Capacities and Flows of Aquatic Ecosystem Services in the Albemarle-Pamlico Basin

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Today's Presentation:

1. Explain why ecosystem services (ES) are of interest

2. Define concepts and terms related to ES analyses

3. Describe methods used to quantify, map ES

4. Show selected products of ES analyses in the APB

Ecosystem Service (ES):

Social benefit provided by ecological processes or conditions

A new eco-sociological lens for viewing environmental issues, assessing sustainability

FRESHWATER ECOSYSTEM GOODS & SERVICES

Provisioning Services

- Drinking water
- Bathing water (swimmable)
- Aquatic foods (fishable)

Regulating Services

- Water purification
- Flood modulation
- Disease regulation

Cultural Services

- Recreation
- Beauty
- Spirituality

Motivation for Biological Conservation?

Biodiversity conservation traditionally focuses on intrinsic value of biota

Biota also provide MANY valuable (and largely unmeasured) benefits

Measuring these utilitarian values may motivate more conservation

General research questions:

What are the spatial linkages among biodiversity conservation, AES, and HWB across a landscape?

When / where do actions and practices that conserve biodiversity enhance or diminish delivery of valued AES?

Ecosystem Service Jargon -- Capacity, Flow, Demand

ES Capacity

inherent (biophysical) ability of an ecosystem to provide an ES

ES Flow

extent to which an ES is used by stakeholders;
for RS, amount of ecological “work” done;
can exceed capacity

ES Demand

extent to which an ES would be (or is) used if available;
can exceed capacity

Data Layers

land cover/use, soil type, topography, hydrology, precipitation, temperature, geomorphology, species distribution, pop’n density

Focal Aquatic Ecosystem Services

Provisioning Services

Supplying water

Regulating Services

Water purification

Nitrogen regulation

Cultural Services

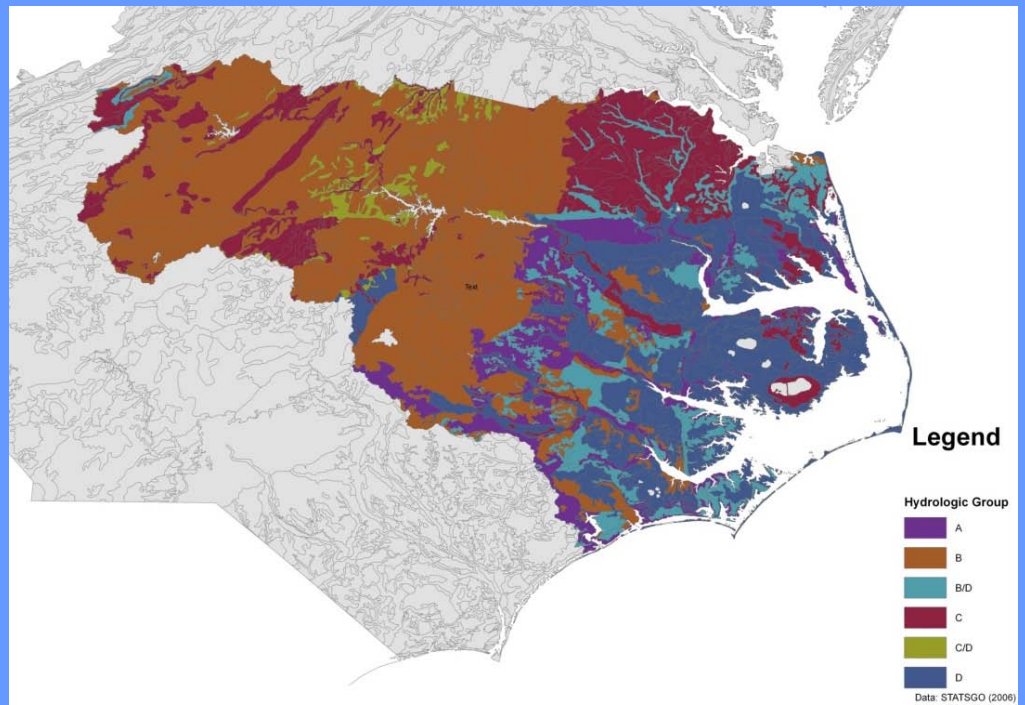
Wildlife-based recreation
(bird watching, fishing)

Our General Approach

Infer ES capacity from biophysical features of landscape
– not empirically measured

Use watershed-framework to account for spatial linkages among ES

Estimate ES flow and demand based on
distribution and intensity of human use



How We Estimate ES Capacities

1. Identify key factors contributing to ES production
   - conceptual model of biophysical processes & components

2. Develop and apply equations to reflect processes

3. Identify and compile spatial and non-spatial data layers available to map factors

4. Use GIS tools to convert non-spatial data to spatial data

5. Calculate ES capacity in spatial (watershed) context

6. Plot maps of ES capacity

Water Supply (Yield)

Definition:

Total surface water and groundwater available for withdrawal (Sun et al. 2008)

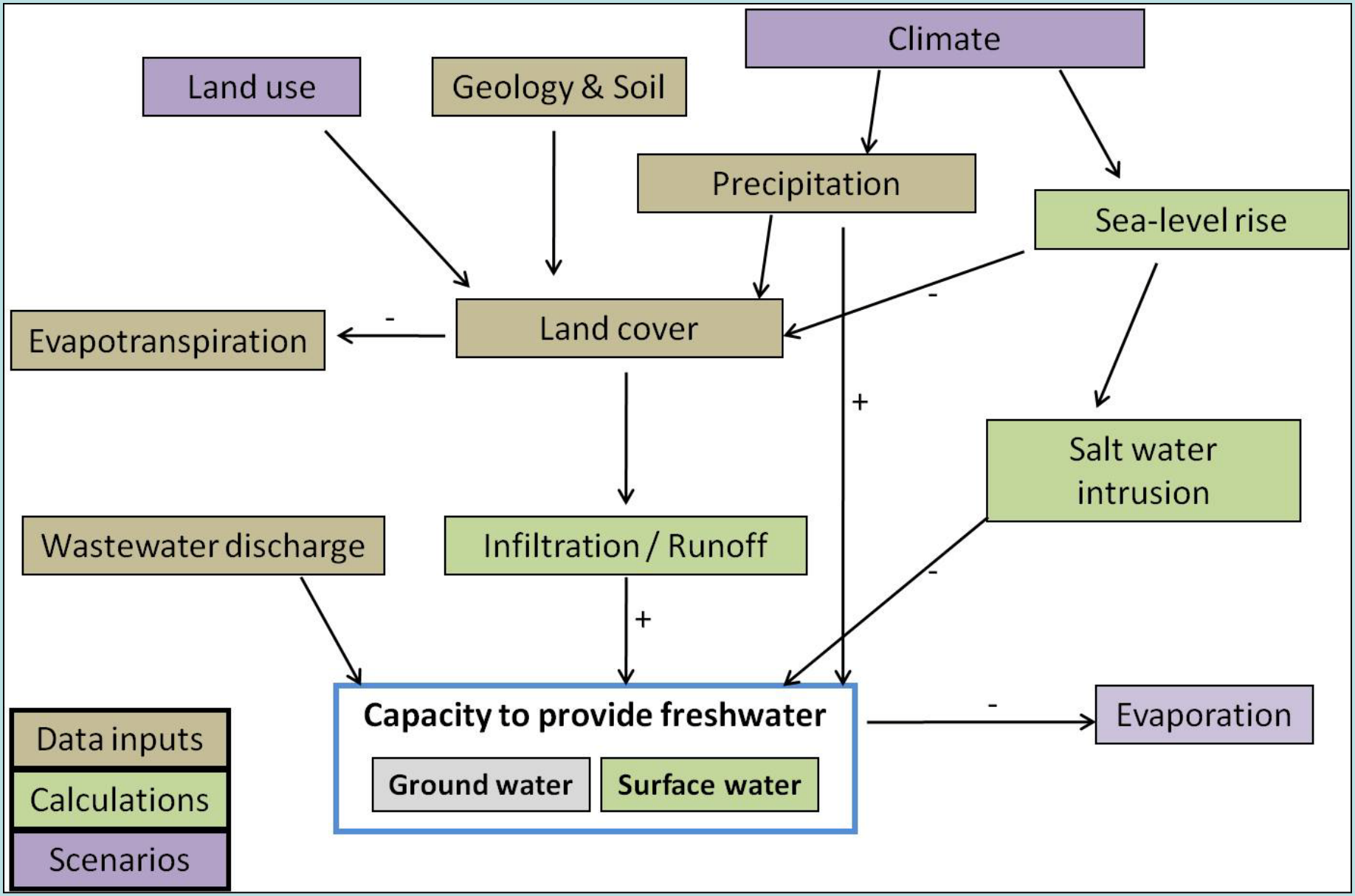
Surface Water Capacity:

Function of precipitation (+), wastewater discharge (+), infiltration (-), and evapo-transpiration (-)

Groundwater Capacity:

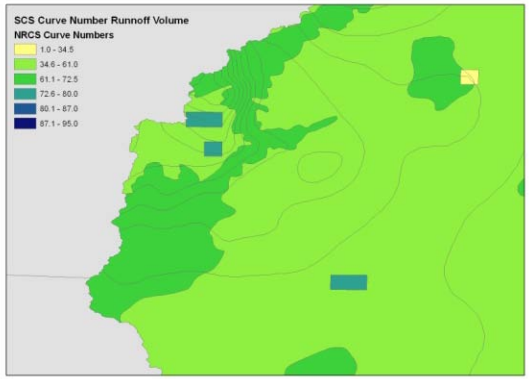
Function of aquifer volume (+) and infiltration (+)

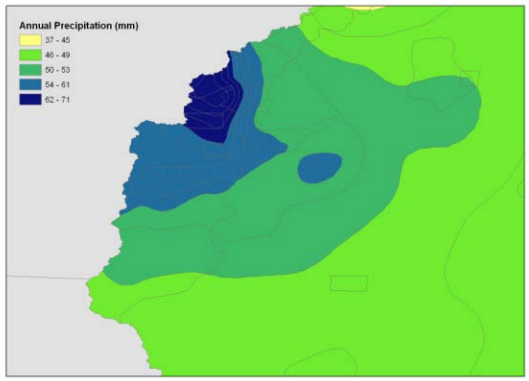
Conceptual Model of Water Supply Capacity



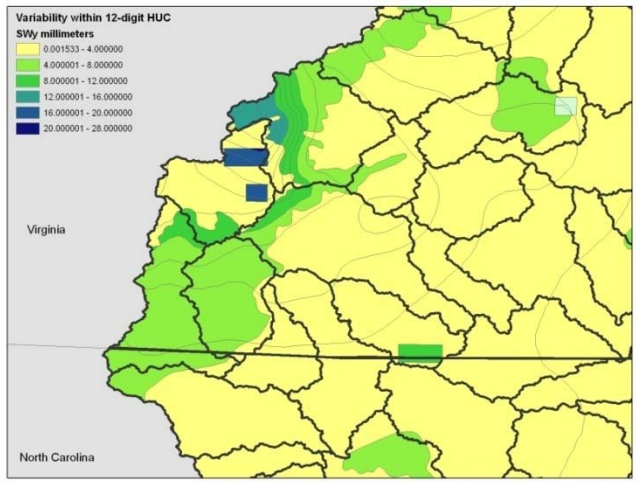
Estimating Surface Water Yield in Albemarle-Pamlico Basin

Step 1: Calculate NRCS Curve number using STATSGO soil hydrologic groups, and NASS land and cropland cover.

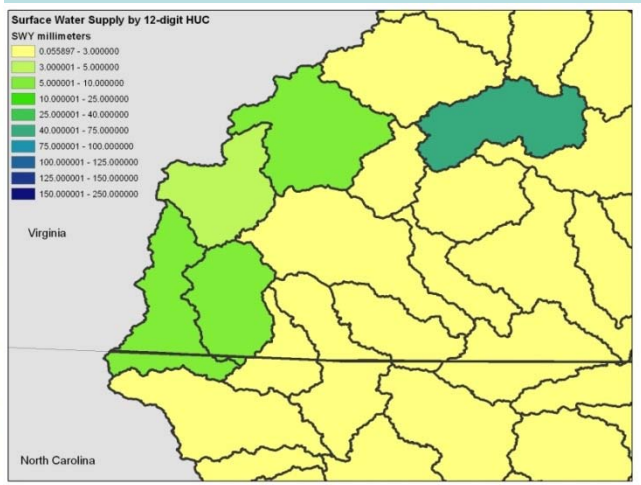


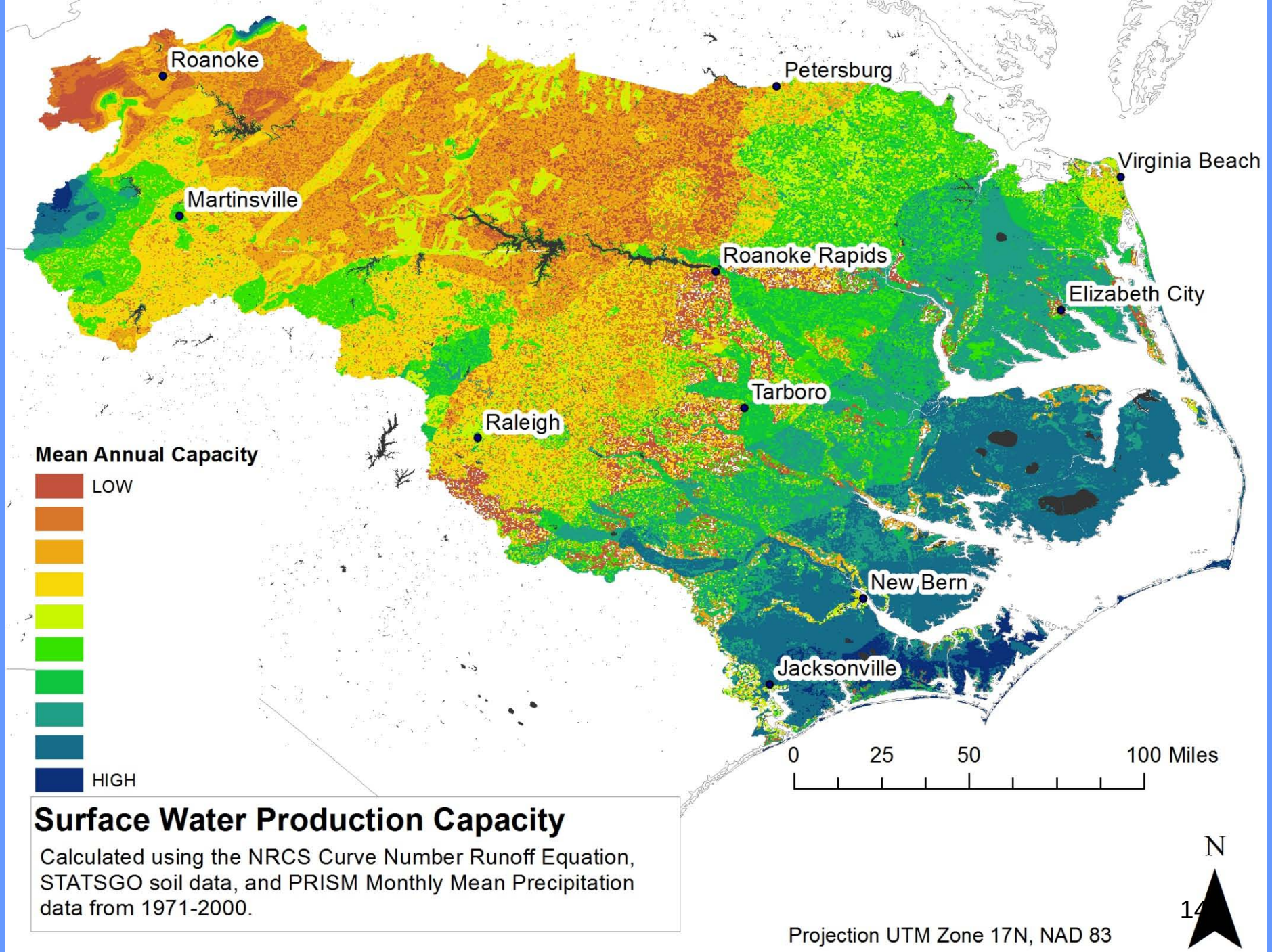


Step 2: Overlay annual precip with curve number maps and calculate runoff volume following NRCS method for each polygon.



Step 3: Calculate total runoff volume for each 12-digit hydrologic unit or county using an area-weighted sum of all runoff polygons.





Surface Water Production Capacity

Calculated using the NRCS Curve Number Runoff Equation, STATSGO soil data, and PRISM Monthly Mean Precipitation data from 1971-2000.

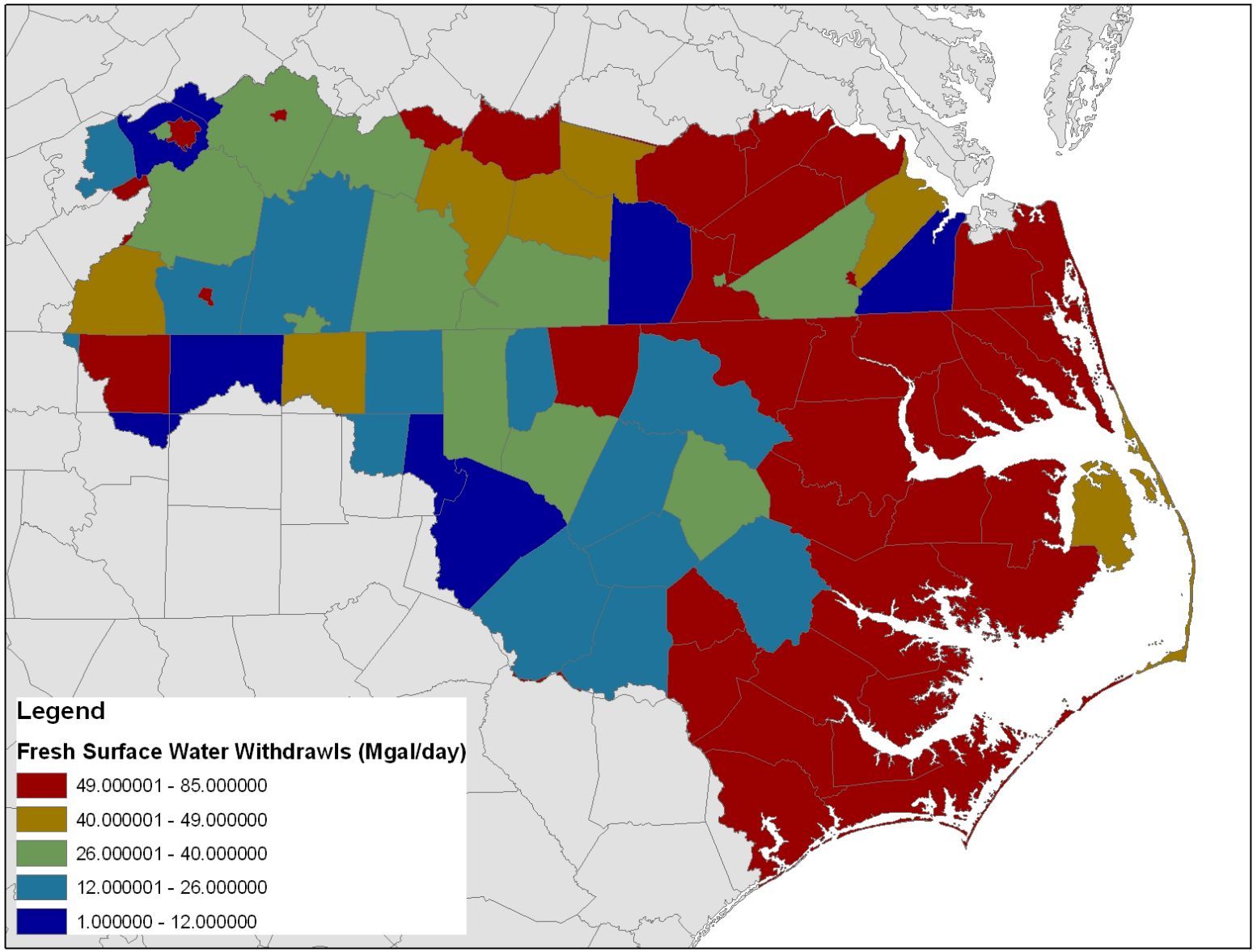
Projection UTM Zone 17N, NAD 83

Flow of Water Supply Service

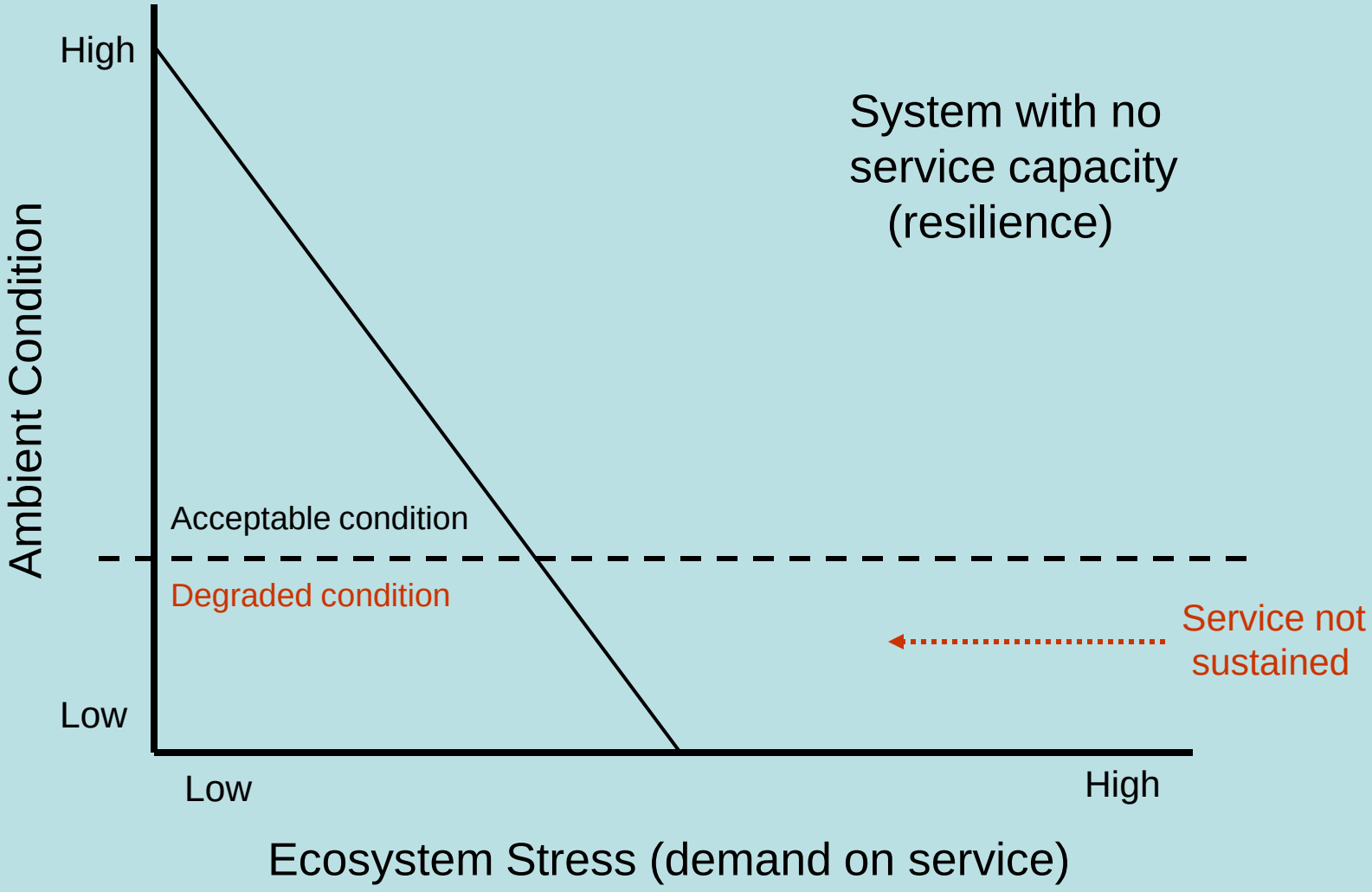
- Flow = amount of water used
  or
  number of people served

- Data source:
  USGS 2005 water use by county

2005 Ranked Water Use in APB



How Regulating Services Do Ecological Work



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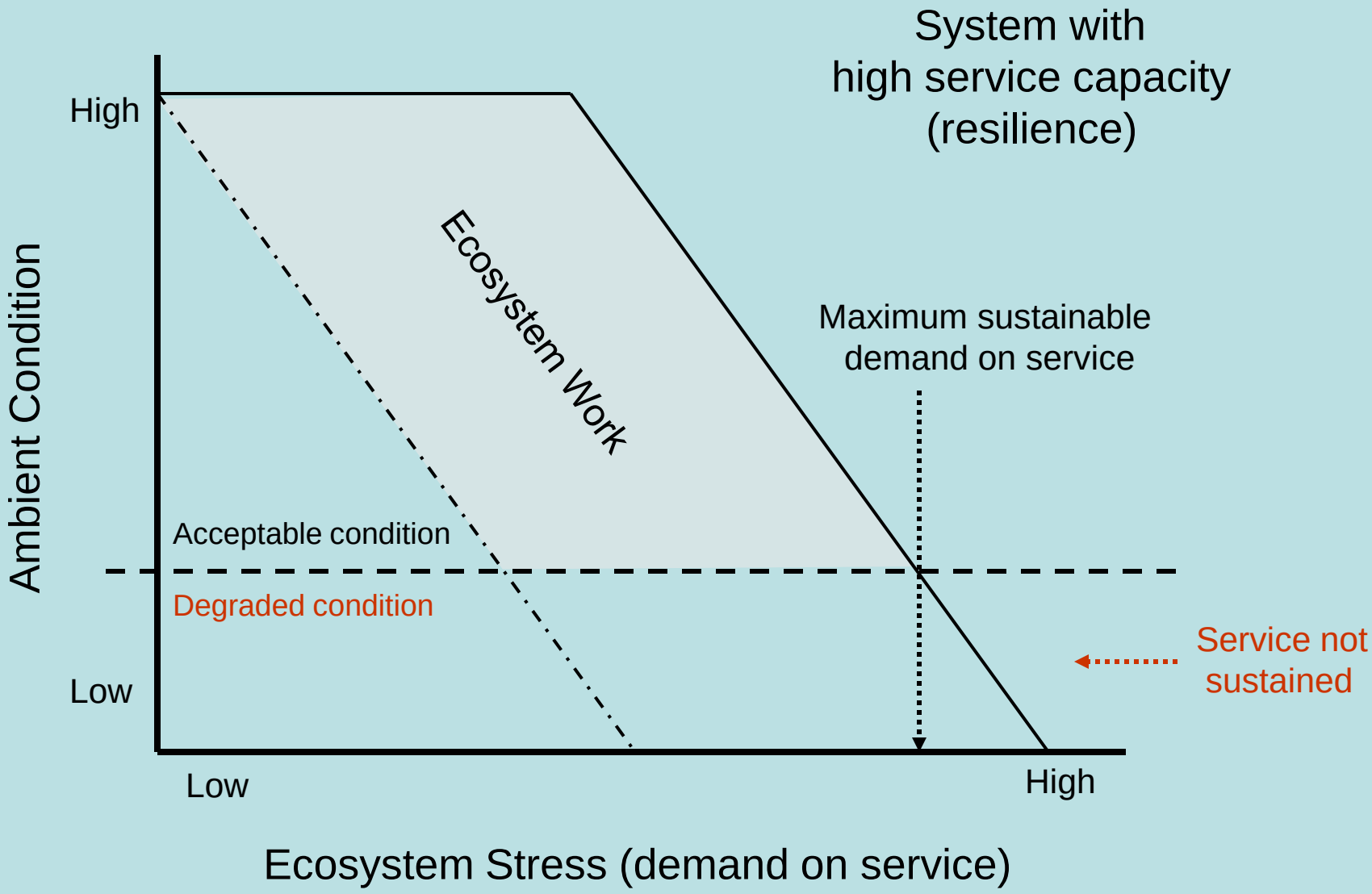


Water Purification

Definition:

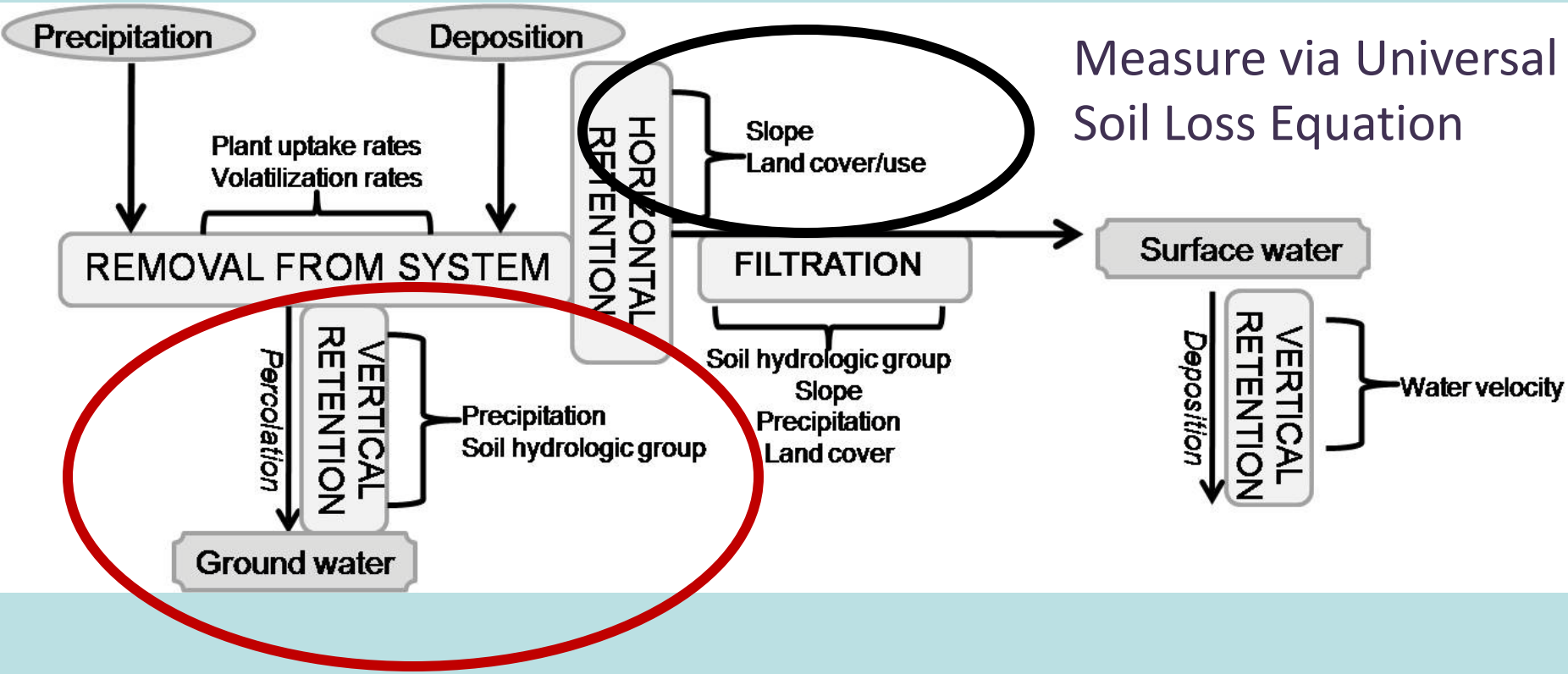
The collective processes that constrain the biological availability of contaminants

Water Purification Capacity:

Operates via landscape features (physical, biological, chemical) that mediate exclusion, removal, or conversion of contaminants;

Function of geology, soil type, land cover, and land use

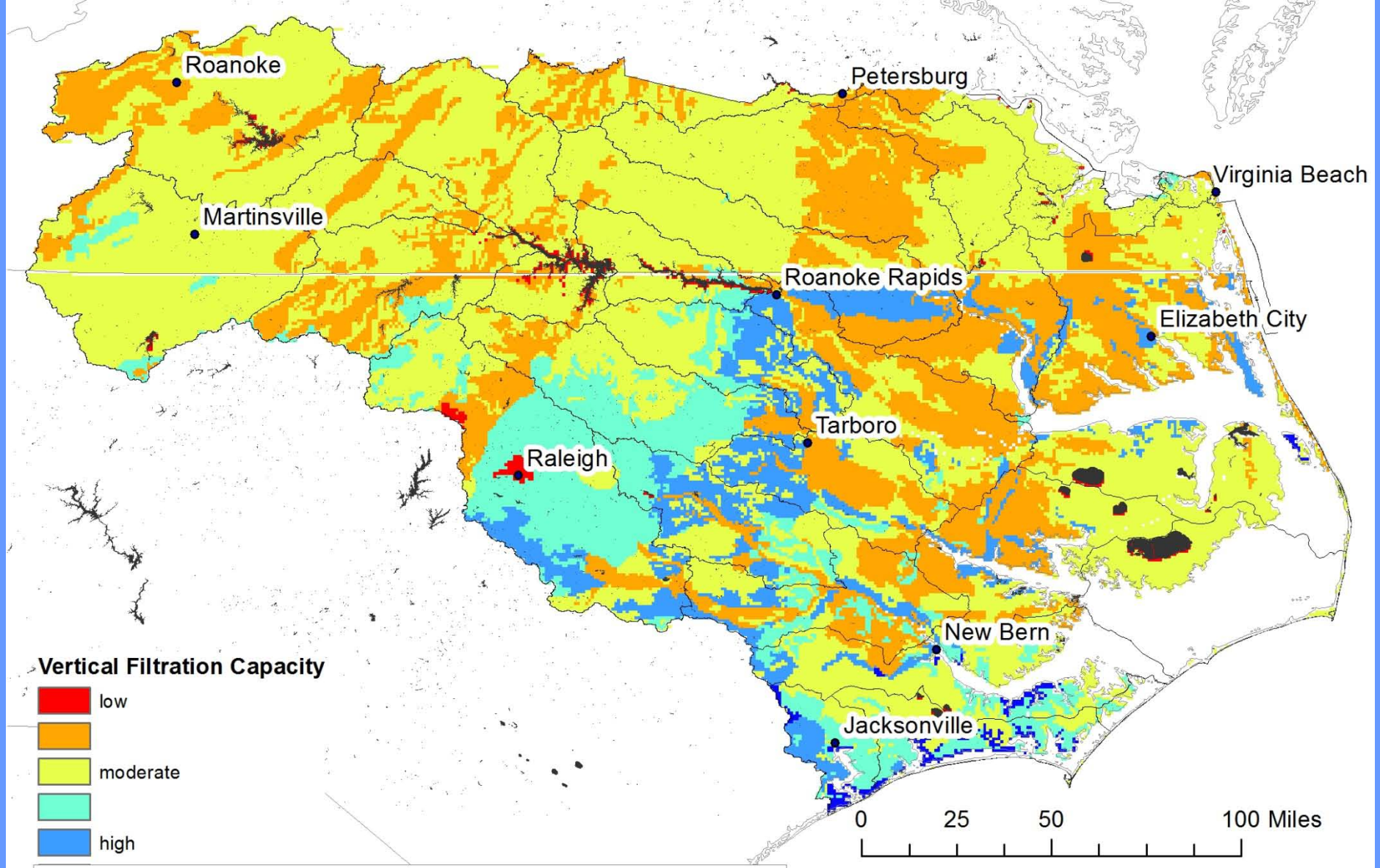
Conceptual Model of Water Purification Capacity



Measure via Universal Soil Loss Equation

Measure Vertical Retention Capacity using a Water-Soluble Contaminant Leaching Index*

*Czymmek et al. 2003. New York Leaching Index



Vertical Filtration Capacity

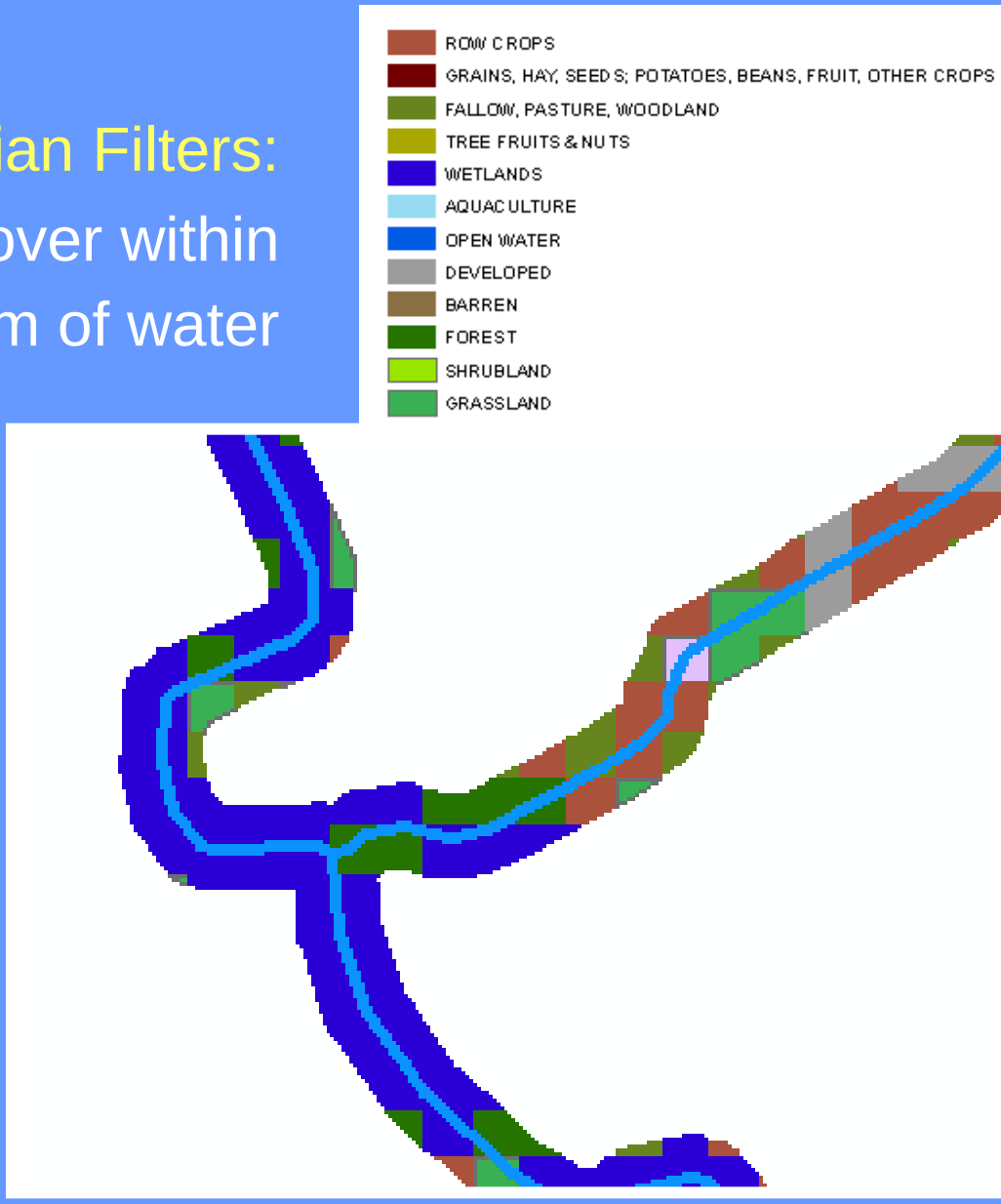
Calculated using the New York Nitrate Leaching Index, STATSGO soil data, and PRISM Monthly Mean Precipitation data from 1971-2000.
Low vertical filtration = low leaching probability.

Projection UTM Zone 17N, NAD 83

Water Purification Capacity – Horizontal Dimension

Riparian Filters:

land cover within 50 m of water



Water Purification Capacity of Riparian Areas

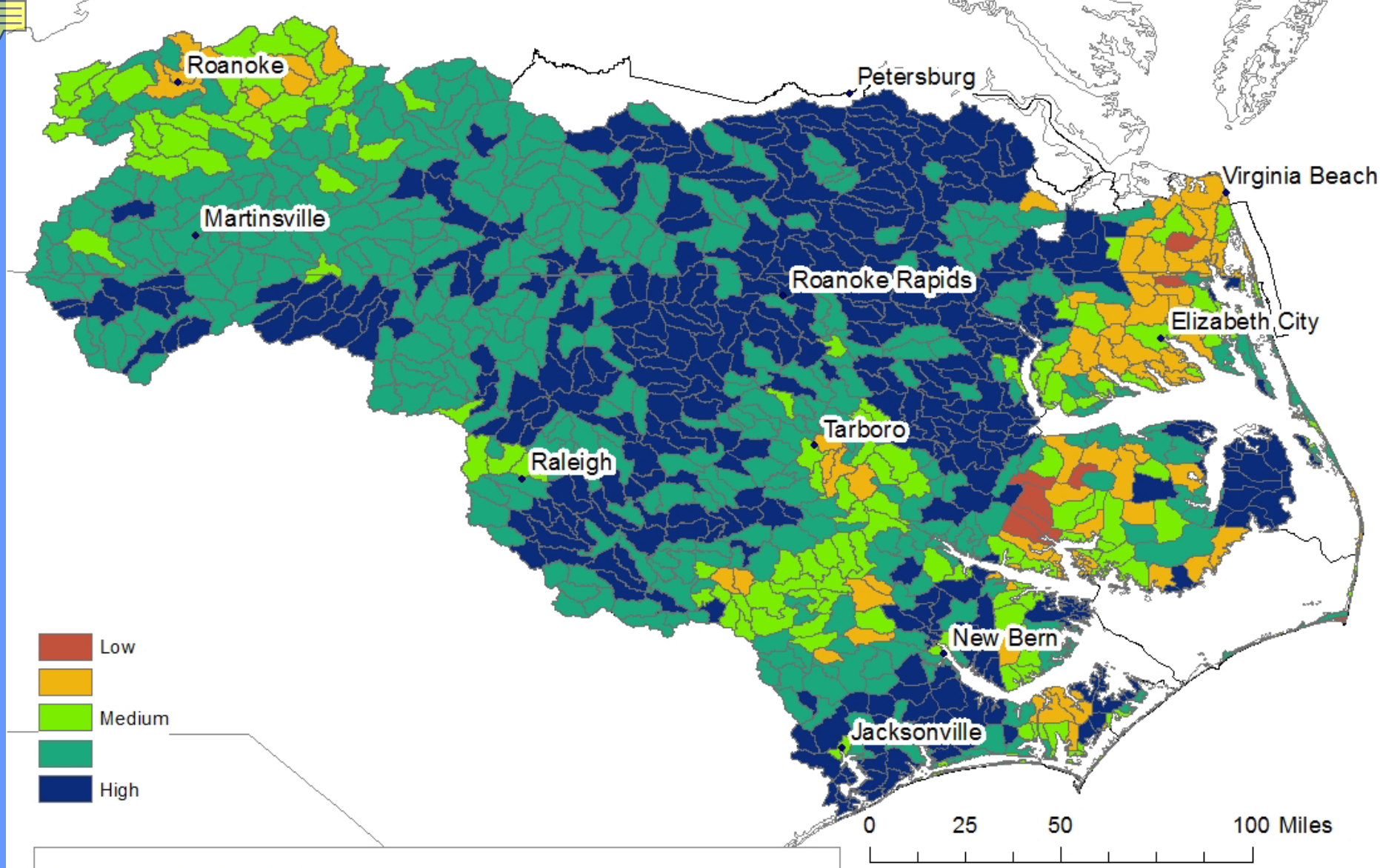
Goal: Identify areas where riparian land cover reduces entry of N into surface waters

Step 1. Summarize variation in ability of land-cover types to function as N sink

Step 2. Map N-sink land cover in riparian areas

Effective Riparian Filters: Land cover functioning as a net SINK for N

General Category	Land cover	N Removal %*
Forest	Forest	72.2
Wetland	Woody Wetland	85.0
	Wetland	72.3
Grass	Grassland	54.0
	Developed/ Open space	48.6
***Mayer 2007**		



Water Purification
Riparian Zone Filtration Capacity

Calculated based on land cover composition within 50 meters of streams using NASS cropland data and the National Hydrography Dataset.

Projection UTM Zone 17N, NAD 83

Thanks for you attention!

Any questions?