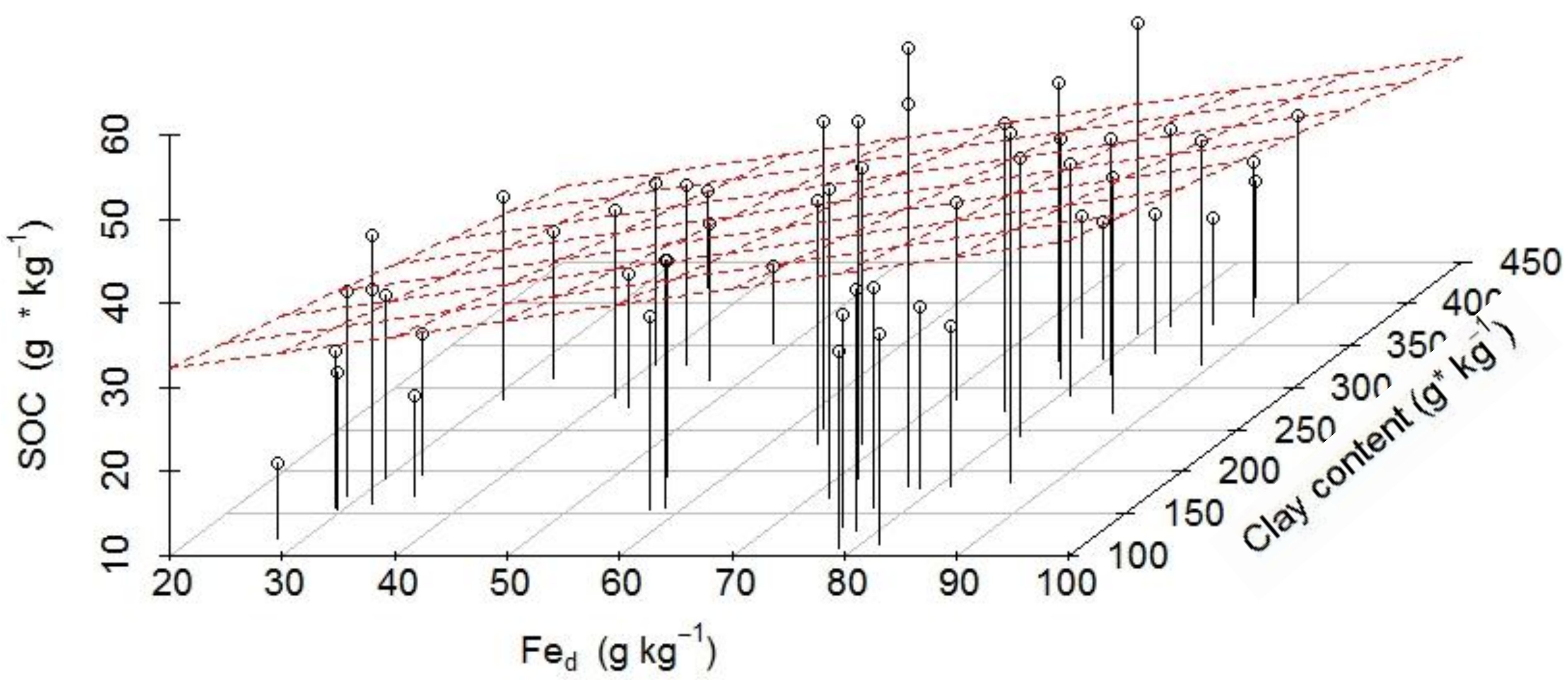

Fig. 6: Soil organic carbon content related to dithionite extractable Fe, and pedogenic oxide free clay content. Data shown for forest samples (5-10 cm depth increment).

4. Outlook

- Quantification of kaolinite content associated to the clay fraction: application of a modified selective extraction scheme (Ziegler *et al*., 2005)
- Identification how a natural gradient in pedogenic Fe oxides and kaolinite controls SOC storage and stabilization by mineral organic associations (MOAs) and aggregation
  a. Density fractionation: heavy fraction used as a proxy for MOAs
  b. Application of dry sieving for aggregate fractionation
  c. MOAs and aggregates (intact and crushed) will be introduced into a respiration experiment

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