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HS 5.2.1 Advances in Socio-Hydrology

Potential of sediment reuse for soil fertilization and water conservation in drylands

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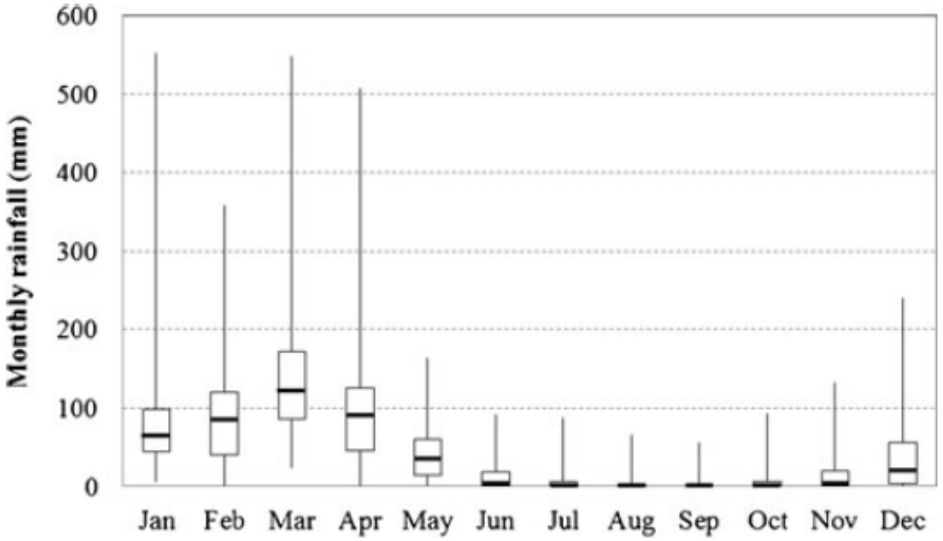
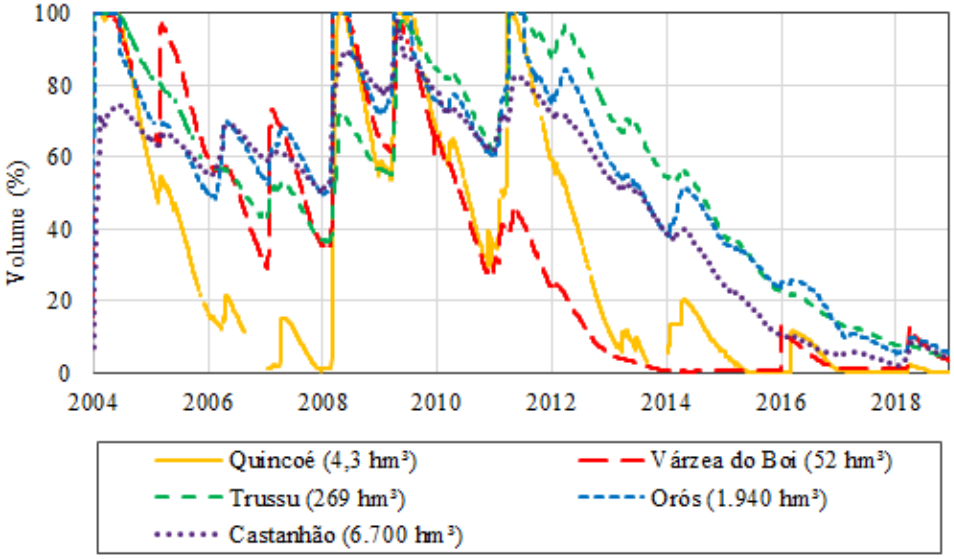
Potential of sediment reuse for soil fertilization and water conservation in drylands

Background

- Water supply in dry regions mostly relies on surface reservoirs
- In the semiarid northeast of Brazil, high temporal variability of rainfall and rivers' intermittency led to the implementation of a reservoir network
  - Over 20,000 dams in the 149,000 km² Ceará State
  - Temporal dynamics of reservoirs varies according to the scale
  - Strategic reservoirs (> 10 x 10^6 m³) supply cities, industries and large irrigation areas
  - Small non-strategic reservoirs supply rural communities



Source: Medeiros and de Araújo, 2014



Source: Nunes and Medeiros, submitted

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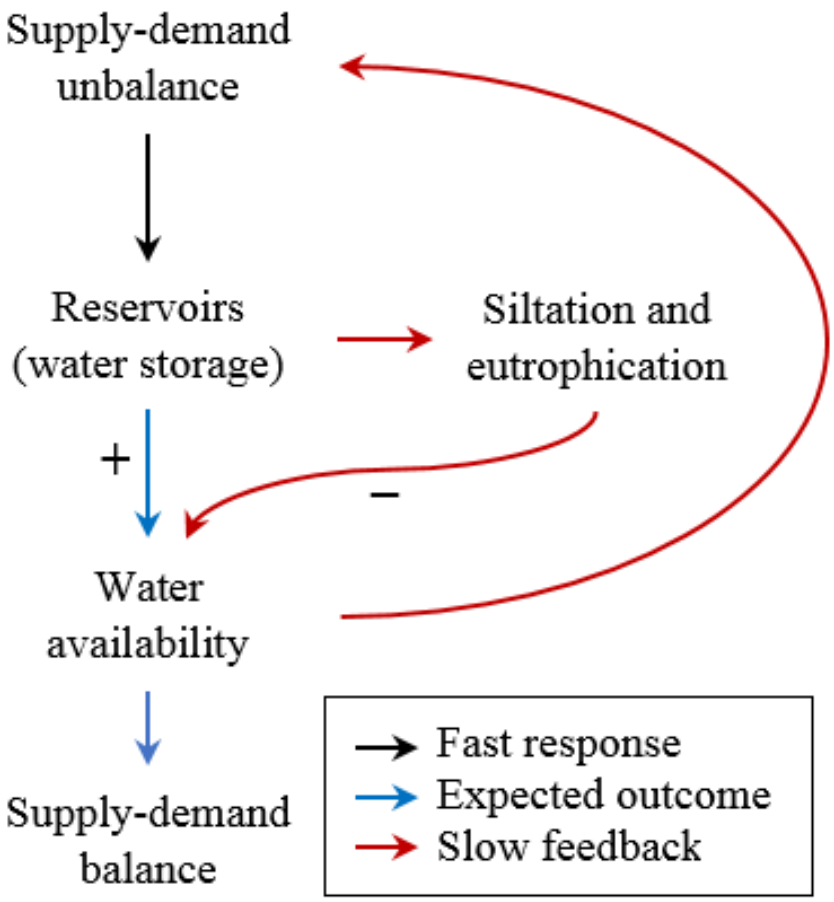
- Reservoir network generated unanticipated feedbacks, among which the “water quality effect”:
  - Increased water residence time
  - Sediment accumulation (reservoir siltation) → storage capacity and water yield reduction
  - Nutrient accumulation (reservoir eutrophication) → water unavailability due to bad quality

→ Sediment reuse as fertilizer proposed as a strategy to remove sediment (and the adsorbed nutrients) from reservoirs



Source: Medeiros and Sivapalan, accepted

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Expected outcomes from the sediment reuse practice

- Replacement of fine particles and nutrients to soils, previously lost by erosion
- Recovery of degraded lands, helping to prevent desertification
- Within-catchment fertilization, preventing the addition of external chemical fertilizers in agricultural fields, which has been pointed out as a major feature accelerating eutrophication
- Recovery of reservoirs' water storage capacity lost by siltation
- Removal of nutrients adsorbed to bed sediments, which represent a major source to the water column, thus helping to keep the water quality at more acceptable levels

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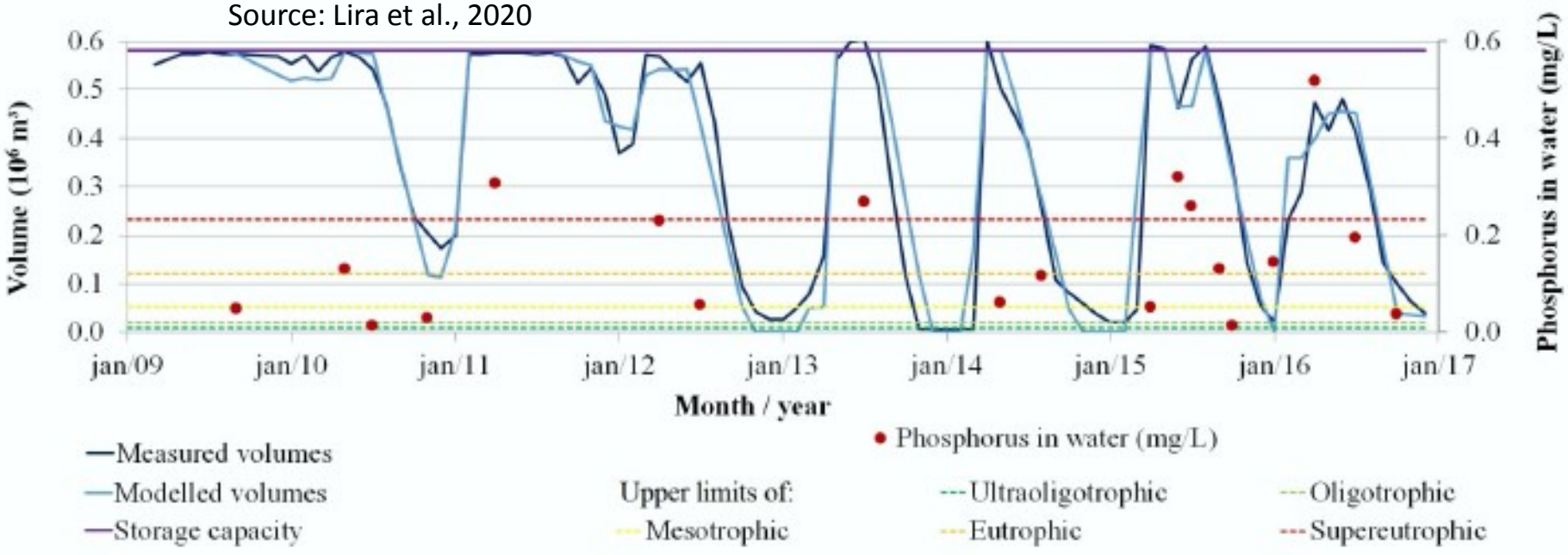
Experience with the sediment reuse practice in the semiarid of Brazil

- **Local features contribute to the adoption of the proposed technique:**

i. Small reservoirs fall dry frequently, exposing the sediments for excavation without the need for dredging

February 2015

Source: Lira et al., 2020



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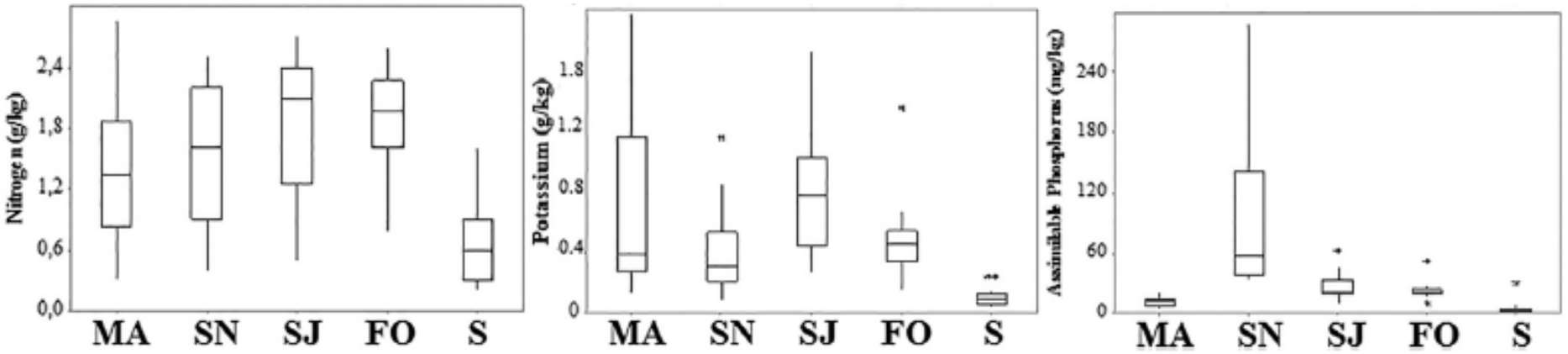
ii. In general, soils present nutritional deficit and, under natural conditions, crop production is limited to patches of fertile soils

iii. Small scale agriculture plays a major role for livelihood of the rural population

Source: Braga et al., 2019



MA, SN SJ and FO refer to reservoirs studied by us, S is for soils in the same region

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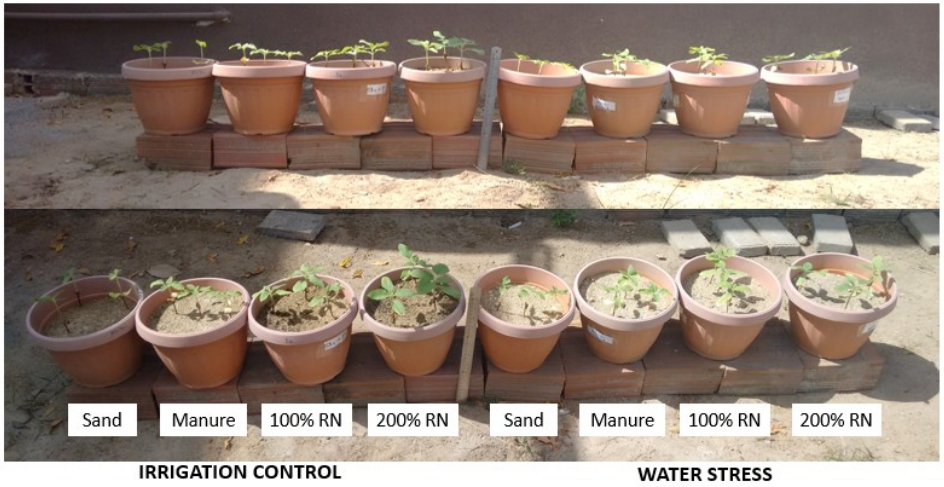
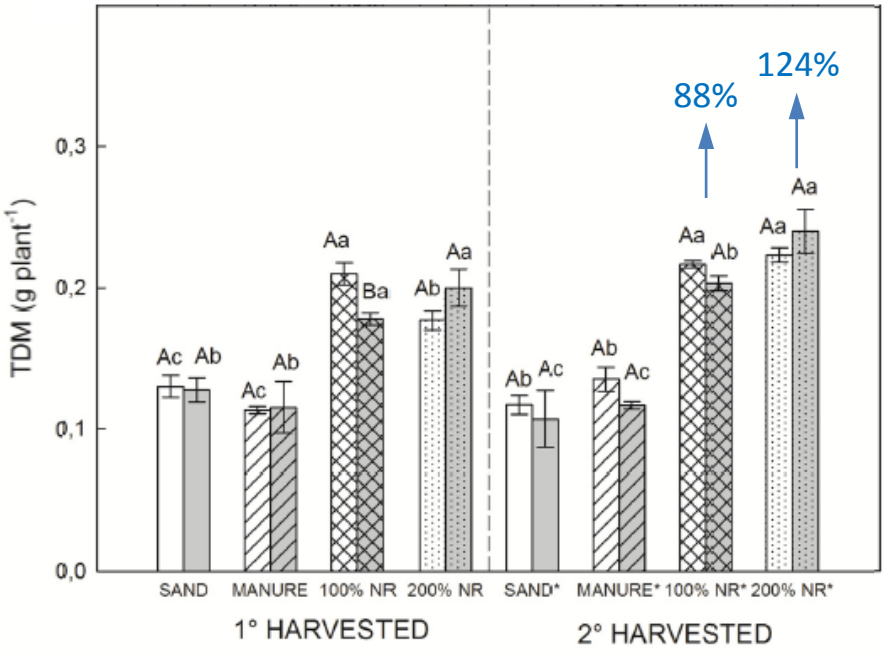
Potential of sediment reuse…

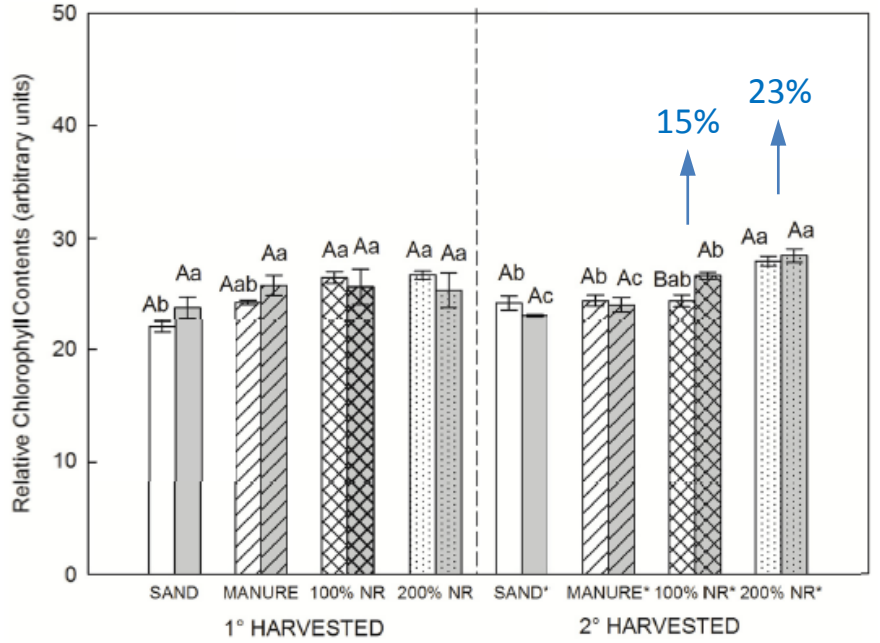
- **Recycling of nutrients from sediments is technically feasible:**

– Sunflower plants (BRS 323) cultivated under controlled conditions in a greenhouse

– Four treatments tested: 1) Sand;
2) Sand + manure;
3) Sand + sediment (100% of the nitrogen recommendation - NR);
4) Sand + sediment (200% NR)



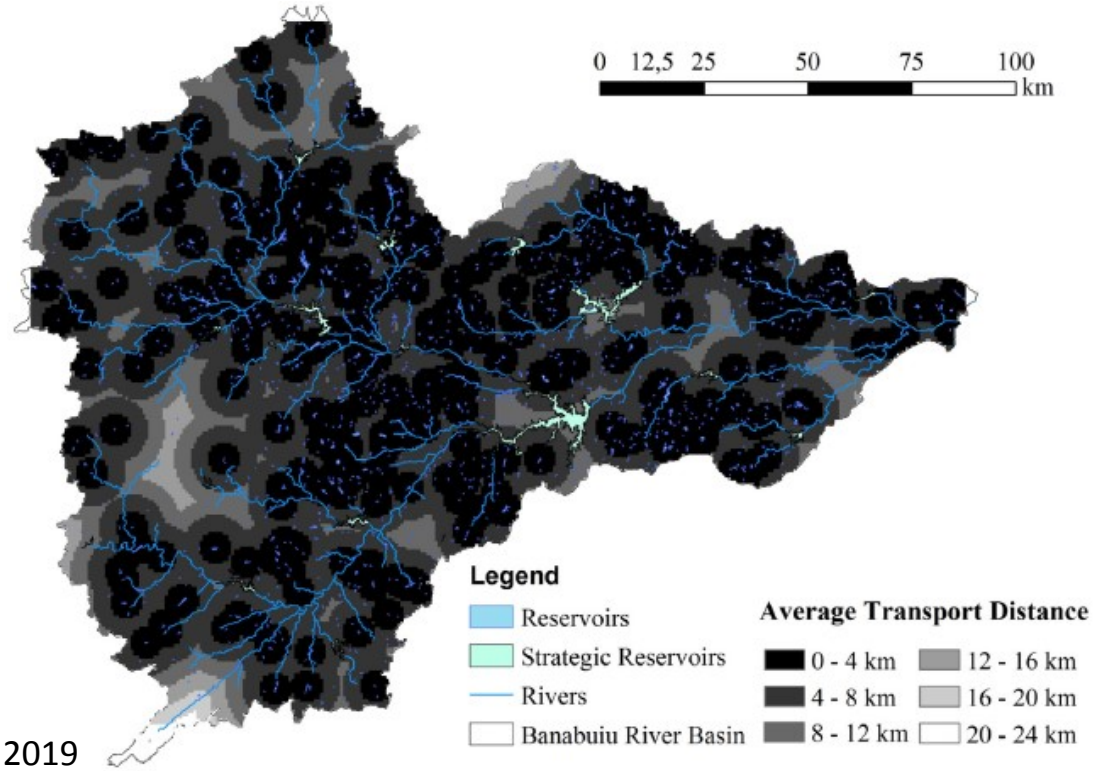




Source: Braga et al., 2017

Potential of sediment reuse for soil fertilization and water conservation in drylands

- **Sediment reuse is economically feasible:**
  - Completely emptying of reservoirs allow sediment removal by excavation
  - High density of reservoirs results in short transport distances
  - Costs of sediment recycling are compatible with traditional fertilization, and savings can reach up to 29 % in some specific cases



Source: Braga et al., 2019

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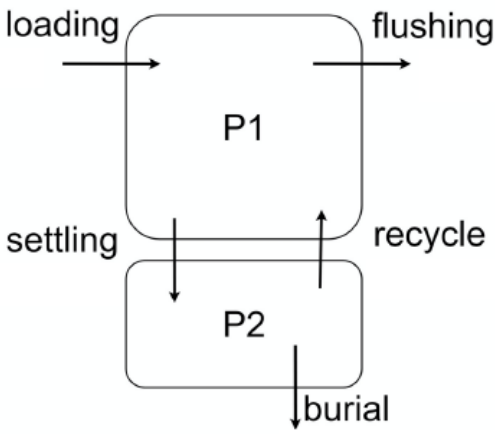
- **Removal of sediment from reservoirs may improve the water quality:**
  - Complete mixing model of total phosphorus budget, with interactions of water and sediment
  - Simulation of the Tijuquinha reservoir (1 x 10^6 m^3)
  - Sediment management may improve water quality – table presents the results for Scenario 1, with annual sediment removal



Trophic state	% of total time		% of time for non-zero volumes	
	No sediment management	Scenario 1	No sediment management	Scenario 1
Empty reservoir	35.6	35.6	0	0
Ultraoligotrophic	0.2	3.1	0.3	4.8
Oligtrophic	1.8	4.3	2.8	6.7
Mesotrophic	6.5	7.5	10.1	11.7
Eutrophic	14.6	9.6	22.7	14.9
Supereutrophic	24.2	24.2	37.6	37.6
Hypereutrophic	17.1	15.7	26.5	24.3

Source:
Lira et al., 2020

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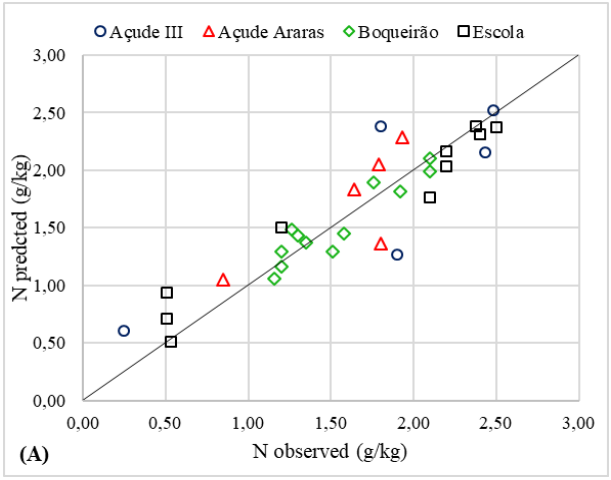
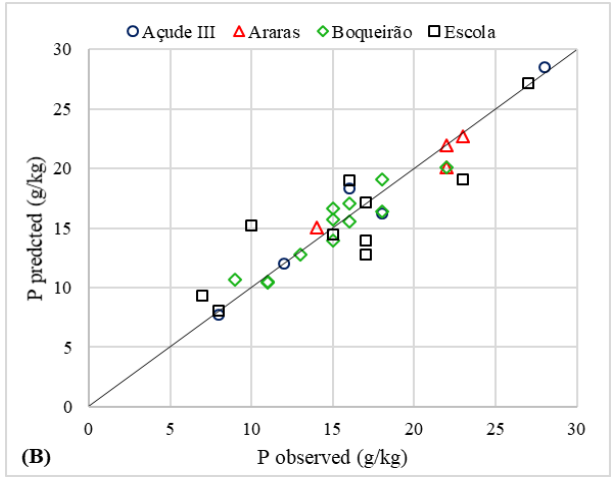
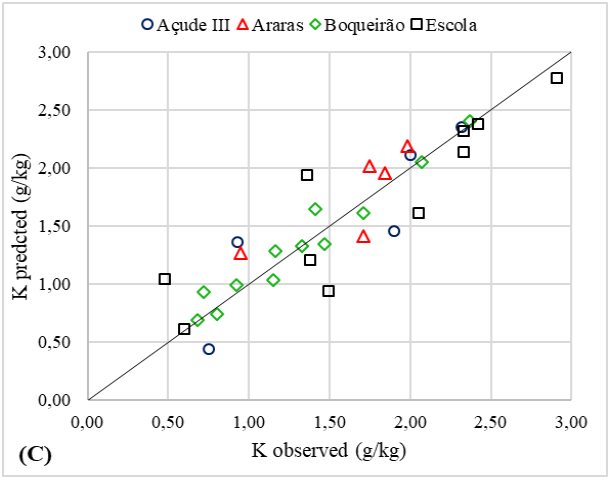
Ongoing sediment characterization by spectroscopy

- Sediment samples collected in ten reservoirs analysed for physicochemical properties and the spectra
- Spectroscopy associated to multivariate analysis is promising to support sediment characterization, especially for finer spatial scales (graphs for reservoirs < 0.10 km²)
- Reduction of the costly and time-consuming laboratory analysis helps to promote the sediment reuse
- Intermediate step for future satellite application

Source: Carvalho et al., in preparation







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CAPES

DAAD

Thank you.

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