Accretion and long-term storage of phosphorus in the stormwater treatment areas of the Everglades basin.

R Bhomia*[,1], P W Inglett[1], K R Reddy[1] and D Ivanoff[2]

[1] Wetland Biogeochemistry Laboratory, Soil and Water Science Department, University of Florida

[2] South Florida Water Management District, West Palm Beach, FL

Introduction

- Stormwater Treatment Areas (STAs) are strategically located to reduce phosphorus loads to the Everglades Protection Area (EPA).
- The six STAs cover approximately 18,000 ha and are managed by the South Florida Water Management District (SFWMD) (**Fig 1.**).
- The STAs have been in operation for varying time periods ranging from 6 to 16 years and are subdivided into cells having emergent and submerged aquatic vegetation.
- Soils serve as long term integrators of stored nutrients – phosphorus (P), nitrogen (N) and carbon (C).

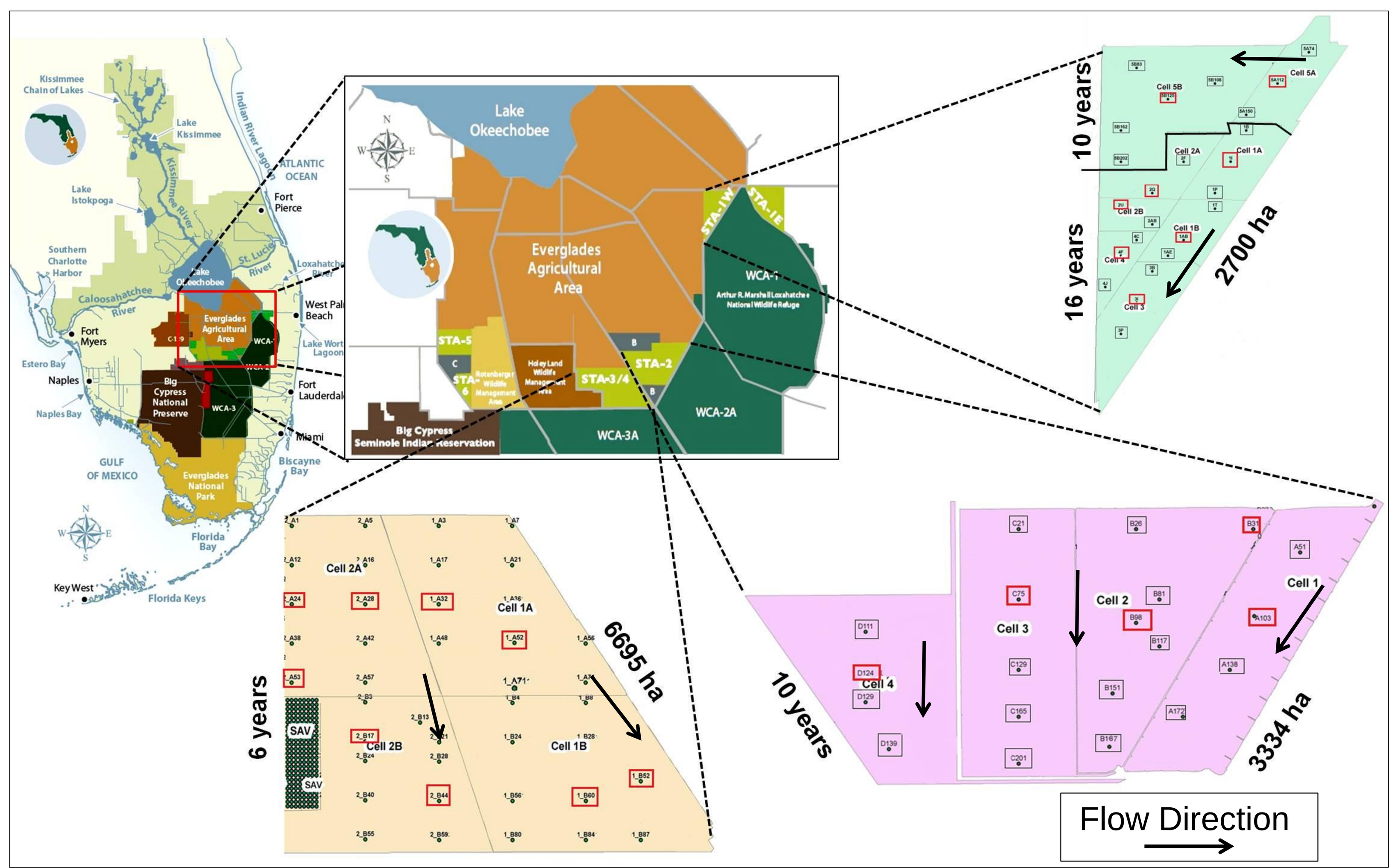

Fig 1. Location of STAs and sampling sites. Red boxes indicate field replicate sites in each transect (Base map: SFWMD).

Hypotheses

- The soil physico-chemical properties and isotopic signatures of $\delta^{13}C$ and $\delta^{15}N$ along the depth profile should enable differentiation between newly accreted material and native peat.
- Rate of soil accretion tends to decrease as these systems age.
- Decrease in soil accretion rate could potentially have a negative impact on outflow water quality.
- Stratigraphic (temporal) changes in soil P fractions in the soil profile are preserved and could indicate the stability of P over time.

Methods

- Intact soil cores from STA-1W, STA-2 and STA-3/4 were collected along transects parallel to the flow direction.
- Soil cores ranged from 20 - 40 cm depth and were sectioned at 2 cm intervals. Soil was oven dried at 70°C prior to lab analysis.
- Bulk density, total P, total C, total N were determined for each soil core. Selective cores were analyzed for $\delta^{13}C$ and $\delta^{15}N$ isotopic ratios.
- Change point depth was considered as the boundary between recently accreted soil (RAS) and pre-STA soil (**Fig 2.**).

Experimental Approach

- A software program SegReg[3] was used for determining change points by applying segmented linear regression to (x, y) data that do not have a linear relationship (**Fig 3.**).
- After determining boundary between RAS and pre-STA soil, new soil cores were collected from same sites from STA-1W and STA-2 (**Fig 4. and Fig 5.**).
- Soil cores were divided into 3 sections – floc, RAS and pre-STA soil.
- Soil nutrients and physico-chemical characteristics were determined on these samples.
- Modified P fractionation scheme was employed to determine inorganic P (Pi), organic P (Po) and residual P fractions in each section.
- Residual P constituted stable (recalcitrant) P pool while Pi and Po together constituted reactive (labile) P.
- Analysis was performed to find vegetation treatment effects on P partitioning between stable and reactive pools in floc and RAS sections (**Fig 6.**).

[3]http://www.waterlog.info/segreg.htm

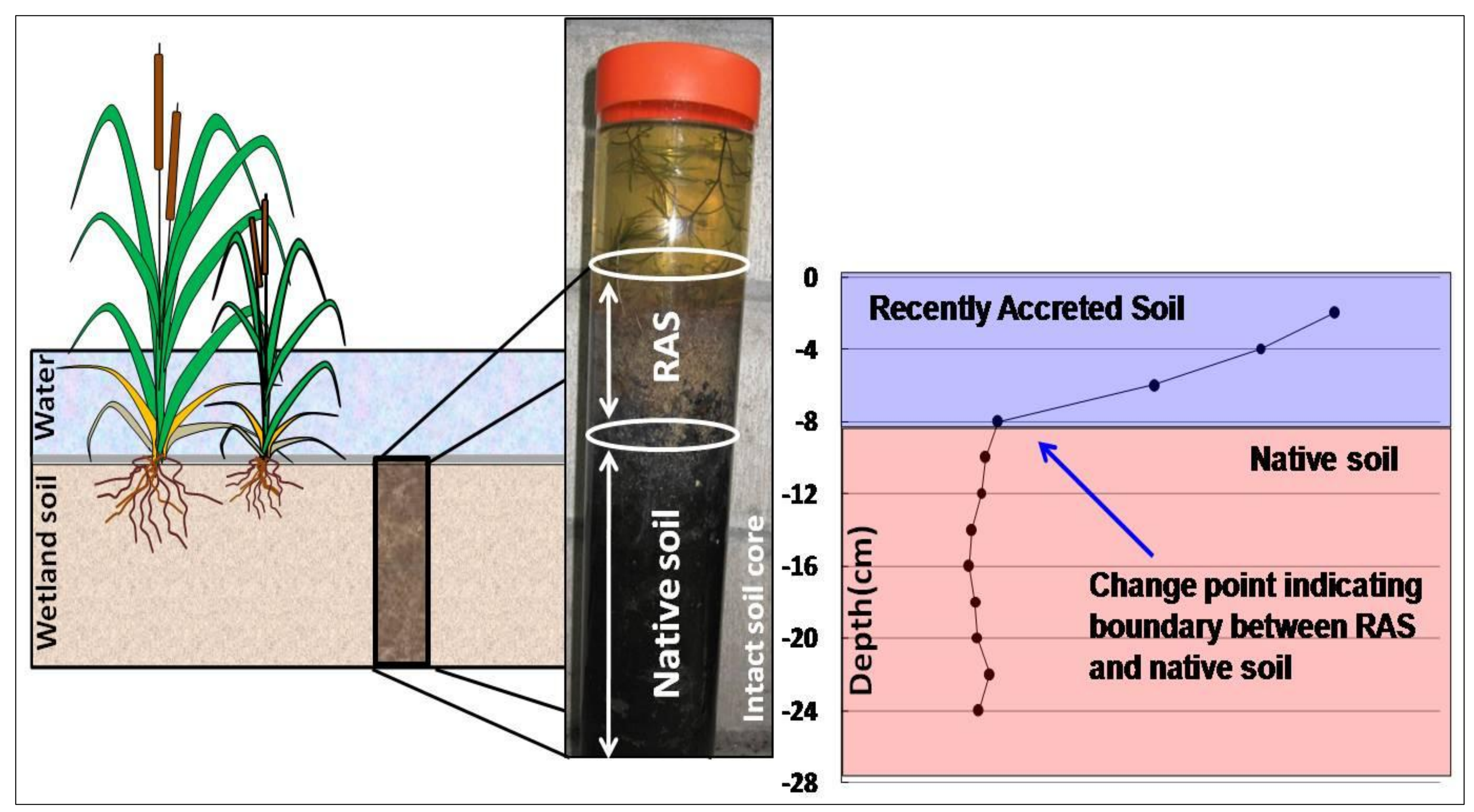

Fig 2. Determination of the boundary between RAS and pre-STA utilizing soil profile physico-chemical characterizations.

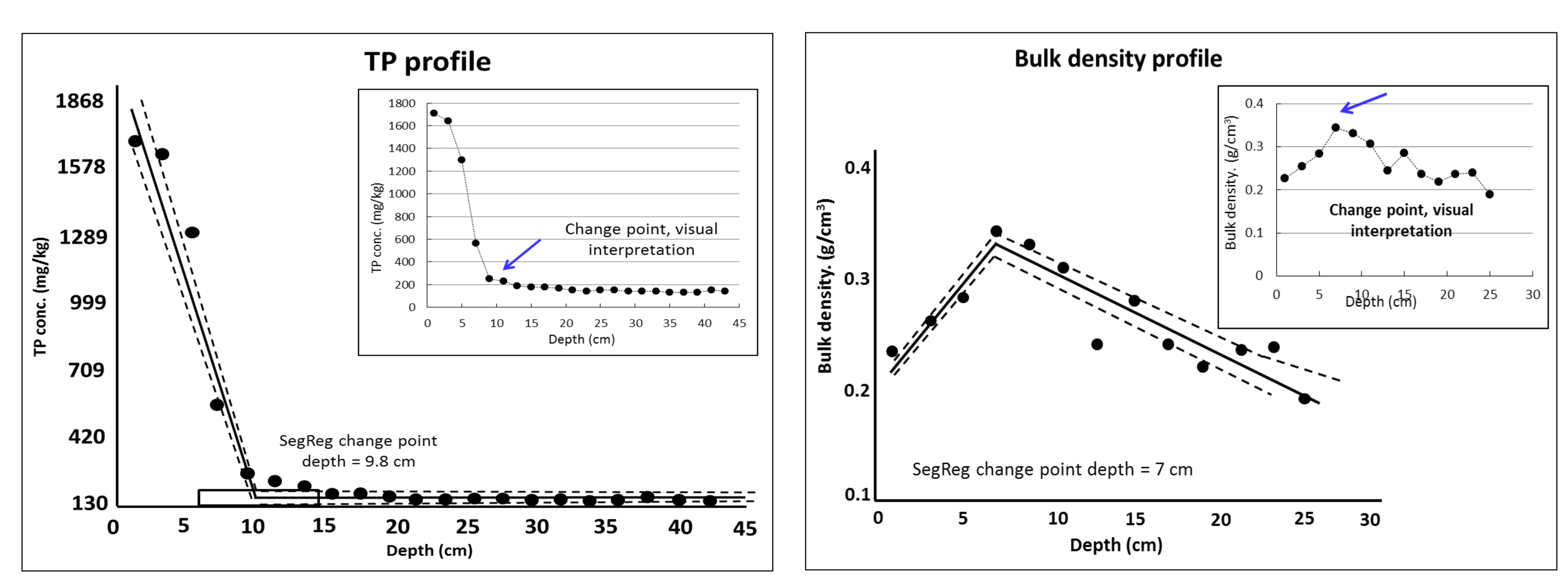

Fig 3. SegReg outputs for different soil variables from different soil cores.

Acknowledgements

This study was funded by the SFWMD and the Everglades Foundation. Ms Yu Wang and Gavin Wilson provided the necessary training for various lab analysis. Dr. Kathryn Curtis helped with isotopic ratio mass spectroscopy (IRMS) analysis.

*Contact: rbhomia@ufl.edu

Results

Recently accreted soil depth and accretion over time

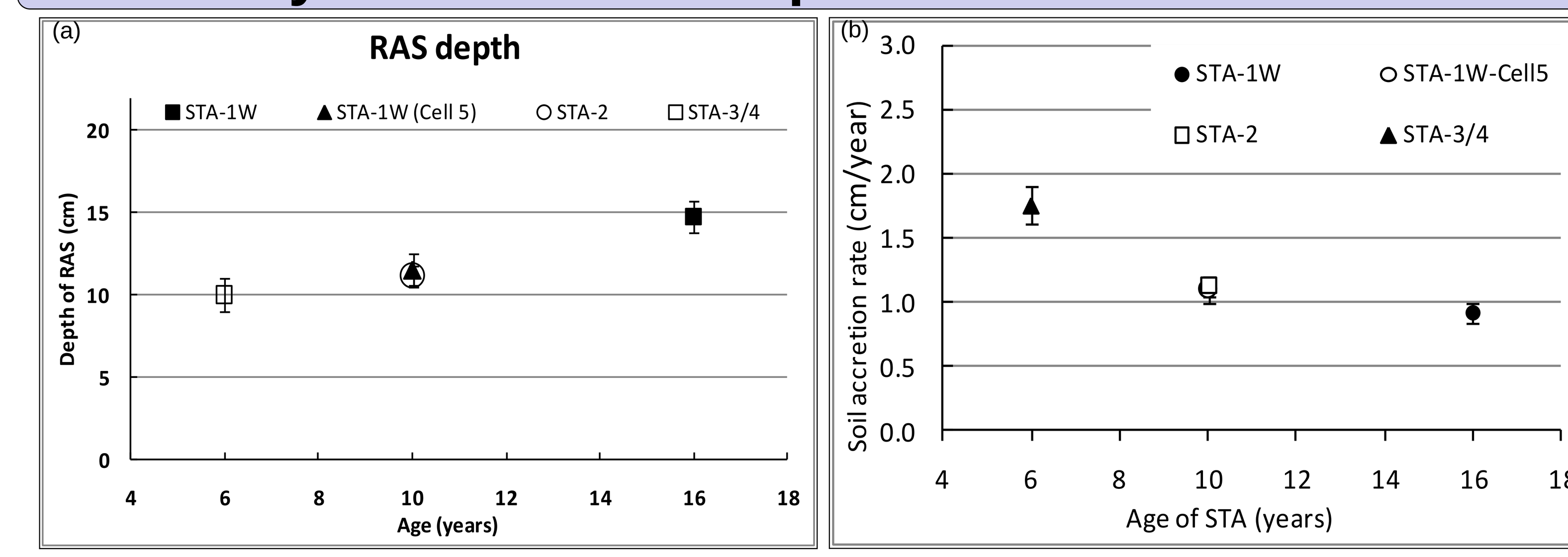

Fig 4. (a)Mean depth of RAS in each STA estimated using four parameters. (b) Change in soil (cm/year).

Phosphorus accretion and water quality impacts

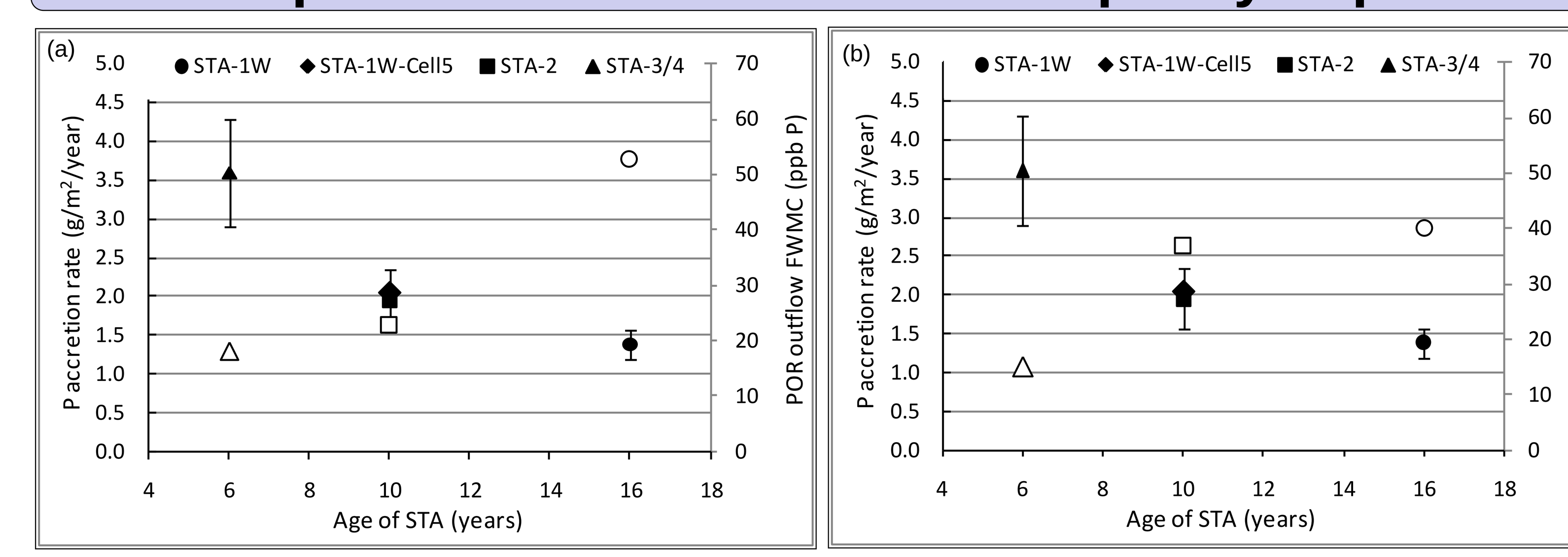

Fig 5. Comparison of RAS depth with (a) period of record mean outflow P conc.(ppb P). & (b) water year 2010 mean outflow P concentration (ppb P).

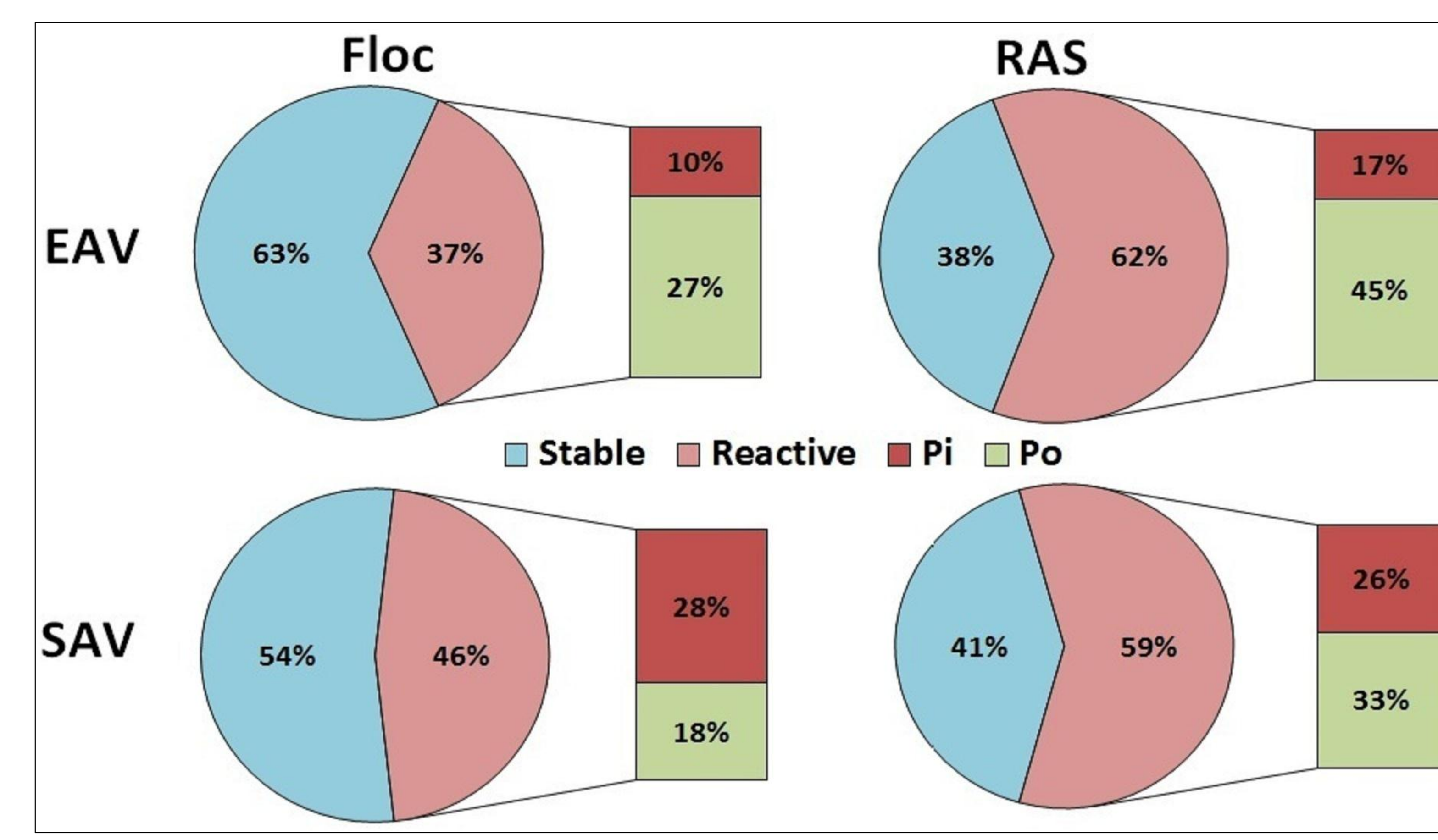

Fig 6. Relative distribution of stable and reactive P forms across the cells of STA-1W and STA-2.

Conclusions

- The RAS depth was proportional to the operational history of STA.
- Mean soil accretion rate across these STAs ranged from 1.0 -1.8 cm/yr.
- Mean P accretion rate across these STAs were 1.4 - 3.6 g P /m² yr.
- Soil and P accretion rate suggests decreasing trend over time, and may potentially be responsible for negative water quality impacts.
- Stable P forms were predominant in floc fractions in comparison to RAS but no significant difference were found between vegetation treatment.