# Institute of Agricultural Sciences in the Tropics (Hans-Ruthenberg-Institute) (490)

Implementing ecological functions in a land use change model to assess impacts of crop expansion and overstocking in a Kenyan savanna

Benjamin Warth, Carsten Marohn, Folkard Asch Institute of Agricultural Sciences in the Tropics (Hans-Ruthenberg-Institute), University of Hohenheim, Germany

#### Introduction

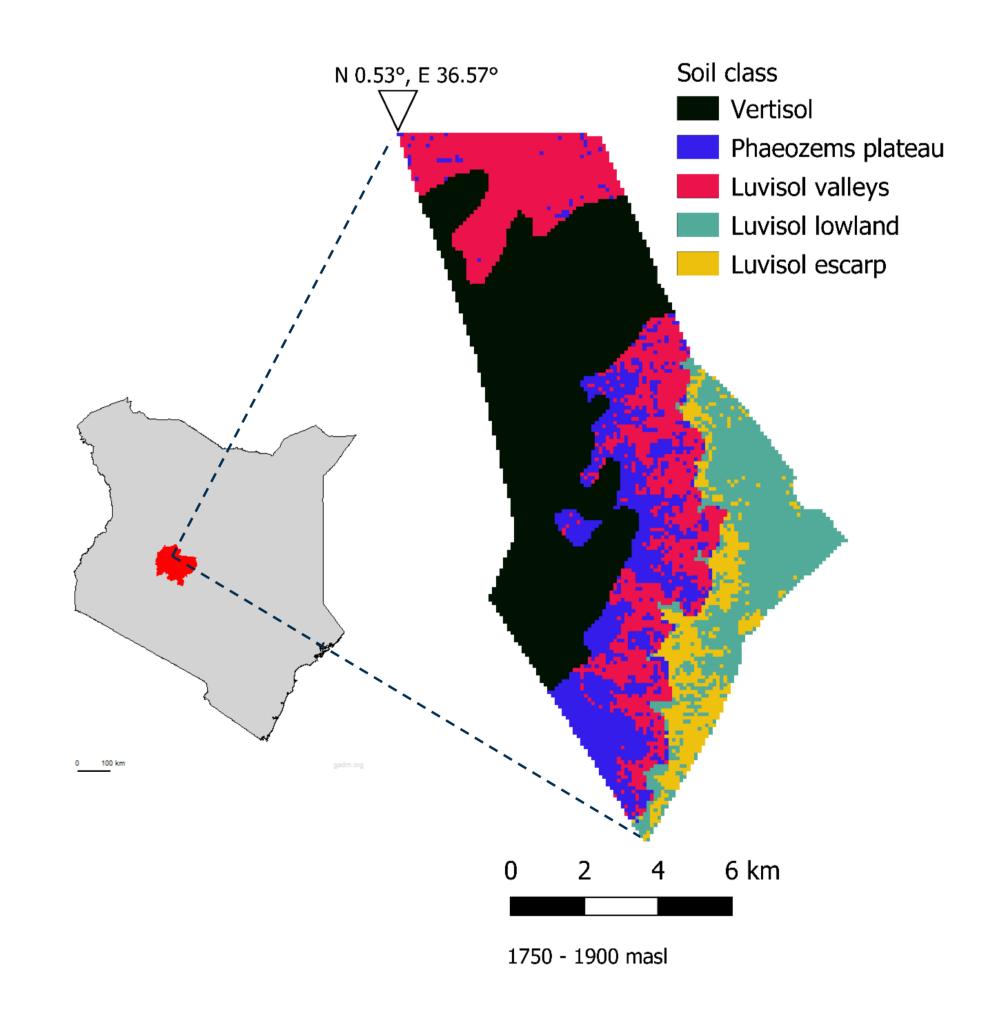
- Veg. cover is seasonally reduced under cropping and tillage disturbs soil
- Loss of rangeland to cropping increases grazing pressure on remaining pastures, causing rangeland degradation
- Does large-scale conversion of African savannas to cropland generate negative ecological impacts?
- Land conversion is happening on OI Maisor ranch and a lot more is planned
- Large scale land use change (LUC) impacts cannot be tested in the field
- → We amend and employ the process-based model LUCIA to run scenarios Model scenarios: Crop expansion vs. Status quo
- 10 year model runs, 4 corrals with 600 cattle each, monthly shifting corral locations, crop and hay expansion reduces pasture from 10,500 to 6,100 ha
- Higher grazing frequency of remaining pastures in crop expansion scenario does not cause additional pasture degradation

• SOC is higher under maize, but lower under hay after pasture conversion

# **Bush-grassland** Maize Grassland Woodland Hay **Topsoil SOC Peak biomass Grazing rotation (part)** Land use stock, year 10 June, year 9 onb Status Feb Mg/ha Mg/ha March 120 expansion Feb

#### Discussion and Conclusion

- Pasture is more productive and grazing resistant on less clayey red soils due to higher plant water availability, despite tree competition
- Plant growth is patchy, because it is highly influenced by lateral water flows
- SOC increases after grassland conversion to maize, because residues are left on fields and are not removed for livestock feeding
- Adjustment of soil physical equations improved simulation of clay soil hydrology and enhanced pasture (re)growth
- Pasture degradation was observed where water limitation and overgrazing coincided



Study site: 11,500 ha farmland in Laikipia 640 mm avg. annual rain in 2 rainy seasons Black cotton soil (Vertisol) & Red loam soils

Model validation

Topsoil moisture predicted well over 7 weeks

Year 2018observedpredictedPeak grass AGB Mg/ha23Maize AGB Mg/ha1911Hay cut Mg/ha86

for different soils and land uses: R<sup>2</sup> 0.52 - 0.75

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### Materials and Methods

Added grazing and growth reserves to LUCIA

#### **Growth reserves module**

- Enables regrowth after grazing
- Reserve depletion causes plant death and vegetation degradation

#### **LUCIA** model

- Land Use Change Impact Assessment tool (lucia.uni-hohenheim.de)
- Spatially explicit, process-based
- Daily timestep, 100m grid resolution

## **Grazing module**

- Monthly shifting grazing locations
- Constant herd size and herbage offtake Dung and urine NPK contents depend on plant NPK contents