The Importance of Scale and Riparian Zones in Modifying Solute Inputs from Land to Streams

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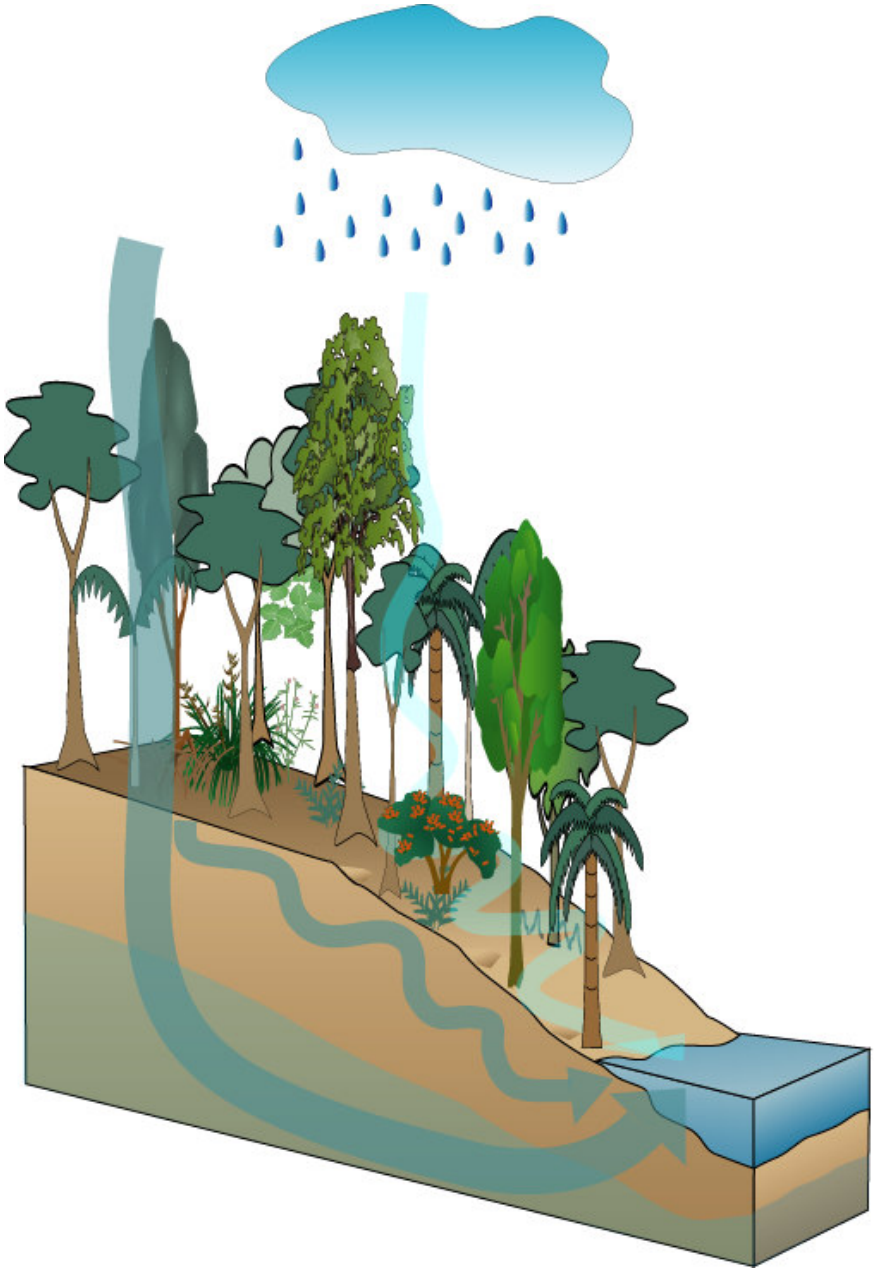
Contributions from:

Daniel Markewitz, Ricardo Figueiredo, Eric Davidson, Mark Johnson, Johannes Lehmann, and others LBA small basin synthesis participants

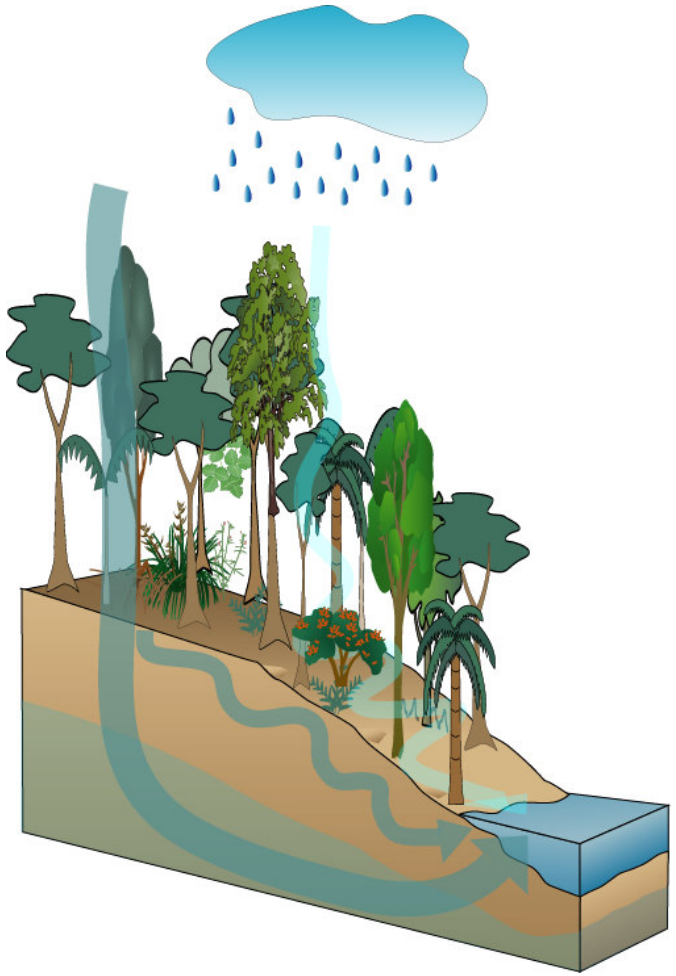
Precipitation falling in watersheds may take a number of pathways to streams

- Fast
  - *Overland flow*
  - *Shallow subsurface flow*
- Slow
  - *Groundwater*
  - *Soil water*



Fundamental Questions:

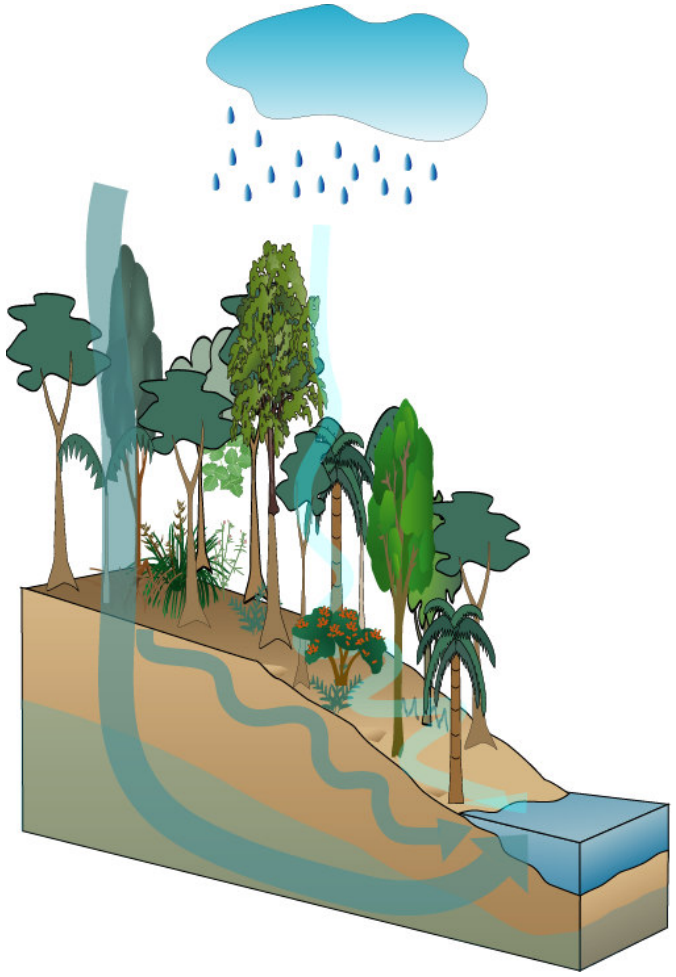
- How do these flowpaths change with deforestation?
- How do these flowpaths change with watershed scale?
- How do these flowpaths change with soil type?
- How do transformations in flowpaths controls stream chemistry?



Approaches:

- Delineating flowpaths and changes with land use at individual sites

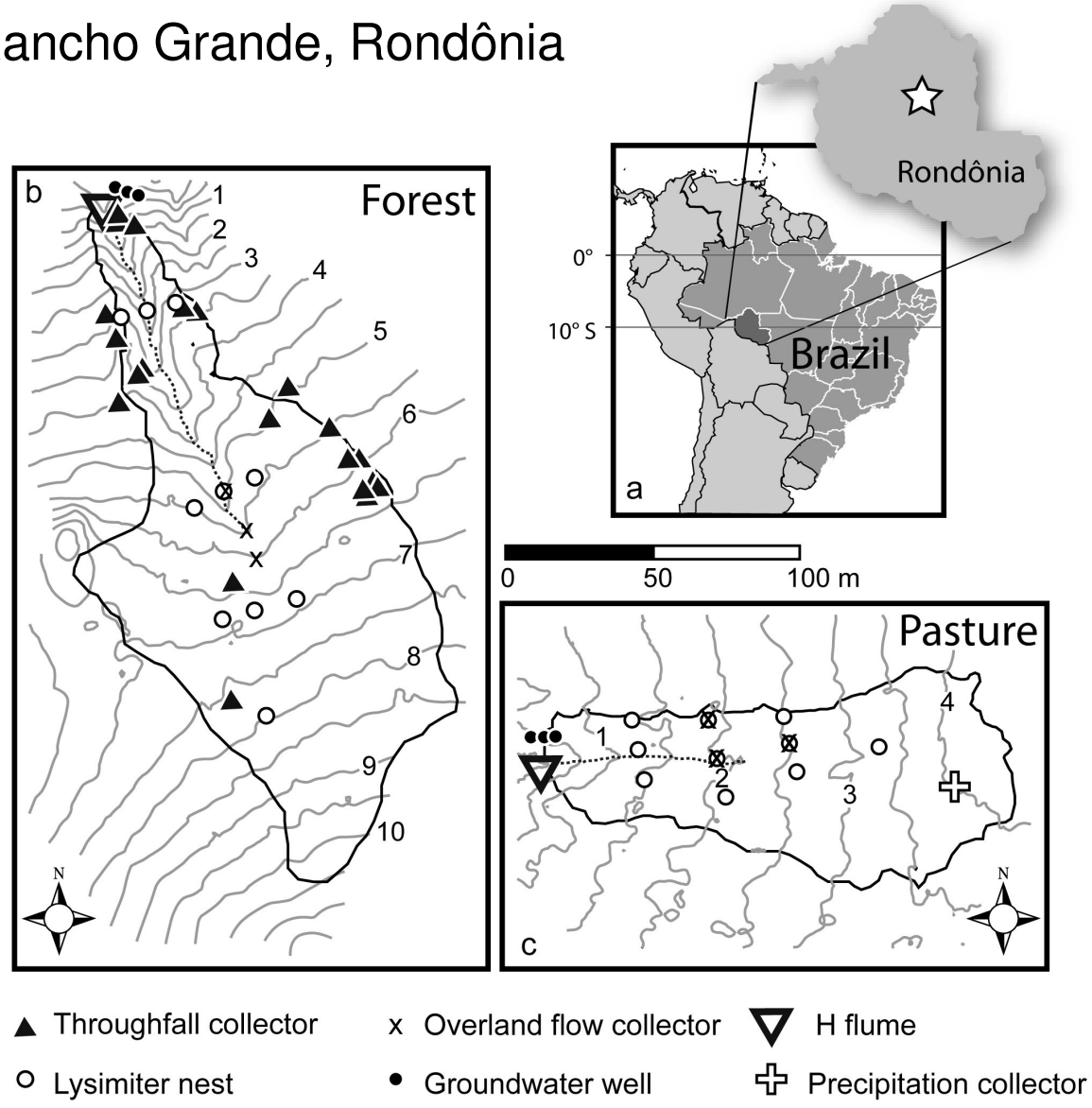
- Comparison of patterns among sites within LBA (ongoing small basin synthesis)



Study site:

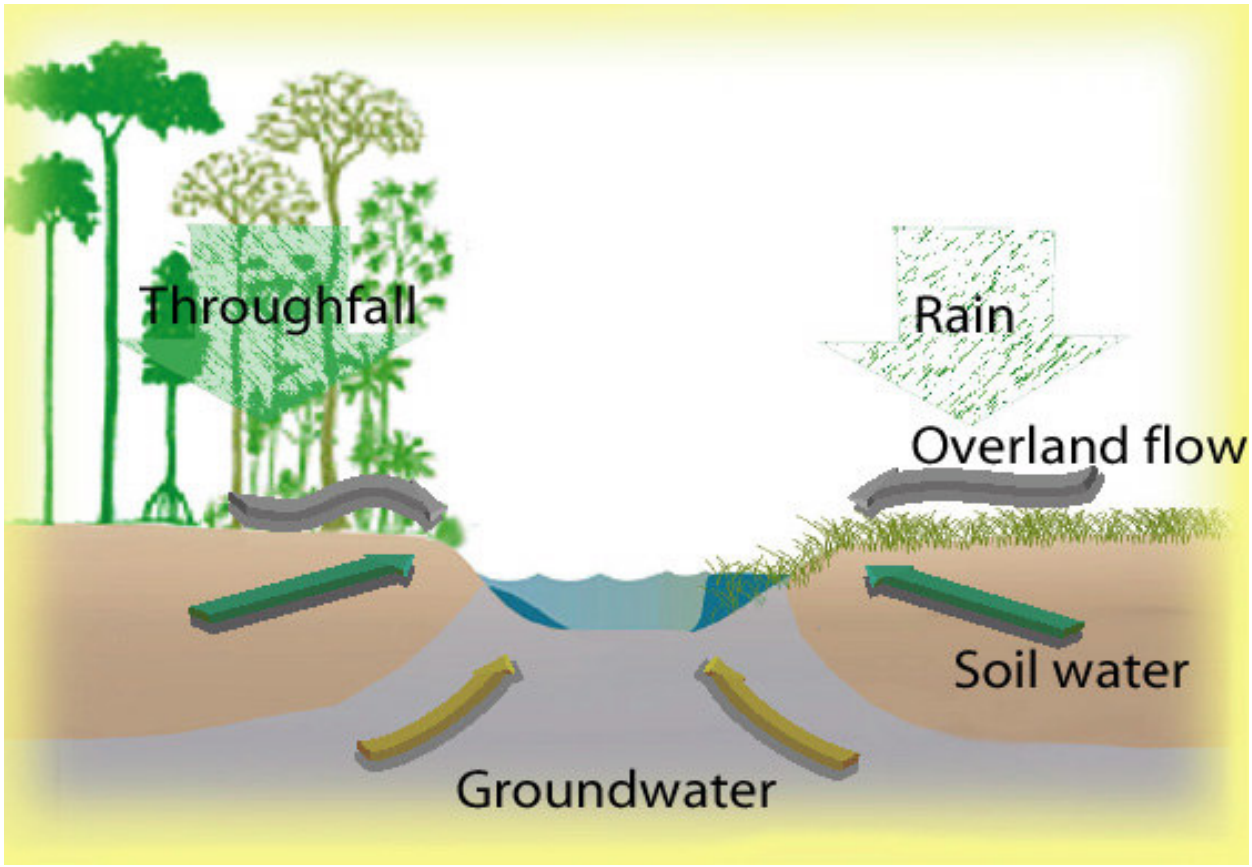
Fazenda Rancho Grande, Rondônia

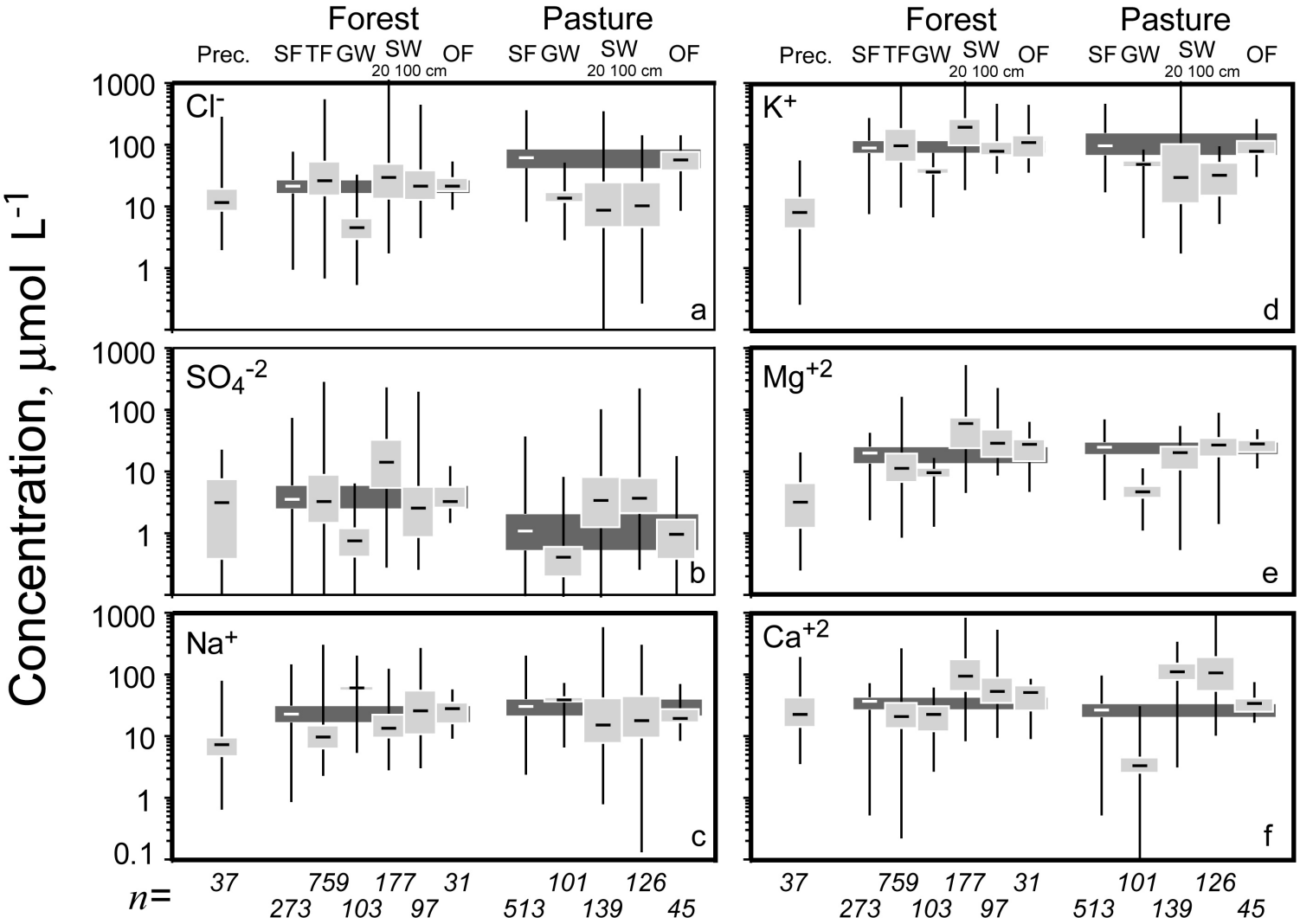
Ultisols



Study site:

Fazenda Rancho Grande, Rondônia

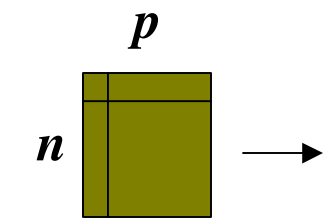



Concentration, µmol L-1
Forest
Pasture
Prec.
SF
TF
GW
SW
20 100 cm
OF
1000
100
10
1
0.1
Cl-
a
SO4-2
b
Na+
c
K+
d
Mg+2
e
Ca+2
f
n=
37
759
177
31
101
126
273
103
97
513
139
45

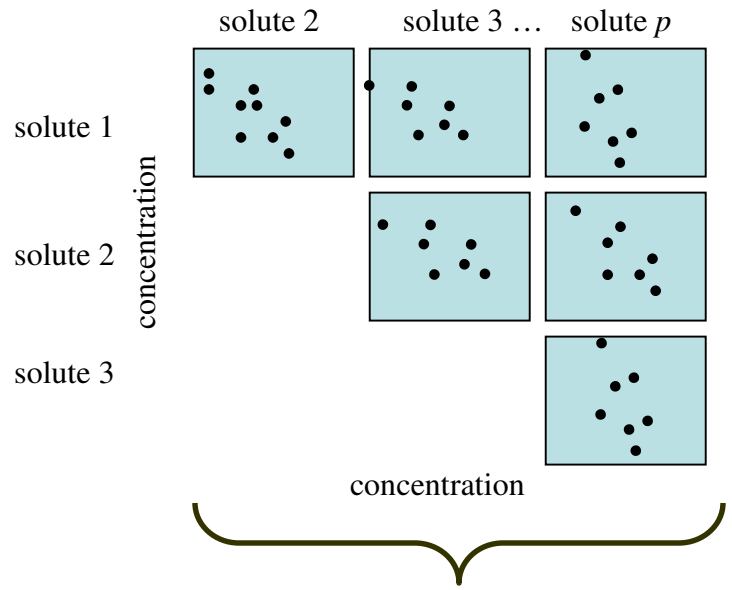
End-Member Mixing Analysis (EMMA)

- Principal Component Analysis (PCA)…*in a nutshell*

Stream water data

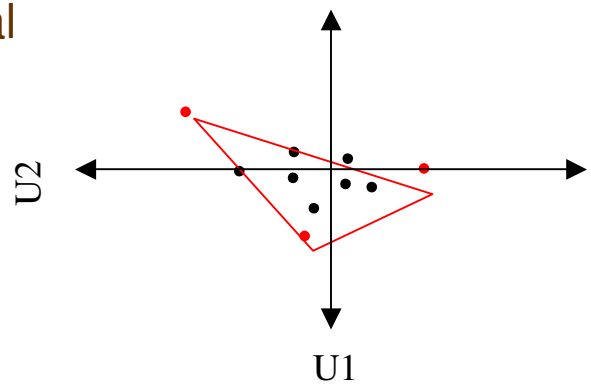


***n** (samples) x **p** (solutes)*



PCA

Lower-dimensional U space



1	1	1	x	=	1
-1.96	7.37	1.36	y		-2.8
-1.15	2.76	-0.88	z		2.6

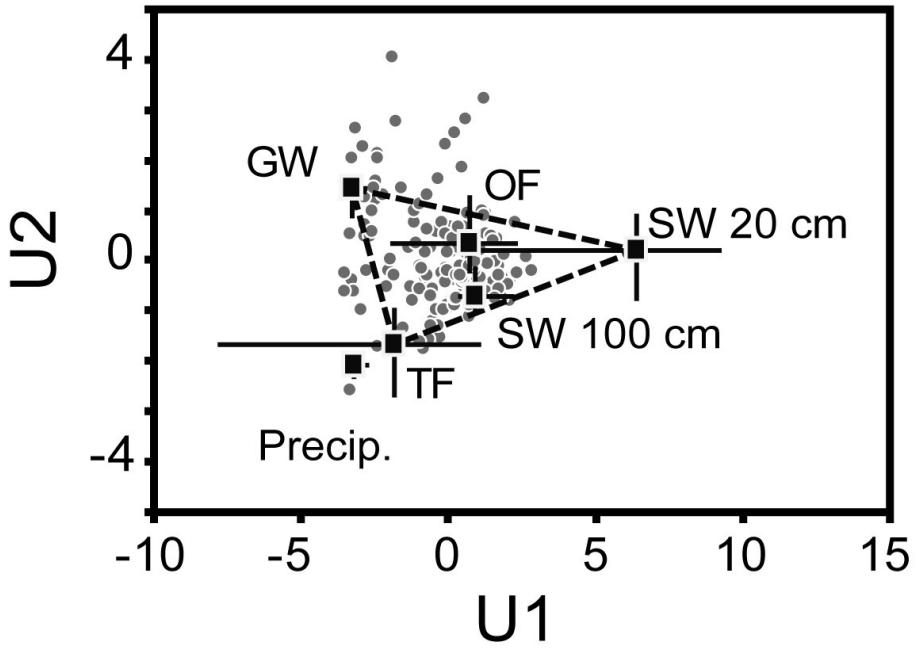
References:

Christophersen, N & Hooper RP **Multivariate Analysis of Stream Water Chemical Data: The Use of Principal Components Analysis for the End-Member Mixing Problem**. Water Resources Research 28: 99–107 (1992)

Hooper RP **Diagnostic tools for mixing models of stream water chemistry.** Water Resources Research 39 : 1055. DOI:10.1029/2002WR001528 (2003)

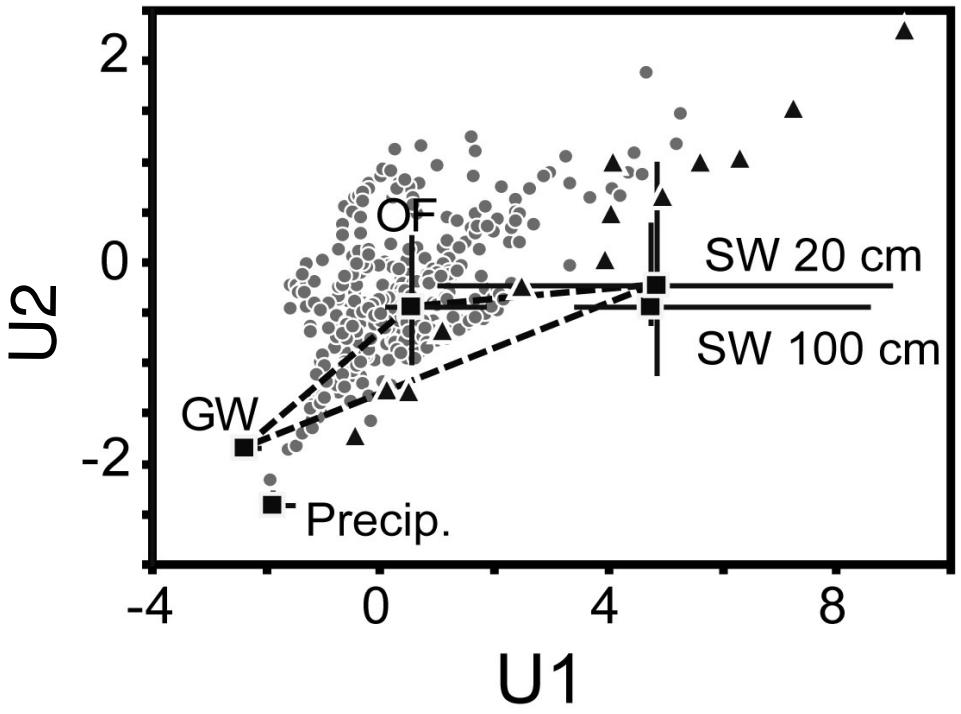
Mixing Diagrams:

Rancho Grande Forest



Mixing Diagrams:

Rancho Grande Pasture

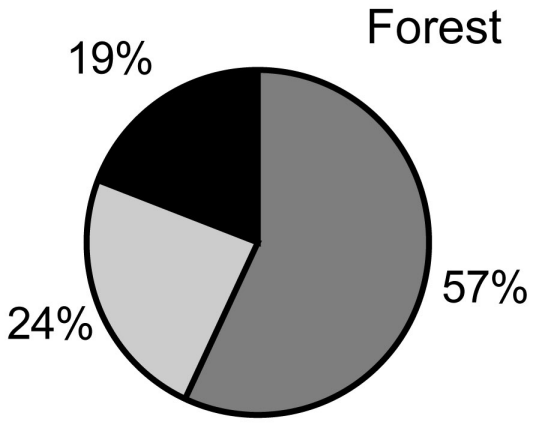


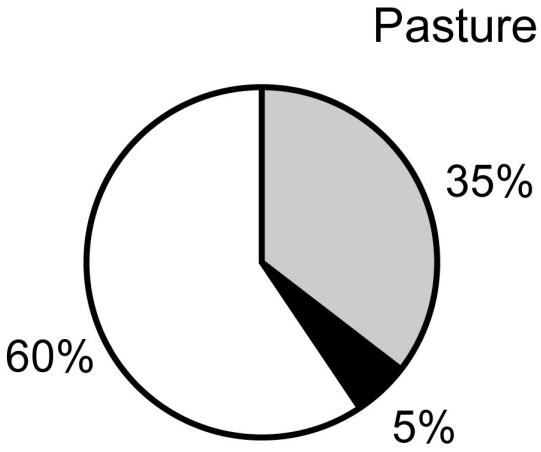
Overall Results:

Rancho Grande Forest

Rancho Grande Pasture

Entire rainy season

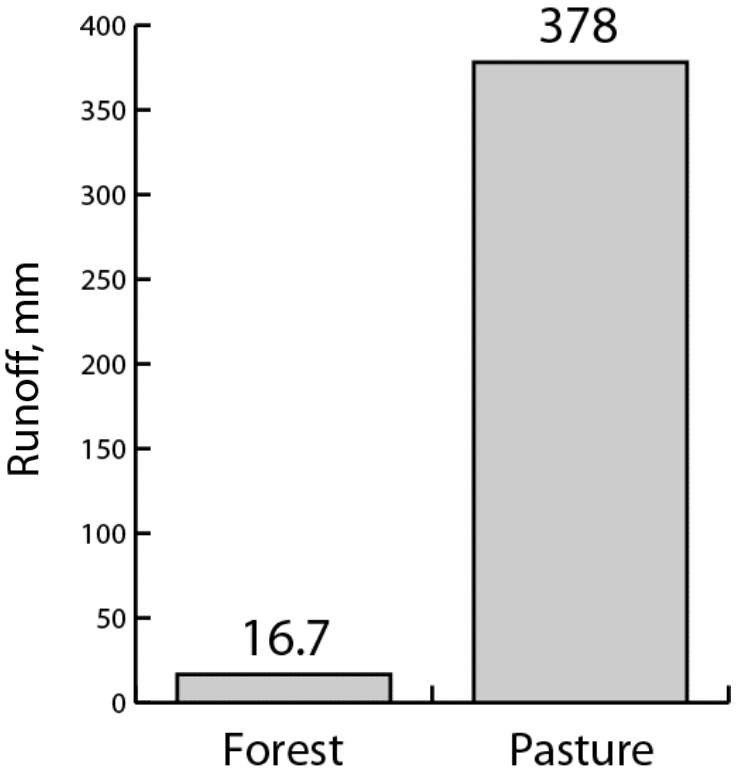




Throughfall Groundwater Soil water Overland flow

How do these patterns change with scale and soils?

Water yields
Rancho Grande

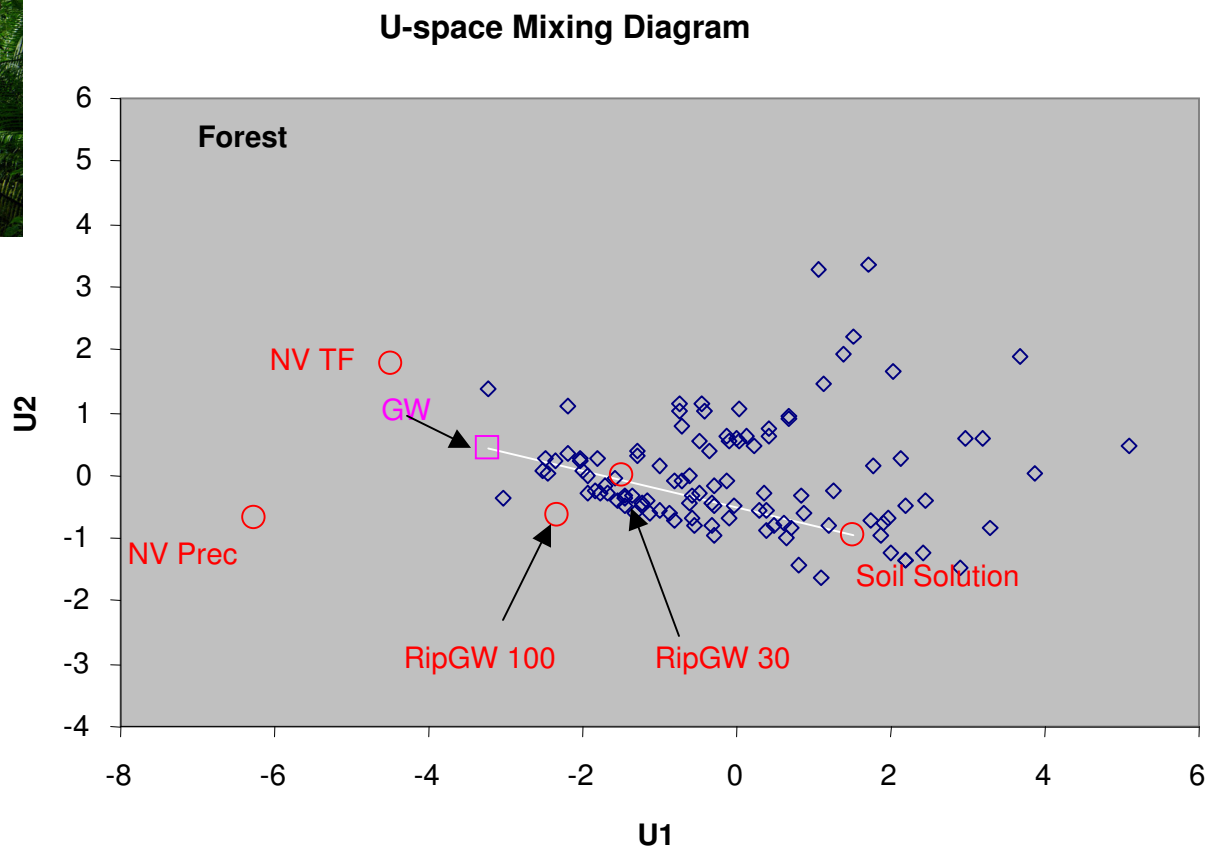


Especially in forest, most water moves into groundwater and enters streams at larger scales

Use This Approach to Look at Larger Scales and Across LBA Sites

Nova Vida Paired Watersheds

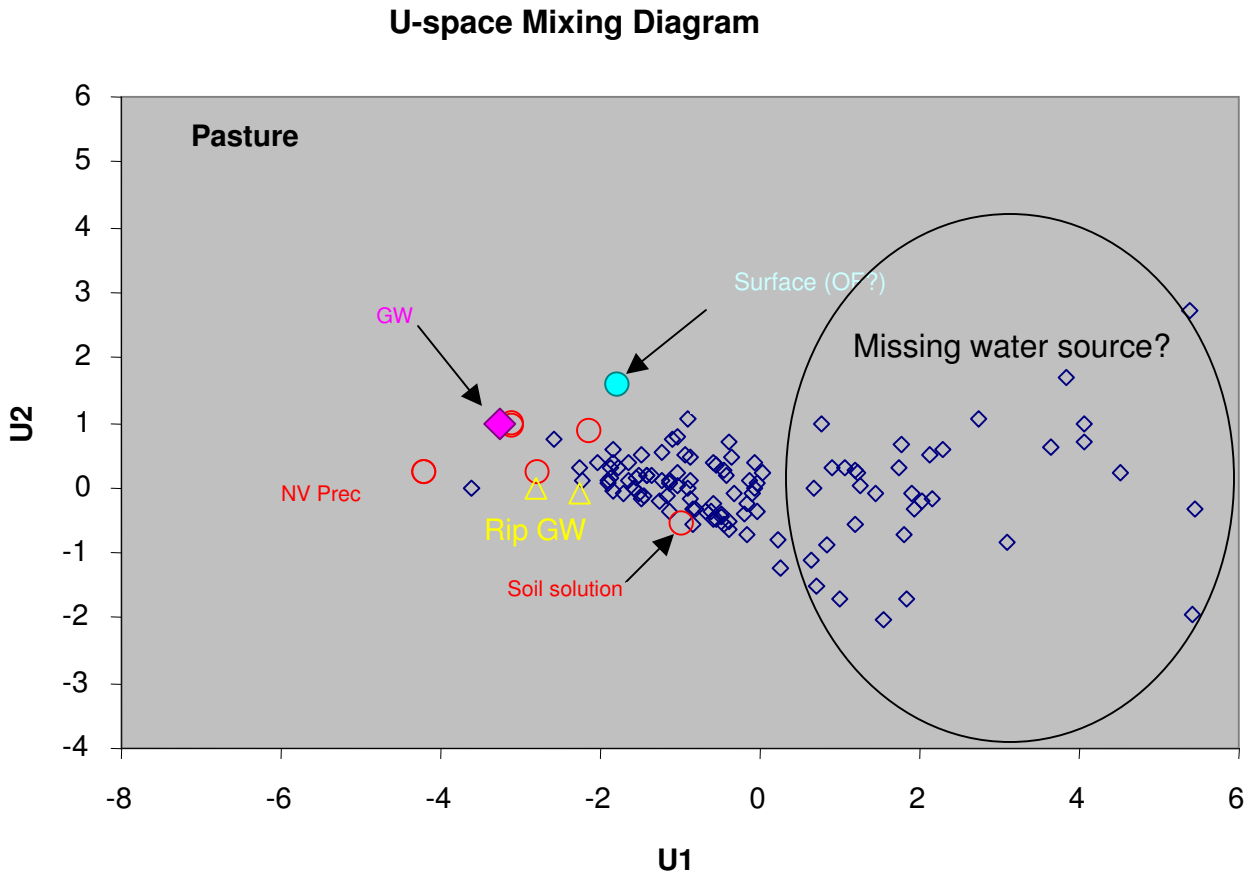
Nova Vida: Forest



Conclusions:

- Soil solution still important as a source of water
- Quick flowpaths delivering throughfall are not
- Riparian zone water looks like mixture of groundwater and soil solution

Nova Vida: Pasture



Conclusions:

- Soil solution still important as a source of water
- Riparian zone water still looks like mixture of groundwater and soil solution
- Appear to be missing some quick flowpaths with different chemistry than the overland flow we sampled

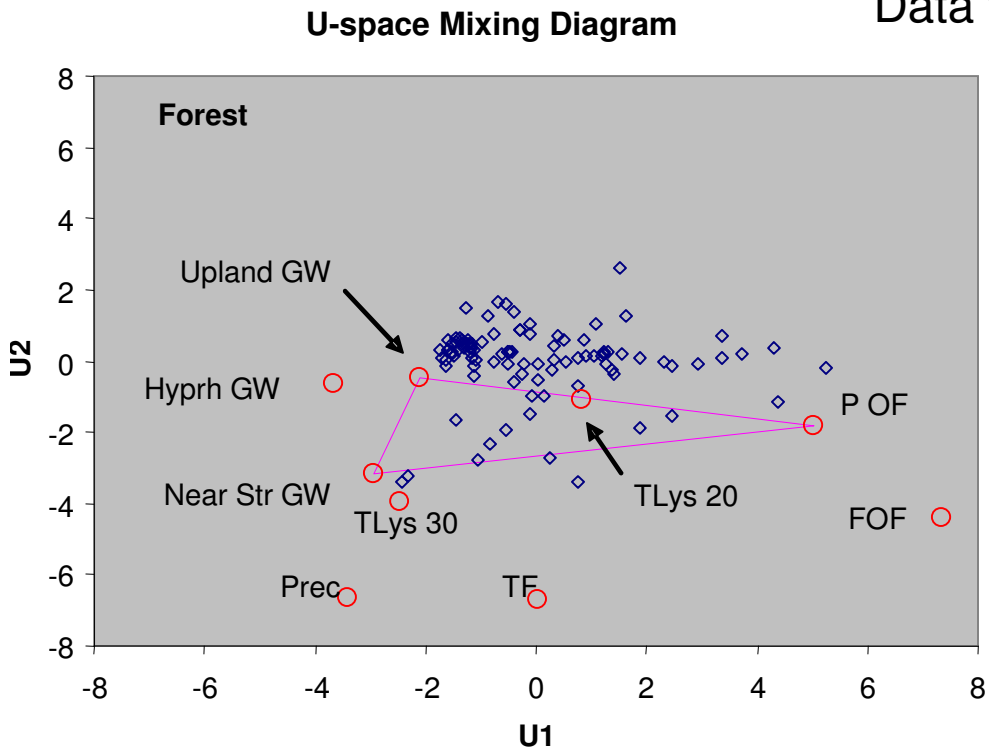
Objectives of Small Basin Cross-Site Synthesis

1. Use EMMA to compare flowpath structure across different sites and scales

2. Use information on flowpath chemistry and EMMA-derived flowpath structure to quantify dominant sites for biogeochemical transformations in relation to soil type and scale

Paragominas: Igarapé 54 (mixed forest and pasture)

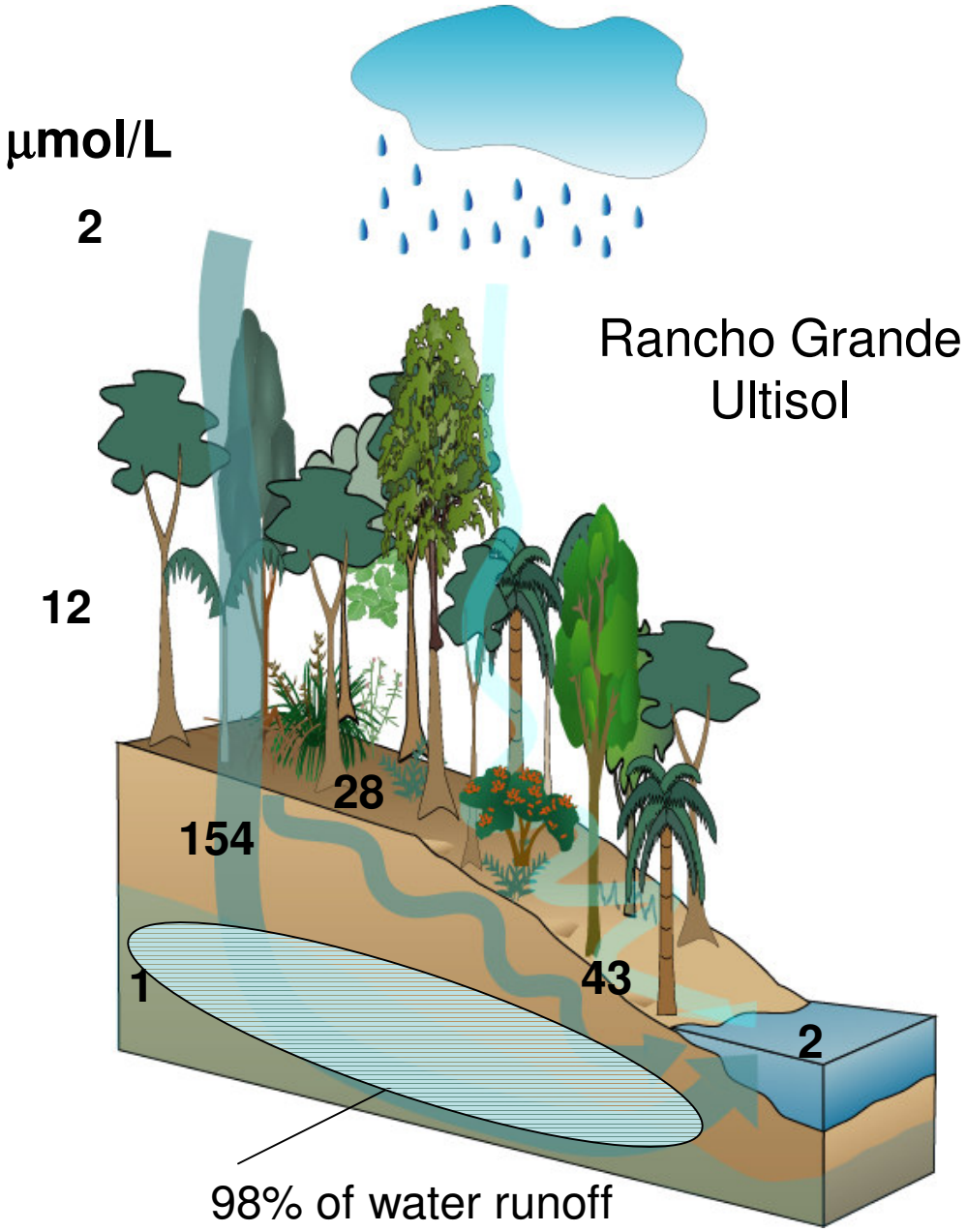
Data from Markewitz et al.



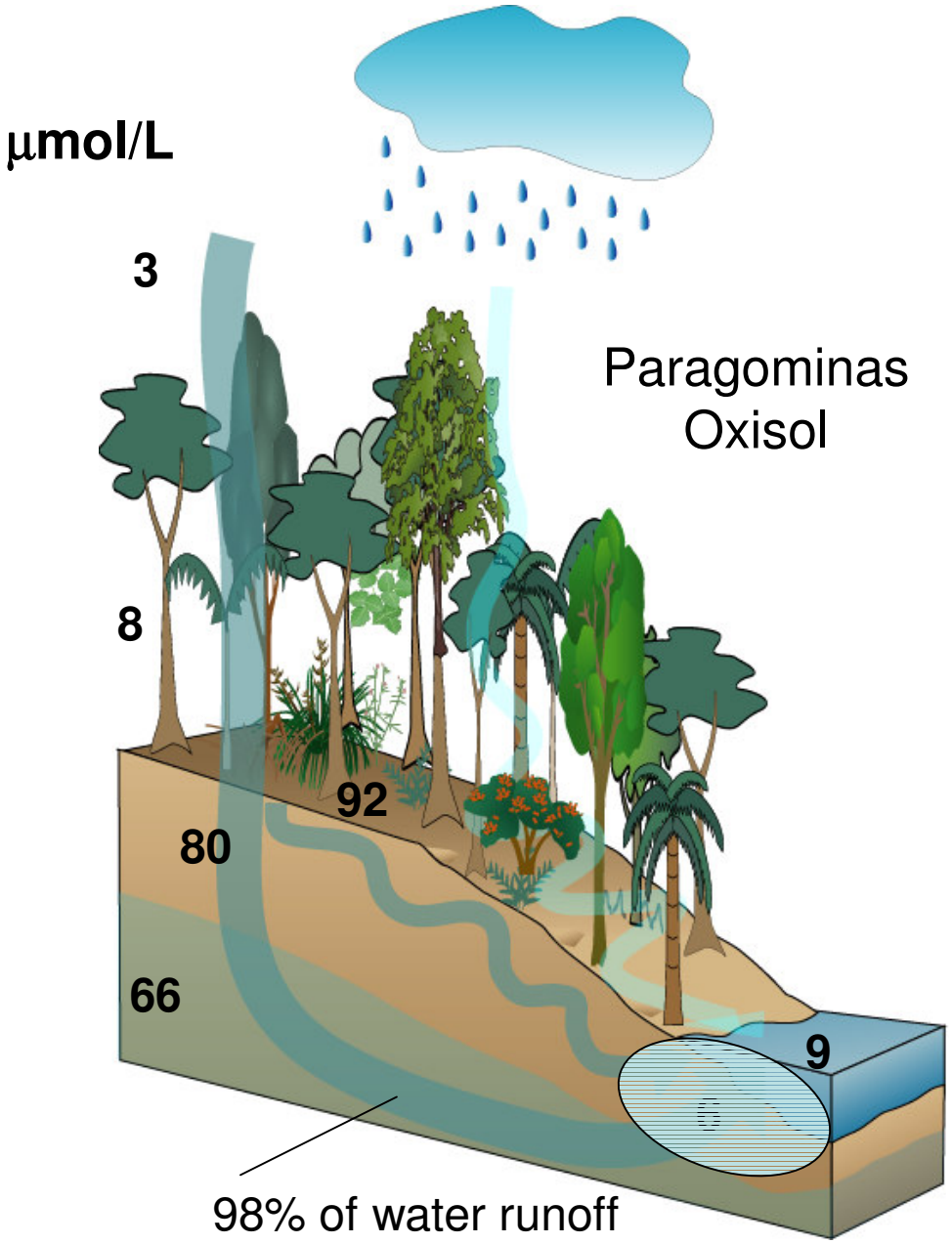
Conclusions:

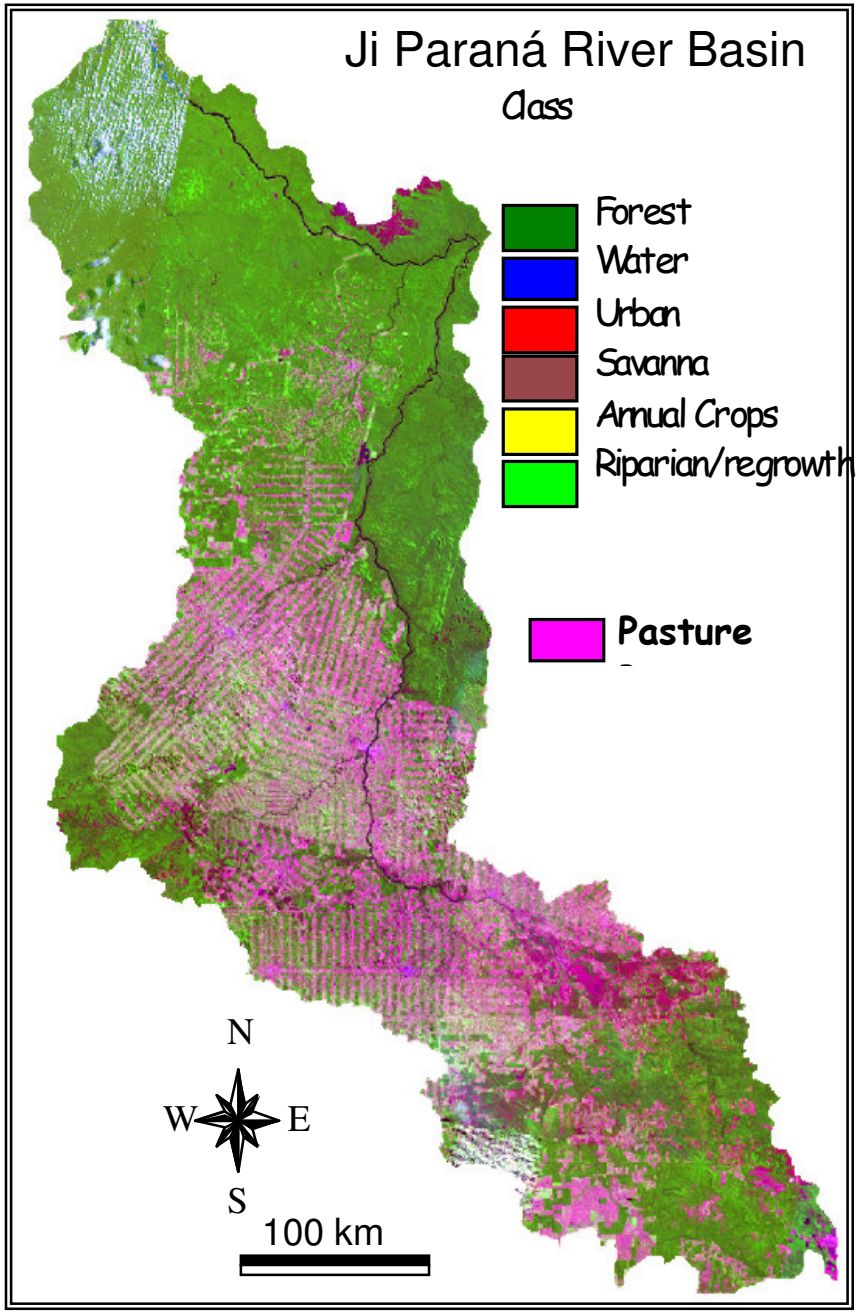
- Ground water dominant source of water
- Pasture overland flow is important contributor to stream flow (consistent with higher Ca, Mg in rainy season)

NO_3^- concentrations—an example



NO_3^- concentrations—an example





Provides a mechanism to map land-water fluxes of water and elements to soils and land use