Spatial Distribution of Phosphorus in the Kissimmee River Floodplain Soils and Sediments

V.D. Nair[1]*, T.Z. Osborne[1], L.R. Ellis[1], B. Jones[2], and W.G. Harris[1]

[1]Soil and Water Sci. Dept., Univ. of Florida, Gainesville, FL. [2]S. FL. Water Management District, West Palm Beach, FL

Introduction

- Construction of a canal in the 1960s through the Kissimmee River in south-central Florida led to severe degradation of the river-floodplain ecosystem
- Portion of river restored, filling in canal with spoil left from dredging to restore flow to the original river channel

Objective

To provide a spatial catalogue of present soil conditions and a baseline assessment of phosphorus (P) within the floodplain to detect changes in landscape over time.

Materials and Methods

Study area: 2 degrees of restoration progress

- Phase I, a partially restored area
- Phase II, currently unrestored area

Landscape units

Channels (active, passive, abandoned, and remnant river channels); backfill; floodplain zone; spoil (spoil mounds, re-graded spoil); upland ecotone; other (road ditch, farm ditch, tributary slough, etc.) (Fig. 1)

Vegetation units

Aquatic Vegetation**:** broad leaf marsh (broad leaf marsh , miscellaneous wetlands); wet prairie (wet prairie, *Spartina*); upland forest; upland shrub (upland herbaceous, upland shrub); and wetland forest and shrub (wetland forest, wetland shrub) (Fig. 1)

Soil sampling

Surface soil samples from 115 predetermined sites in Phase I and II (Fig. 2)

Soil analysis

pH, water soluble P (WSP), Mehlich 1- P, Fe and Al, total P (TP) and total metals (TAl, TFe, TCa, TMg)

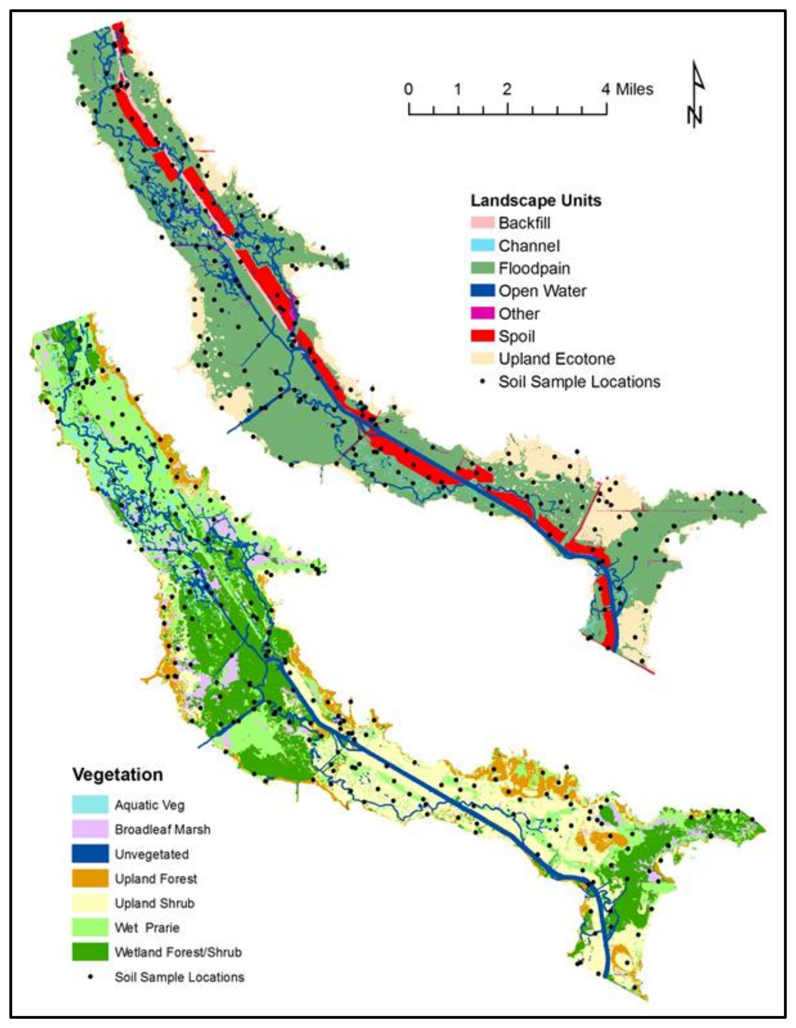

Fig. 1. *Landscape classifications (top) and vegetation classifications (bottom) utilized in the stratification process. Vegetation and landscape unit data source SFWMD2008.*

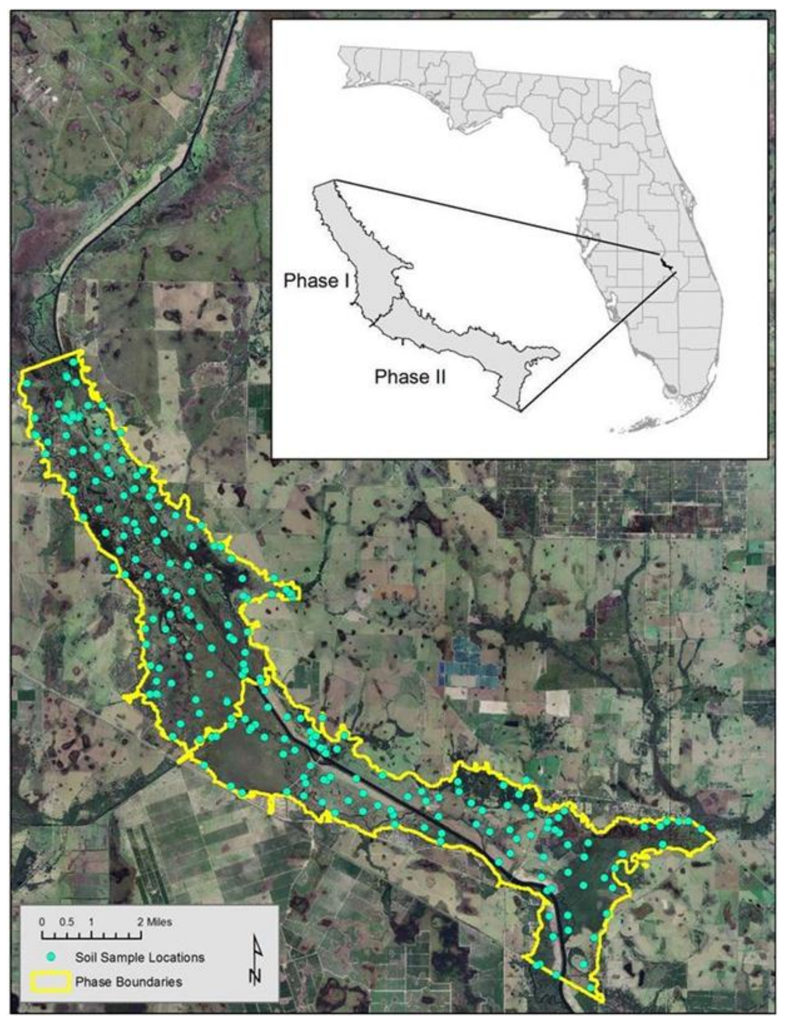

Fig. 2. *Study area delineating Phase I and Phase II. Yellow lines indicate floodplain boundary and green dots indicate sample sites.*

Results and Discussion

Table 1: Mean values for selected soil parameters for the various ecosystem classifications within the Kissimmee River Basin (KRB)

Phase	Ecosystem Classification	pH	WSP†	M1-P	SPSC	TP	TCa	TMg	TFe	TAl
			------- mg kg^{-1}------			---------------------- mg kg^{-1}--------------------				
I	Backfill	7.5	0.6	83	-102	1001	16527	781	4029	7838
I	Floodplain	5.5	2.0	9	15	473	4832	644	4111	8968
II	Floodplain	5.3	5.3	17	-2	475	6707	777	3491	7414
I	Upland Ecotone	4.4	4.2	5	20	378	2521	383	2435	4358
II	Upland Ecotone	5.1	2.8	8	9	316	2483	316	1722	3621
I	Channel	5.5	0.3	3	19	436	5122	577	3751	6690
II	Channel	5.4	2.9	8	12	358	4527	666	3827	8362
I	Spoil	6.6	0.5	143	-190	809	18485	1629	5159	10517
II	Spoil	6.7	2.8	88	-120	1479	46649	3295	7378	15301
I	Other	5.6	0.6	69	-66	386	4600	704	4491	8682
II	Other	5.9	4.6	67	-67	381	4956	547	2949	5617

† Water soluble P (WSP), Mehlich 1-P (M1-P), soil P storage capacity calculated using P, Fe and Al in a Mehlich 1 solution (SPSC), total P (TP) and total metals: total Ca (TCa), total Mg (TMg), total Fe (TFe) and total Al (TAl) for the various ecosystem classifications for the 0-10 depth.

Note: SPSC originally calculated from Oxalate P, Fe and Al (Nair and Harris, 2004)

$SPSC_{Ox}$ = (0.1 – Soil PSR_{M1})*(Ox-Fe + Ox-Al)*31 (mg P kg^{-1}) where PSR_{Ox} is the molar ratio of P to (Fe+Al) in an oxalate solution

SPSC calculated from Mehlich 1- P, Fe and Al (Nair et al., 2010)

$SPSC_{M1}$ = (0.1 – Soil PSR_{M1})*(M1-Fe + M1-Al)*31*1.3 (mg P kg^{-1}) where PSR_{M1} is the molar ratio of P to (Fe+Al) in a Mehlich 1 solution

Table 2. Water soluble P and total P in soils of various land-uses in the Lake Okeechobee Basin (LOB) Source: Graetz et al. (1999).

Land-use	Water Soluble P, mg kg^{-1}	Total P, mg kg^{-1}
Intensive	72.8	2314
Holding	59.8	873
Pasture	17.5	254
Forage	2.1	42
Beef Pasture	2.1	45
Native†	0.4	31

- TP values in the KRB are much higher (Table 1) than those of other land-uses within the LOB except for the areas near the barns (intensive/holding) of dairy farms (Table 2)
- High TP with high Fe, Al and Ca content (Table 1) and low WSP indicate that the spoil (Fig. 3) is possibly influenced by geologic phosphatic material exhumed in canal construction
- Low WSP despite high TP and negative SPSC (Table 1) suggests low P loss risk as long as sediment entrainment is minimized

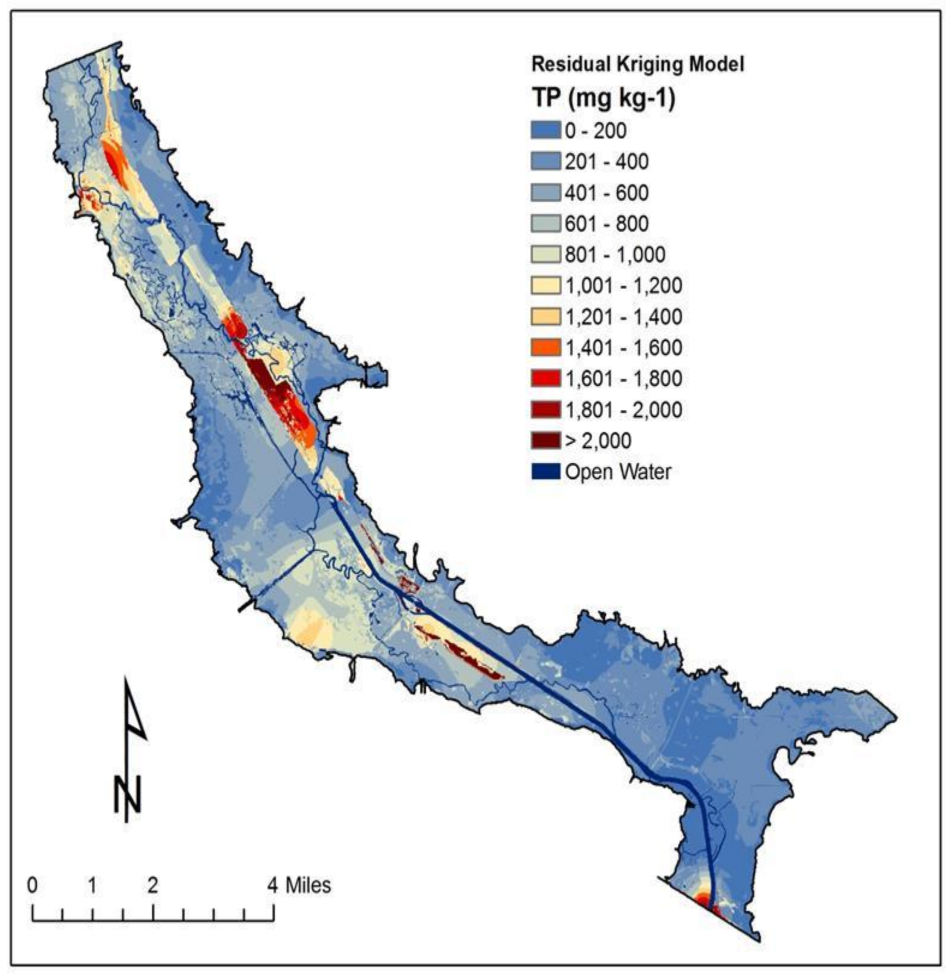

Fig. 3. *Spatial distribution (Residual Kriging) of total phosphorus (TP) in the surface 0-10 cm depth at the sampling locations in Phase I and II of the Kissimmee River Floodplain restoration. Note the presence of spoil and re-graded spoil materials clearly in the interpolation. Units are mg kg^{-1}.*

Conclusion

Relation between WSP and SPSC or TP differs between anthropogenic (e.g., inorganic fertilizers, manure) and non-anthropogenic (e.g., spoil piles, backfill) sources of P. The latter tend to have less releasable P with increasingly negative SPSC. High P concentrations in spoil piles suggest that caution is warranted in handling of these materials.

References

- Graetz, D.A., V.D. Nair, K.M. Portier, and R.L. Voss. 1999. Agric. Ecosyst. Environ. 75:31-40.
- Nair, V.D., and W.G. Harris. 2004. New Zealand J. Agric. Res. 47:491-497.
- Nair, V.D., W.G. Harris, D. Chakraborty, and M. Chrysostome. 2010. http://edis.ifas.ufl.edu/pdffiles/SS/SS54100.pdf

Acknowledgment: This project was supported in part by the South Florida Water Management District. Thanks are due to Debolina Chakraborty for soil and statistical analysis. Field soil sampling by Matt Norton is gratefully acknowledged.