THE FLUX AND SOURCE OF DISSOLVED ORGANIC AND INORGANIC CONSTITUENTS IN MANAGED HEADWATERS OF THE UPPER GULF COASTAL PLAIN, MISSISSIPPI

Clay Mangum
Dr. Jeff Hatten
Janet Dewey
Byoungkoo Choi

Introduction

- Headwaters are places from which the water in river or stream originates. (USGS)
- Headwater systems contribute water and nutrients to downstream fluvial environments.
- Mississippi has more than 8 million hectares in active forest management much of which is in headwater systems.

Introduction

- Sediments, organic matter, and nutrients such as nitrogen are constituents that frequently lead to impaired rivers in Mississippi.
- The focuses of this research is to examined the source of these materials in headwater systems and how headwaters connect to downstream reaches as well as quantify the flux.

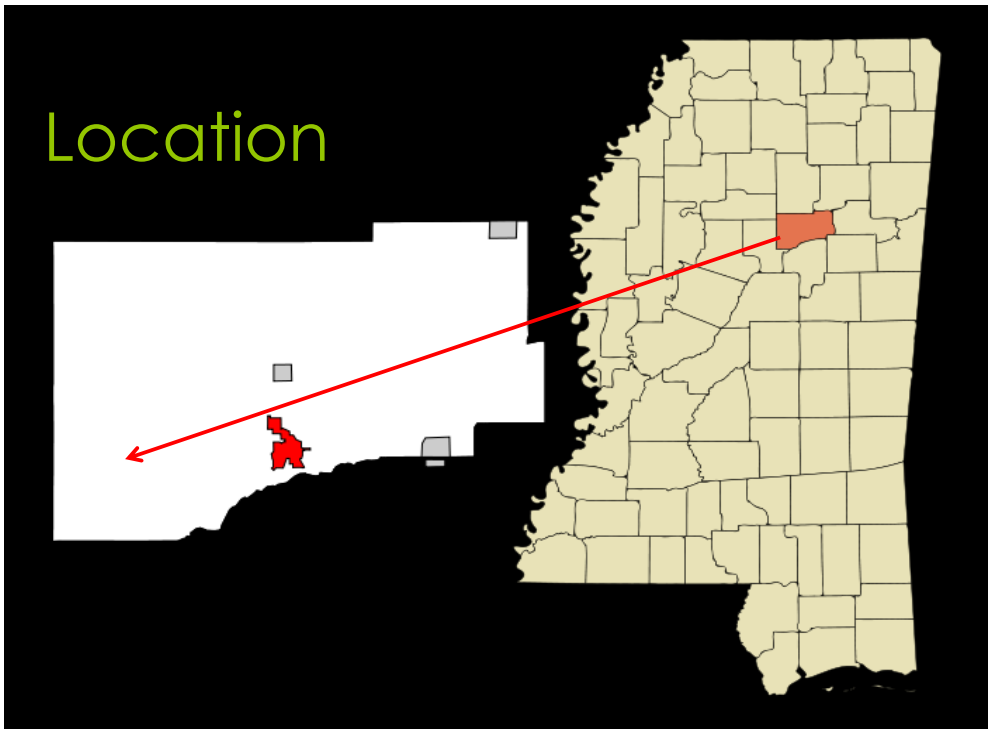
Objectives

- Determine the source of water in streams throughout storm events and seasons.
- Determine the flux of dissolved constituents in ephemeral and perennial streams

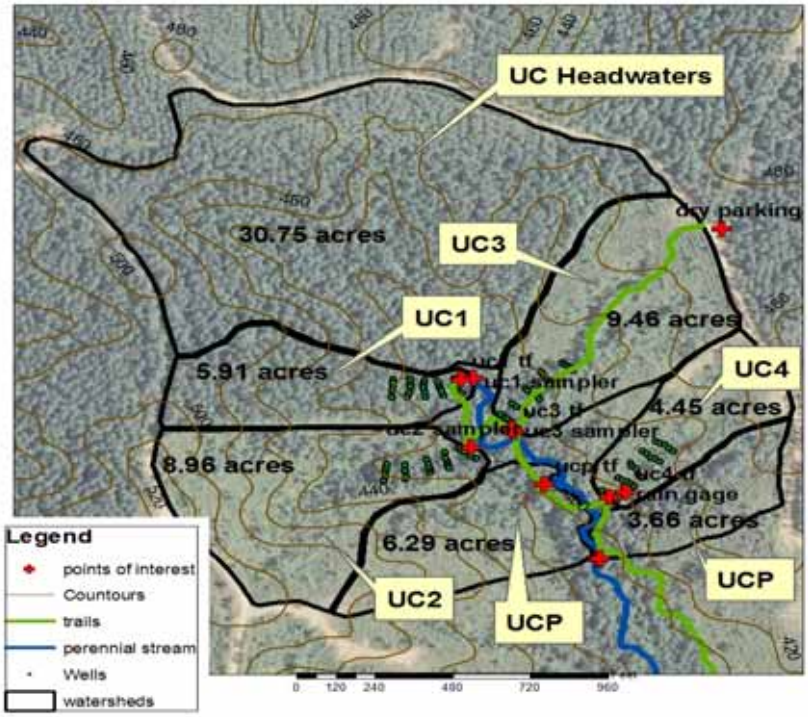
Study Site

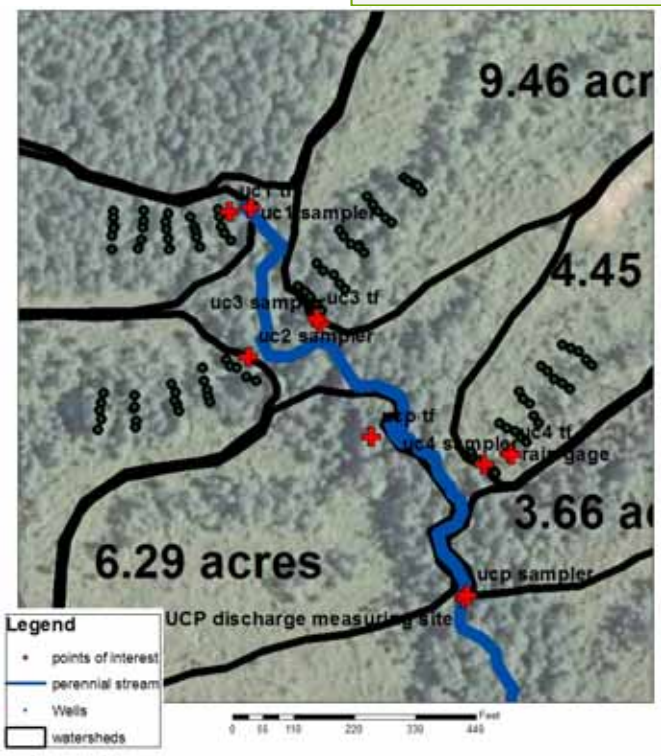
- The site is in Webster County, MS on a small scale headwater system in the Hilly Coastal Plain province. The site has different SMZ treatments.

Location



Study Area


UC Headwaters
30.75 acres
UC3
dry parking
9.46 acres
UC1
5.91 acres
UC4
4.45 acres
8.96 acres
rain gage
3.66 acres
6.29 acres
UC2
UCP
UCP
Legend
points of interest
Countours
trails
perennial stream
Wells
watersheds


9.46 acr
4.45
uc3 tf
uc2 sampler
3.66 a
6.29 acres
ucp sampler
UCP discharge measuring site
Legend
points of interest
perennial stream
Wells
watersheds

UC1

UC2

UC3

UC4

UCP

Instrumentation

- 100 Ground water wells: 25 per treatment
  - 1 to 4 meters in depth
  - 5 rows 20 meters apart with 5 wells per row five meters apart.
- 4 Throughfall buckets
  - 18.9 L acid washed buckets
- 3 Soil solutions
  - O-horizon
  - A-10cm
  - A-20cm

Instrumentation

- 5 discrete ISCO water samplers
- 5 area velocity sensor
- 4 flowloggers
- Sampling structure 4 1.8 m long, 254 mm diameter section of schedule 40 pipe
- 1 stilling well
- Tipping bucket rain gage

Samples and Analysis

- 232 stream (event) samples
- 80 stream grab samples
- 67 well samples
- 48 throughfall samples
- 11 soil solution samples
- Total of 438 samples over 15 months
- February 2010 – May 2011

Lab Analysis

- Samples were filtered through a glass fiber filter (GFF) 0.7µm to leave only dissolved constituents
- After this the samples were split
  - DON, DIN, and UVA- in house
  - DOC sent to UC Davis's Stable Isotope facility

Lab Analysis

- UV absorbance was determined
- DIN was determined DIN=NH_4^+ + NO_3^-
- DON was microwave digested to determine total N. DON = total N (NH_4^+) minus DIN

Lab Analysis

- Dionex Chromotograph
- Anions – Cl^-, NO_2^-, NO_3^-, PO_4^{-3}, SO_4^{-2}

(Chlorine, Nitrite, Nitrate, Phosphate, and Sulfate)

- Cations + Na+, NH4+, K, Mg+2, Ca+

(Sodium, Ammonium, Potassium, Magnesium and Calcium)

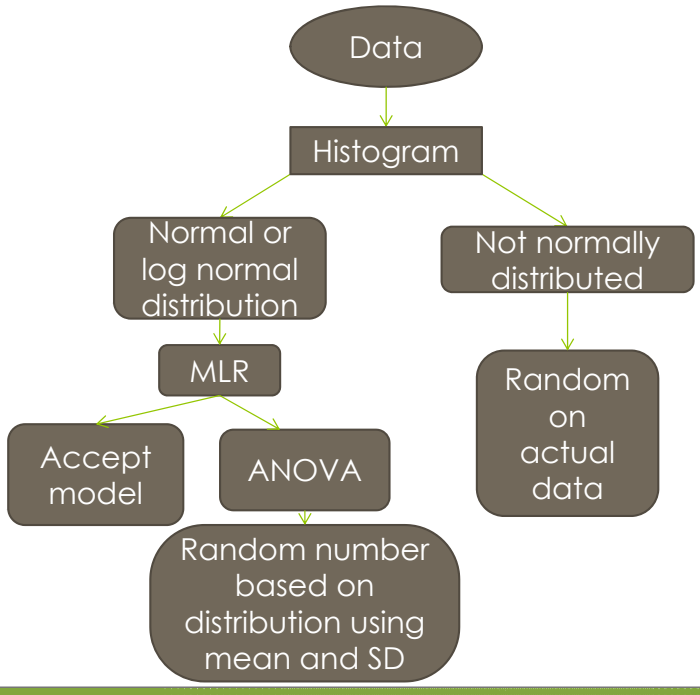
Lab Analysis

- Microwave Digestion

Flux calculation

- Stream samples collected were used to determine flux for DON, NO_3^- -N, NH_4^+-N, DOC and PO_4^{-3}

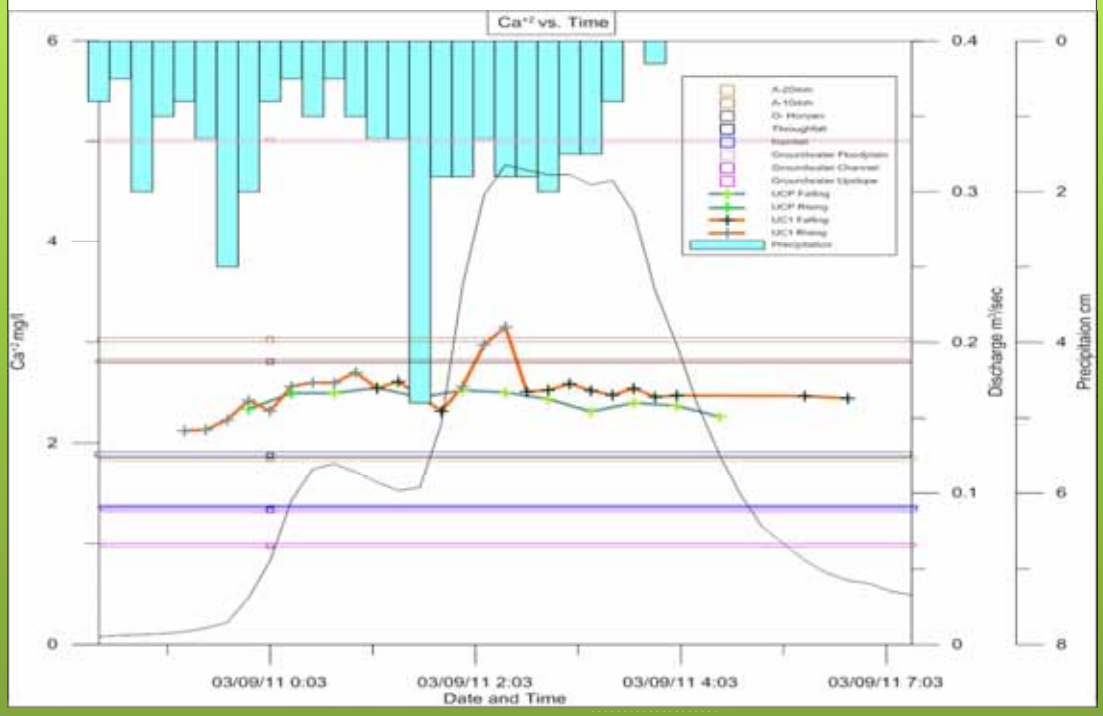
Flux calculation



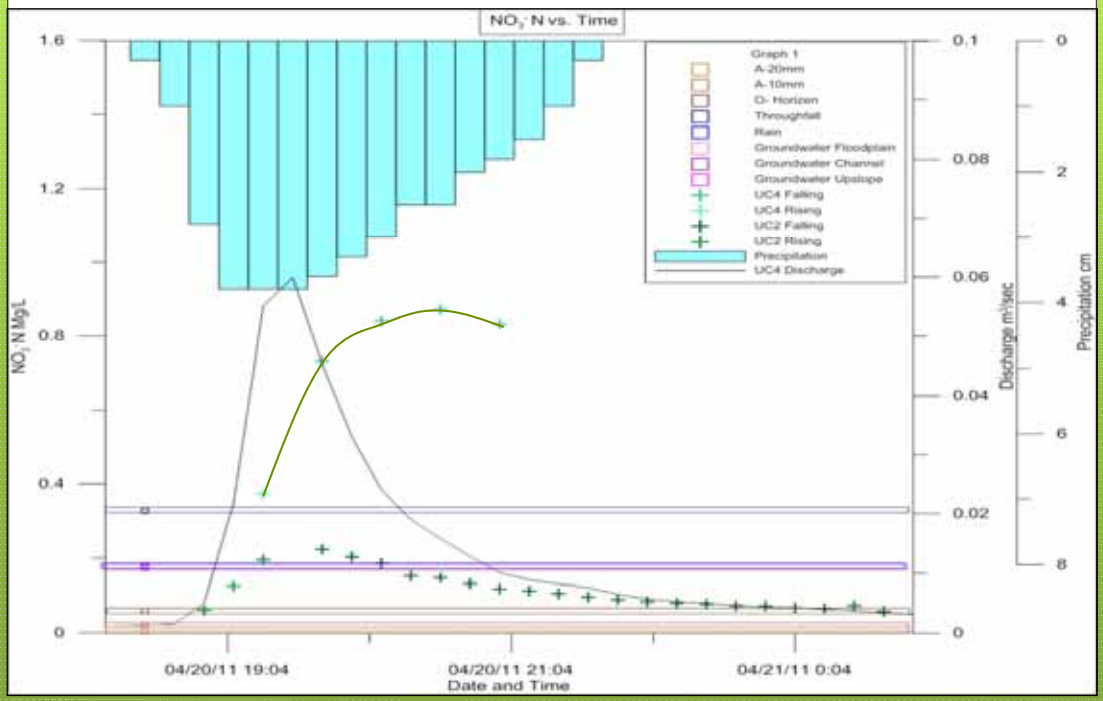
Source determination

- EMMA was used to determine the sources of stream water.
- Principal component analysis (PCA) was used to determine the total number of end members.
- Constituents SO_4^{-2}, Cl^-,Na Mg^{+2},NO3 and UVA were used in PCA.
- Using R 2.14.2

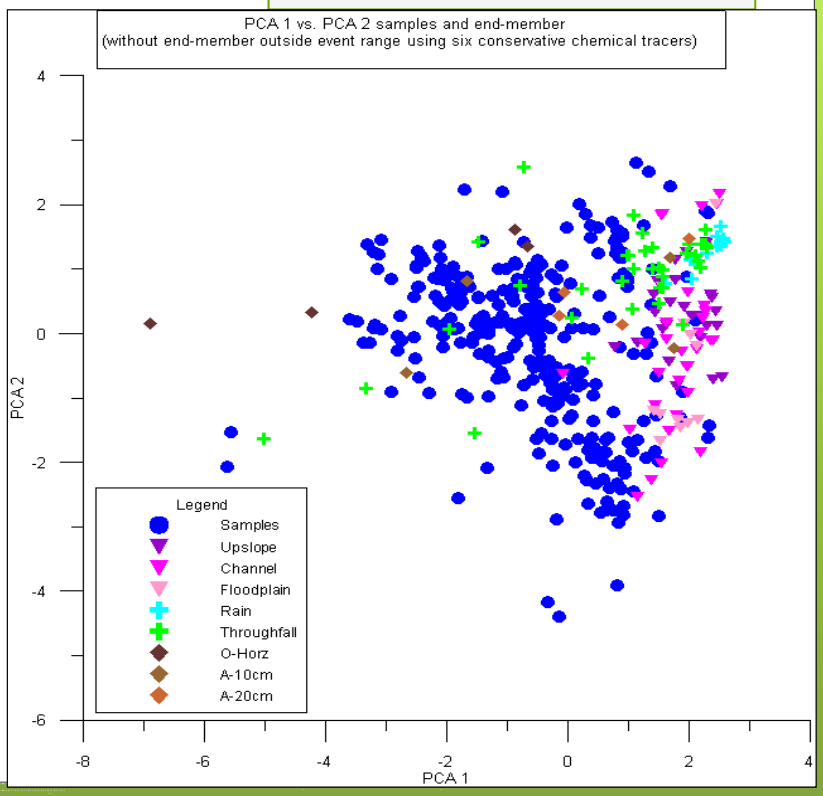
Source

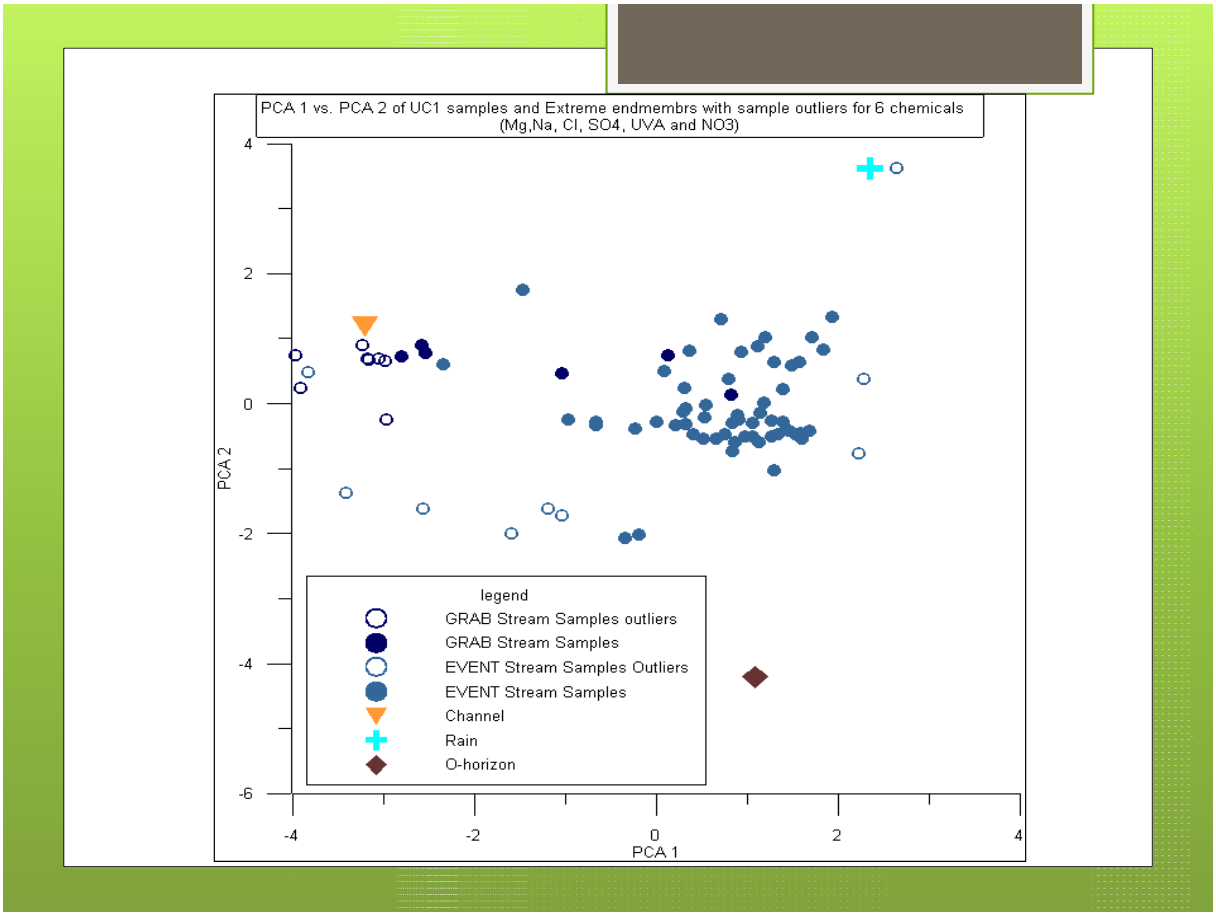


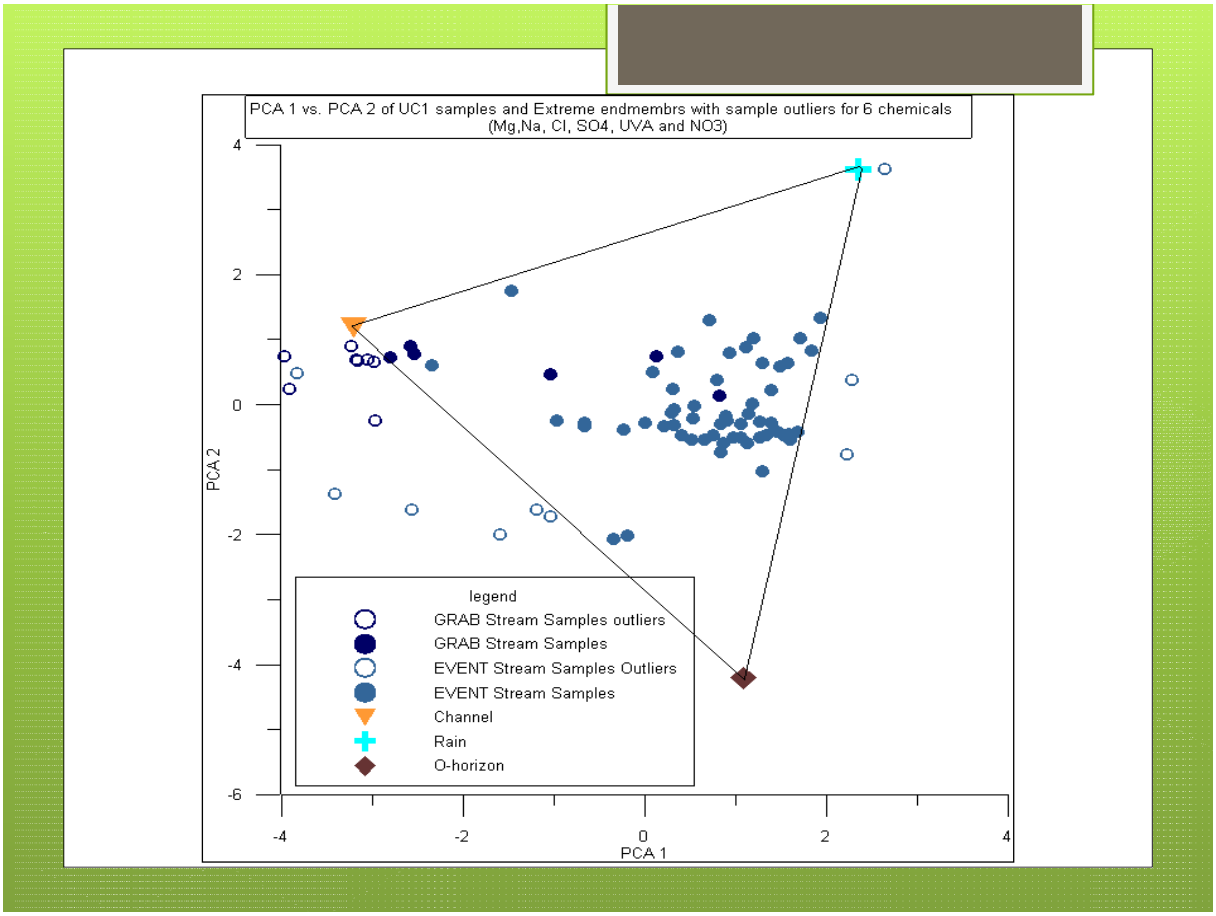
Flux


NO3- N vs. Time
Graph 1
A-20mm
A-10mm
O- Horizen
Throughfall
Rain
Groundwater Floodplain
Groundwater Channel
Groundwater Upslope
UC4 Falling
UC4 Rising
UC2 Falling
UC2 Rising
Precipitation
UC4 Discharge
NO3- N Mg/L
Discharge m3/sec
Precipitation cm
1.6
1.2
0.8
0.4
0
0.1
0.08
0.06
0.04
0.02
0
0
2
4
6
8
04/20/11 19:04
04/20/11 21:04
04/21/11 0:04
Date and Time

PCA


PCA 1 vs. PCA 2 samples and end-member
(without end-member outside event range using six conservative chemical tracers)
PCA 2
PCA 1
4
2
0
-2
-4
-6
-8
-6
-4
-2
0
2
4
Legend
Samples
Upslope
Channel
Floodplain
Rain
Throughfall
O-Horz
A-10cm
A-20cm


PCA 1 vs. PCA 2 of UC1 samples and Extreme endmembrs with sample outliers for 6 chemicals
(Mg,Na, Cl, SO4, UVA and NO3)
PCA 2
PCA 1
4
2
0
-2
-4
-6
-4
-2
0
2
4
legend
GRAB Stream Samples outliers
GRAB Stream Samples
EVENT Stream Samples Outliers
EVENT Stream Samples
Channel
Rain
O-horizon


PCA 1 vs. PCA 2 of UC1 samples and Extreme endmembrs with sample outliers for 6 chemicals
(Mg,Na, Cl, SO4, UVA and NO3)
PCA 2
PCA 1
4
2
0
-2
-4
-6
-4
-2
0
2
4
legend
GRAB Stream Samples outliers
GRAB Stream Samples
EVENT Stream Samples Outliers
EVENT Stream Samples
Channel
Rain
O-horizon

Source

UC1-UCP	EM #1 Channel-Floodplain	EM #2 Rain	EM #3 O-Horizon
EVENT			
Mean	25.85%	39.20%	34.95%
Min	11.94%	21.91%	13.80%
Max	37.48%	53.44%	63.68%
GRAB			
Mean	73.25%	16.66%	10.09%
Min	61.93%	0.53%	0.28%
Max	90.77%	37.79%	33.17%

Yield (kg/ha/yr)

	NO_3^-	DON	PO_4^{-3}	NH_4^+	DOC
Ephemeral	0.421	7.851	0.255	1.053	133.500
Perennial	0.694	7.482	0.233	0.983	67.256

82% to 84% is organic nitrogen
77% of all nitrogen is DON

Acknowledgments

- Dr. Robert Kröger, and Dr. Ying Ouyang
- Amanda Mangum
- Jay Mack, Joanna McGinnis and Bryce May

Sponsors

Questions