Table 1: General soil parameters and microbial activity parameters for all sites, Kalahari sands and old floodplains.

Methods: Direct cell count using Sybr Green and epifluorescence microscopy, isotope pool dilution, CO_2 flux measurement, exoenzyme measurements using fluorogenic substrate analogs, C_2H_2 inhibition method for denitrification, spectrophotometric method for nitrate.

Exoenzyme parameters: v_{max}, maximum velocity of the enzyme; $K_m + S_n$, substrate concentration at which the reaction is half of v_{max}; affinity, strength with which an enzyme binds the substrate; specific activity, estimated enzyme activity per single bacterial cell.

	All sites (N=23-25)	Kalahari Sands		Old Floodplains	
Sampling periods		Nov 2011	Mar/Apr 2011 Mar/Apr 2012	Nov 2011	Mar/Apr 2011 Mar/Apr 2012
Soil temperature [°C]	27.7	-	28.4	-	27.0
Water content [%]	2.9	0.5	3.3	1.5	4.4
pH (H_2O)	6.7	6.2	6.3	7.3	7.1
pH ($CaCl_2$)	5.9	5.8	5.3	6.6	6.2
pH (mean)	6.3	5.5	5.8	6.9	6.6
Co_2 flux ex situ [µmol CO_2 m^{-2} s^{-1}]	0.4	-	-	-	0.4
Total cell number [x 10^9 g_{DW}^{-1}]	1.0	0.3	0.7	1.1	1.6
Microbial biomass [x 10^7 µm^3 g_{DW}^{-1}]	7.2	2.1	5.9	5.4	12.0
Cell biomass carbon [µg C g_{DW}^{-1}]	8.7	2.6	7.2	6.5	14.5
Cell biomass nitrogen [µg N g_{DW}^{-1}]	2.2	0.6	1.8	1.6	3.6
Ammonification rate [µg N g_{DW}^{-1} d^{-1}]	4.4	-	0.7	-	6.3
Nitrification rate [µg N g_{DW}^{-1} d^{-1}]	22.6	-	4.9	-	31.5
Aminopeptidase					
v_{max} [µmol g_{DW}^{-1} h^{-1}]	1.4	0.8	0.6	1.9	1.6
$K_m + S_n$ [µM]	49.3	28.9	31.8	77.4	47.9
affinity [x 10^{-2} ml g_{DW}^{-1} h^{-1}]	3.8	3.9	3.0	2.5	5.6
spec. activity [x 10^{-9} µmol cells^{-1} h^{-1}]	1.4	2.2	1.1	1.7	1.0
Glucosidase					
v_{max} [µmol g_{DW}^{-1} h^{-1}]	2.1	1.1	1.3	2.5	2.9
$K_m + S_n$ [µM]	37.6	42.0	42.1	37.6	32.5
affinity [x 10^{-2} ml g_{DW}^{-1} h^{-1}]	7.5	5.1	5.4	8.4	9.4
spec. activity [x 10^{-9} µmol cells^{-1} h^{-1}]	2.6	3.5	2.3	2.8	2.0
Phosphatase					
v_{max} [µmol g_{DW}^{-1} h^{-1}]	0.7	0.7	0.6	0.4	1.1
$K_m + S_n$ [µM]	69.3	100.9	50.7	69.5	63.5
affinity [x 10^{-2} ml g_{DW}^{-1} h^{-1}]	2.0	2.1	1.7	0.9	2.5
spec. activity [x 10^{-9} µmol cells^{-1} h^{-1}]	1.2	1.9	1.1	0.7	1.3
Xylosidase					
v_{max} [µmol g_{DW}^{-1} h^{-1}]	0.5	0.3	0.3	0.5	0.6
$K_m + S_n$ [µM]	27.7	33.4	40.8	25.2	19.2
affinity [x 10^{-2} ml g_{DW}^{-1} h^{-1}]	3.0	4.3	1.0	2.6	3.8
spec. activity [x 10^{-9} µmol cells^{-1} h^{-1}]	0.6	1.2	0.5	0.6	0.5
Denitrification potential [ng N_2O g_{DW}^{-1} h^{-1}]	45.0	2.1	0.3	68.3	39.1
Soil nitrate concentration [µg NO_3 g_{DW}^{-1}]	22.1	9.8	8.5	40.5	19.3

In: Oldeland, J., Erb, C., Finckh, M. & Jürgens, N. (2013) [Eds.]: Environmental Assessments in the Okavango Region. – Biodiversity & Ecology **5**: 109–111. DOI: 10.7809/b-e.00260.

Fig. 1: Namibian and German microbiologists working at a bushveld site (photo: J. Overmann).

Fig. 2: Stimulation experiment in the field (photo: J. Overmann).

Table 2: Percentage abundances of dominant soil phyla for all sites, Kalahari sands and old floodplains.

Sampling period: March/ April 2011
Methods: Extraction of RNA, high throughput Illumina sequencing of partial 16S rRNA sequences.
Number of generated sequences: 39919254

Phyla abundances	All sites (23)	Kalahari Sands	Old Floodplains
	[%]	[%]	[%]
Actinobacteria	37.3	38.4	36.8
Proteobacteria	23.3	20.1	24.7
Acidobacteria	11.8	12.4	11.6
Planctomycetes	7.9	7.1	8.3
Firmicutes	6.8	7.8	6.3
Cyanobacteria	5.9	7.3	5.3
Chloroflexi	1.8	2.5	1.5
Bacteroidetes	1.4	0.9	1.5
Gemmatimonadetes	1.3	1.3	1.4
Sum of rare phyla (<1%)	1.2	0.9	1.3
Unclassified Bacteria	1.2	1.2	1.2

Soil is one of the most complex and diverse microbial habitats with one gram typically containing about 10^9 cells and 50,000 bacterial species. Interestingly, even nutrient poor and semi-arid savanna soils harbour these high amounts of bacterial cells. Nutrient availability and other soil parameters are dominant factors controlling soil microbial diversity and activity. Microbiologists in TFO study soil bacteria involved in the bio-geochemical nutrient cycling and focus on a quantitative understanding of bacterial carbon and nitrogen transformations as major determinants of soil fertility. The central aim is to elucidate the feedback mechanisms between different soil management practices and bacterial mineralization, ammonification, and nitrification in the Okavango region. Replicate sampling plots were chosen that differed in the land use type (woodland, bushveld, drought agriculture, irrigation agriculture, and fallow) and in the soil type (old floodplains and Kalahari sands). For analysis of the initial steps in C-, N-, and P-mineralization, the activities of four different exoenzymes (alkaline phosphatase, beta-glucosidase, xylosidase, and amino-peptidase) are determined. Focusing on a later part of the microbial N-cycle, the denitrification potential is measured as N_2O release, as well as soil parameters such as nitrate concentrations. The abundance and transcription of key genes related to microbial nitrogen cycling is also assessed. The effects of relevant nutrients on the bacterial community composition and associated activities are studied by in situ incubation experiments. Old flood plain soils exhibited higher bacterial cell numbers and higher bacterial activities than Kalahari sand soils (Tab.1). Cell numbers and bacterial activities were higher in March/April than in November, probably due to increased water availability after the rainy season. Abundant soil bacteria were affiliated with the phyla Actinobacteria, Acidobacteria, and Proteobacteria (Tab. 2), indicating that these phyla harbour key players of C-, N-, and P-cycles.

In cooperation with other subprojects of TFO, quantitative models of C- and N-cycles in the Okavango savanna soils will be calculated. These models and multivariate statistical analyses will help 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.

Acknowledgements

This study was funded by the BMBF (The Future Okavango project). For details see authors' general acknowledgements in this volume.

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