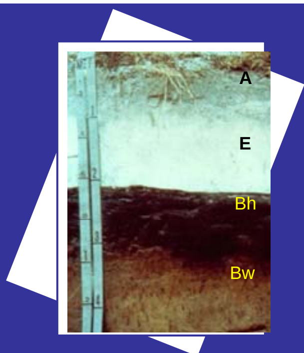


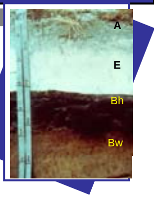
Phosphorus Issues and Protocol Development for Risk Assessment in Florida Watersheds

V.D. Nair, W.G. Harris, D.A. Graetz, R.D. Rhue, M. Chrysostome, and L.R. Ellis

Soil and Water Science Department
University of Florida

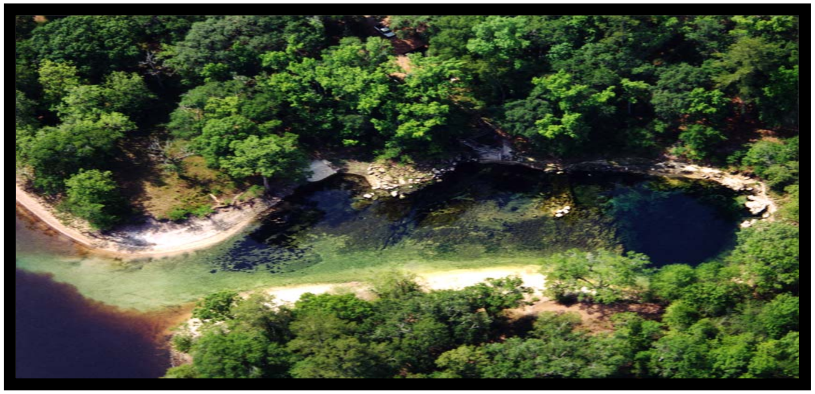
February 27, 2008

The Suwannee River Basin (SRB)



- Complex hydrologic system
- Zones of surface and subsurface (karst) drainage
- Cody scarp between the 2 zones

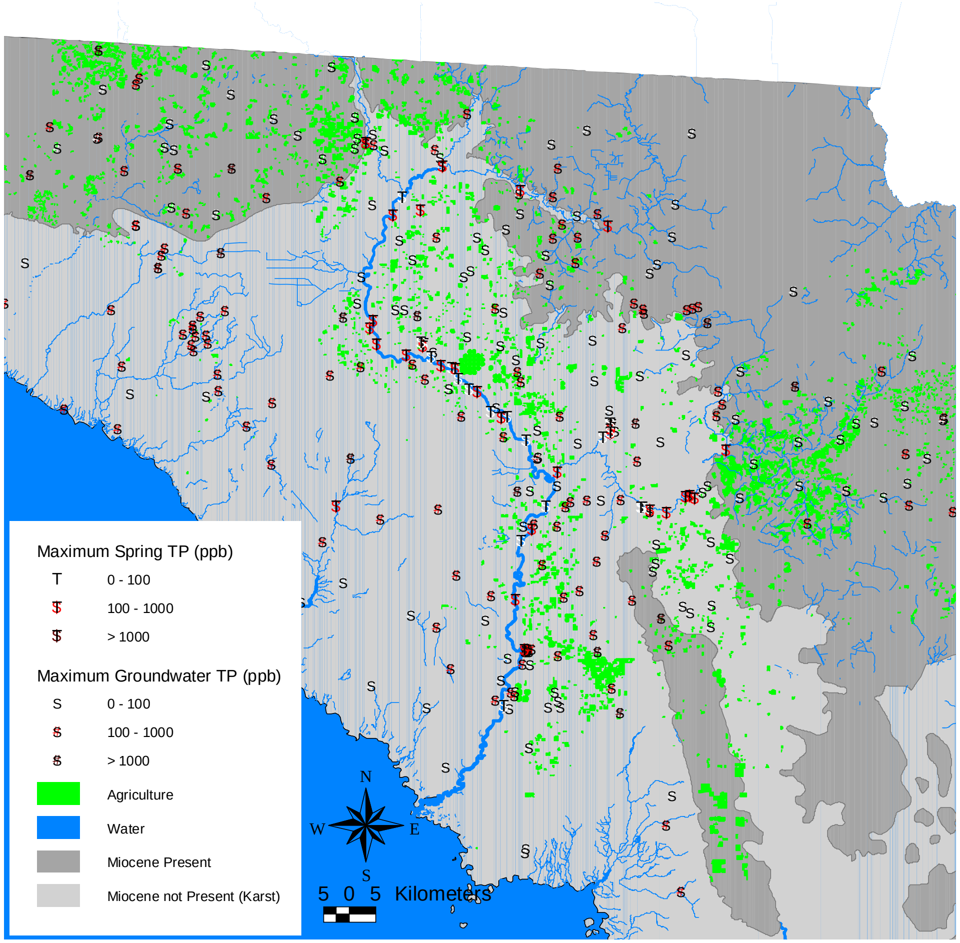
Springs of the Lower SRB



- High concentration of springs; haven for species; manatee, gulf sturgeon
- Combination of sandy soils over limestone constitutes a scenario of high vulnerability for ground- and surface water contamination

Photo credit: David Hornsby

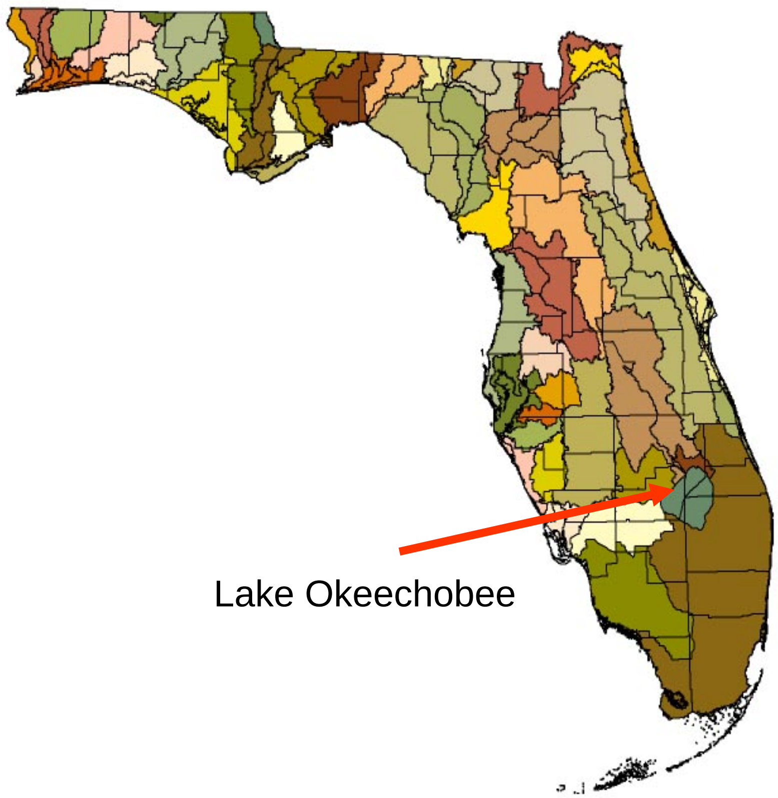
Water Quality Concerns - SRB



Data: Suwannee River Water Management District

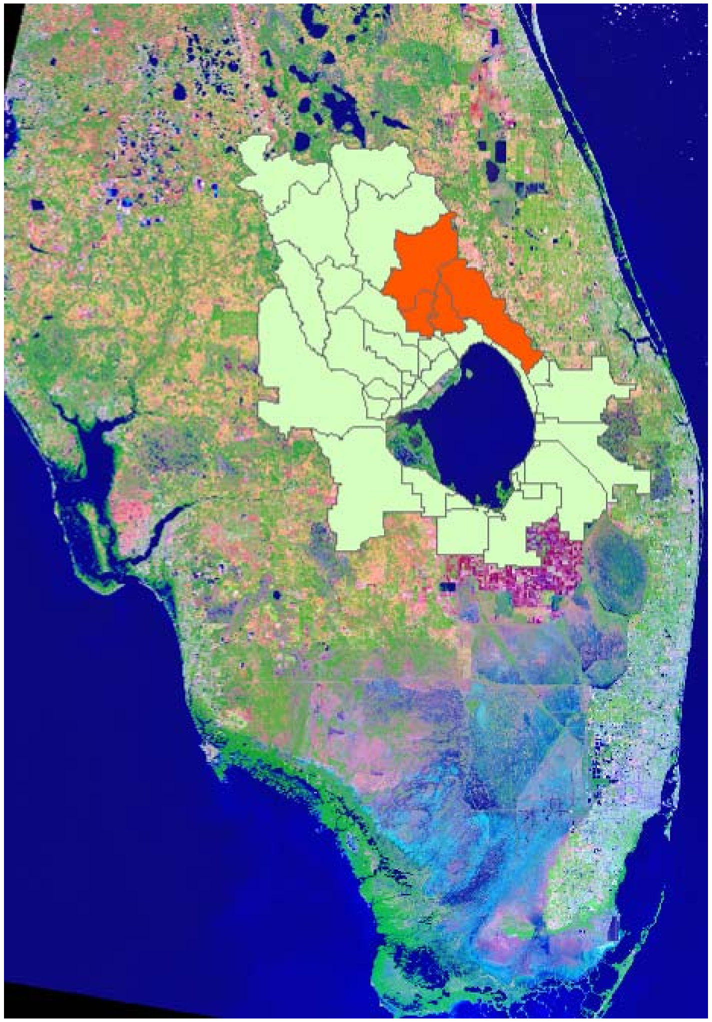
- Average spring P concentrations generally in 0-100 ppb (0-0.1 mg P L^{-1}) range
- Several instances where maximum spring water P is between 0.1 and 1.0 mg L^{-1} (Environmental concerns about P are often based on a P concentration of ≥0.1 mg P L^{-1}).

Lake Okeechobee Basin (LOB)



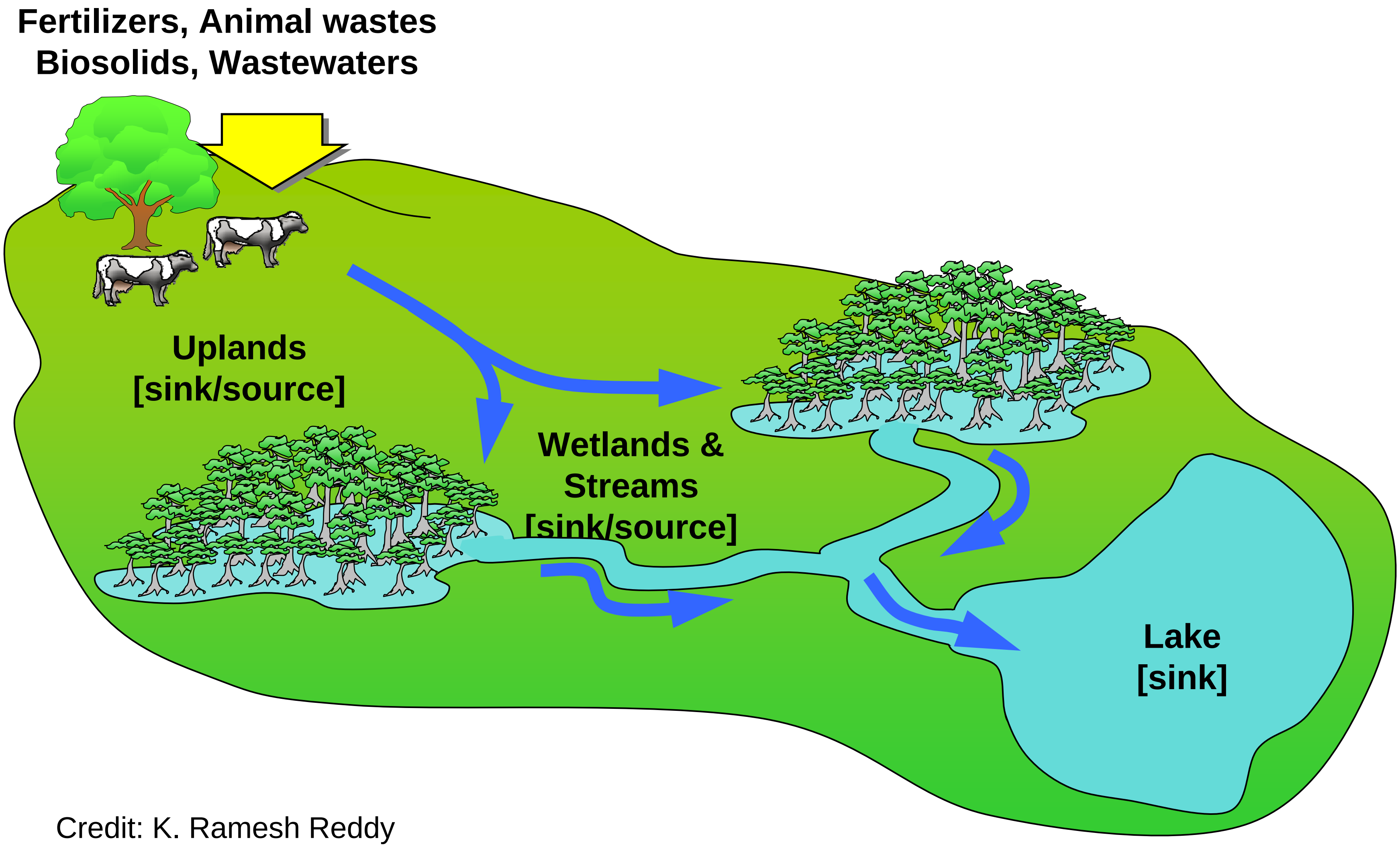
- 98% of P imported to the watershed supports agriculture (Fluck et al., 1992)
  - Fertilizers 73%
  - Dairy feed 16%

Water Quality Concerns - LOB



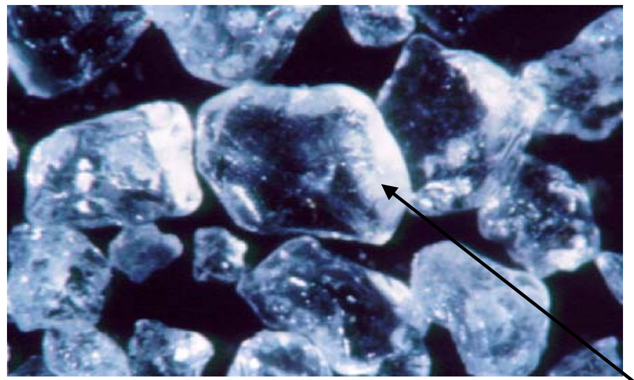
- Four Priority Sub-basins
  - 12% of watershed area
  - 35% of P load

Phosphorus Transfer



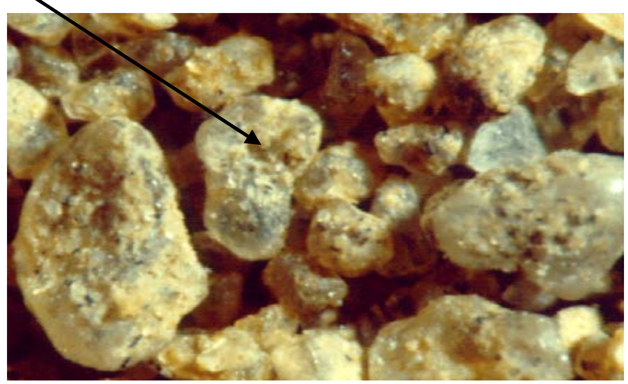
Credit: K. Ramesh Reddy

Soils of Florida Watersheds



makes a big difference in P retention capacity

their presence or absence,



Sand grain coatings,

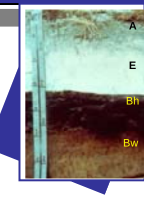
Development of a New Tool

- Based on extractable P of soil
- Also on P retention capacity of soil (related to Fe+Al)
- New tool: “Safe” Soil P Storage Capacity (SPSC)
- Calculations based on oxalate-extractable P, Fe and Al

Developed using soils of the SRB in Florida.

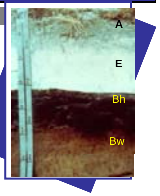
USDA-IFAFS

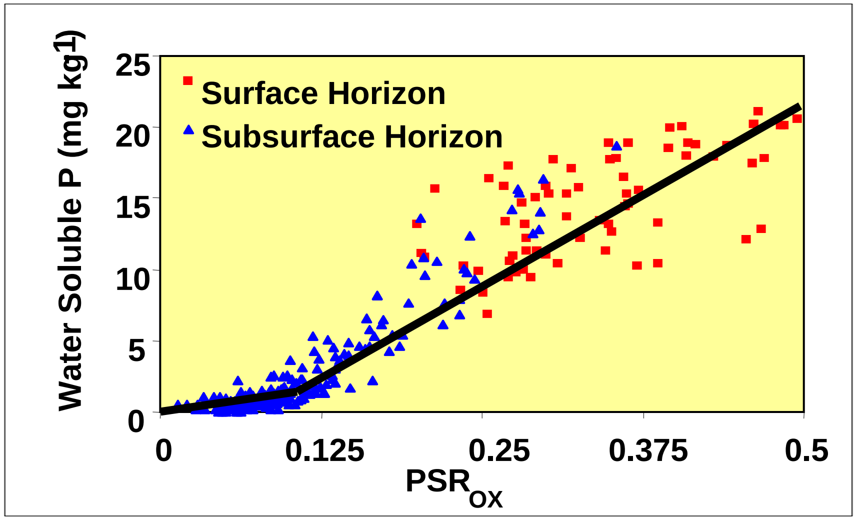
The Need for a New Protocol

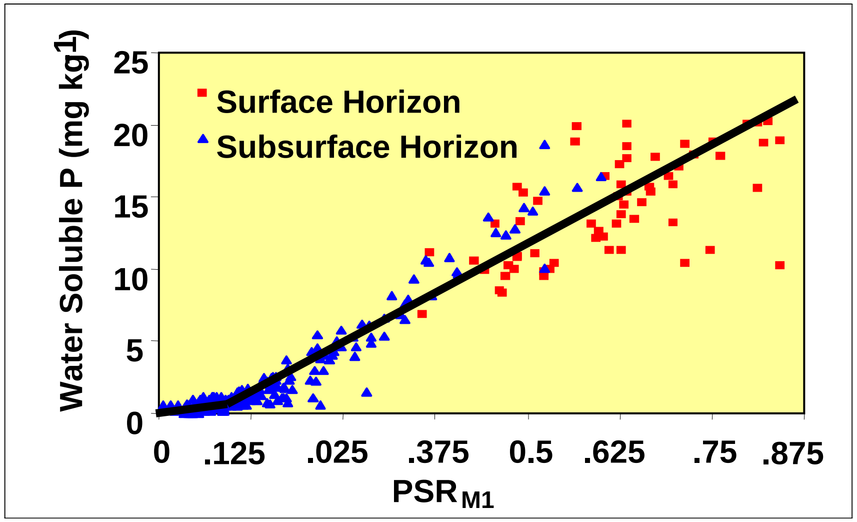


- Low value of soil test P (STP) is not necessarily an indicator of low environmental risk if P is added to a soil
- Some sandy soils, such as those of the LOB, could have 99% quartz sand in the upper horizons and negligible P retention
- STP does not convey the amount of P that can be safely added to a soil in an absolute sense

P Saturation Ratio (PSR)







- Ex-P/ [ExFe + ExAl]
  (Ex = Extractable)
- Change point ~ 0.10
- Confidence intervals: 0.05 – 0.15
- Threshold PSR: 0.15

Nair, V.D., K.M. Portier, D.A. Graetz, and M.L. Walker. 2004. J. Environ. Qual. 33:107-113.

FDEP

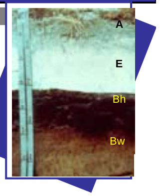
The Approach – "Safe" Soil Phosphorus Storage Capacity (SPSC)

$$\boldsymbol{SPSC} = (0.15 - \textbf{Soil PSR}) * \left[\frac{Oxalate\,Fe}{56} + \frac{Oxalate\,Al}{27}\right] * 31$$

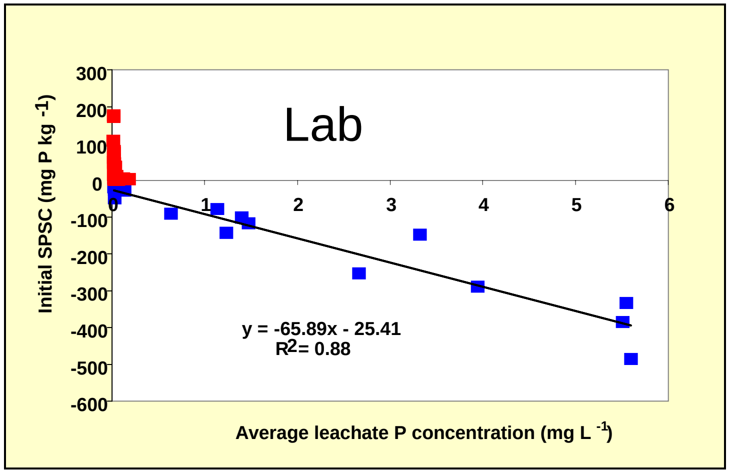
(mg P kg^{-1})

- SPSC can also be expressed in mmoles P kg^{-1}, or kg P ha^{-1}
- SPSC is additive; SPSC for horizons within a sandy soil can be added providing a single value for a designated depth

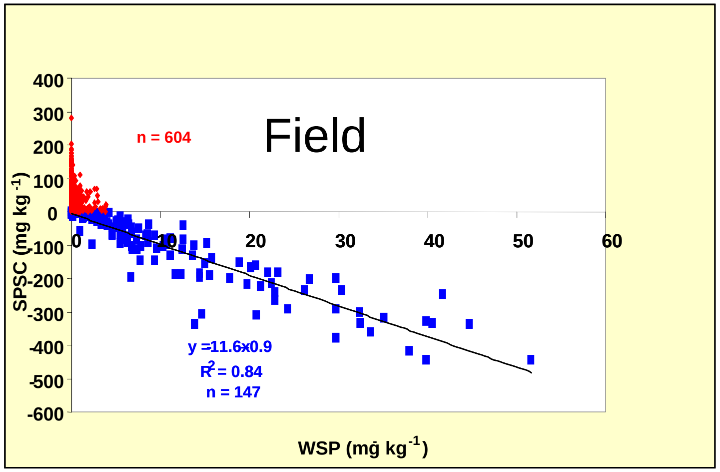
Nair, V.D., and W.G. Harris. 2004. New Zealand J. Agric. Res. 47:491-497.



SPSC and Water Soluble P (WSP)

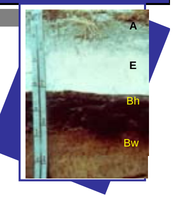


Column Study Set-up

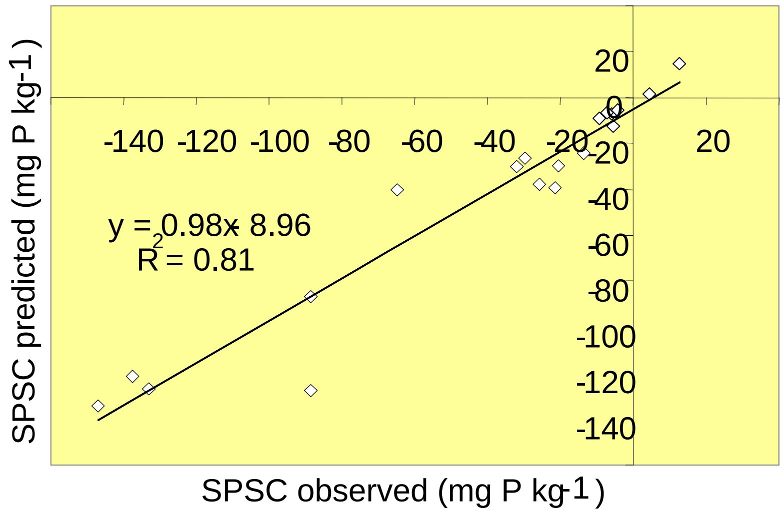


- Soil is a P sink when SPSC is positive and a source when SPSC is negative
- Similar observation under field conditions
- 95% of samples with positive SPSC (soil is a P sink) indicate less than 0.1 mg L^{-1} P in solution

Chrysostome, M, V.D. Nair, W.G. Harris, and R.D. Rhue. 2007. Soil Sci. Soc. Am. J. 71:1564–1569.



Laboratory Verification of SPSC



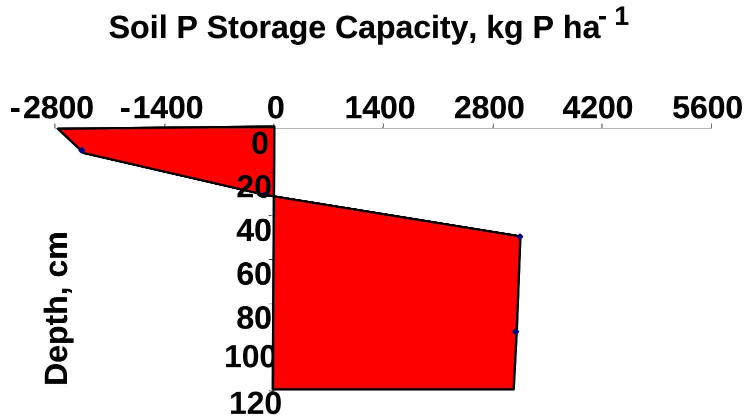
$$Predicted\ PSR = \frac{Initial\ \ OxP \quad + \quad P\, gained\ \ or\ lost}{Ox\,(Fe\ +\ Al\,)}$$

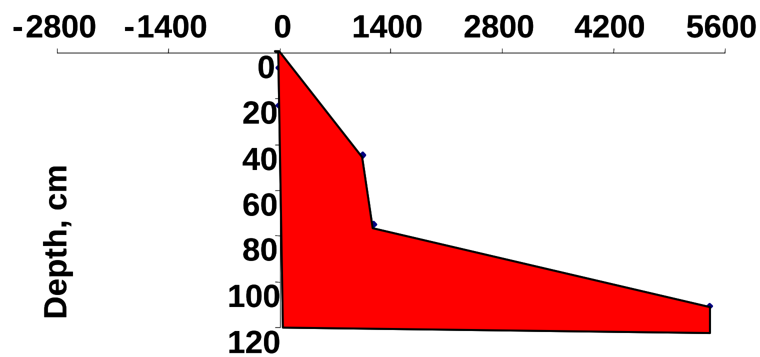
$$SPSC_{predicted} = (0.15 - predicted\ PSR)\ x\ Ox\ (Fe + Al)\ x\ 31$$

Chrysostome, M, V.D. Nair, W.G. Harris, and R.D. Rhue. 2007. Soil Sci. Soc. Am. J. 71:1564–1569.

Application: Soils of the SRB

High intensive dairy soils *vs* less P-impacted pasture soils

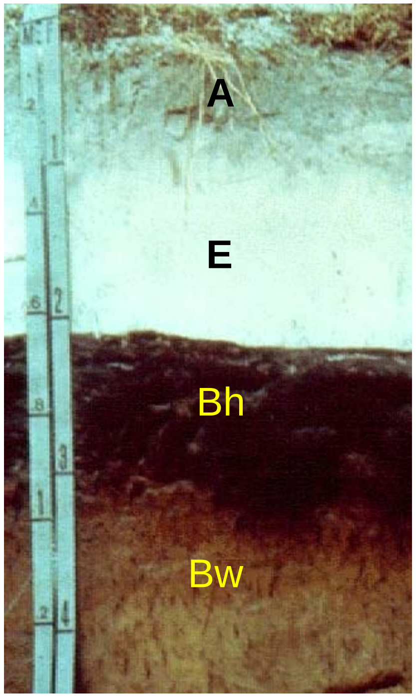




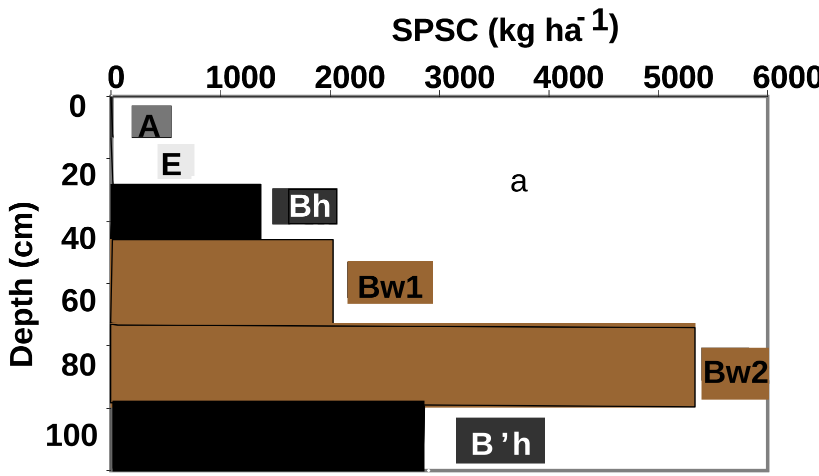
- High dairy manure-impacted soils (top); negative SPSC in surface; soil is P source
- Low manure-impacted soils (bottom) have remaining capacity

Nair, V.D. and W.G. Harris. 2004. NZ J Agric. Res. 47:491-497.

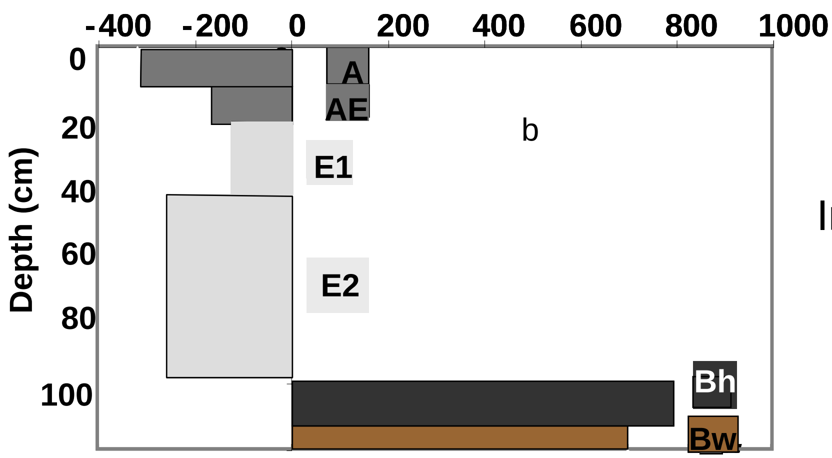
Application: Soils of LOB



Spodosol Profile

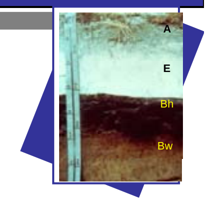


Minimally impacted



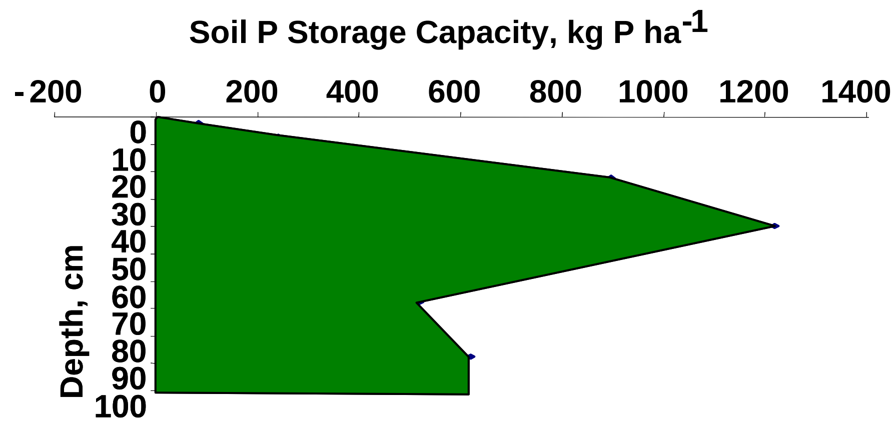
Impacted

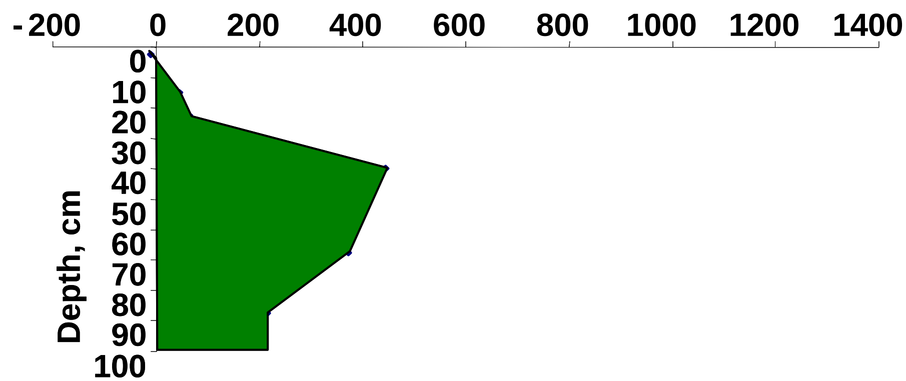
FDACS



Applications

Tree-based *vs* tree-less pasture





Nair, V.D. P.K.R. Nair, R.S. Kalmbacher, and I.V. Ezenwa. 2007. Ecol. Eng. 29:192-199.
Michel, G.-A., V.D. Nair, P.K.R. Nair. 2007. Plant Soil. 297:267-276.

USDA/IFAFS, through the Center for Subtropical Agroforestry

Other Field Applications

- Predict reduction in P storage capacity of soil with time if P loading known, such as in dairy spray fields
- Evaluate how much P can be safely applied to soil before soil becomes an environmental risk if manure application is based on N requirement of crop
- Use SPSC in P-Index as a replacement for STP
- Use SPSC to estimate how long a P loaded site would continue to release P at environmentally elevated levels
- Identify suitable areas for animal-based agriculture by selecting soils which have greater capacity to retain P
- Verify suitability of potential locations for the construction of stormwater treatment areas.

Summary and Conclusions

- SPSC is a better indicator of environmental P risk than STP
- Provides estimate of amount of P that can be safely applied to the volume (or mass) of soil represented by depth of sampling
- SPSC is additive; may be added across depths to obtain P storage within a soil profile
- SPSC is a P sink when positive and a source when negative
- Negative SPSC linearly related to WSP
- SPSC has potential to serve as indicator that balances agronomic requirements with environmental risk considerations

Acknowledgments

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