Spontaneous vegetation ("weeds") monitoring as key soil bio-indicators in mangrove rice production agroecologies in Guinea-Bissau

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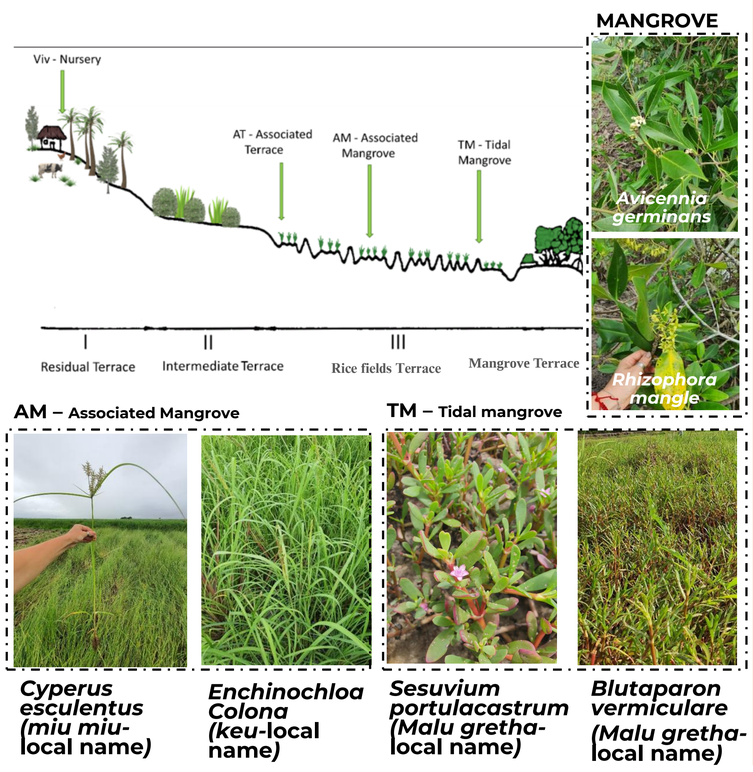
1 INTRODUCTION

- Rice cultivation is crucial for Guinea-Bissau small scale farmers
- Natural and well-preserved agroecologies without chemical fertilization
- Very low crop yields due to numerous challenges, **natural**: climate change, low soil fertility, water scarcity, pests & diseases, etc. **social-economic**: poverty, labour shortages, migration, etc.
- Plant biomass (weeds & rice stubs) and runoff flows are the principal organic matter and nutrient source
- Knowledge of nutrient flows through C & N isotopic signals is crucial for proper **soil management practices**.

2 METHODS AND ANALYSIS

A. Agro-ecological soil-weed characterization



*Cyperus esculentus (miu miu-*local name*)* | *Enchinochloa Colona (keu-*local name*)* | *Sesuvium portulacastrum (Malu gretha-*local name*)* | *Blutaparon vermiculare (Malu gretha-*local name*)*

B. Weed spatial distribution & Image processing

Phantom 4 multispectral Images 2022-2023
(for the studied transects)

Agisoft Metashape software processing

- Images Orthorectification
- Digital surface models-(DSM)
- RGB, NIR, RedEdge & Vegetation Indexes: **NDVI, SAVI, SR**

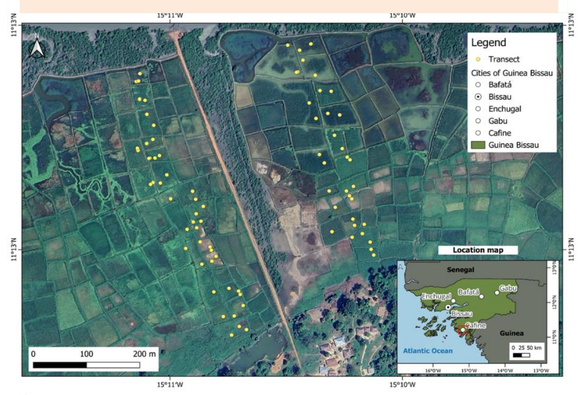
Random Forest Classification

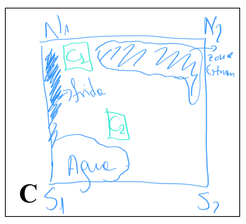
- Weeds (species of interest)
- Water
- Bare Soil
- others

Validation
In situ transect validation
Mavic 2 image

C. Transects

Weed species transect identification, distribution and abundance





A. Location of the Cafine village transects; B. Two points representing the validation grids for each plot; C. Field notes for each plot (July 2023).

D. Soil, water & weed isotopic signals

- **300 topsoil samples** (0-20 cm)
- **155 weed samples** (from both transects)
- **50 filtered water samples** (Particulate Organic Matter (POM), during
  - Rice sawing and transplantation
  - Rice flowering

Isotope measurements C, N, $\delta^{13}C$ & $\delta^{15}N$ topsoil and weed samples, & POM for water samples

Isotopic calculations

δ = (Rsample / Rstandard – 1) * 1000

Where: R= 13C/12C for $\delta^{13}C$ values

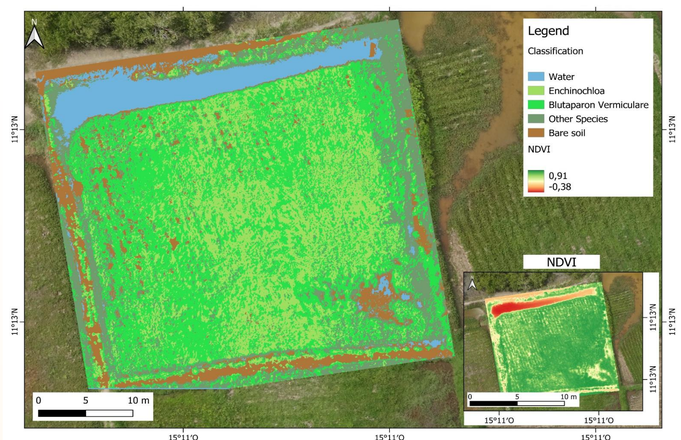
R= 15N/14N for $\delta^{15}N$ values

Mass spectrometer was used for the analyses, with standard for reporting carbon V-PDB (Vienna-PDB) and for nitrogen the atmospheric nitrogen (AIR).

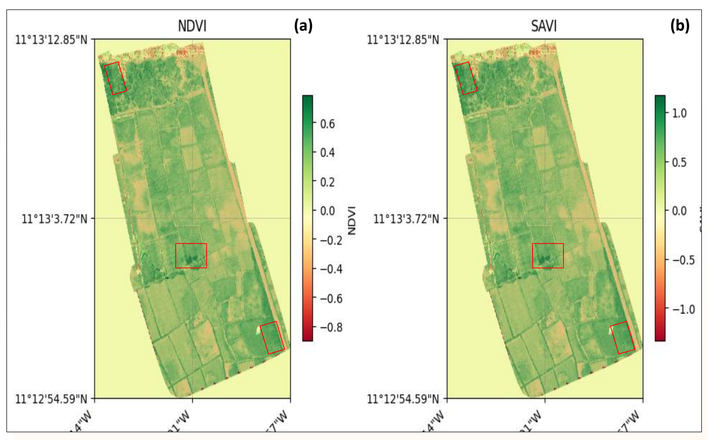
IACT- Stable Isotope Laboratory of the Instituto Andaluz de Ciencias de la Tierra (CSIC-UGR, Granada).

3 RESULTS AND CONCLUSIONS

A. Weed spatial distribution & abundance

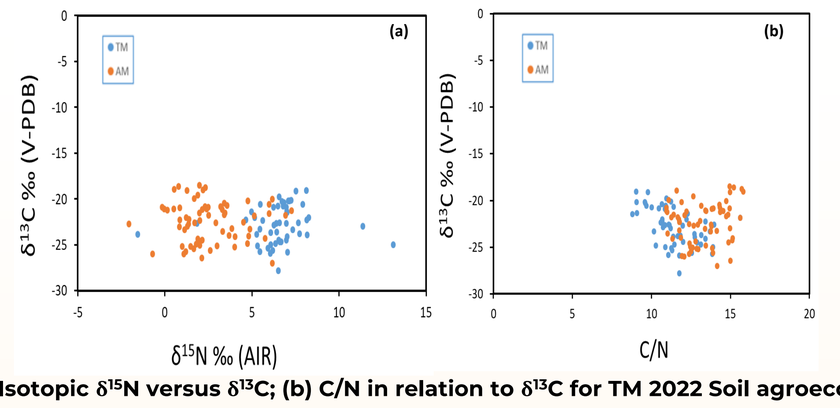


Plot 1 classification for main identified plant species; Ph-4 image taken the 24th July 2023.

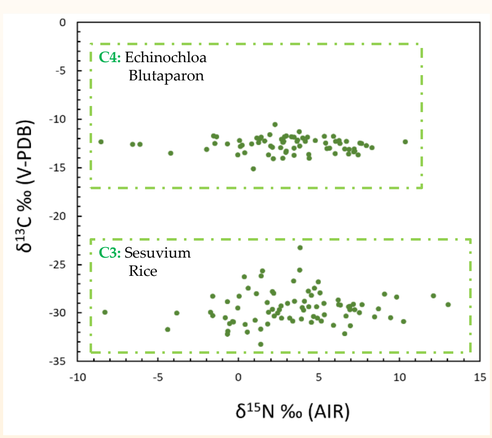


Overall classification of Transect 1 and surrounding fields in Cafine village – July 2023. The red rectangles highlight areas of very high vegetation density as detected by the a) NDVI and b) SAVI indices.

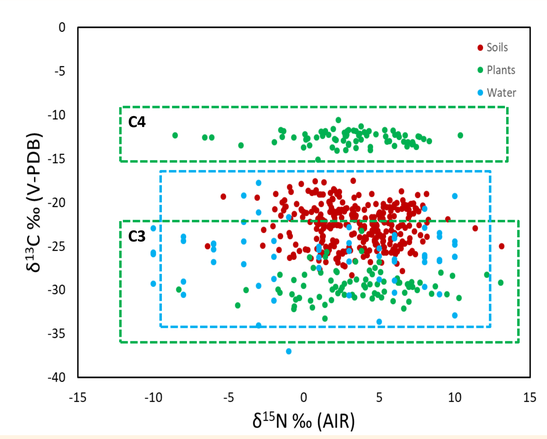
B. Soil – weed – water isotopic signals



(a) Isotopic $\delta^{15}N$ versus $\delta^{13}C$; (b) C/N in relation to $\delta^{13}C$ for TM 2022 Soil agroecologies.



Isotopic nitrogen $\delta^{15}N$ versus carbon $\delta^{13}C$ for weed soil samples showing clear isotopic distinction between the C3 and C4 weed plant species.



Nitrogen $\delta^{15}N$ and Carbon $\delta^{13}C$ isotopic signatures in soils (red), plants (green), and POM- (blue), including overall samples for 2022 and 2023.

- **Drone multispectral images** have a high capability to identify the most abundant weed species.
- **Human impact on isotopic signatures:** Long-term rice cultivation and flooding irrigation in Guinea-Bissau's mangrove systems have reinforced **$\delta^{13}C$** patterns typical of C_3 plants, showing how long-term ***farming practices*** shape soil organic matter, nutrient cycling, and ecosystem functioning.
- **Nitrogen cycling dynamics:** $\delta^{15}N$ values reveal clear differences across agroecologies — higher mineralization and microbial activity in TM soils versus more conservative nitrogen turnover in AM soils.
- **Towards sustainable management:** Combining science with local knowledge is vital for resilient rice production and food security in Guinea-Bissau.

Follow Malmon farming practices