Influence of Wetland Vegetation on Stability of Accreted Phosphorus in the Everglades Stormwater Treatment Areas

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1 Introduction

Treatment wetlands are utilized globally to reduce the amount of nutrients discharged into downstream water bodies. Sustainability of these wetlands depend on accumulation of stable (non-reactive) forms of retained nutrients. Storage of such stable pools of nutrients is influenced by a range of environmental factors such as hydrology, temperature, vegetation and nutrient loading. Our focus was to characterize phosphorus (P) retained by treatment wetlands in the Everglades Agricultural Area Basin. Six stormwater treatment areas (STAs) with a combined foot print of approximately 18,000 ha are currently operational in south Florida. To date, these six STAs have removed over 1,400 metric tons of P from agricultural and surface runoff (Ivanoff *et al.*, SFER, 2012).

We examined the influence of different vegetation on stability of accreted P in soils of selected cells of STA-1W and STA-2 (Fig 1). STAs are divided into emergent aquatic vegetation (EAV) cells and submerged aquatic vegetation (SAV) cells based on dominant vegetation species.

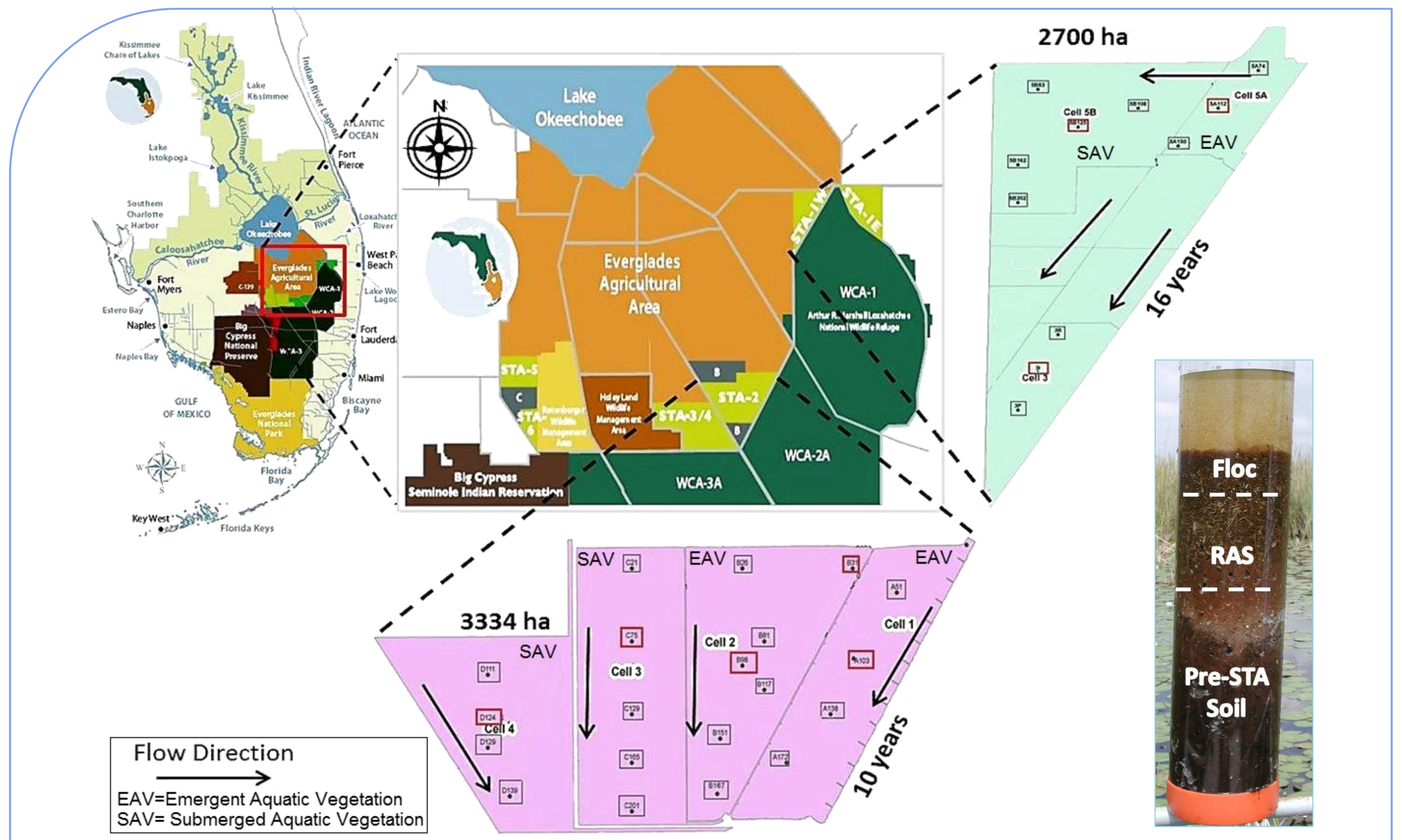

Fig 1 a). Location of STAs and soil sampling sites. Field replicate sites shown in red boxes. **b)**Typical soil cores with floc, RAS and pre-STA soil sections.

2 Objectives

- Determine relative proportion of reactive and stable P pools in floc, recently accreted soils (RAS) and pre-STA soils.
- Explore relationship between dominant vegetation (EAV or SAV) and long-term stability of P in floc and soil fractions.

3 Experimental Approach

- Intact soil cores were collected from STA-1W (n=17) and STA-2 (n=27) along transects parallel to water flow direction. Soil cores (20-30 cm depth) were divided into floc, RAS, and pre-STA soils.
- Samples were oven-dried at 70°C prior to lab analysis. Moisture content, bulk density, total P (TP), total carbon (TC), total nitrogen (TN) were determined.

3 Experimental Approach

- Inorganic (Pi), organic (Po), and residual P pools were measured using simplified chemical fractionation scheme (Fig 2). HCl (1M) fraction was analyzed for labile Pi and metals (Fe, Al, Ca and Mg).
- All comparisons were carried out using student's t test assuming equal variances (P< 0.05). The distribution of reactive (extractable Po + Pi) and highly stable (residual P) forms in floc, RAS and pre-STA soils were explored for EAV and SAV cells.

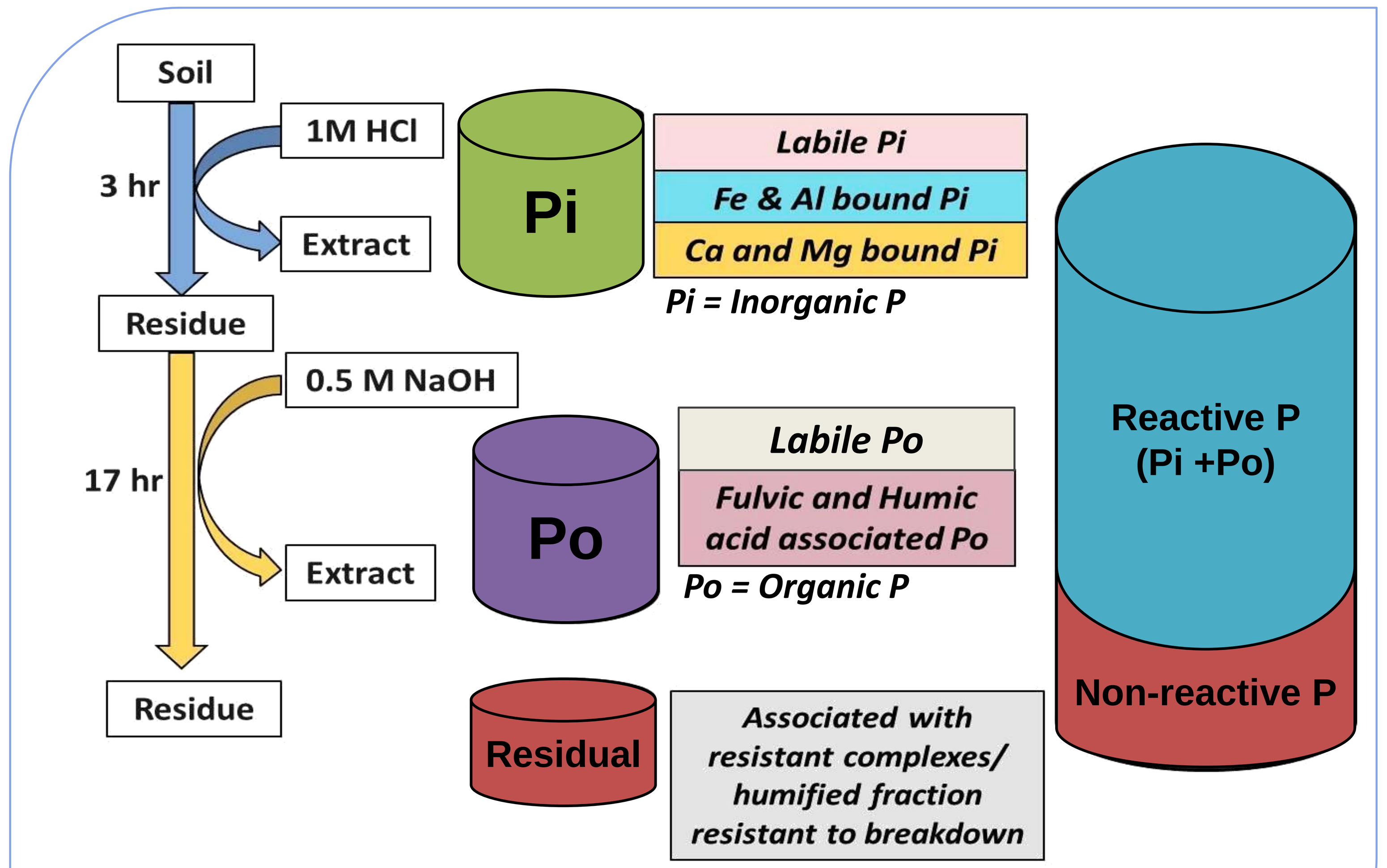

Fig 2. Chemical fractionation scheme used to determine reactive and non-reactive P pools in floc and soil samples. (Modified from Ivanoff *et al.*,1998, Soil Sci. 163:36-45.)

4 Results

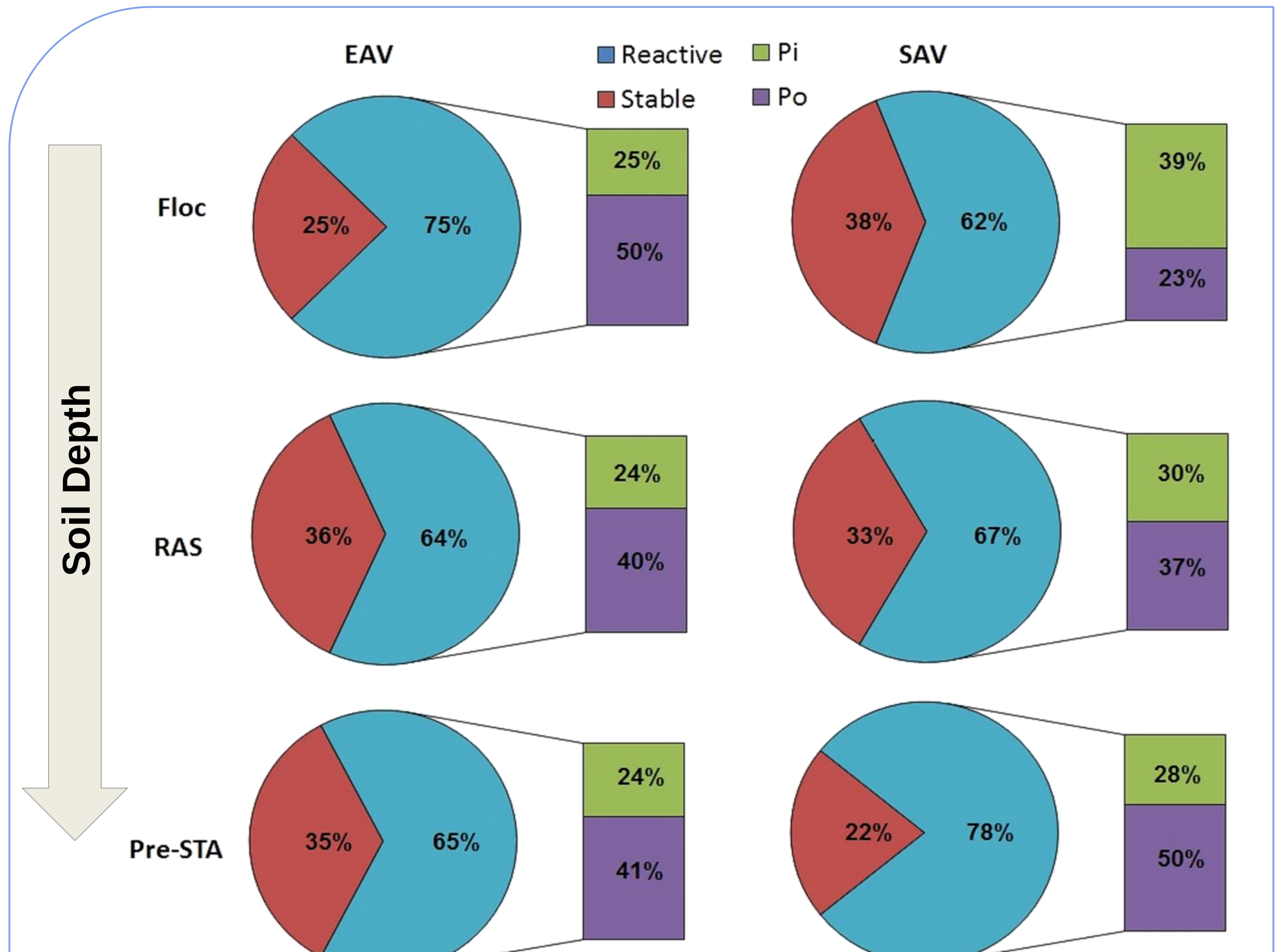

Fig 4. Non-reactive and reactive phosphorus pools (%) in EAV and SAV cells in floc, RAS and pre-STA soils of STA-1W and STA-2.

4 Results

EAV						SAV					
	Bulk density	LOI	TP	Ca	Mg		Bulk density	LOI	TP	Ca	Mg
	g cm^{-3}	%	mg kg^{-1}	g kg^{-1}	g kg^{-1}		g cm^{-3}	%	mg kg^{-1}	g kg^{-1}	g kg^{-1}
Floc (n=23)	0.14	76	1082	40	2.8	Floc (n=14)	0.21	47	845	164	4.8
RAS (n=26)	0.26	84	467	37	3.3	RAS (n=20)	0.32	74	579	78	4.6
Pre-STA (n=24)	0.30	88	244	29	2.8	Pre-STA (n=20)	0.35	79	335	34	2.7

Table 1. Soil physico-chemical characteristics in floc, RAS and pre-STA soil sections for EAV and SAV cells of STA-1W and STA-2.

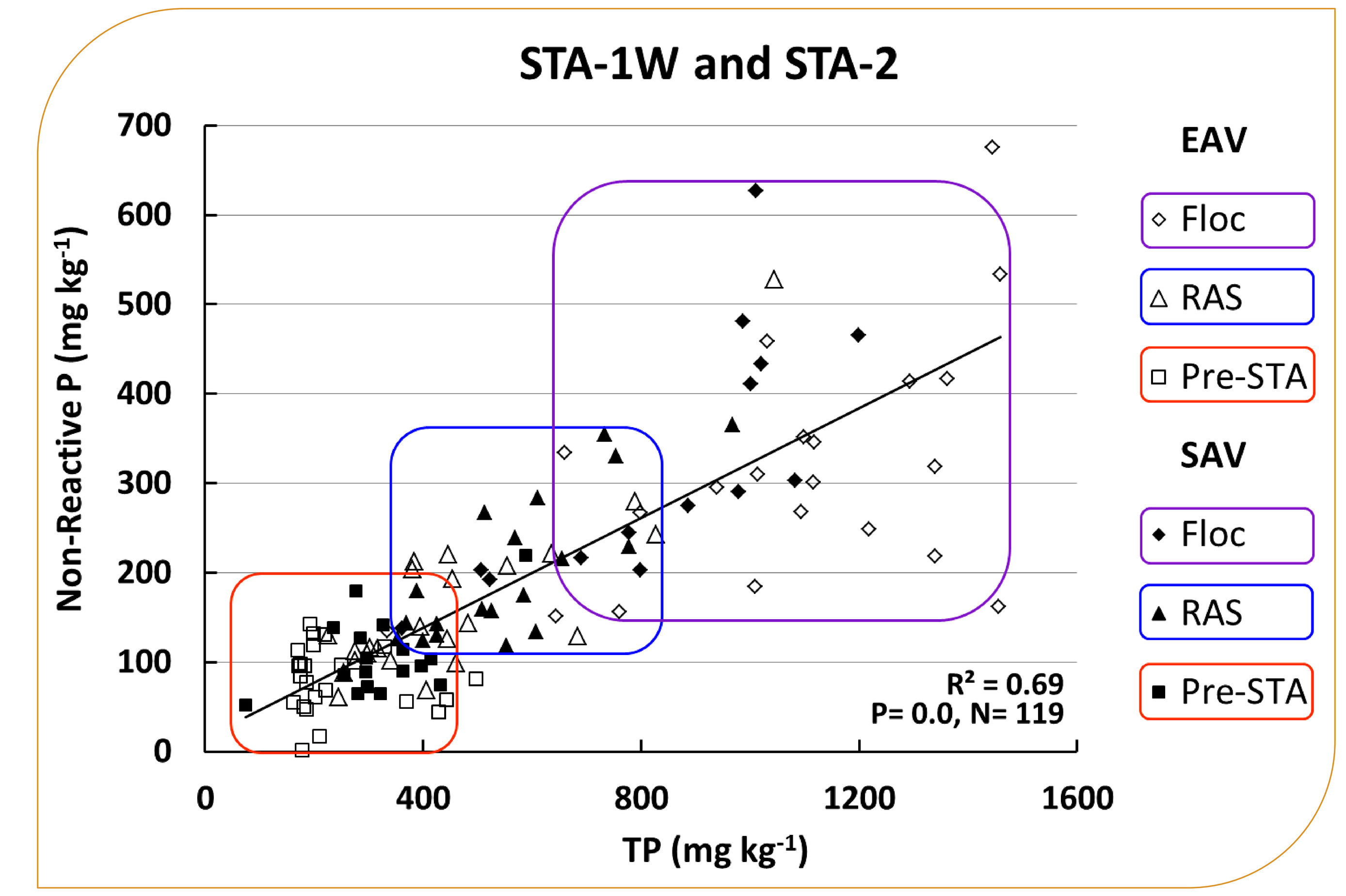

Fig 5. Non-reactive phosphorus (stable P) as a fraction of total phosphorus in floc, RAS and pre-STA soils of STA-1W and STA-2.

5 Conclusions

- The SAV and EAV cells did not differ significantly in relative proportion of reactive and stable (non-reactive) P pools.
- Floc, RAS, and pre-STA soil showed some difference in P pools, but no significant difference were observed between reactive and non-reactive pools.
- Accretion of Ca-rich marl layer in SAV cells suggest Ca-P co-precipitation as one of the pathways contributing to P uptake within the cell.
- Organic P pool is subject to mineralization in EAV cells particularly during periods of dry out, and therefore could potentially contribute to internal P loading in the STAs.
- High proportion of reactive P in STAs soils suggests a need for management strategies to help minimize potential P release from soil to the water column due to changes in environmental factors.
- Further research is needed to identify means to promote retention and storage of stable (non-reactive) pools of P.

6 Acknowledgements

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