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Introduction

Agricultural and hydrologic modifications continue to have consequences for the Everglades ecosystem. Phosphorus (P) enrichment has accumulated in the soils of different hydrologic units of the Everglades. The canals that drain these units receive P loads which can lead to the generation of legacy P in canals, with consequences for downstream ecosystems.

Objective

To determine the interactions that affect phosphorus dynamics in a given reach of an agriculturally impacted Everglades canal by a mass balance approach using STELLA® iconographic software

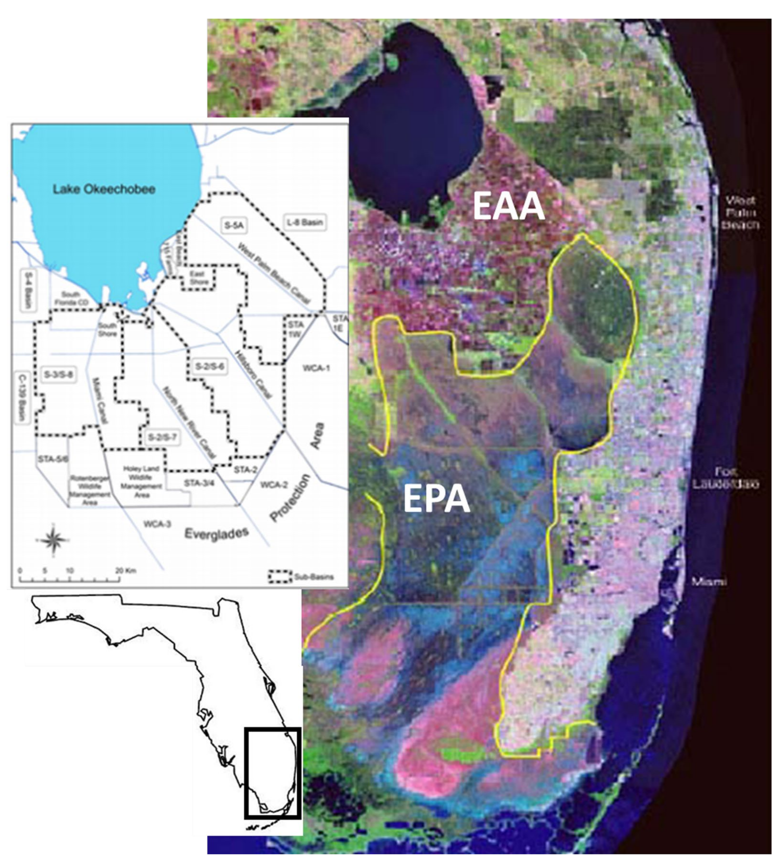


Figure 1: Right map shows the Everglades Ecosystem with the main drainage canals (green lines)indicating high phosphorus loads that are discharged into the Everglades Protected Area (EPA). Top left map shows the Everglades Agricultural Area(EAA) with the canals that drain the unit.

Methodology

Conceptual model and processes

- The conceptual model will constitute P stores within two main compartments: water column and sediments
- The processes governing the rates of mass change of phosphorus between stores will be described by first order kinetics and expressed as parameters in equations

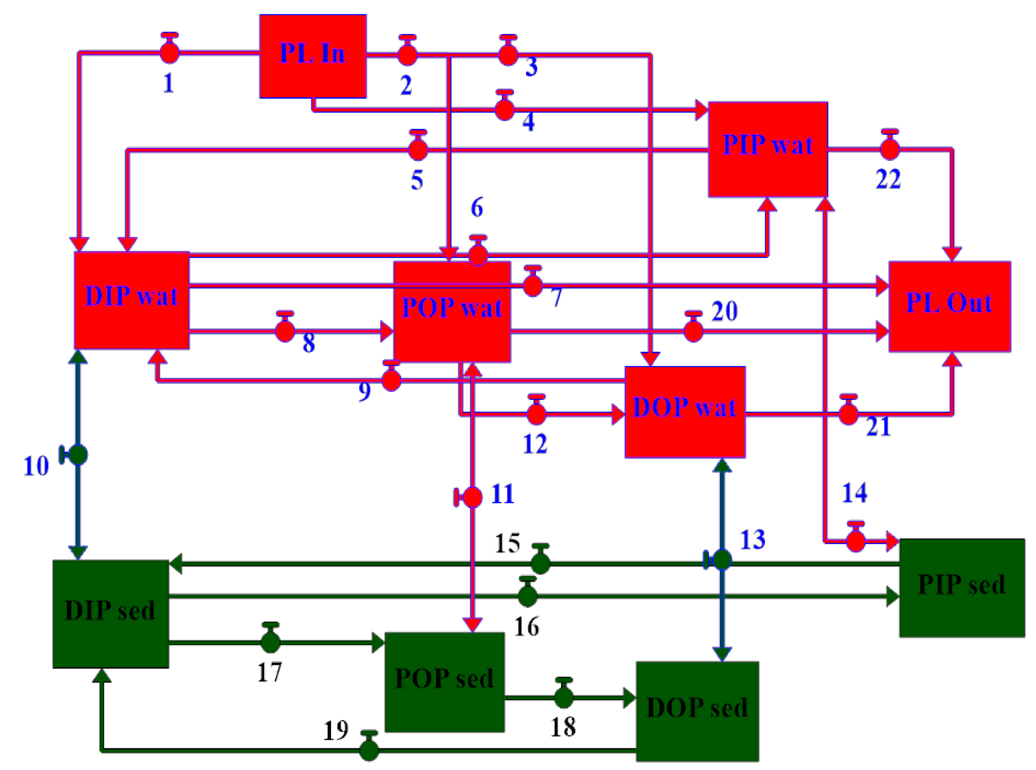


Figure 2: Conceptual Canal Phosphorus Dynamics Model in STELLA ®

1,2,3,4 = TP mass load in	8, 17 = Biotic uptake	11, 14 = Settling/ resuspension
5, 15 = Desorption/ Dissolution	9, 19 = Hydrolysis	12, 18 = Decomposition
6, 16 = Adsorption/ Precipitation	10, 13 = Diffusive Flux	7, 20, 21, 22 = TP mass load out

Table 1: Numeric representation

Stores (Water and Sediment)	Processes	Equation
Dissolved Inorganic Phosphorus (DIP), Dissolved Organic Phosphorus (DOP)	Diffusive flux	Fick's law $dS/dt = D(C1- C2)/dx$
Dissolved Inorganic Phosphorus (DIP) to Particulate Organic Phosphorus (POP)	Biotic uptake	Michaelis-Menten $dS/dt = K_m S/(K_s + S)$
Particulate Organic Phosphorus (POP), Dissolved Organic Phosphorus (DOP) to Dissolved Inorganic Phosphorus (DIP)	Decomposition, Hydrolysis	Exponential decay $C = C_o e^{-kt}$
Dissolved Inorganic Phosphorus (DIP), Particulate Inorganic Phosphorus (PIP)	Adsorption, Desorption	Linear Adsorption isotherm $x/m = k_d C_f$
Particulate Inorganic Phosphorus (PIP), Particulate Organic Phosphorus (POP)	Entrainment	a function of shear velocity
	Settling	Terminal settling velocity using Stoke's law

Table 2: Phosphorus stores and process equations

Model assumptions, calibration and validation

- Units of g P m^{-2} d^{-1} will be selected for P transformation and transport and g P m^{-2} for storages
- Simulations will be based on literature values on P studies carried out on EAA canals, and unavailable data either supplemented with values from similar studies in rivers and wetlands, or assumed
- The model will be validated by comparing simulated outputs with available water and phosphorus empirical data
- Statistics such as root mean square error will be used for error analysis

Expected Results

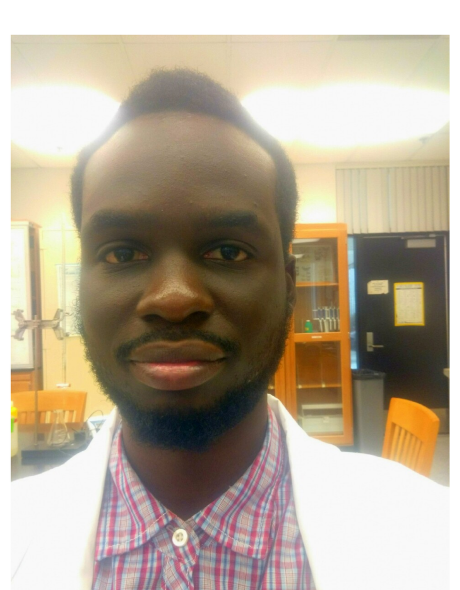
- Model simulations will determine the general relationships that affect fate and transport of agriculturally impacted canals.
- Input parameter values not available from EAA canals will reveal knowledge gaps and highlight research needs
- Since a mass balance approach is being utilized, the model will be able to quantify the mass of internally generated P within the canal and predict the time it will take such legacy P contribution to diminish
- Sensitivity analysis of model parameters will identify the dominant stores and processes influencing P retention and export. This will provide insight into the development of effective remediation strategies to remove target phosphorus species from such canals

References

Martin, J. F., & Reddy, K. R. (1997). Interaction and spatial distribution of wetland nitrogen processes. *Ecological Modelling*, *105*(1), 1-21.

Reddy, K. R., Newman, S., Osborne, T. Z., White, J. R., & Fitz, H. C. (2011). Phosphorous cycling in the greater Everglades ecosystem: legacy phosphorous implications for management and restoration. Critical Reviews in Environmental Science and Technology, 41(S1), 149-186.

Wade, A. J., Whitehead, P. G., & Butterfield, D. (2002). The Integrated Catchments model of Phosphorus dynamics (INCA-P), a new approach for multiple source assessment in heterogeneous river systems: model structure and equations. Hydrology and Earth System Sciences Discussions, 6(3), 583-606.



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