TP04 – Analysis of microbial nutrient cycling, GHG production, BNF and plant growth promotion for sustainable land use management

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Project description

Introduction

Savanna ecosystems occupy 43 % of the African continent and are mainly located in the Subsahara. In the savannas of southern Africa, nitrogen typically limits plant productivity, and essentially all nitrogen and up to 80% of the phosphorus resides in soil organic matter. Microbial mineralization of soil organic matter thus represents a crucial process for plant nutrition and agriculture. Yet, only little is known on the coupling between soil management practices and microbial nutrient cycling in savanna soils.

Objectives

Within "The Future Okavango", microbiological subproject 04 analyses the interdependence and feedback mechanisms between land use and biogeochemical cycling as mediated by soil microorganisms. This project will thus focus on the mineralization of soil organic carbon as well as key transformations of the soil nitrogen cycle (ammonification, nitrification, N_2-fixation and denitrification) that are largely or entirely performed by soil bacteria. These processes are central to the nutrient supply and stability of savanna soils and will by analyzed by quantitative models. The bacteria involved in biogeochemical nutrient cycling will be identified by molecular techniques, representative species will be isolated by novel cultivation approaches, physiologically characterized, and transferred to cooperating African institutions for future studies of their application potential. Moreover, in order to increase agricultural production and sustainable soil use, bacterial symbionts for nitrogen fixation and plant growth promotion will be isolated and provided. In cooperation with other subprojects of TFO, quantitative models of C- and N-cycles in the Okavango savanna soils will be generated. These models will aid in the understanding of soil nutrient supply, and in the assessment of future land use scenarios and the impact of predicted changes in local climate.

Accordingly, work in subproject 04 concentrates on **four tasks**:

1. Development of robust methods to quantify microbial carbon and nitrogen cycling, and greenhouse gas emission as crucial ecosystem functions
2. Interdependence between microbial nutrient cycling / greenhouse gas emission and biodiversity, climate change and land management

3. Development of improved land management practices for food security, biodiversity and climate protection

4. Sustainable utilization of natural microbial resources by partner countries

Contribution to TFO

Subproject 04 will elucidate the actual biological processes that underlie the impact of land use management and climate change on soil carbon and nutrient inventory as determined in soil science subproject 03. In particular, subproject 04 will provide quantitative data on nutrient recycling that determine soil fertility as a critical ecosystem function in the study region. By translating these data into the corresponding crop yield, the information originating from subproject 04 will enable the economic valuation of soil fertility by the stakeholders. Secondly, project 04 will contribute essential information for the predictive modeling of the effects of land use change, climate change and of future land management scenarios. A third part of subproject 04 is product-oriented. The analysis of nodulating and plant growth-promoting bacteria will open new avenues for direct improvements of crop yield and quality, with presumably low levels of production of greenhouse gas (N_2O). Moreover, intensification of agricultural practices for food security, thus hopefully preventing massive burning of forests to gain new fields, can be envisaged with different land management scenarios.

Figure Legends

Fig. 1
Soil sampling on fallow land near Mile 46/Mutompo, Kavango region, Northeastern Namibia. © *Jörg Overmann, 2010*

Fig. 2
Soil sampling on Mahango field near Mile 46/Mutompo, Kavango region, Northeastern Namibia. © *Jörg Overmann, 2010*

Fig. 3
Field of a subsistence farmer in the Kavango region of Namiba with intercropping of cowpea and traditional cereals on poor soils. © *Barbara Reinhold, 2010*

Fig. 4
Roots of cowpea with low nodulation rate. © *Barbara Reinhold, 2010*