Pedological and agronomic assessment of salt-affected rice cultivation areas along a coastal gradient in the Zambezi Delta, Mozambique

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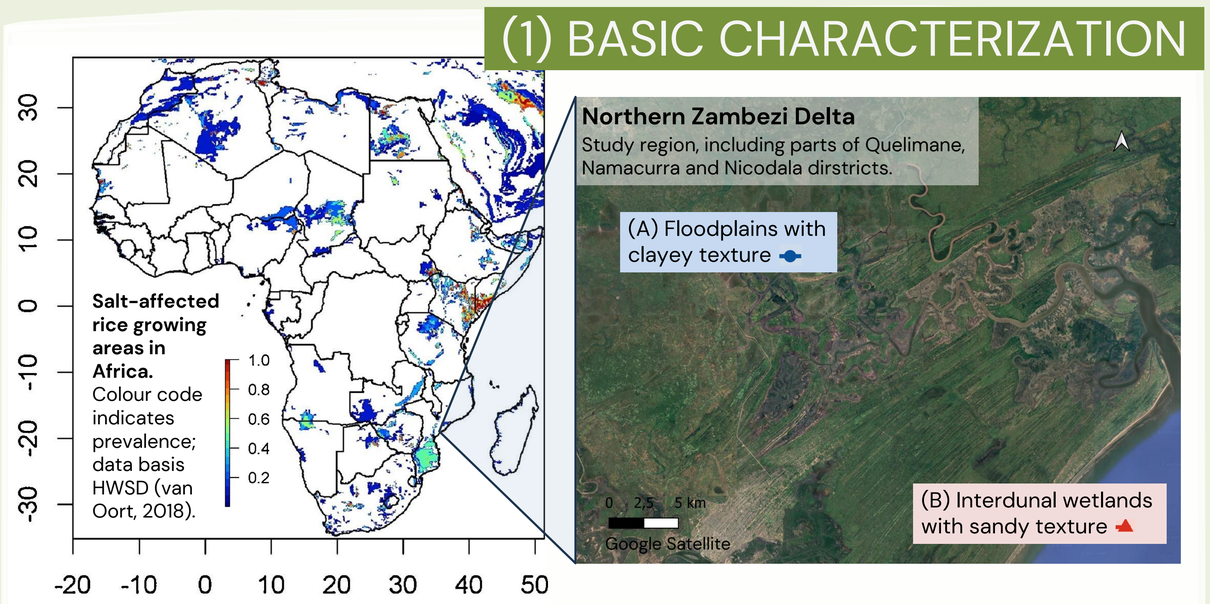
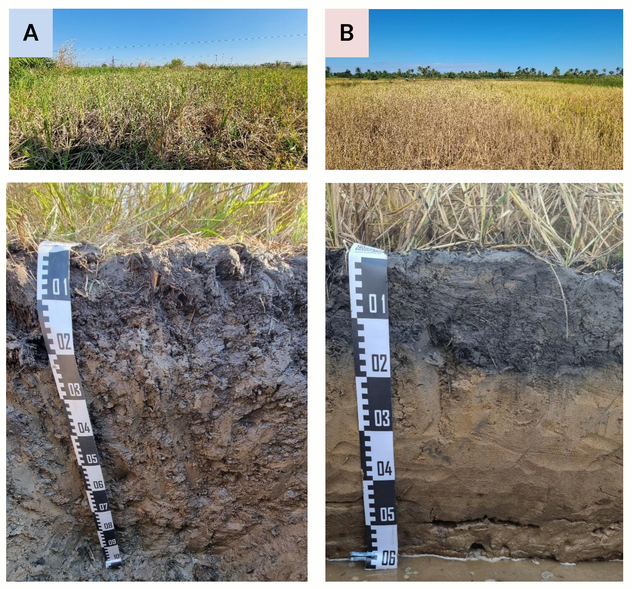
BACKGROUND & RESEARCH OBJECTIVE

- **Salt-affected lowland rice** production systems are found across Eastern Africa (~16% of Mozambican rice cropped area; van Oort, 2018), posing a significant threat to crop productivity.
- Salinity characteristics (i.e. type and magnitude) and salinity effects on **soil nutrient cycling** are largely unknown.
- The study explores the availability of soil nutrients (NPK) and beneficial elements (Si) in soils under rainfed lowland rice production in the Zambezi River Delta across **salinity gradients**.
- Data were collected as part of a **master thesis project**, covering (1) basic soil characterization & land management, and (2) topsoil nutrient availability & plant uptake in relation to salinity.

(1) BASIC CHARACTERIZATION



Land management and soil classification



Smallholder rice farming: rainfed, lowland, minimal input use.

(A) Clayey floodplain soils:

- Gleyic Stagnosols and Gleyic Stagnic Sodic Solonchaks
- Market-oriented, one-season rice monocrop.

(B) Sandy interdunal soils:

- Gleyic Arenosols and Gleyic Sodic Solonchaks.
- Subsistence, rice - upland crop rotations.

Selected soil properties along the salinity gradient

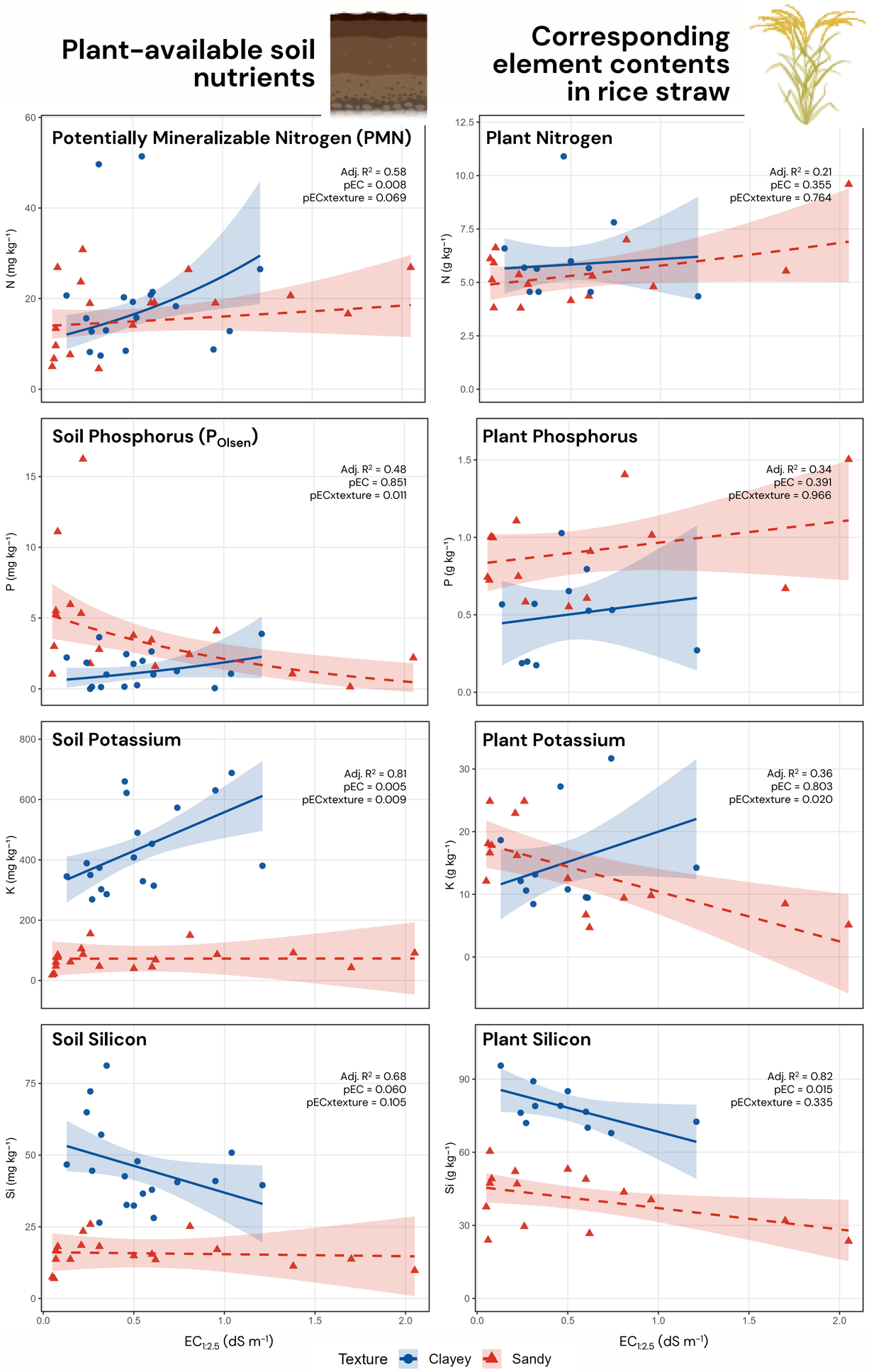
Transect	Profile	Horizon (cm)	Texture	pH	EC_e (dS m^{-1})	$SAR_{1:2.5}$	CCE (g kg^{-1})	TOC (g kg^{-1})
(A) Floodplains with clayey texture	Non-saline	0–20	HC	6.04	0.59	2.74	0.24	18.82
		20–45	HC	4.95	2.55	5.00	0.24	10.47
		45–75	HC	4.51	4.06	5.52	0.32	8.59
		75–100+	HC	4.39	4.59	6.34	0.27	3.48
	Salt-affected	0–15	C	6.04	1.89	11.02	0.24	23.28
		15–25	HC	6.31	2.98	16.61	0.24	11.36
		25–60	HC	6.91	6.66	26.59	0.24	6.07
		60–100+	SiC	6.80	15.32	31.84	0.32	1.34
(B) Interdunal wetlands with sandy texture	Non-saline	0–20	LS	6.44	2.76	1.50	0.49	0.88
		20–40	FS	6.71	4.13	0.86	0.50	2.19
		40–80+	FS	6.78	4.10	0.84	0.66	0.47
	Salt-affected	0–20	LS	6.19	20.36	16.41	1.40	10.70
		20–50	FS	7.10	100.13	33.21	0.66	0.65
		50–70+	FS	7.33	134.43	36.94	3.47	7.16

Methods. Semi-structured **farmer interviews**; **soil classification** according to WRB (2022); **soil texture**: pipette method, classified according to WRB; **pH** measured in a 1:2.5 soil:water extract; **EC_e**: electrical conductivity measured in a 1:2.5 soil:water extract and converted to saturated paste equivalent according to WRB; **$SAR_{1:2.5}$:** sodium adsorption ratio determined in a 1:2.5 soil:water extract, Na, Mg and Ca measured by ICP-OES; **CCE** (calcium carbonate equivalent) and **TOC** (total organic carbon) determined with a CNS analyser.

(2) SOIL NUTRIENT AVAILABILITY & PLANT UPTAKE

Plant-available soil nutrients

Corresponding element contents in rice straw



Methods soil analysis. All measurements were conducted on topsoil (0–20 cm) samples, n = 36; **PMN:** potentially mineralizable nitrogen via anaerobic incubation at 40°C for 7 days, NH_4^+ measured photometrically; **P_{Olsen}:** sum of the first two P-extraction steps of the Hedley fractionation, inorganic P measured photometrically; **K:** potassium exchangeable in 1 M NH_4OAc at pH 7 under inclusion of water-soluble K **Si:** silicon released via anaerobic incubation at 40°C for 7 days; K/Si measured by ICP-OES.

Methods plant analysis. Rice straw was collected directly at the corresponding soil sample spots and subsequently analysed for element contents, n = 30; **N:** determined with a CNS analyser; **P** and **K:** microwave-assisted acid digestion (H_2O_2/HNO_3); **Si:** microwave-assisted alkaline digestion (H_2O_2/NaOH); P/K/Si measured by ICP-OES.

Statistical analysis and creation of graphs: R. Icons: BioRender.com.

PRELIMINARY KEY FINDINGS AND IMPLICATIONS

- Salinity effects only proved statistically significant for **plant-available NPK** but not for Si; with differing trends, depending on texture and nutrient element.
- Significant salinity effects on **rice straw element content** was detected solely for K (diverging trends between texture classes) and Si (consistent negative trend).
- Straw element contents thus not consistently reflect plant-available nutrients in soil.
- Overall **low nutrient status** in investigated soils imply production constraints under persistently low fertilizer use, which is further aggravated by salinity.
- This is reflected by plant element contents consistently below **deficiency thresholds**.

Acknowledgements: The presented research was funded by the German Research Foundation (DFG), the Council for Tropical and Subtropical Agricultural Research (ATSAF e.V.), and the Polytechnic University of Madrid (UPM). We further thank the collaborating farmers, local authorities, and lab members.

EGU General Assembly
EGU26-10446