The Effects of Riparian Ecosystem Processes on Water Quality: Nutrient Mineralization and Budgeting in the Difficult Run Floodplain Study

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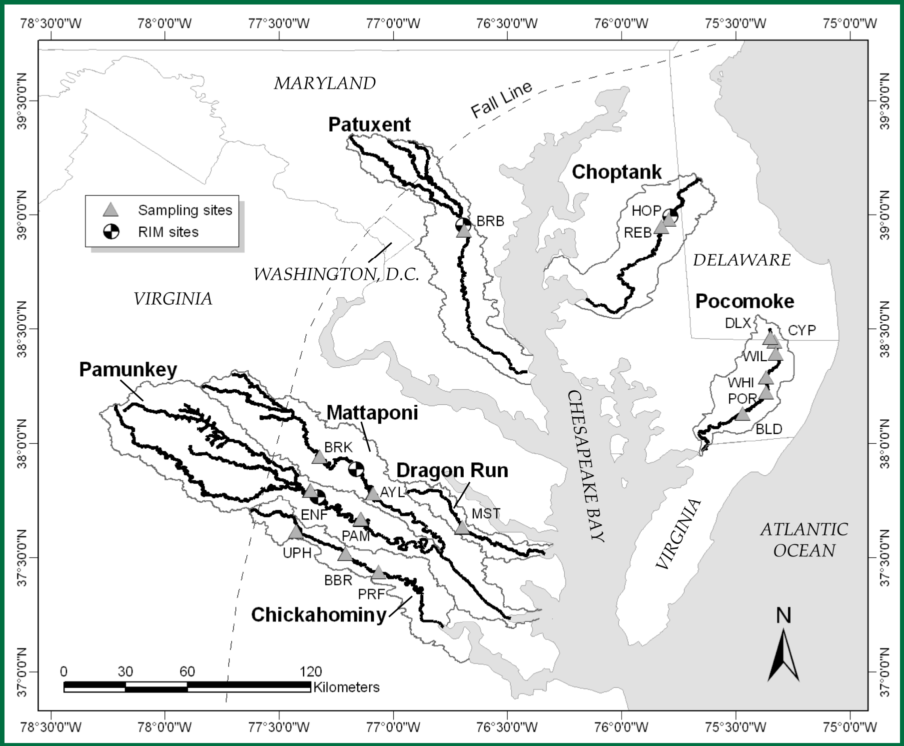
Coastal Plain floodplains trap large nutrient loads

1) Measured sedimentation fluxes in plots
2) Scaled to entire CP extent of floodplain
3) Compared to river load

$$\frac{g\ m^{-2}\ yr^{-1} \times m^2}{g\ yr^{-1}}$$

Percent retention for 7 rivers:

	Median	Range
Nitrogen	22%	(5 to 150%)
Phosphorus	59%	(14 to 587%)
Sediment	119%	(53 to 690%)



Noe and Hupp. 2009. *Ecosystems*.

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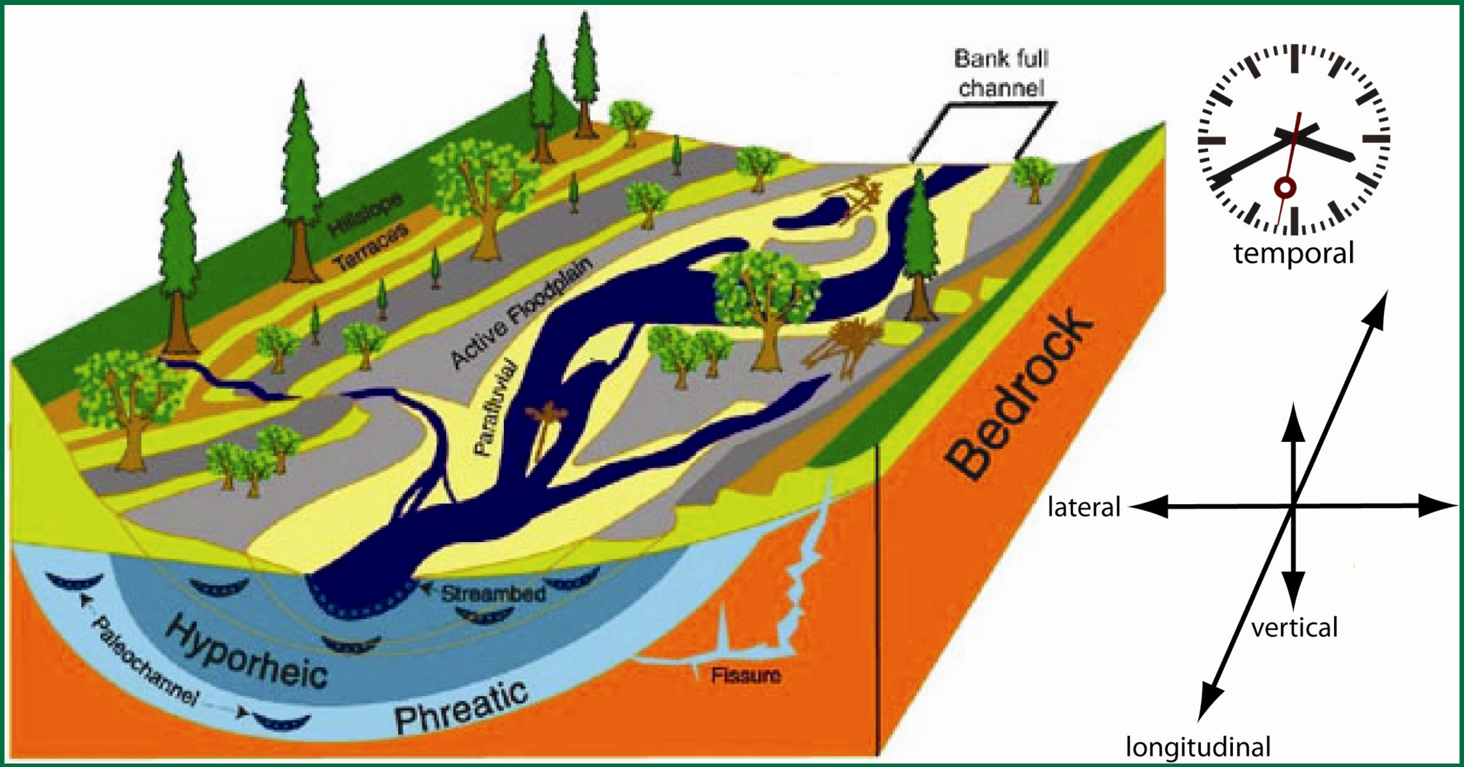
Hydrogeomorphic controls in floodplain ecosystems

Four dimensions of river corridors influence floodplain ecosystem processes through river-floodplain ***hydrologic connectivity***

This heterogeneity is critical to the prediction and scaling of floodplain effects on water quality



Noe. 2012. *Treatise of Geomorphology.* Modified from NRC 2002.

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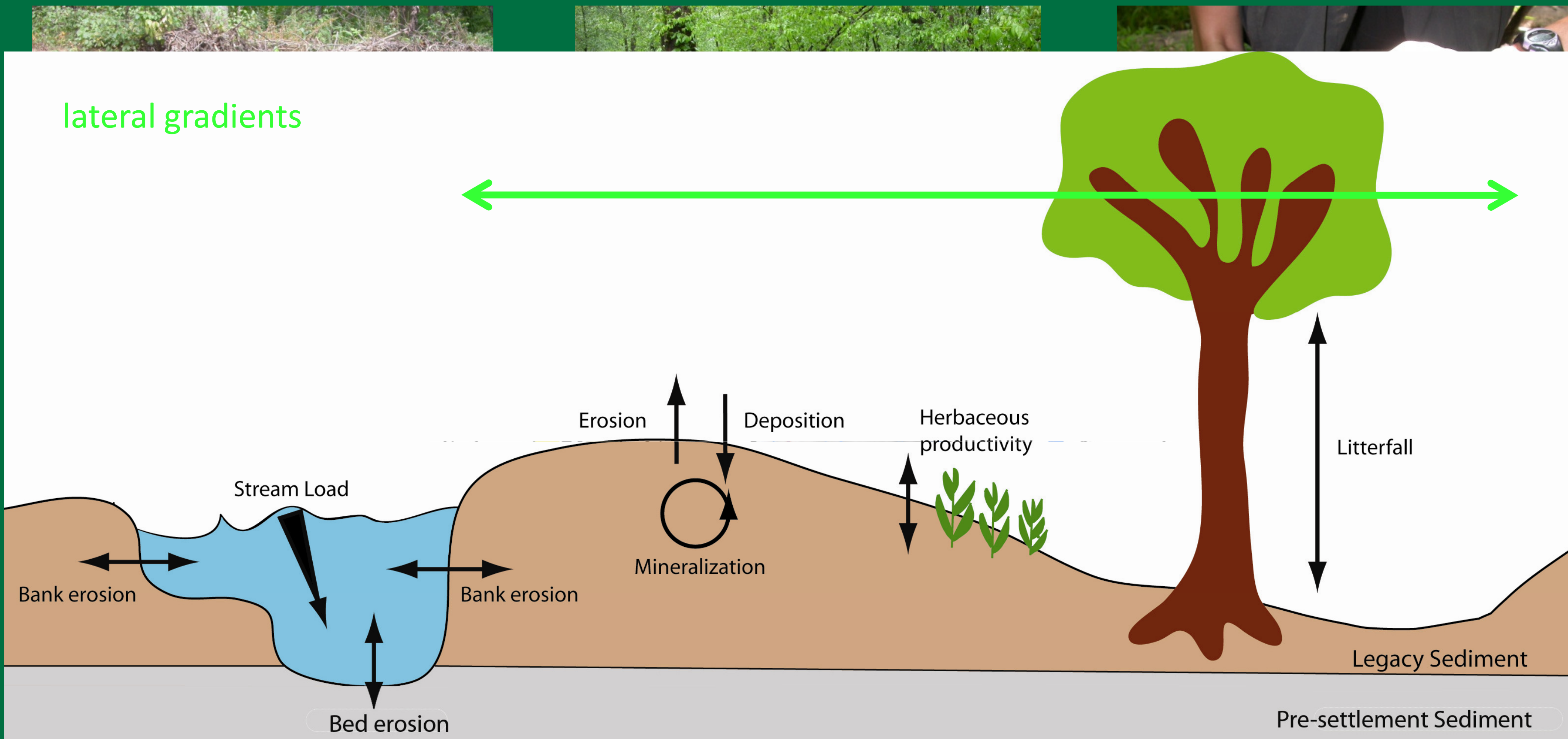
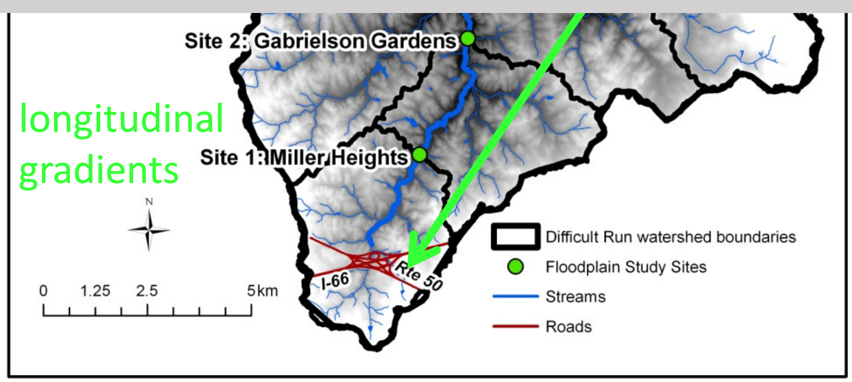
Difficult Run Floodplain Study

measuring sediment and nutrient retention along lateral and longitudinal floodplain gradients in an urban, Piedmont watershed





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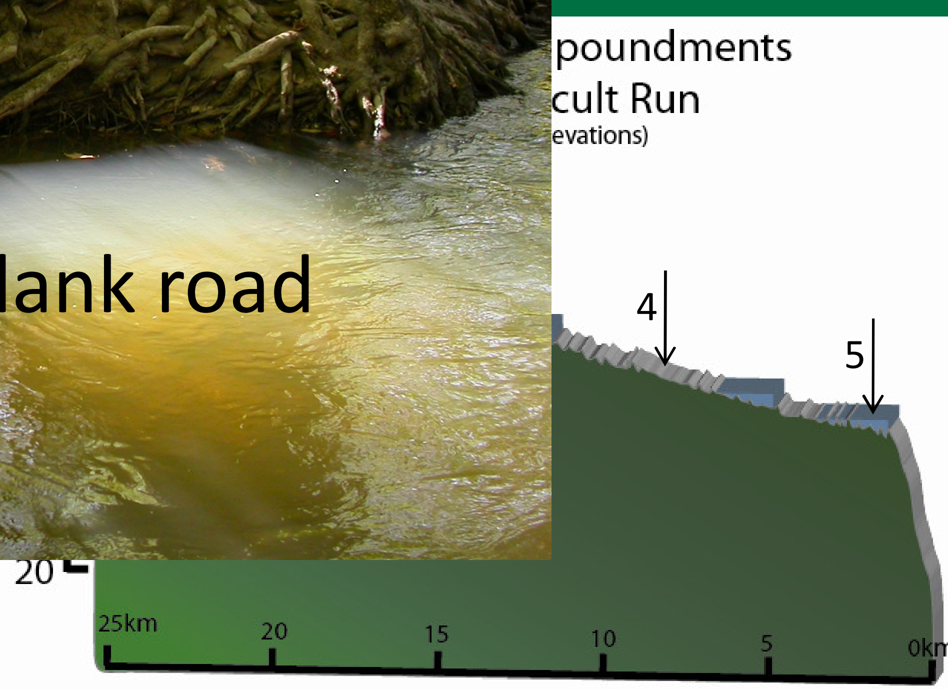
Historic mill dams and legacy sediment

instem length
d



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Difficult Run Floodplain Study

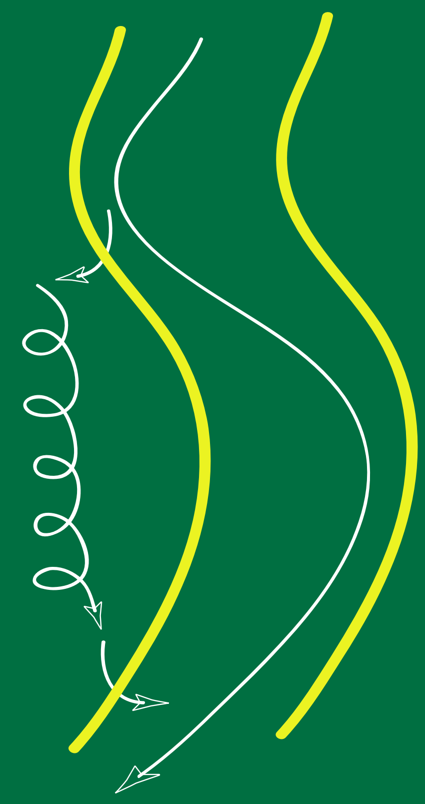
measuring sediment and nutrient retention along lateral and longitudinal floodplain gradients in an urban, Piedmont watershed

Goals:

Quantify the sediment and nutrient retention functions of urban, Piedmont floodplains of the Chesapeake Bay

Hypothesis:

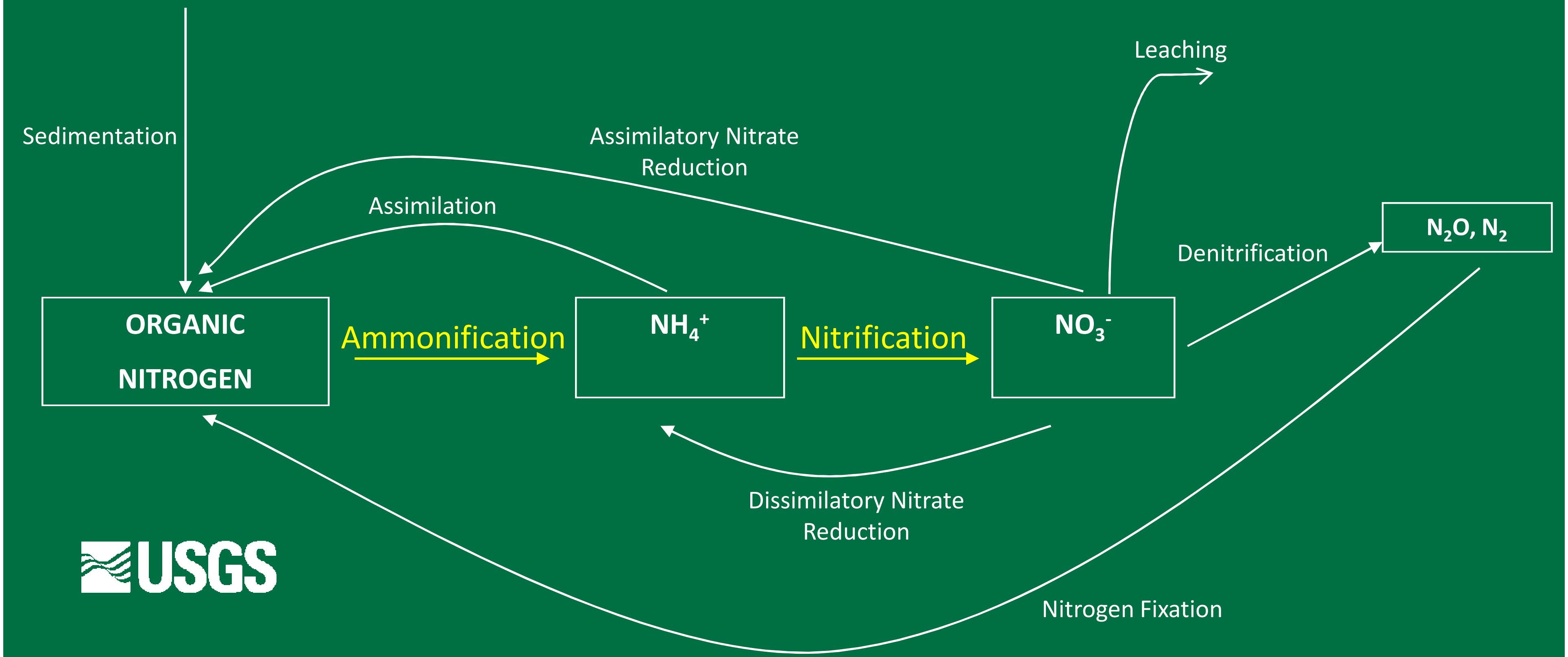
Floodplain fluxes increase with distance downstream
in the watershed (longitudinal),
and at lower elevations within floodplains (lateral),
due to greater river-floodplain hydrologic connectivity.



Nutrient cycling in wetlands

Mineralization is a bottleneck biogeochemical process

- long-term retention
- internal cycling
- plant nutrient availability



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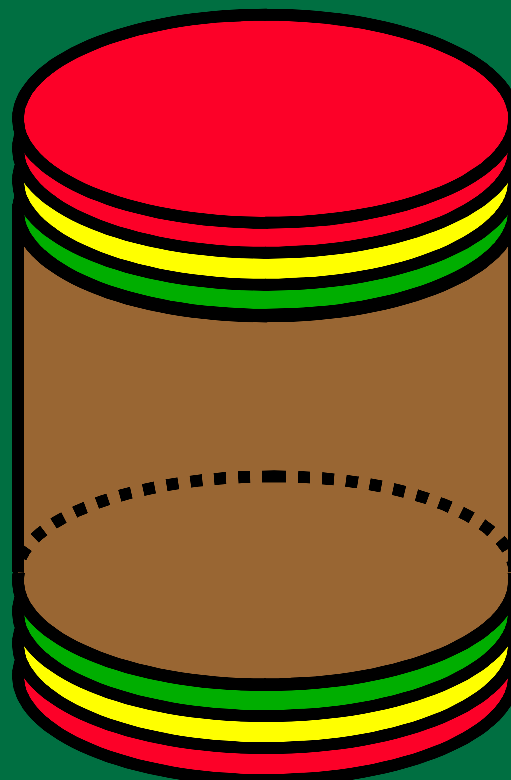
in situ soil net N and P mineralization: modified resin cores

2M KCl: NH_4^+, NO_3^-, SRP



Upper outer resin bag
Upper middle resin bag
Upper inner resin bag

0-5 cm soil

Lower inner resin bag
Lower middle resin bag
Lower outer resin bag

Noe. 2011. *SSSAJ*.

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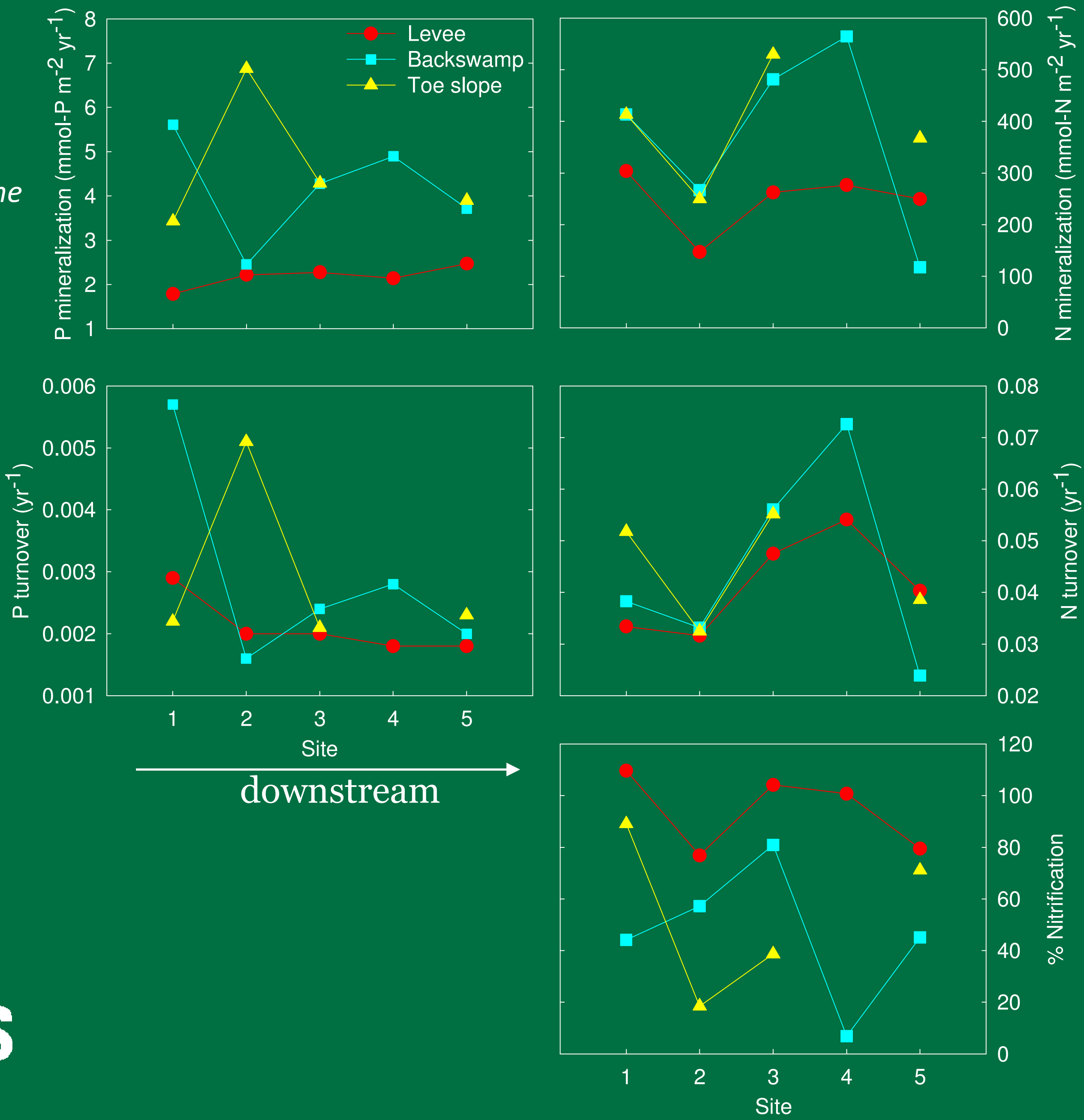
Annual net mineralization rates

Lateral
Time
Longitudinal x Time

Lateral
Time



Time

Time

Lateral

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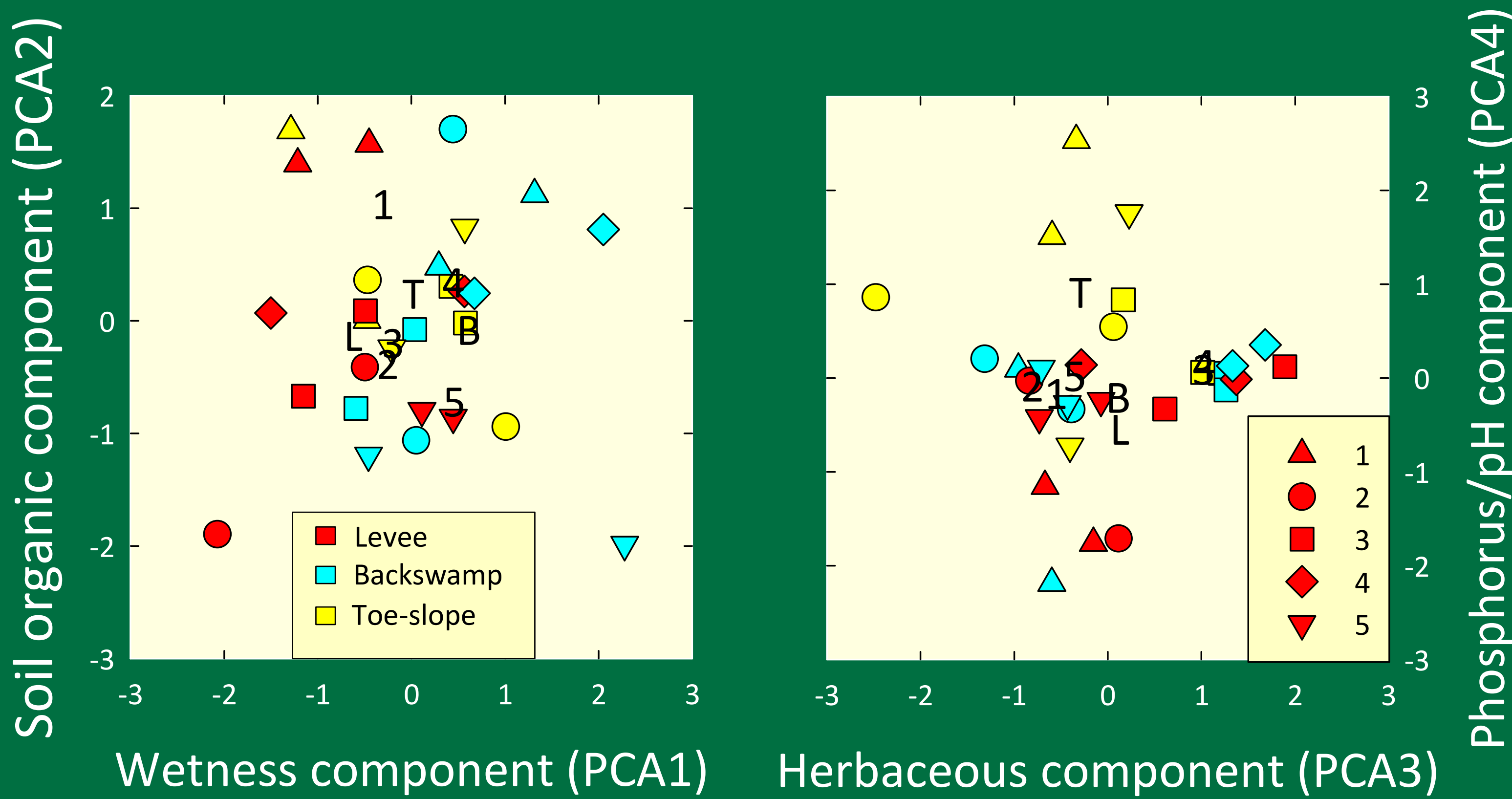
Hydrogeomorphic and vegetation gradients: PCA



Wetness (PCA1)	Soil organic (PCA2)	Herbaceous (PCA3)	Soil P / pH (PCA4)
+ Soil moisture WFPS	+ C:P	+ Herbaceous N flux	- pH
+ Soil moisture volume	+ N:P	+ Herbaceous C flux	+ TP
+ Hydroperiod	+ %C	+ Herbaceous P flux	+ SRP
- Deposition	+ %N	+ soil temperature	
+ Soil moisture grav.	- Bulk density		
+ Groundwater depth	+ NH_4^+		
	+ C:N		

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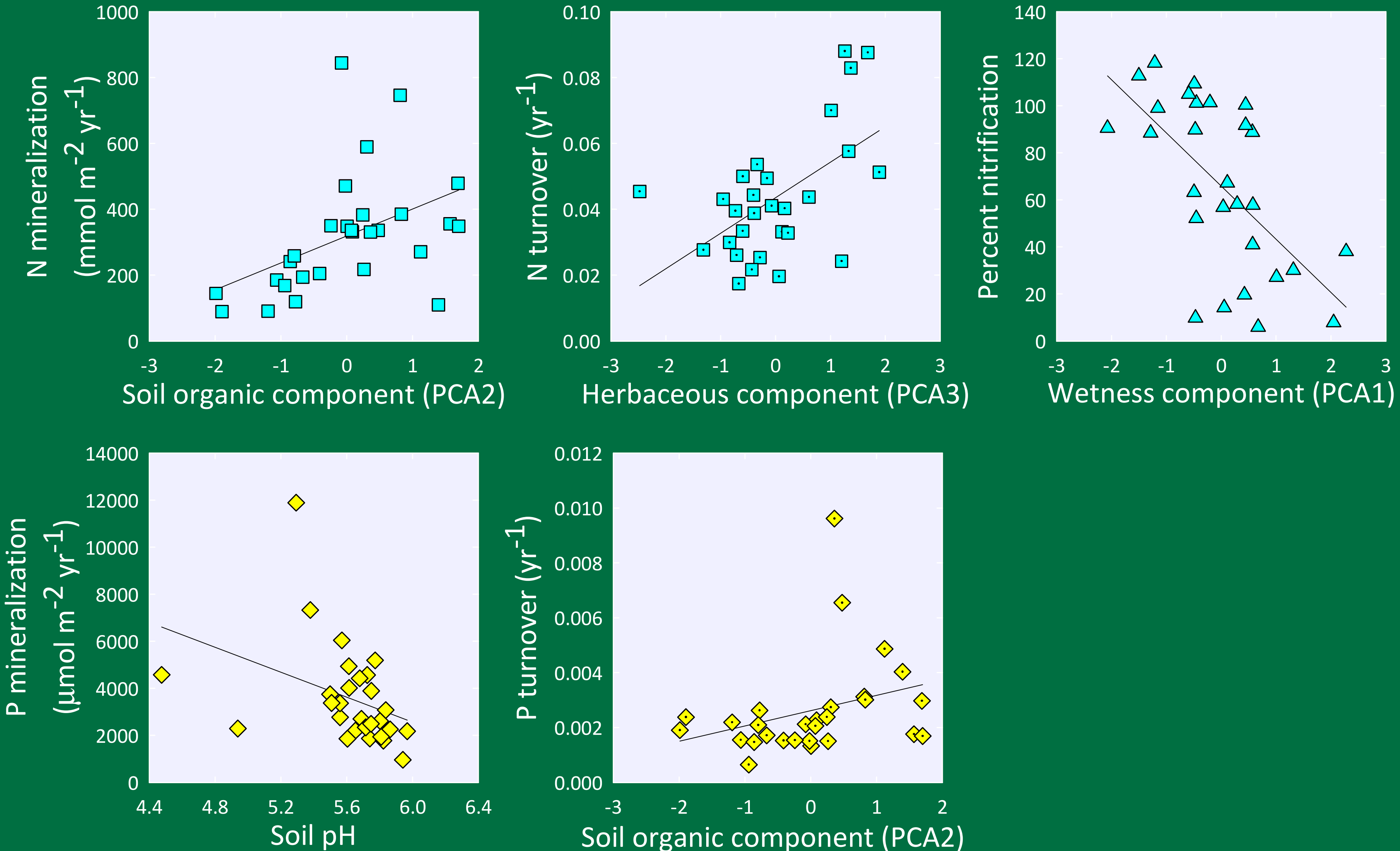
Mineralization controls



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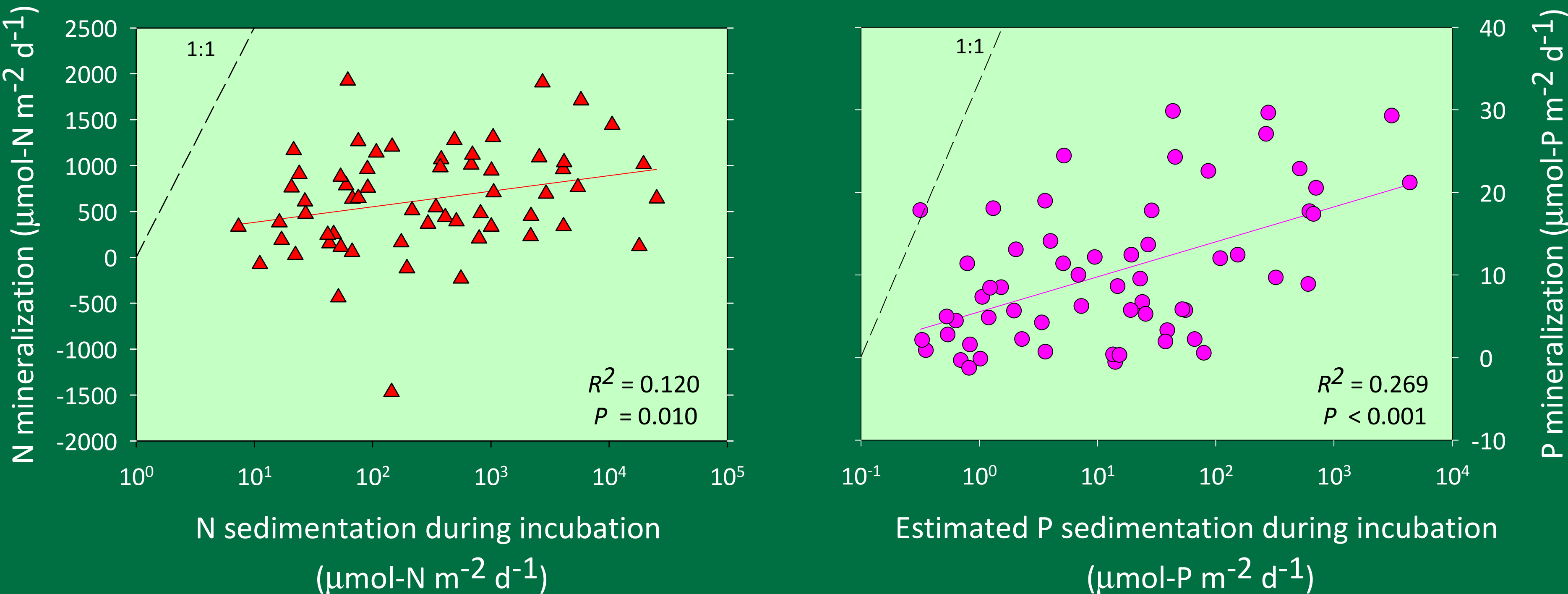
Sedimentation stimulates mineralization



Five overbank flood events occurred at the mid-watershed floodplain site during the year of study, for a total of 41.5 hr

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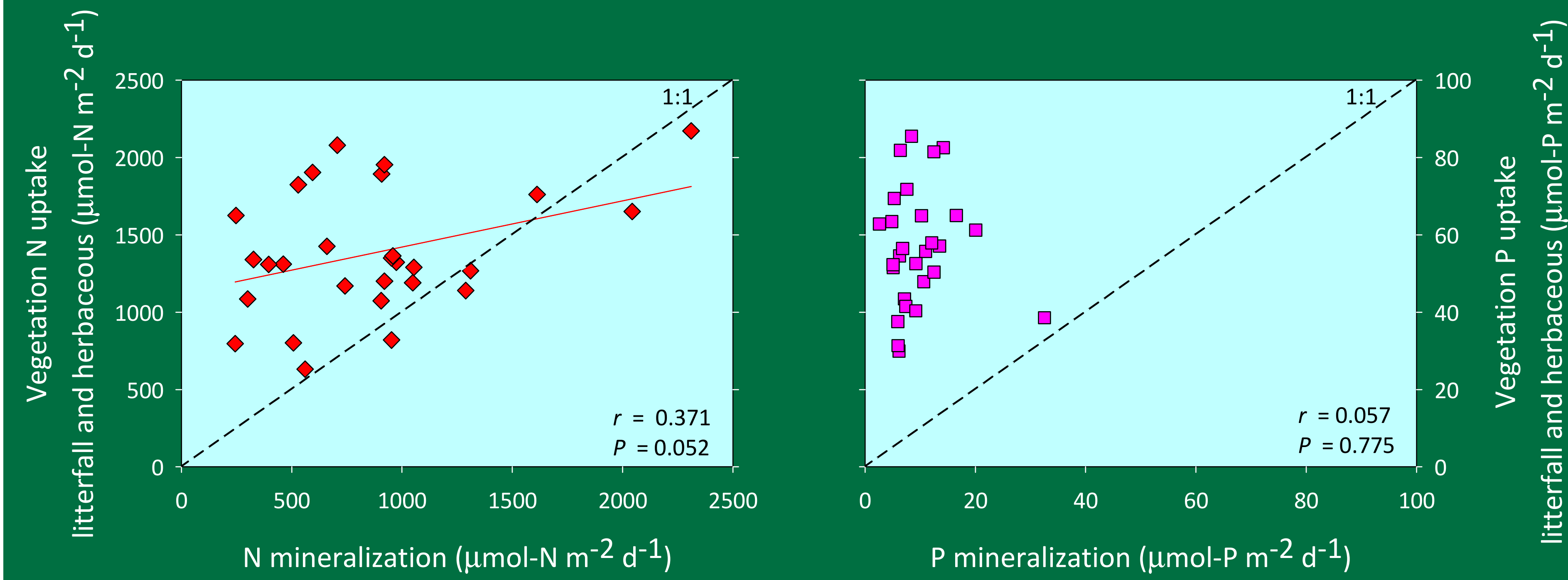
Plant uptake vs. mineralization



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Turnover of soil N and P pools

Rate	Areal mineralization (mmol m^{-2} yr^{-1})	Turnover rate (mol mol^{-1} yr^{-1})	Turnover time (yr)
P mineralization	3.60	0.0026	383
N mineralization	319	0.044	23

% nitrification	66%

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Noe et al. *in review*

Controls of nutrient mineralization

- Lateral and longitudinal gradients in floodplain hydrology, soil organics, vegetative fluxes, and TP and pH
- Strong lateral gradients of mineralization among floodplain geomorphic zones, but weak longitudinal gradients from headwaters to mouth
- Organic nutrient availability and lability controls N and P mineralization, as well as pH and redox for P
- Wetness and redox determine balance of ammonification and nitrification
- Sedimentation stimulates mineralization

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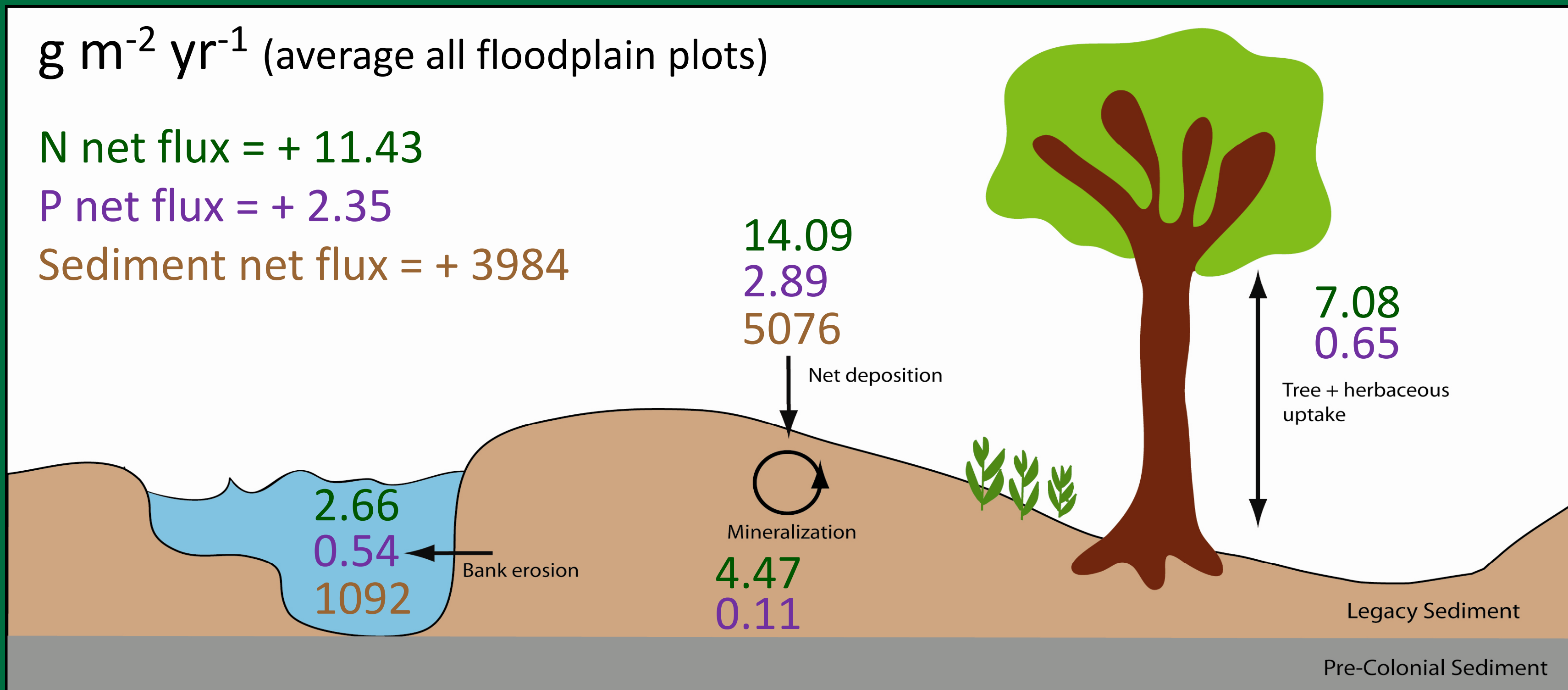
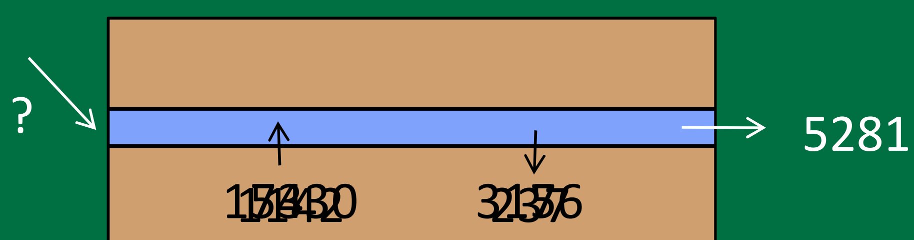
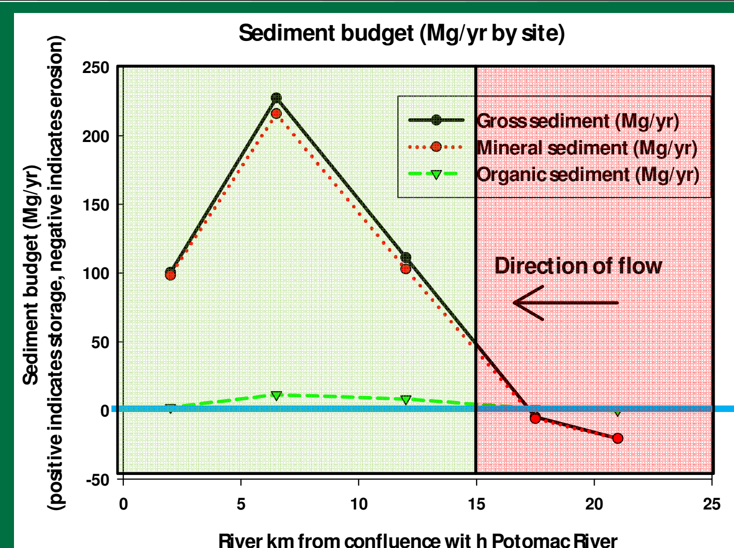
Budgeting: mainstem floodplains



Headwater basin



Sediment: Mg/yr



Nutrient and sediment retention in urban, Piedmont floodplains

- Long turnover of soil N and P, and plant uptake rates ≥ mineralization, indicating tight spiralling of N and P
- The large pool and residence time of floodplain sediment necessitates a geomorphic perspective to understand the fluvial system and identify changes due to BMPs
- Urban Piedmont floodplains can flood and retain N and P and sediment

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