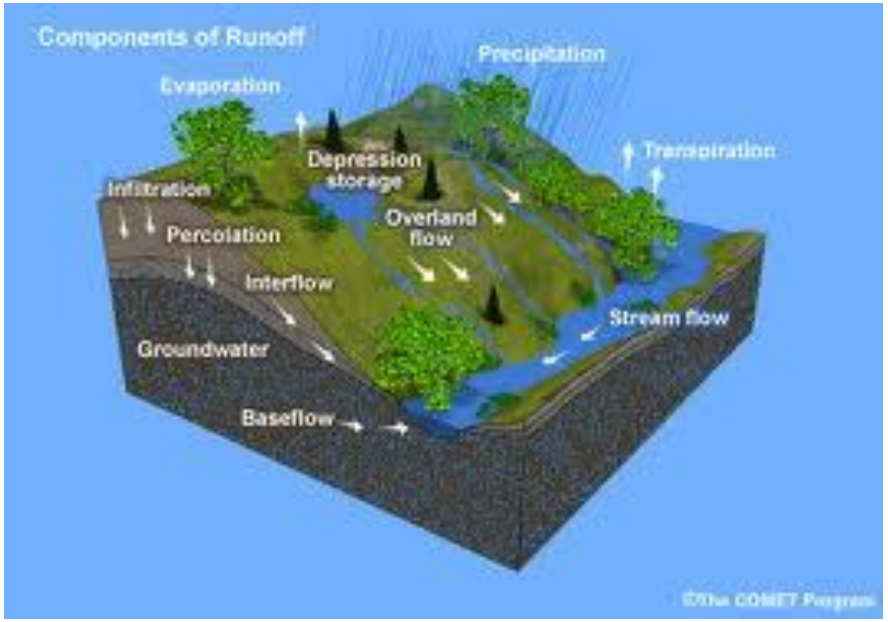
The Response of Different Soil Types to Precipitation Events over Contrasting Soil Moisture Conditions

CE 394K TERM PROJECT

By: Nathan Meyer



Introduction

Task: Analyzing how runoff and vadose zone retention varies over different soil types.

Hypothesis: Drier soil are able to hold more precipitation than saturated, tightly packed soils, decreasing the runoff and increasing infiltration

Methods:

- A robust dataset of **Soil Water Content** measurements over time is key
- Compare **Inputs** and **Outputs** of a small watershed.
- Create a **Budget** to quantitatively assess the retention ability of the soils.

Data Gathering and Background

Long Term Ecological Research Sites
(LTER)

Harvard Forest LTER

Coweeta LTER

Data and Processing

1.) NHDPlus

- Watershed Area
- Streamlines
- Gauging Stations
- Elevation Data

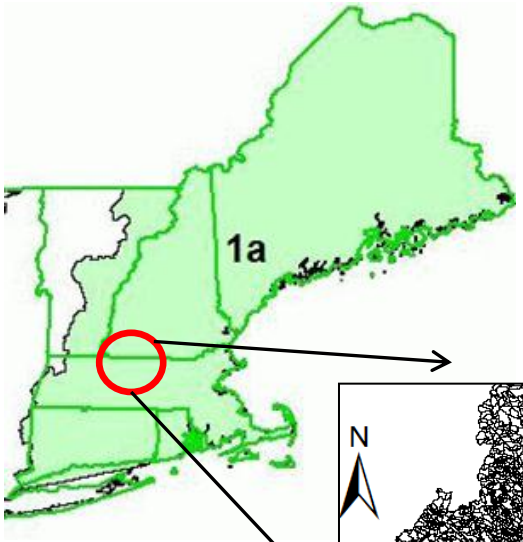
2.) UC Davis Soil Resource Laboratory

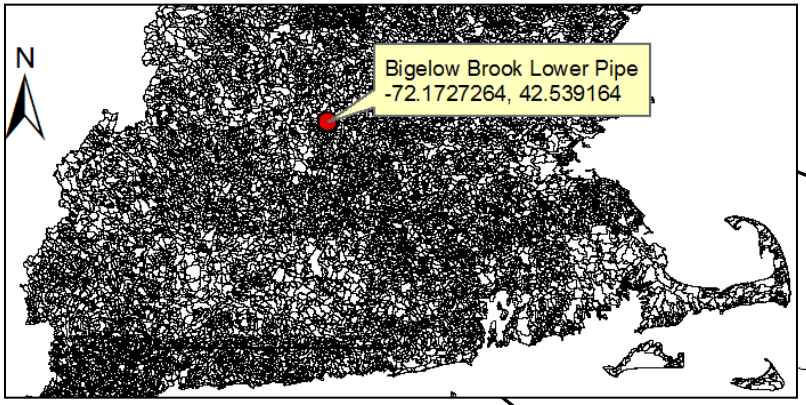
- US Soil Survey data (SSURGO)
- Google Earth Survey Browser

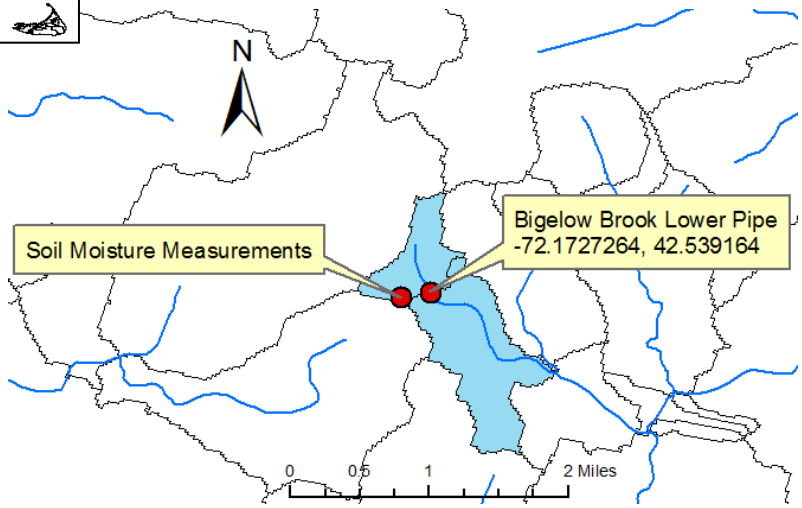
3.) LTER Localized Data Sets

- Hydrographs
- Precipitation
- Soil Moisture
- Additional GIS Data Sets

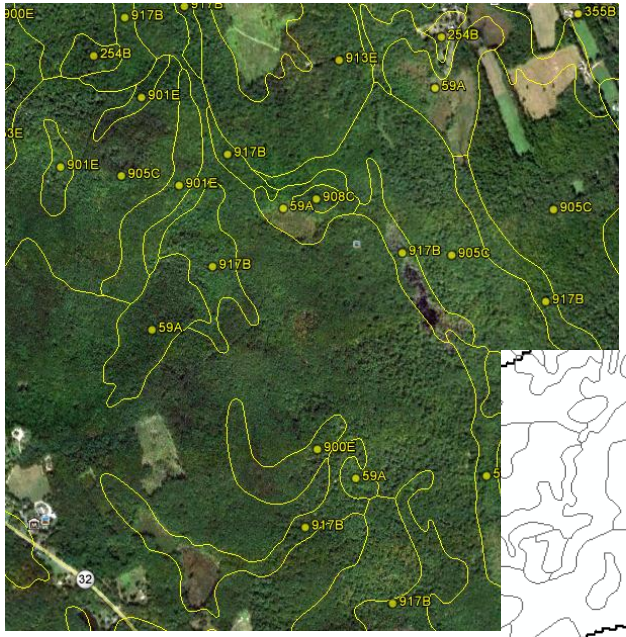
Local Watershed Designation







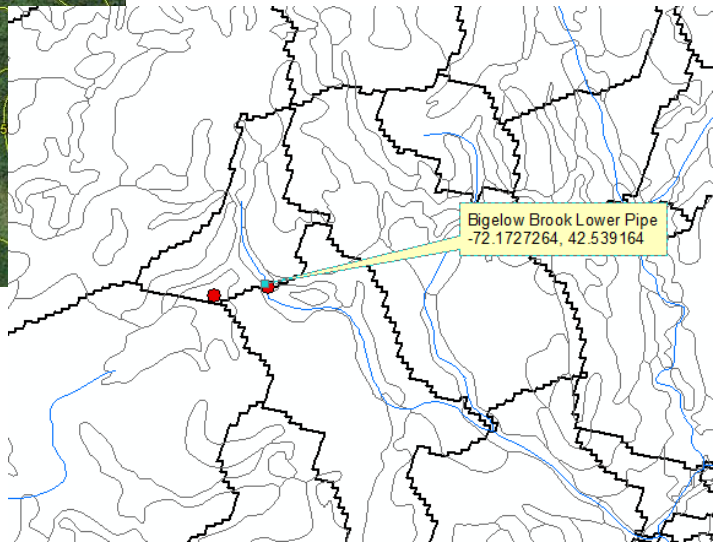
Soil Series KML to Feature

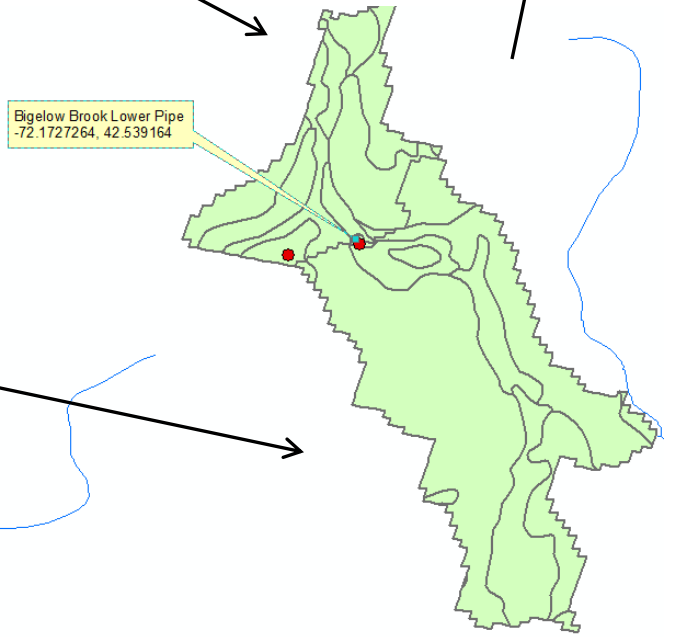


Table

intersect

PopupInf_1	Shape_Le_1	Shape_Ar_1	COMID_1_13	realarea
	0.009745	0.000002	0	0.021863
	0.022209	0.00001	0	0.06342
	0.057397	0.000051	0	0.065999
	0.545998	0.000572	0	0.108092
	0.017922	0.000006	0	0.002467
	0.048703	0.000046	0	0.00388
	0.021635	0.000011	0	0.029918

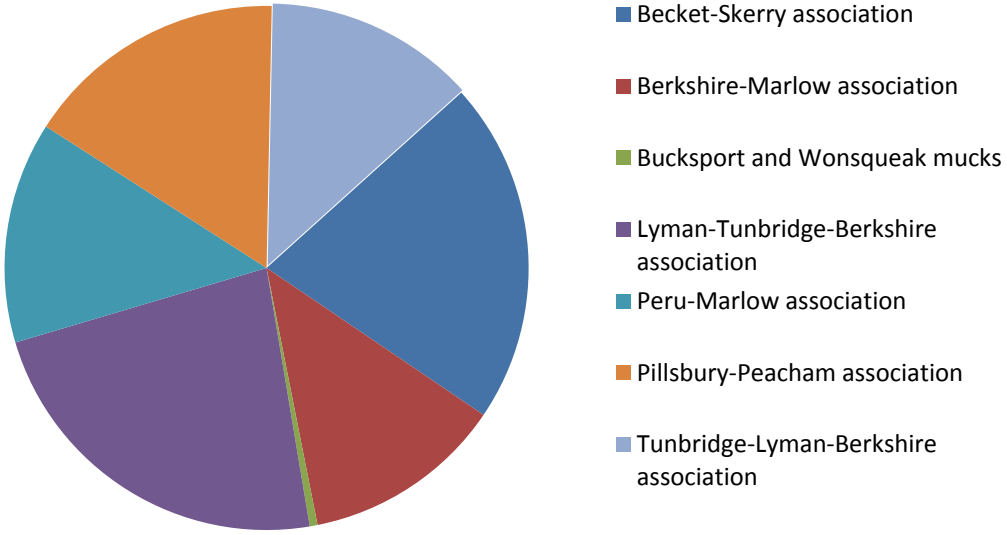




Tools:

- KML to Feature
- Reproject all into North America Albers Equal Area Conic
- Use Intersect Tool to join feature classes
- Use Calculate Geometry to find area of soil in watershed

Harvard LTER Soils



Soil Series	% Area
Lyman-Tunbridge-Berkshire association	23.05
Becket-Skerry association	21.15
Pillsbury-Peacham association	16.24
Peru-Marlow association	13.68
Tunbridge-Lyman-Berkshire association	13.03
Berkshire-Marlow association	12.41
Bucksport and Wonsqueak mucks	0.48

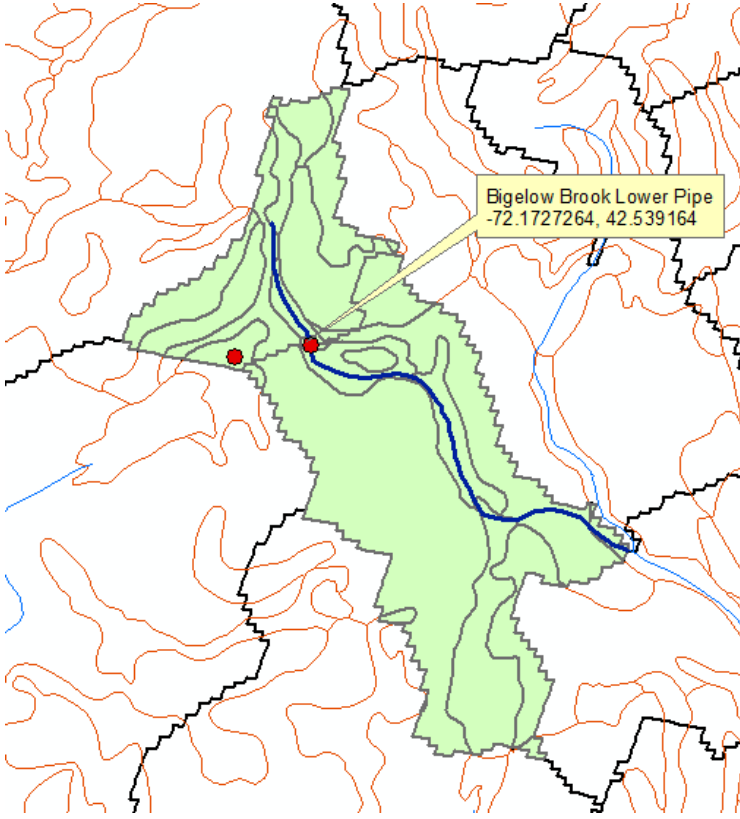
Soil Orders

- Spodosols
- Inceptisols

Data sets to use:

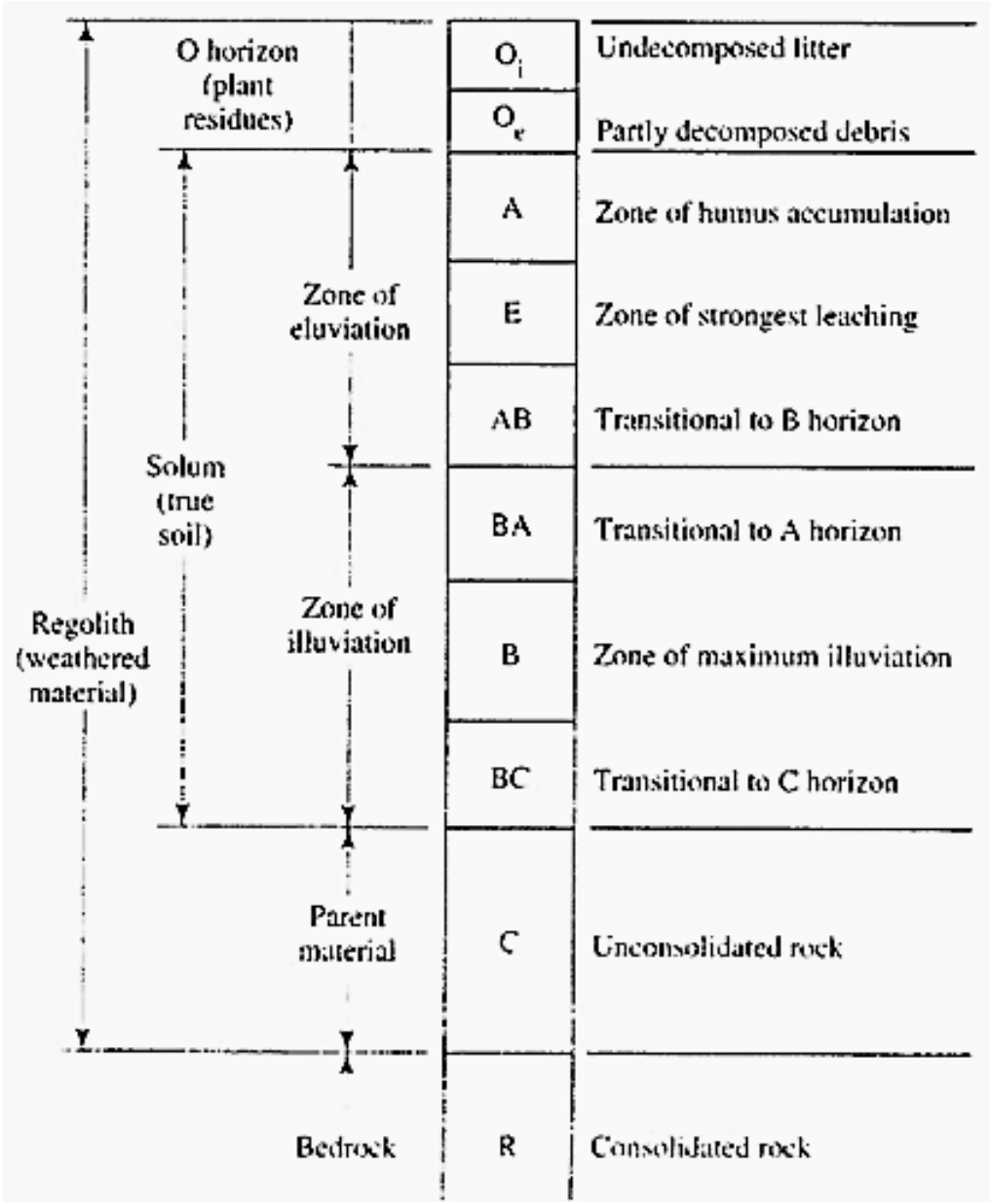
Soil Moisture: HEM Tower HF153-09
Hydrograph: Prospect Hill Hydrological Stations HF070
Dates: 4/26- 7/11/2006
Total Area: 0.51 km^2

Note: Several soil series within this watershed are described as very rocky



Soils


Oie
Oa
E
Bh
Bs1
Bs2
C

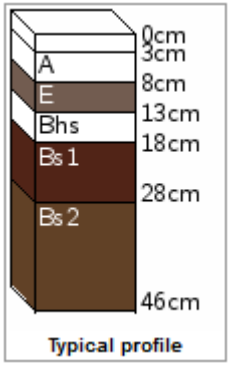

O horizon (plant residues)
Zone of eluviation
Solum (true soil)
Zone of illuviation
Regolith (weathered material)
Parent material
Bedrock
O_i
Undecomposed litter
O_e
Partly decomposed debris
A
Zone of humus accumulation
E
Zone of strongest leaching
AB
Transitional to B horizon
BA
Transitional to A horizon
B
Zone of maximum illuviation
BC
Transitional to C horizon
C
Unconsolidated rock
R
Consolidated rock

Harvard LTER

Lyman-Turnbridge-Berkshire

Soil Taxonomy

Order:	*Spodosols*
Suborder:	*Orthods [Map of Suborders]*
Greatgroup:	*Haplorthods*
Subgroup:	*Lithic Haplorthods*
Family:	*Loamy, mixed, frigid Lithic Haplorthods*
Soil Series:	*Lyman (Link to OSD) (Link to SM Tool)*



Typical profile

Spodosols

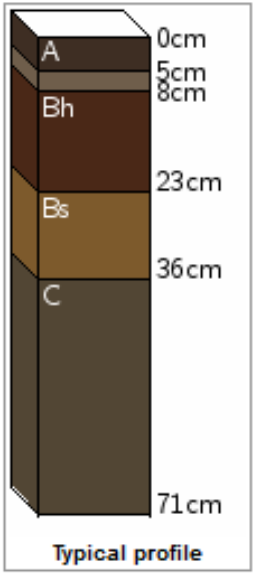
Spodosols are acid soils characterized by a subsurface accumulation of humus that is complexed with Al and Fe. These photogenic soils typically form in coarse-textured parent material and have a light-colored E horizon overlying a reddish-brown spodic horizon. The process that forms these horizons is known as *podzolization*.

Spodosols often occur under coniferous forest in cool, moist climates. Globally, they occupy ~4% of the ice-free land area. In the US, they occupy ~3.5% of the land area.

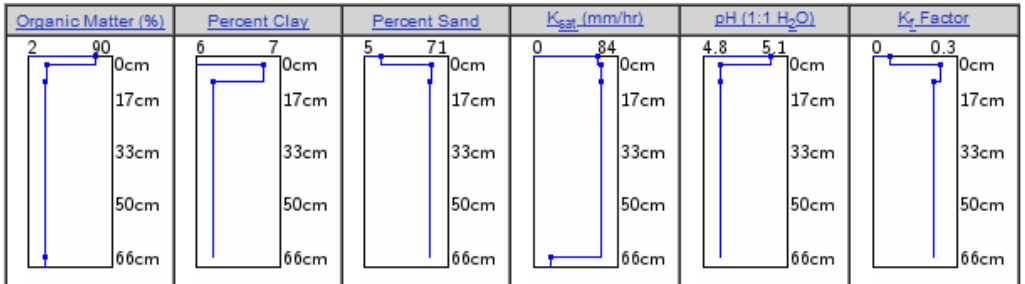
Many Spodosols support forest. Because they are naturally infertile, Spodosols require additions of lime in order to be productive agriculturally.

Soil Taxonomy

Order:	*Spodosols*
Suborder:	*Orthods [Map of Suborders]*
Greatgroup:	*Haplorthods*
Subgroup:	*Typic Haplorthods*
Family:	*Coarse-loamy, mixed, frigid Typic Haplorthods*
Soil Series:	*Tunbridge (Link to OSD) (Link to SM Tool)*

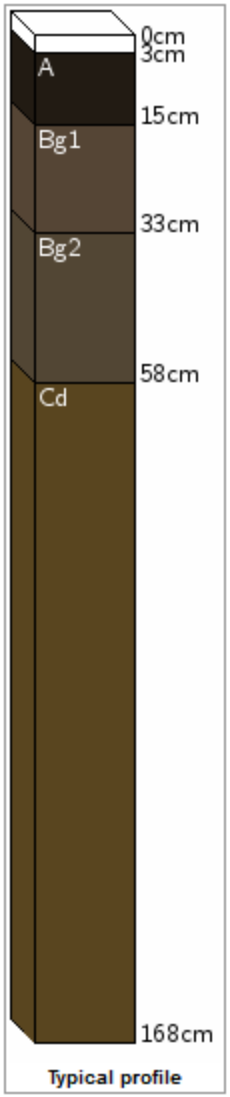


Typical profile



Harvard LTER

Pillsbury-Peachum



Soil Taxonomy

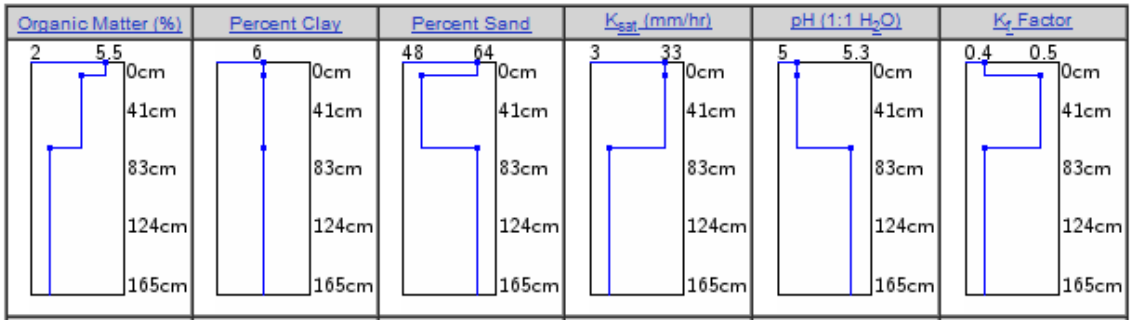
Order:	*Inceptisols*
Suborder:	*Aquepts* [Map of Suborders]
Greatgroup:	*Haplaquepts*
Subgroup:	*Aeric Haplaquepts*
Family:	*Coarse-loamy, mixed, acid, frigid Aeric Haplaquepts*
Soil Series:	*Pillsbury* (Link to OSD) (Link to SM Tool)

Inceptisols

Inceptisols are soils that exhibit minimal horizon development. They are more developed than Entisols, but still lack the features that are characteristic of other soil orders.

Although not found under aridic climate regimes, Inceptisols nevertheless are widely distributed and occur across a wide range of ecological settings.They are often found on fairly steep slopes, young geomorphic surfaces, and on resistant parent materials. Land use varies considerably with Inceptisols. A sizable percentage of Inceptisols are found in mountainous areas and are used for forestry, recreation, and watershed.

Inceptisols occupy an estimated 15% of the global ice-free land area – only the Entisols are more extensive. In the US, they occupy ~9.7% of the land area. Inceptisols support ~20% of the world's population, the largest percentage of any of the soil orders.



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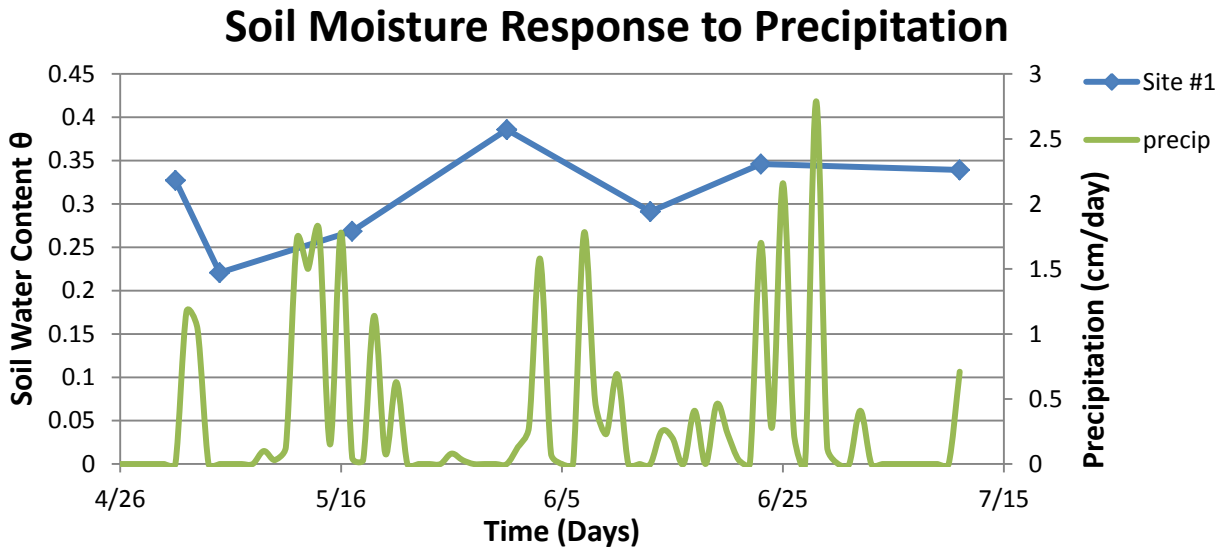
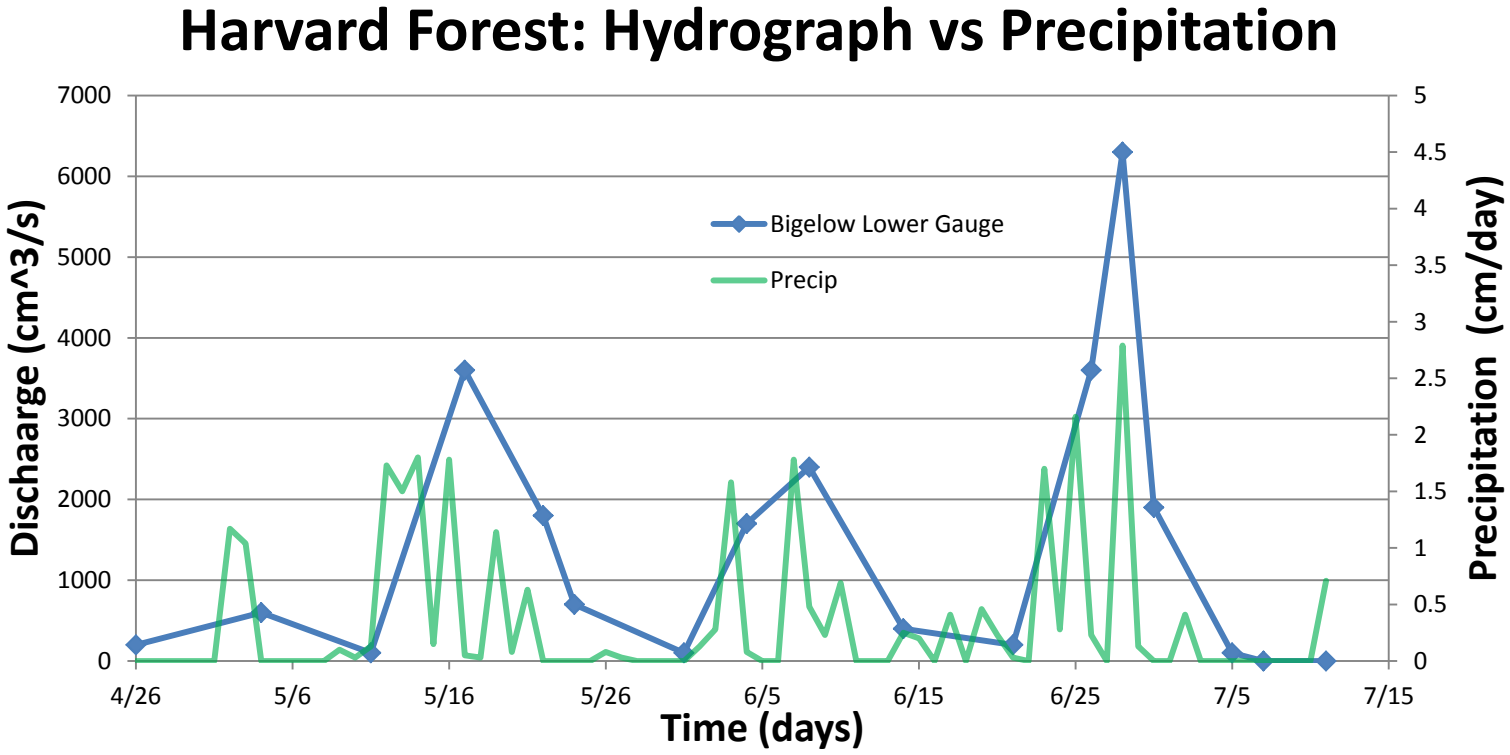
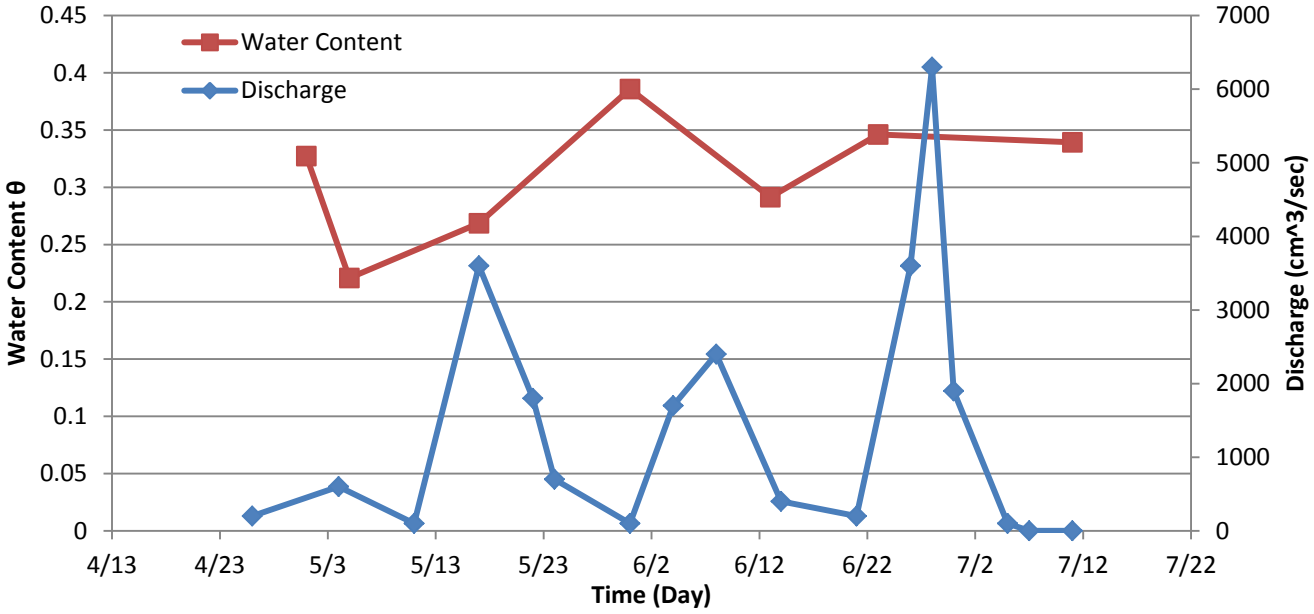


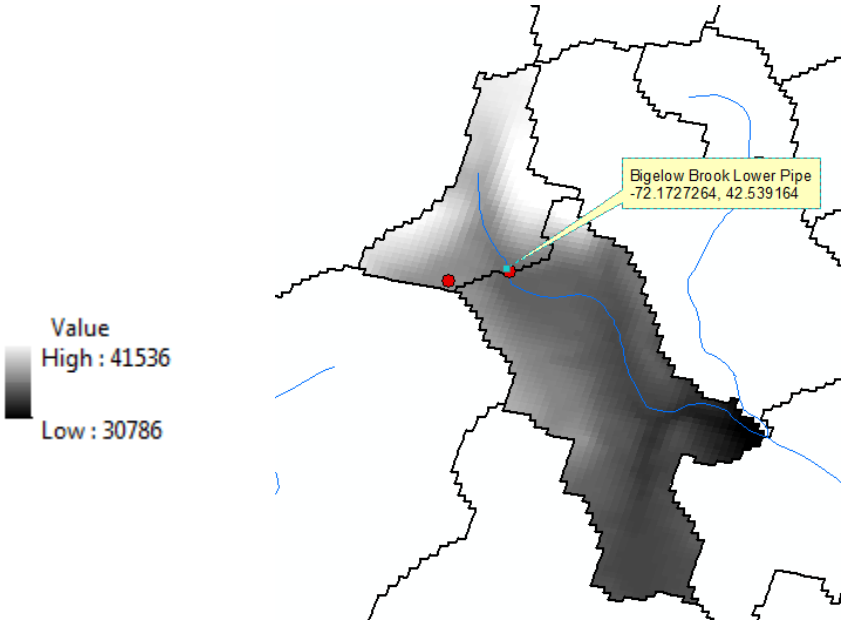


Harvard LTER

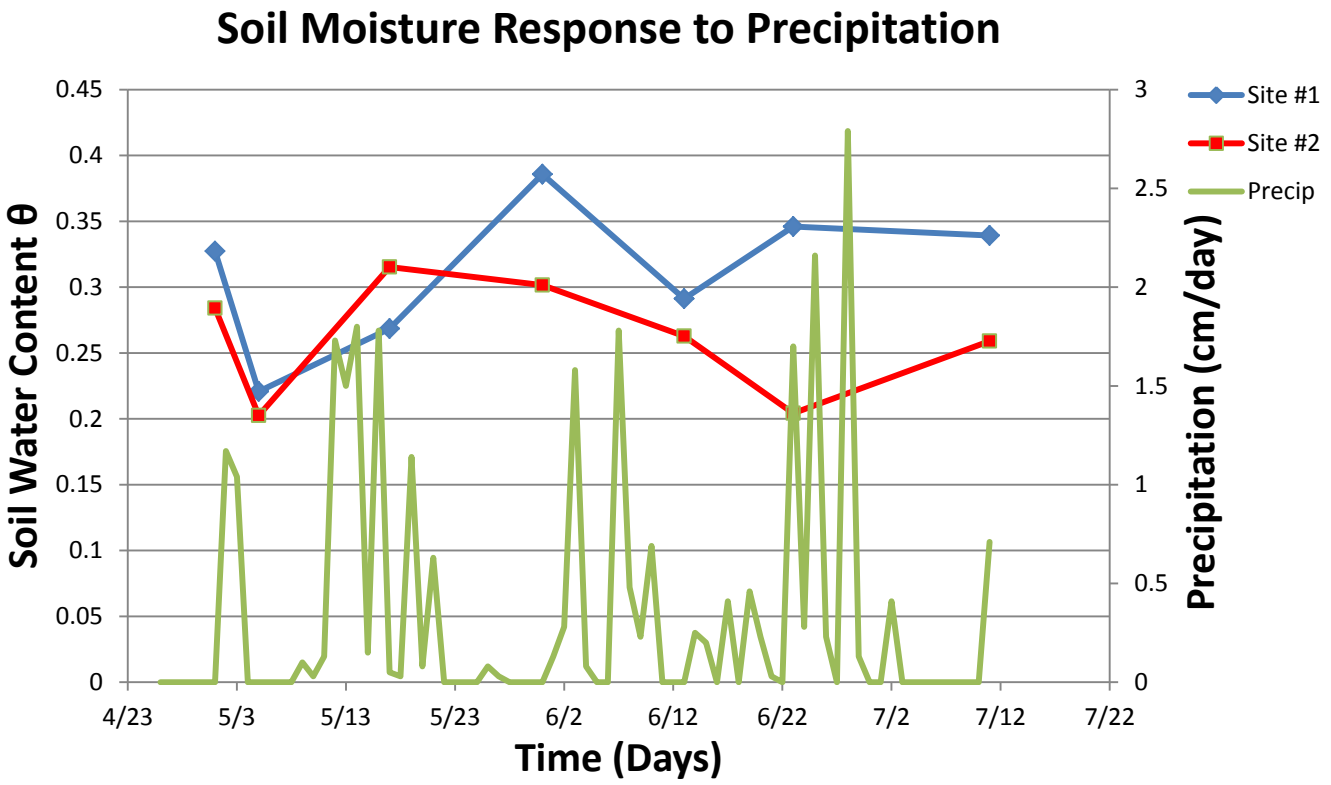
Harvard LTER: Discharge and Soil Water Content



	Totals	
Discharge:	7979.04	m^3
Soil Moisture Change:	1226.77	m^3
Precip:	0.2671	m
Basin Area:	511,000.00	m^2
Input over basin:	136,488.10	m^3
	D = P - dSw	
Total	135,261.332	m^3



Harvard LTER



Introduction of error:

- Evapotranspiration
- Water Storage Below 20cm
- Heterogeneous Soil Conditions
- Heterogeneous Precipitation
- Lack of Measurements
- Accuracy of Measurements
- Depression Filling

Coweeta LTER

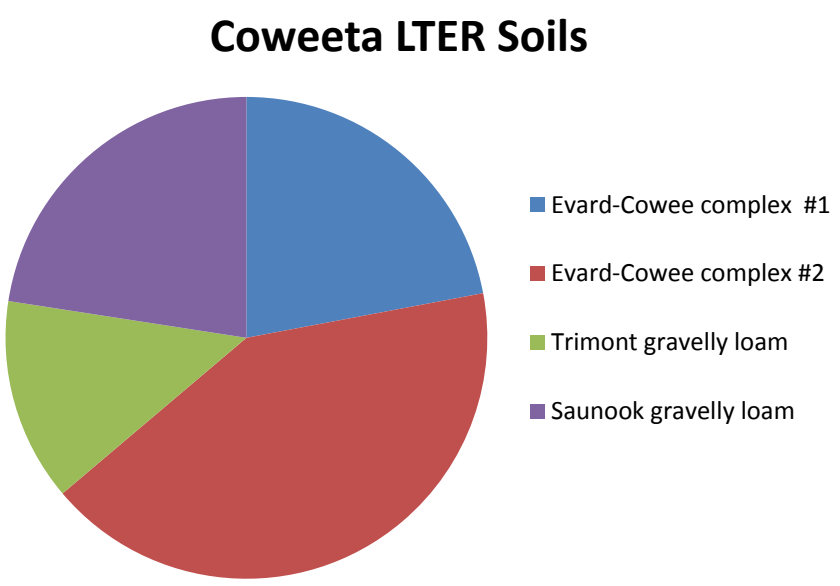
Data sets to use:

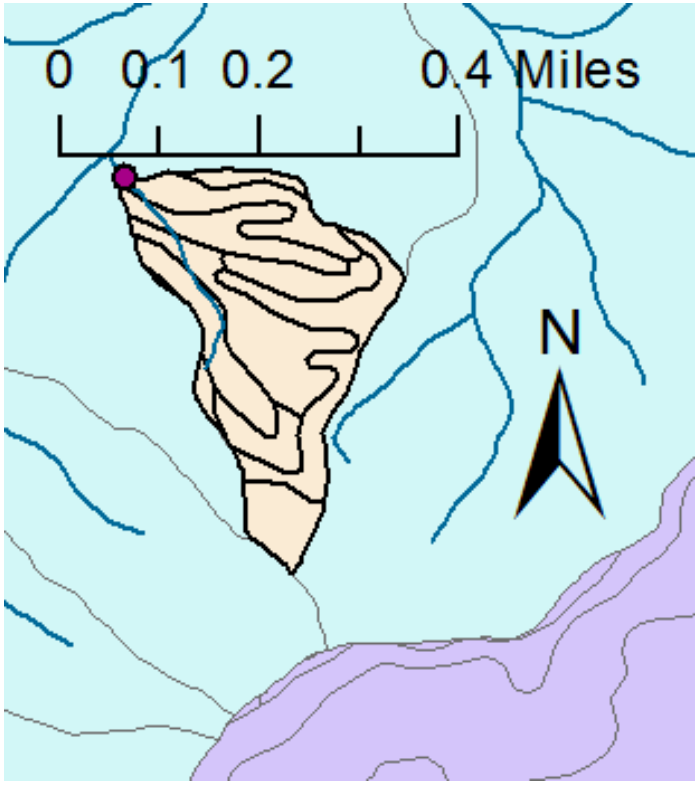
Soil Moisture: Terrestrial gradient microclimate measurements, 1013, Jennifer Knoep
Hydrograph: Watershed 18 daily stream discharge, 3033, Stephanie Laseter
Meteorology: Climate Station 1 Climate Data, 1011, Stephanie Laseter
Dates: 4/1 - 10/3/06
Area: 123,587 m^2

Soil Orders

- Ultisols

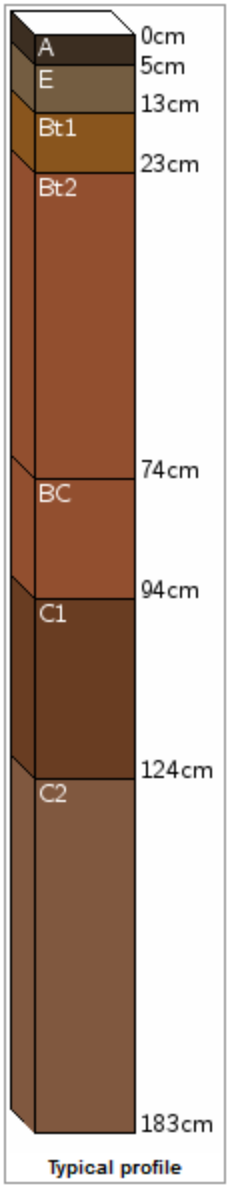
Soil Series	% Area
Evard-Cowee complex #1	19.64
Evard-Cowee complex #2	37.24
Trimont gravelly loam	12.14
Saunook gravelly loam	20.10





Coweeta LTER

Evard - Cowee Complex

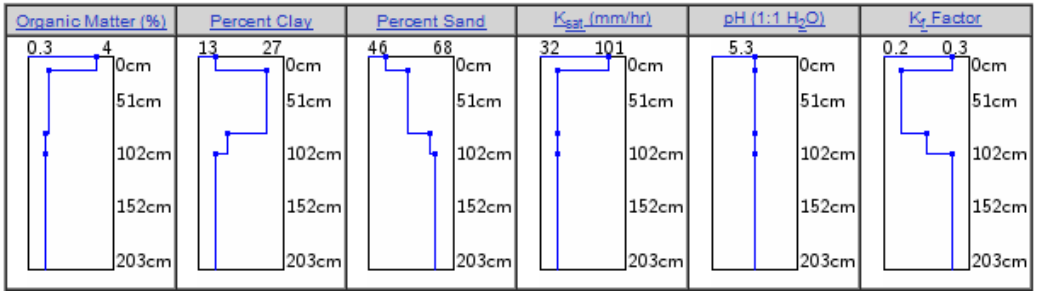


Soil Taxonomy

Order:	*Ultisols*
Suborder:	*Udults* [Map of Suborders]
Greatgroup:	*Hapludults*
Subgroup:	*Typic Hapludults*
Family:	*Fine-loamy, parasesquic, mesic Typic Hapludults*
Soil Series:	*Evard* (Link to OSD) (Link to SM Tool)

Ultisols

Ultisols are strongly leached, acid forest soils with relatively low native fertility. They are found primarily in humid temperate and tropical areas of the world, typically on older, stable landscapes. Intense weathering of primary minerals has occurred, and much Ca, Mg, and K has been leached from these soils. Ultisols have a subsurface horizon in which clays have accumulated, often with strong yellowish or reddish colors resulting from the presence of Fe oxides. The 'red clay' soils of the southeastern United States are examples of Ultisols.



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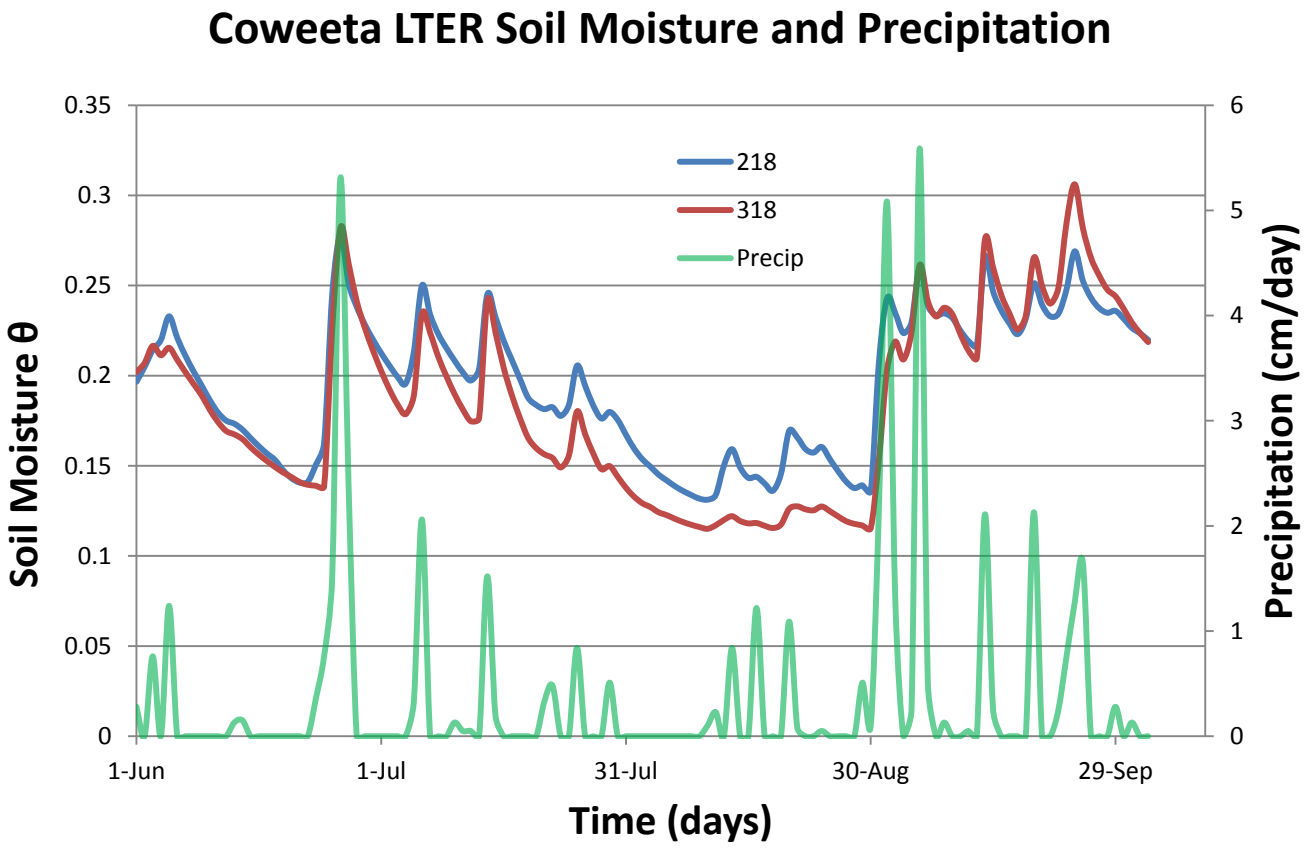

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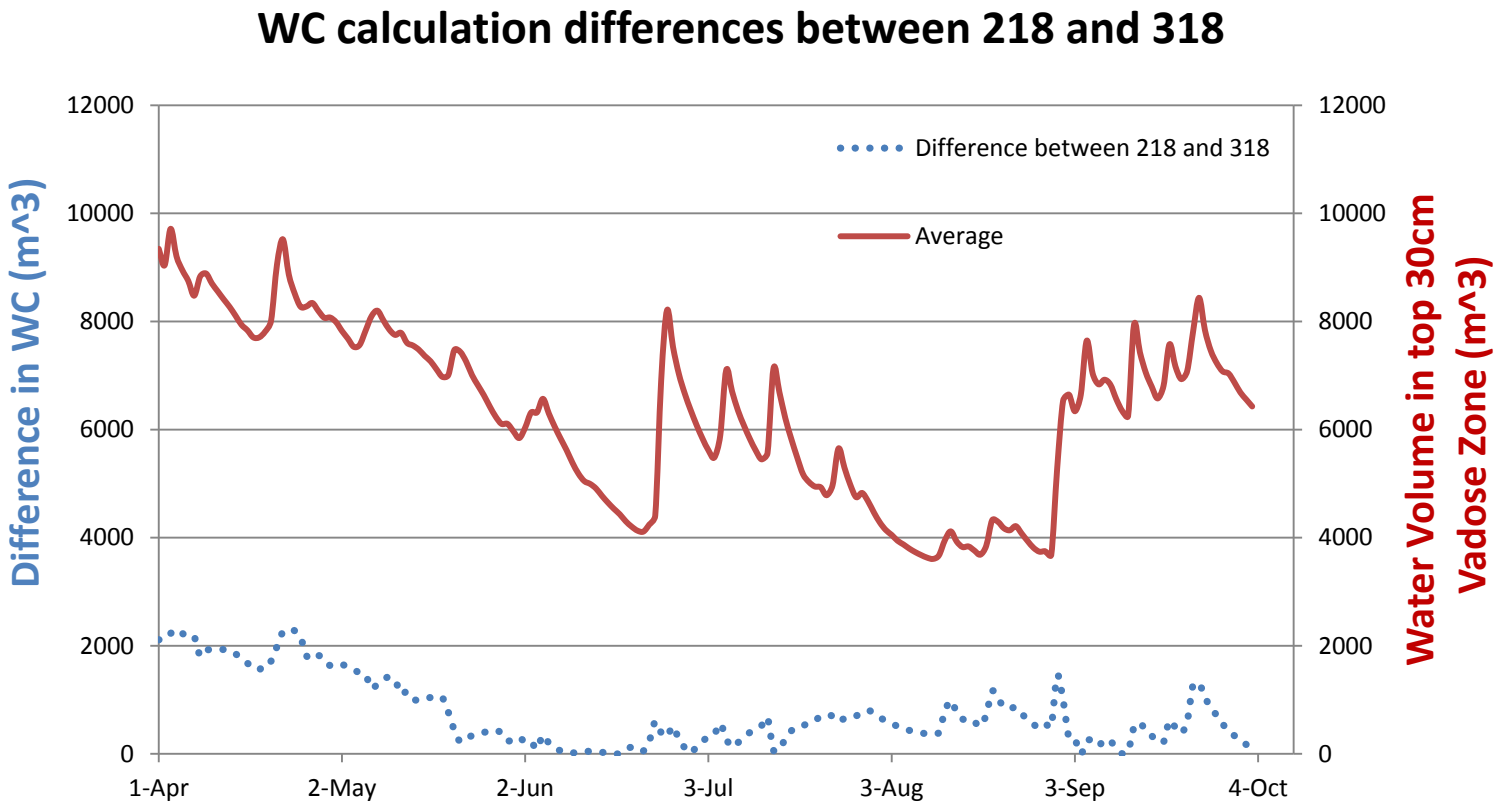
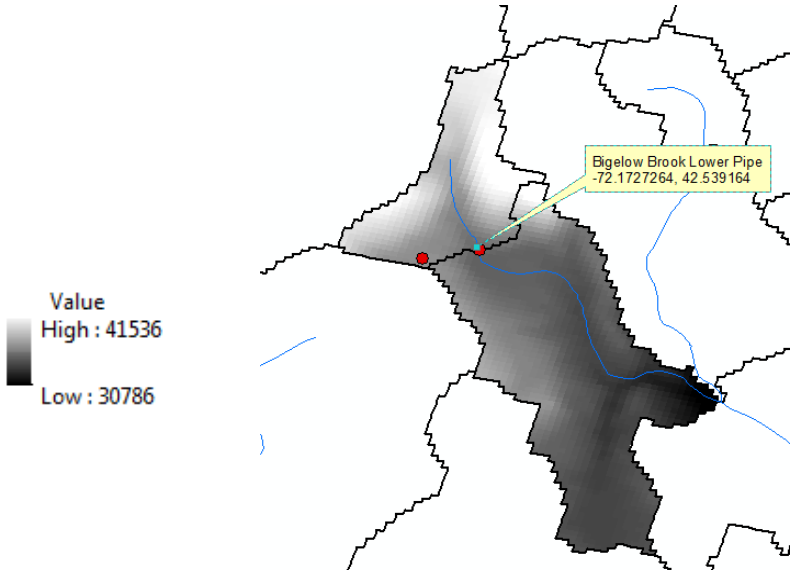


Site Comparison:

Harvard:

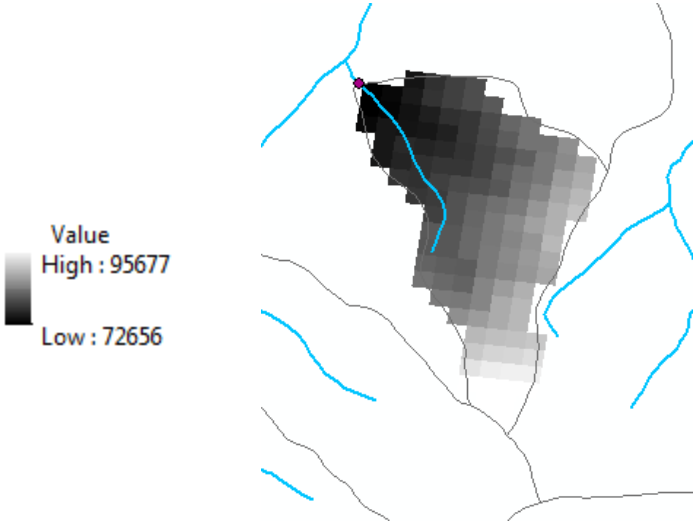
- Spodosols and Inceptisols
- Hill slope

Area: 511,000 m^2
Elevation Difference: 108m



Coweeta:

- Ultisols
- Hill slope



Area: 123,587m^2
Elevation Difference: 230m

Error Incorporation

Errors:

- Evapotranspiration
- Water Storage Below Measurements
- Heterogeneous Soil Conditions
- Heterogeneous Precipitation
- Depression Filling
- Ponding
- Intense Precip/Low Conductivity
- Terrain aspect / Hillslope
- Low Measurement Density
- Low Accuracy of Measurements

Future work

Further Steps to complete this project

- Work more with the Coweeta LTER data set to establish refined budgets (at different flow volumes)

Current limits on Project

- Measurement density, and the exact locations of each measurement

Ideal Data Set Collection:

- Small watersheds key
- More extensive network
- Consideration of Hillslope and ET values
- Single storm event after dry period.

- Although this project did not yield the results I had expected and was MUCH more convoluted than I had originally imagined. It provided a greater insight into the degree the vadose zone plays in local hydrology and how difficult it is to measure quantities that can accurately describe a location larger then the measurement area itself.


Thank You