Mashare - Soils

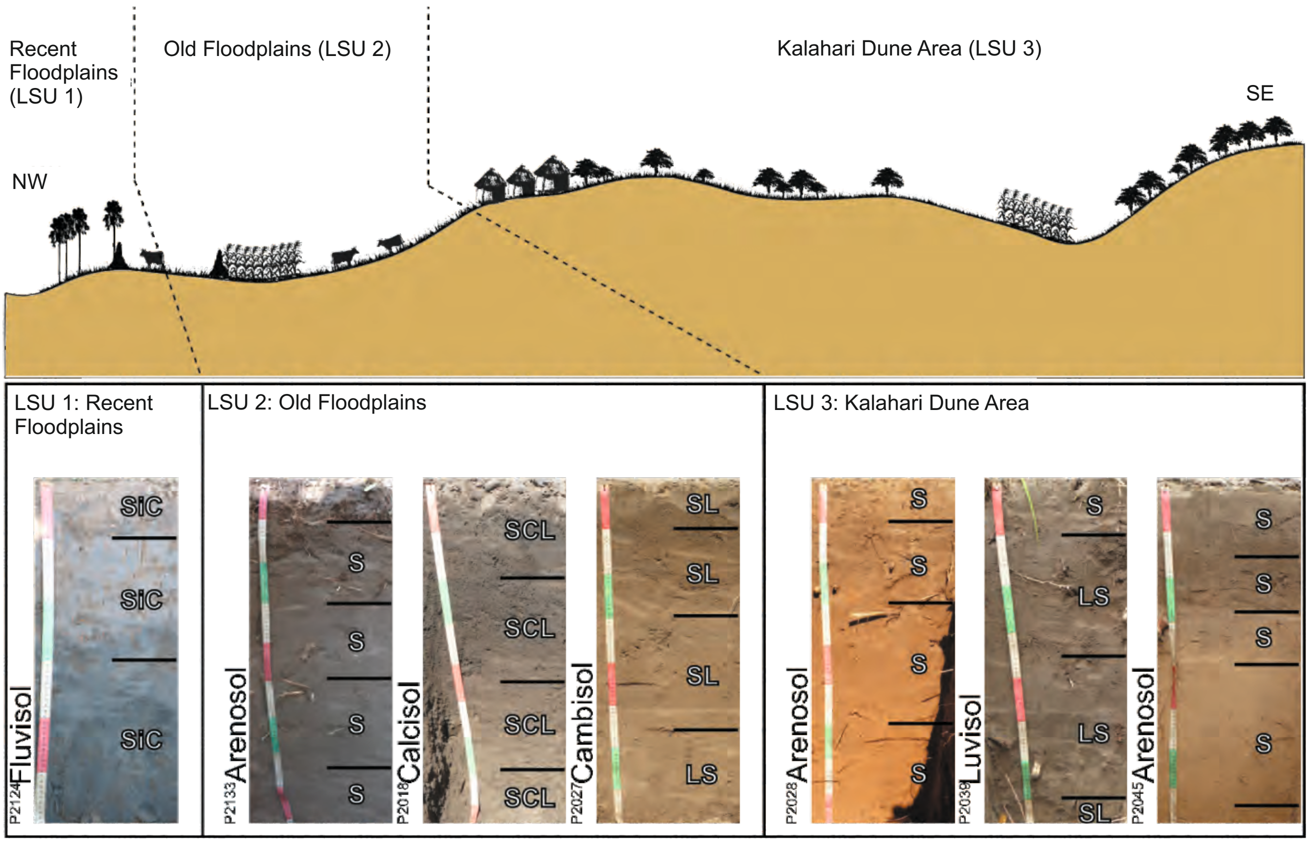

Fig. 1: Landscape transect of the Mashare core site with major landscape units (LSU), representative soil profiles and with indication of texture classes for each horizon according to WRB (IUSS Working Group WRB 2006).

Recent Floodplains (LSU 1)

Within the Recent Floodplains two sub-units have been distinguished depending on their topographic position: The riverbed and depressions are periodically inundated, characterized by deposition of fresh sediments and are dominated by clayey Fluvisols and arenic Gleysols (LSU 1.1). Levees and other parts with higher elevation are only episodically flooded and typically consist of Endogleyic Arenosols (LSU 1.2).

Old Floodplains (LSU 2)

The terraces of the Old Floodplains are structurally similar to the recent flood-plains, however the soils have lost signs of fluvial deposition. As in the Recent Floodplains on levees (LSU 2.1), Rubic Arenosols as well as Petriluvic Calcisols are to be found whereas depressions (LSU 2.2) are characterized by Eutric Cambisols, Petri-luvic Calcisols and Stagnic Luvisols. Areas with loamy or clayey substrates are preferred zones for mound building termite species.

Kalahari Dune Area (LSU 3)

This landscape unit, with the biggest extent within the core site, is divided into four subunits defined by their soil colours and topographic features. The transition zone (LSU 3.1) with reddish-brown sands outlines the change between substrates of fluviatile and eolian origin. Soil types include Eutric Cambisols and Rubic Arenosols. The major parts of the Kalahari Dune Area are dominated by eolian sediments with slightly reddish ochre (LSU 3.2) or substrate specific pale soil colours (LSU 3.3), which form exclusively Haplic to Rubic Arenosols. A special feature is the existence of an ephemeral to fossile river system (LSU 3.4) with clayey carbonate-rich Gleysols in the centre.

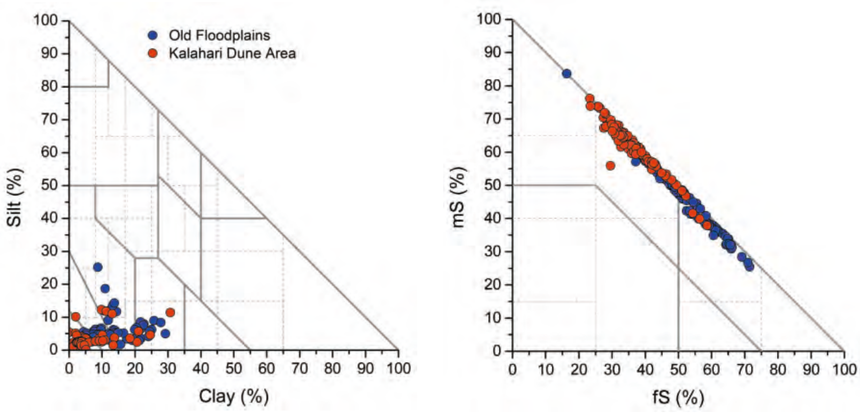

Fig. 2 a, b: Grain size distribution of the mineral fine soil factions for all major landscapes in the Mashare core site. Figure 2 a shows soil texture (relation between clay, silt and sand). Figure 2 b shows grain size distribution within the sand fraction.

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

No. LSU	**1**		**2**		**3**			
Name of LSU	**Recent Floodplains**		**Old Floodplains**		**Kalahari Dune Area**			
No. Sub-LSU	**1.1**	**1.2**	**2.1**	**2.2**	**3.1**	**3.2**	**3.3**	**3.4**
Name of Sub-LSU	Levee	Depression	Levee	Depression	Transition Zone	Brownish-Reddish Soils	Pale Soils	Omurambas
No. reference profile	P 2126	P 2124	P 2132	P2027	P 2028	P 2045	P 2042	P 2039
Soil type reference profile	Endogleyic Arenosol, eutric	Gleyic Fluvisol, humic, dystric, clayic	Rubic Arenosol, eutric	(Irrargic) Cambisol, eutric	Rubic Arenosol, eutric	Haplic Arenosol, eutric, greyic	Haplic Arenosol, eutric, greyic	Haplic Luvisol, hyper-eutric, arenic
Latitude [°]	-17.8850	-17.8923	-17.8867	-17.8944	-17.8968	-17.9891	-17.9196	-17.9179
Longitude [°]	20.2285	20.2392	20.2128	20.2117	20.2096	20.1838	20.2072	20.2070
Topographic height [m a.s.l.] *	1,054	1,051	1,057	1,072	1,070	1,102	1,060	1,061
Topsoil properties								
Soil colour (wet)	10YR 4/2	10YR 2/2	7,5YR 4/4	10YR 3/4	7.5YR 2.5/3	10YR 3/3	10YR 3/1	10YR 2/1
pH (in $CaCl_2$)	5.2	4.2	4.9	7.6	5.1	4.4	5.3	5.8
EC [µS cm^{-1}]	174	55	41	96	18	3	11	22
Total organic carbon [% DW]	0.65	2.44	0.48	0.41	0.44	0.37	0.41	0.67
Total inorganic carbon [% DW]	0	0	0	0.14	0.01	0.01	0	0
Total nitrogen [% DW]	0.048	0.226	0.031	0.047	0.040	0.028	0.035	0.060
C/N ratio	13.5	10.8	15.7	8.7	10.9	13.2	11.8	11.2
Nitrate in water extract [mg kg^{-1}]	45.4	0.4	8.5	30.1	10.6	3.7	2.6	25.3
Plant available phosphorous [mg kg^{-1}]	n.a.	n.a.	n.a.	35.45	43.95	3.43	4.65	15.52
Exchangeable potassium [mg kg^{-1}]	n.a.	n.a.	n.a.	199.99	37.46	14.72	0.00	0.00
Plant available potassium [g kg^{-1}]	0.044	0.052	0.076	0.174	0.026	0.009	0.013	0.078
Exchangeable magnesium [mg kg^{-1}]	n.a.	n.a.	n.a.	387.95	25.02	27.58	0.00	0.00
Magnesium water extract [mg kg^{-1}]	4.5	5.8	9.1	6.3	13.2	3.3	3.2	19.6
Exchangeable calcium [mg kg^{-1}]	n.a.	n.a.	n.a.	3432.01	158.36	113.03	0.00	0.00
Calcium water extract [mg kg^{-1}]	16.3	11.1	5.2	36.7	6.9	2.7	6.4	19.6
Subsoil properties (1 m)								
Soil colour (wet)	10YR 6/3	10YR 4/1	5YR 4/6	10YR 4/3	5YR 4/6	10YR 4/4	10YR 5/4	10YR 4/2
Bulk density [g cm^{-3}]	n.a.	n.a.	n.a.	1.30	n.a.	n.a.	1.56	n.a.
pH (in $CaCl_2$)	6.2	7.1	4.7	8.0	4.3	4.5	4.9	5.9
EC [µS cm^{-1}]	9	95	14	77	5	5	6	10

No. LSU	1		2			3		
Name of LSU	**Recent Floodplains**		**Old Floodplains**			**Kalahari Dune Area**		
No. Sub-LSU	**1.1**	**1.2**	**2.1**	**2.2**	**3.1**	**3.2**	**3.3**	**3.4**
Subsoil properties (1 m)								
Total organic carbon [% DW]	0.05	0.28	0.09	0.25	0.10	0.10	0.09	0.12
Total inoganic carbon [% DW]	0	0	0	0.54	0	0	0	0
Total nitrogen [% DW]	0.002	0.031	0.012	0.026	0.014	0.014	0.010	0.011
C/N ratio	2.5	9.0	7.3	9.5	6.9	7.1	9.4	10.5
Nitrate in water extract [mg kg^{-1}]	n.a.	n.a.	0.5	2.2	n.a.	n.a.	0.5	n.a.
Plant available phosphorous [mg kg^{-1}]	n.a.	n.a.	n.a.	81.20	103.04	6.54	1.10	4.91
Exchangeable potassium [mg kg^{-1}]	n.a.	n.a.	n.a.	102.44	26.99	9.85	0.00	0.00
Plant available potassium [g kg^{-1}]	n.a.	n.a.	27.3	0.6	n.a.	n.a.	6.4	n.a.
Exchangeable magnesium [mg kg^{-1}]	n.a.	n.a.	n.a.	787.49	14.20	24.12	0.00	0.00
Magnesium water extract [mg kg^{-1}]	n.a.	n.a.	22.0	8.6	n.a.	n.a.	4.4	n.a.
Exchangeable calcium [mg kg^{-1}]	n.a.	n.a.	n.a.	3,932.68	50.50	45.36	0.00	0.00
Calcium water extract [mg kg^{-1}]	n.a.	n.a.	7.6	21.8	n.a.	n.a.	2.4	n.a.

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

Fig. 3: In situ soil CO_2 efflux measurements (photo: A. Groengroeft).

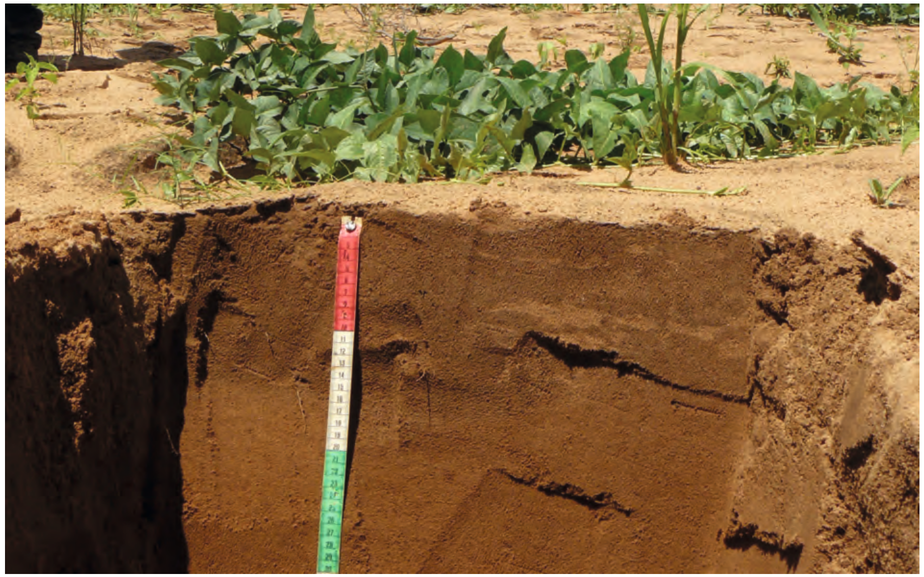

Fig. 4: Soil sampling on a dryland agriculture field in Mashare (photo: A. Groengroeft).

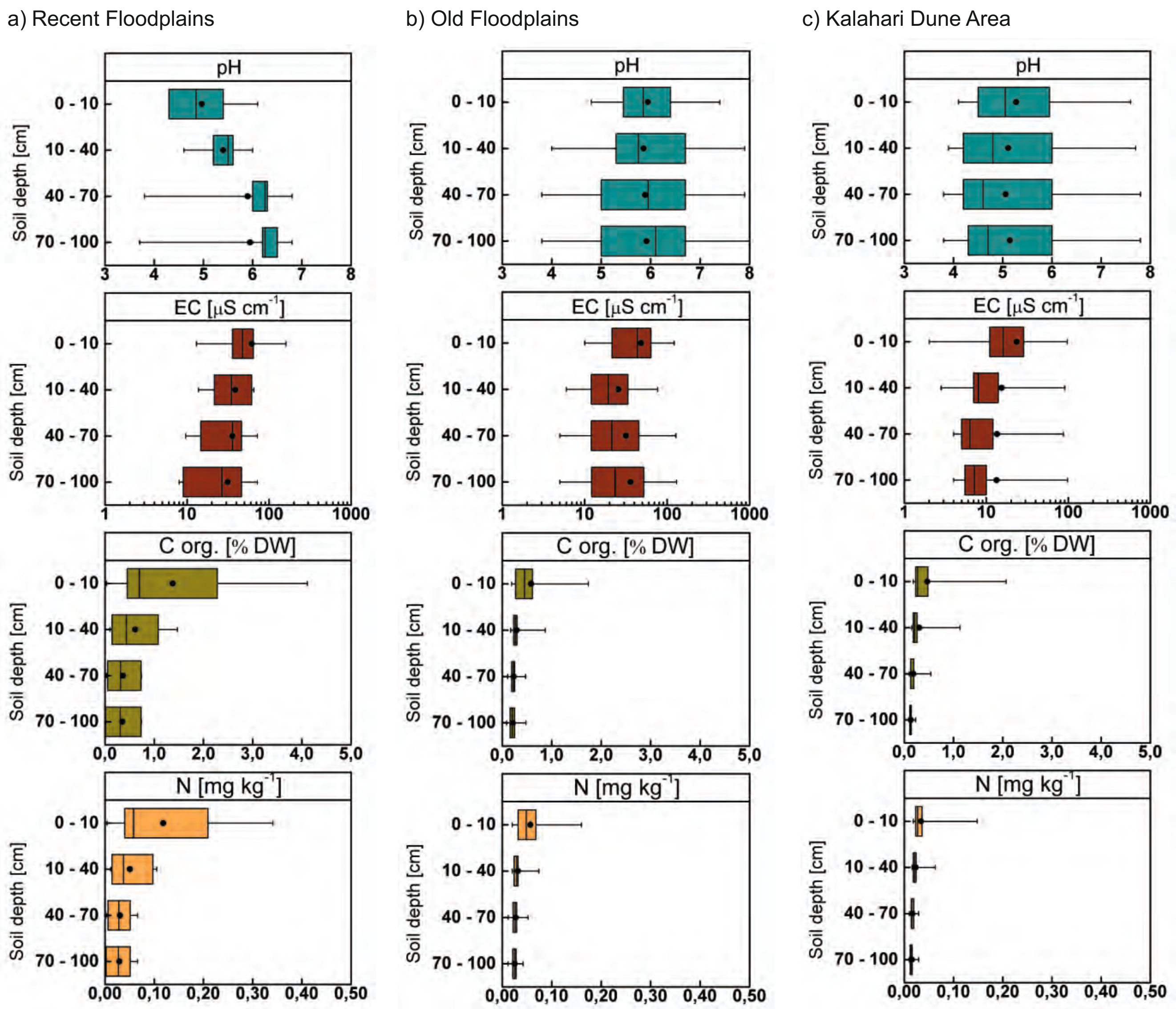

Fig. 5 a, b, c: Boxplots (Box: 25%, 75% percentile, mean and median; Whisker: min./max.) showing pH, electrical conductivity, organic carbon content and total nitrogen content for four depth intervals comparing LSU 1 (a) with LSU 2 (b) and LSU 3 (c).

Comparing all three major landscape units, the Recent Floodplains (LSU 1) show the highest variability in soil properties due to perennial input of fresh sediments and nutrients with flooding events and a highly diverse landscape structure ranging from Endogleyic Arensols on sandy levees to clayey Fluvisols in depressions (Fig. 5). In particular, carbon and nitrogen contents are the highest of this core site with maxima of 4.11% and 0.34% respectively in the topsoil.

However, the adjacent terraces of the Old Floodplains (LSU 2) and the Kalahari Dune Area (LSU 3), situated in the hinterland, reflect soil properties of the majority of the landscape with low amounts of carbon and nitrogen and a generally low nutrient level, particularly in the Kalahari Dune Area (Groengroeft et al. 2013).

The preferred area for cropping (depressions in LSU 2 and dry river beds in LSU 3) are slightly loamy with a mean clay content of 11% in the topsoil. Here, the pH-values are only slightly acidic and the total reserves of nutrients like phosphorous, potassium and magnesium are significantly higher than in the Arenosols of the Kalahari Dune Area.

At special places with calcretes in the subsoil in LSU 2 or with clayey Gleysols in dry riverbeds in LSU 3, alkaline pH-values at simultaneously low to moderate salinity are found. The dominating Arenosols of LSU 3 are characterized by an overall low nutrient availability, however with some minor differences between the transition zone, the brownish and the pale units. Within this sequence, the C/N ratio increases, the reserves of phosphorous and potassium decrease and also the amounts of available zinc decline strongly.

Acknowledgements

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