Cusseque - Soils

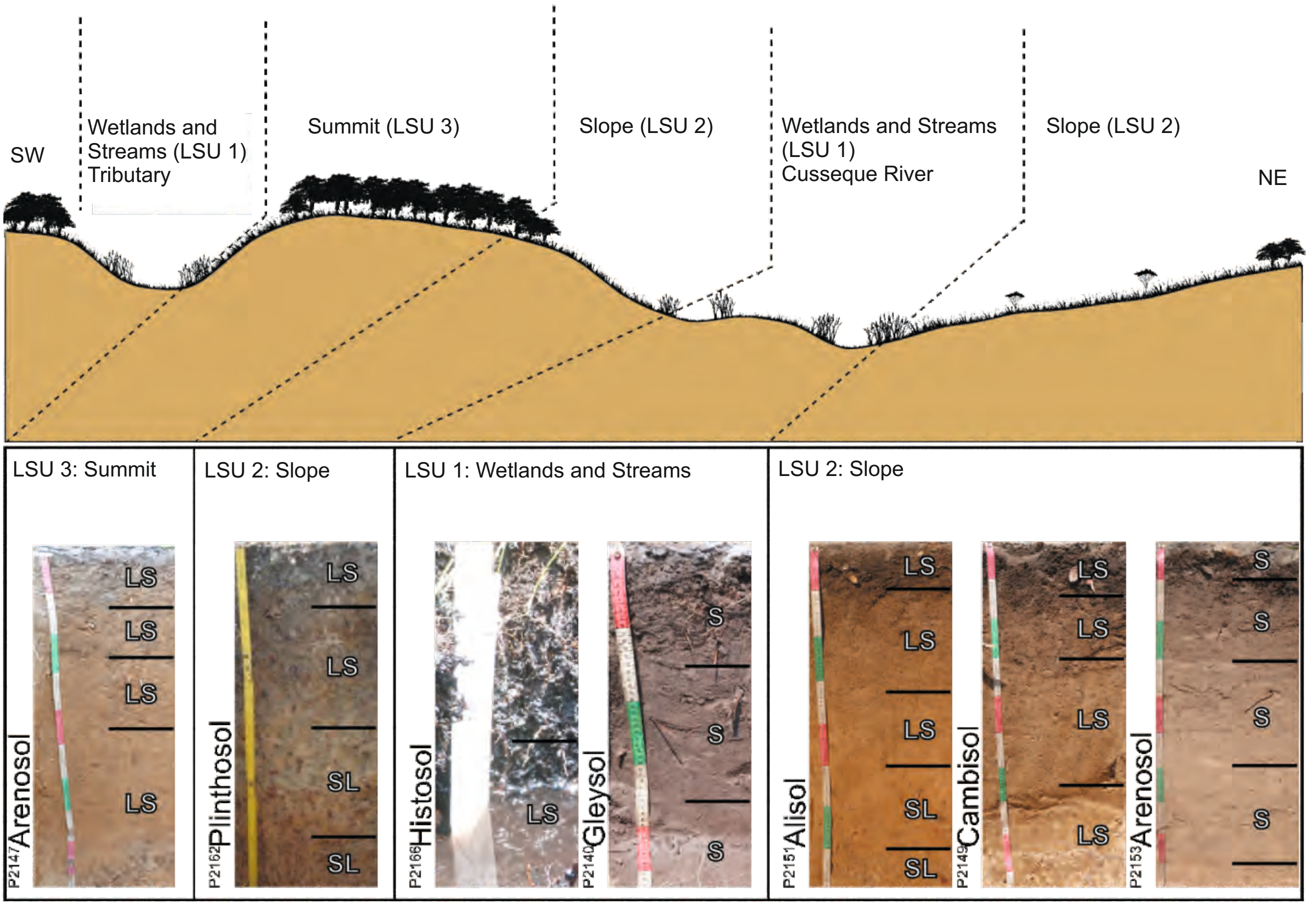

Fig. 1: Landscape transect of the Cusseque core site showing major landscape units (LSU) and representative soil profiles with indication of texture classes for each horizon according to WRB (IUSS Working Group WRB 2006).

Wetlands and Streams (LSU 1)

The wetlands around the Cusseque River and its tributaries can be subdivided into two subunits: bogs (LSU 1.1) and wetlands with mineral soil (LSU 1.2) (Fig. 1). Soils are defined as Histosols in the bog centre and Gleysols at the edges. The bogs are often framed by a strip of bleached white sand in the top soil.

Slopes (LSU 2)

On the hillslopes two different soil communities can be found. On the eastern part of the Cusseque Valley (LSU 2.1) in deep sandy substrates, Cambisols and Arenosols dominate. On the western part of the valley (LSU 2.2) the sands overlaying an old layer of weathered granite are often shallow. Depending on the thickness of the sandy cover and the clay and plinthite content, the community consists of Arenosols and Plinthosols.

Summits (LSU 3)

Soils of the hilltops are mostly characterized by deep and developed, slightly loamy Arenosols (Fig. 2) under closed woodlands. Cassava and maize are the most common crops in this landscape unit. Some of the slash and burn fields are a long way from the nearest settlement.

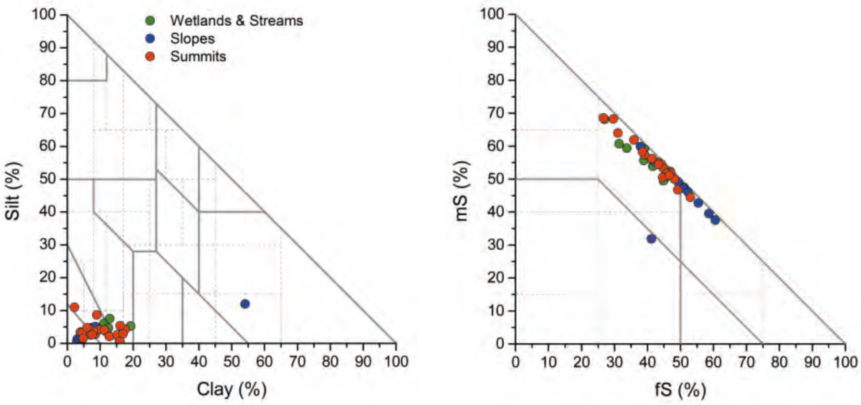

Fig. 2 a, b: Grain size distribution of the mineral fine soil fractions for all major landscapes in the Cusseque core site. Figure 2 a shows soil texture (relation between clay, silt and sand). Figure 2 b shows grain size distribution within the sand fraction.

In: Oldeland, J., Erb, C., Finckh, M. & Jürgens, N. (2013) [Eds.]: Environmental Assessments in the Okavango Region.
– Biodiversity & Ecology **5**: 51–54. DOI: 10.7809/b-e.00245.

Table 1: Properties of selected reference soil profiles for Cusseque.

No. LSU	1		2			3
Name of LSU	**Wetlands**		**Slopes**			**Summits**
No. Sub-LSU	**1.1**	**1.2**	**2.1**	**2.1**	**2.2**	**3.1**
Name of Sub-LSU	Peaty Wetlands	Mineral Wetlands	Shallow Soils	Shallow Soils	Deep Sandy Soils	Summits
No. reference profile	P 2146	P2161	P 2162	P 2143	P 2165	P 2142
Soil type reference profile	Sapri-rheic Histosol, dystric, drainic	Haplic Gleysol, dystric, greyic, arenic	Pisolithic Plinthosol, abruptic	Alisol	Rubic Arenosol, dystric	Hyperluvi-rubi-brunic Arenosol, dystric
Latitude [°]	-13.7020	-13.7028	-13.7026	-13.6871	-13.7079	-13.6908
Longitude [°]	17.0778	17.0633	17.0636	17.0820	17.1037	17.0633
Topographic height [m a.s.l.] *	1,516	1,528	1,535	1,556	1,534	1,574
Topsoil properties						
Soil colour (wet)	N 1/0	10YR 5/1	10YR 4/2	10YR 4/3	10YR 4/1	10YR 4/2
pH (in$CaCl_2$)	4.5	4.5	5.1	4.3	3.8	4.7
EC [µS cm^{-1}]	313	40	45	43	15	35
Total organic carbon [% DW]	16.3	1.32	1.24	1.03	0.84	0.89
Total inorganic carbon [% DW]	0	0	0	0	0	0
Total nitrogen [% DW]	1.191	0.083	0.071	0.057	0.042	0.056
C/N ratio	13.6	15.9	17.3	17.8	19.9	15.9
Nitrate in water extract [mg kg^{-1}]	9.1	0.9	0.3	0.7	2.7	5.4
Plant available phosphorous [mg kg^{-1}]	14.0	10.0	5.0	10.0	n.a.	7.0
Plant available potassium [mg kg^{-1}]	458.0	68.0	61.0	63.0	n.a.	22.0
Magnesium water extract [mg kg^{-1}]	5.6	3.3	3.8	3.6	0,3	2.2
Calcium water extract [mg kg^{-1}]	14.6	5.6	5.5	6.5	< 0.1	3.9
Subsoil properties (1 m)						
Soil colour (wet)	N 1/0	10YR 8/2	7.5YR 6/8	5YR 4/6	10YR 5/6	2.5YR 4/6
pH (in $CaCl_2$)	4.0	4.2	4.4	3.9	4.3	4.0
EC [µS cm^{-1}]	140	6	6	7	6	10
Total organic carbon [% DW]	9.82	0.14	0.15	0.24	0.11	0.12
Total inorganic carbon [% DW]	0	0	0	0	0	0
Total nitrogen [% DW]	0.492	0.020	0.016	0.019	0.010	0.010
C/N ratio	20.0	7.0	9.1	12.8	10.7	11.5
Nitrate in water extract [mg kg^{-1}]	n.a.	n.a.	n.a.	n.a.	1.1	0.9
Plant available potassium [mg kg^{-1}]	n.a.	n.a.	n.a.	n.a.	< 0.005	0.8
Magnesium water extract [mg kg^{-1}]	n.a.	< 0.1	n.a.	n.a.	< 0.1	0.1
Calcium water extract [mg kg^{-1}]	n.a.	< 0.1	n.a.	n.a.	< 0.1	< 0.1

n.a.: not analysed; * measured by GPS

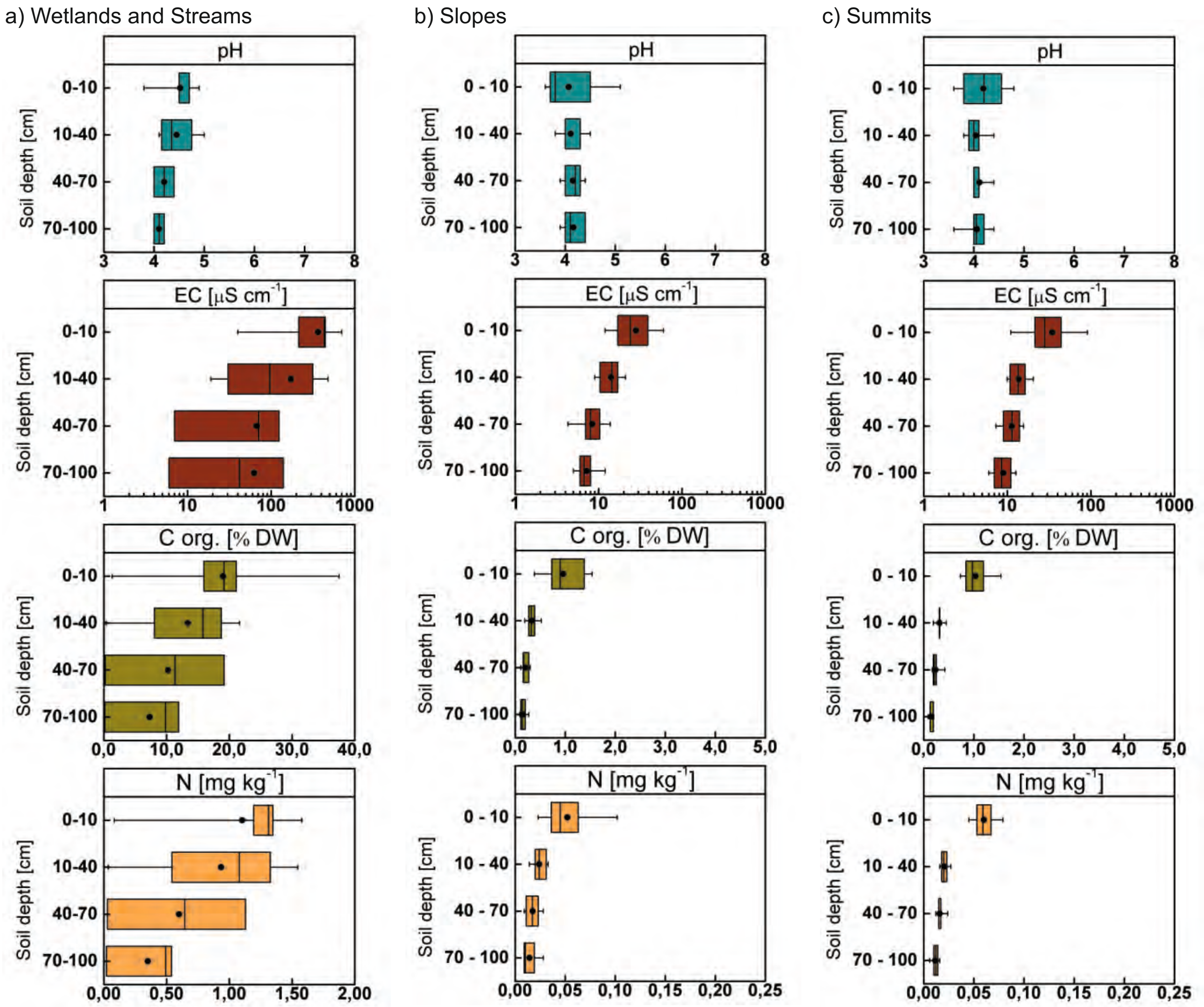

Fig. 3 a, b, c: Boxplots (Box: 25%, 75% percentile, mean and median; Whisker: min./max.) showing pH, electrical conductivity, organic carbon content and total nitrogen content for four depth intervals comparing LSU 1 (a) with LSU 2 (b) and LSU 3 (c).

The Cusseque core site has the highest pedodiversity among all core sites in the Okavango Basin (Fig.1). Along with this pedodiversity, soil chemical parameters are highly variable (Tab. 1) especially in the wetlands (LSU 1). However, due to the long-term leaching processes driven by high precipitation amounts and temperature, almost all soils are extremely acid (pH 3.5-4.4) with lowest pH-values found on the summits and only slight changes occuring with depth.

A part of the percolating rain water does not contribute to groundwater recharge but moves laterally at shallow depth in the direction of the valley floor. This permanent interflow from the upper areas to the streams has created peat accumulating wetlands (soil reference group Histosols) with up to 38% organic carbon and with a mean C/N ratio of 17. Here, high evapotranspiration rates in the dry season lead to EC values of 320 µS cm^{-1} due to evaporative nutrient translocation and concentration in upper soil areas. The bogs are framed by sandy contact zones separating the wetlands from the adjacent grasslands. These zones are characterized by strong nutrient leaching through lateral transport of ions. Thus, the plotted parameters show minimum values within these Gleysols (Fig. 3 a).

The two soil communities on the slopes of the Cusseque valley (LSU 2) exhibit a comparable accumulation of organic carbon in the topsoil (up to 1.5%), however the C/N ratio and the nitrogen availability is lower on the deep sandy Arenosols on the eastern slopes compared to the shallow soils of the western slopes on granitic bedrock (e.g. Plinthosols). In the Arenosols, the concentrations of nutrients are also significantly lower in the topsoils. On average, for plant available phosphorous we found 7.2 mg kg^{-1} in the West versus 3.7 mg kg^{-1} in the East, for potassium 58 mg kg^{-1} vs. 8 mg kg^{-1} and for water soluble magnesium 3.0 mg kg^{-1} vs. 0.5 mg kg^{-1}, respectively. In general, low electrical conductivity and very to slightly low organic carbon and nitrogen content, especially in the subsoils, are typical for both parts of this landscape unit (Fig. 3 b).

The typical soils of the summits (LSU 3) are Arenosols. They are quite similar in their soil chemical properties to soils of LSU 2.2 (Fig. 3 c), and their subsoil properties show very low variability. Concentrations of nutrients are intermediate to the LSU 2.1 and 2.2. Slash-and-burn cultivation leads to a slight increase in topsoil pH, available potassium, and nitrate analysed in the dry season.

Acknowledgements

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

Reference

IUSS Working Group WRB (2006): World Reference Base for Soil Resources 2006. World Soil Resources Report No. 103. Rome, Italy: FAO.

Responsible authors: A. Groengroeft, J. Luther-Mosebach, L. Landschreiber, A. Eschenbach