Changing Hydrologic Conditions in the Mississippi River Basin: Implications for Restoration and Ecological Processes

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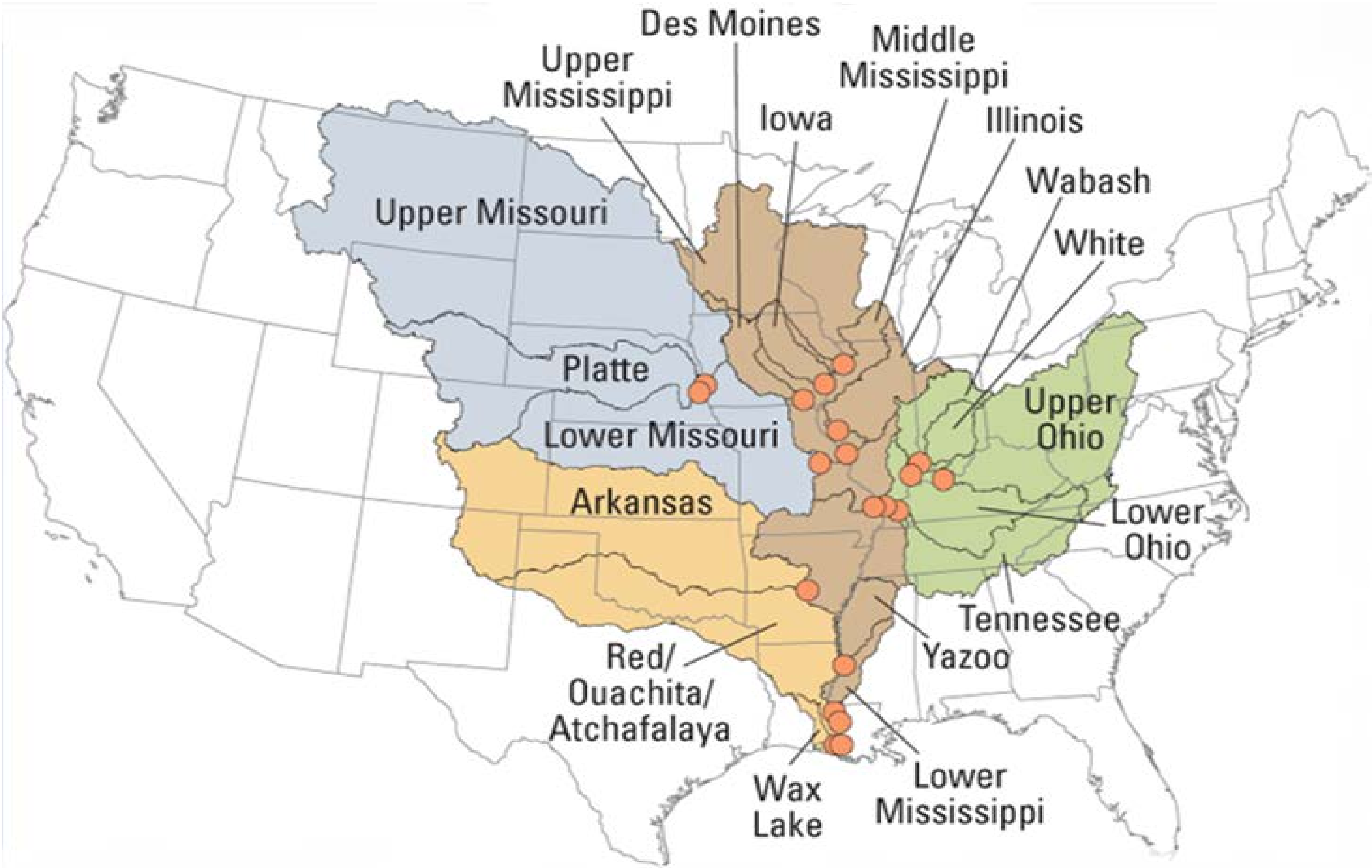
Mississippi River Basin



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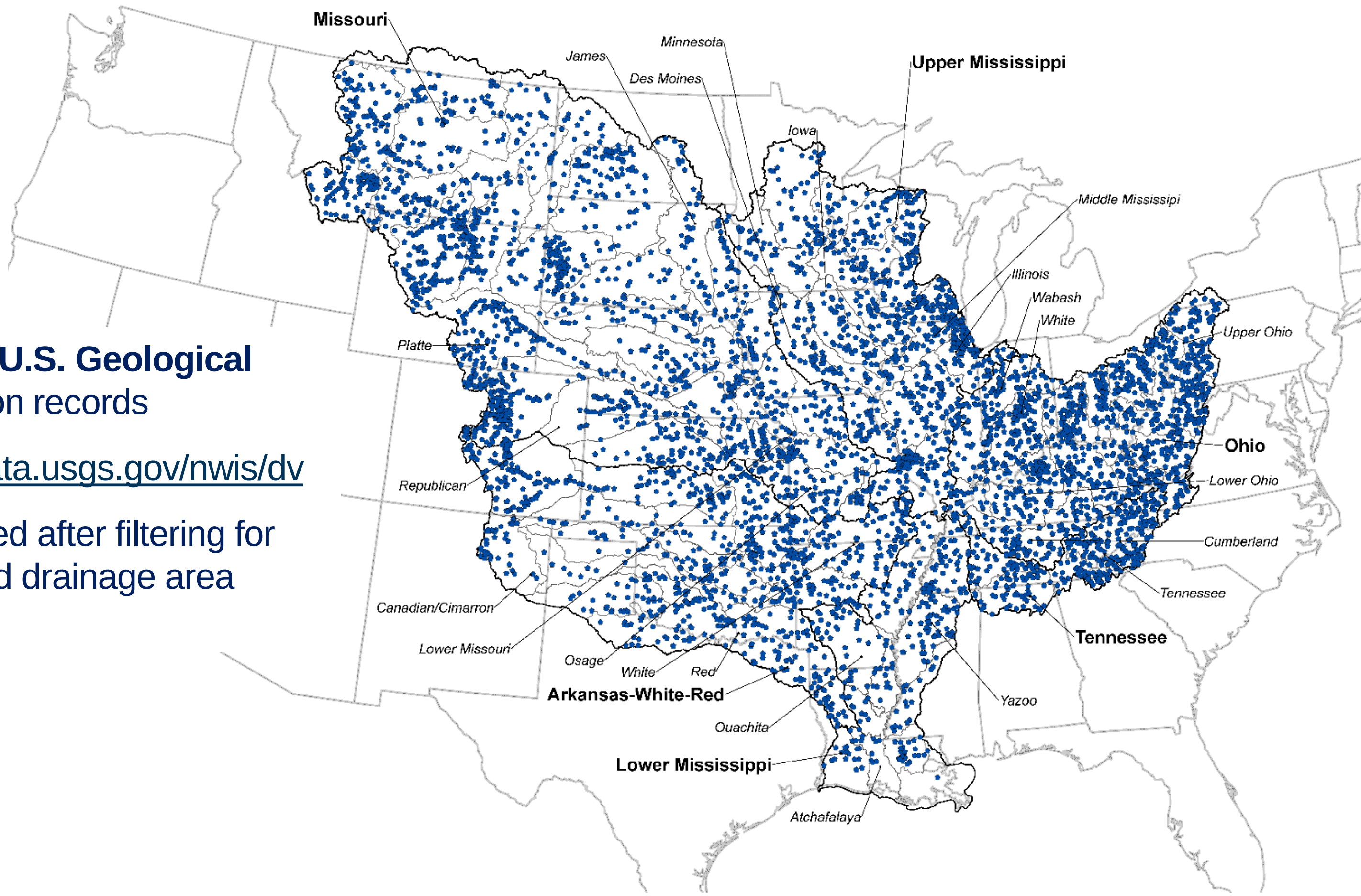
Streamflow Data

Mean-daily data from **U.S. Geological Survey** gauging station records

- http://nwis.waterdata.usgs.gov/nwis/dv
- **6,186 stations** used after filtering for years of record and drainage area computation



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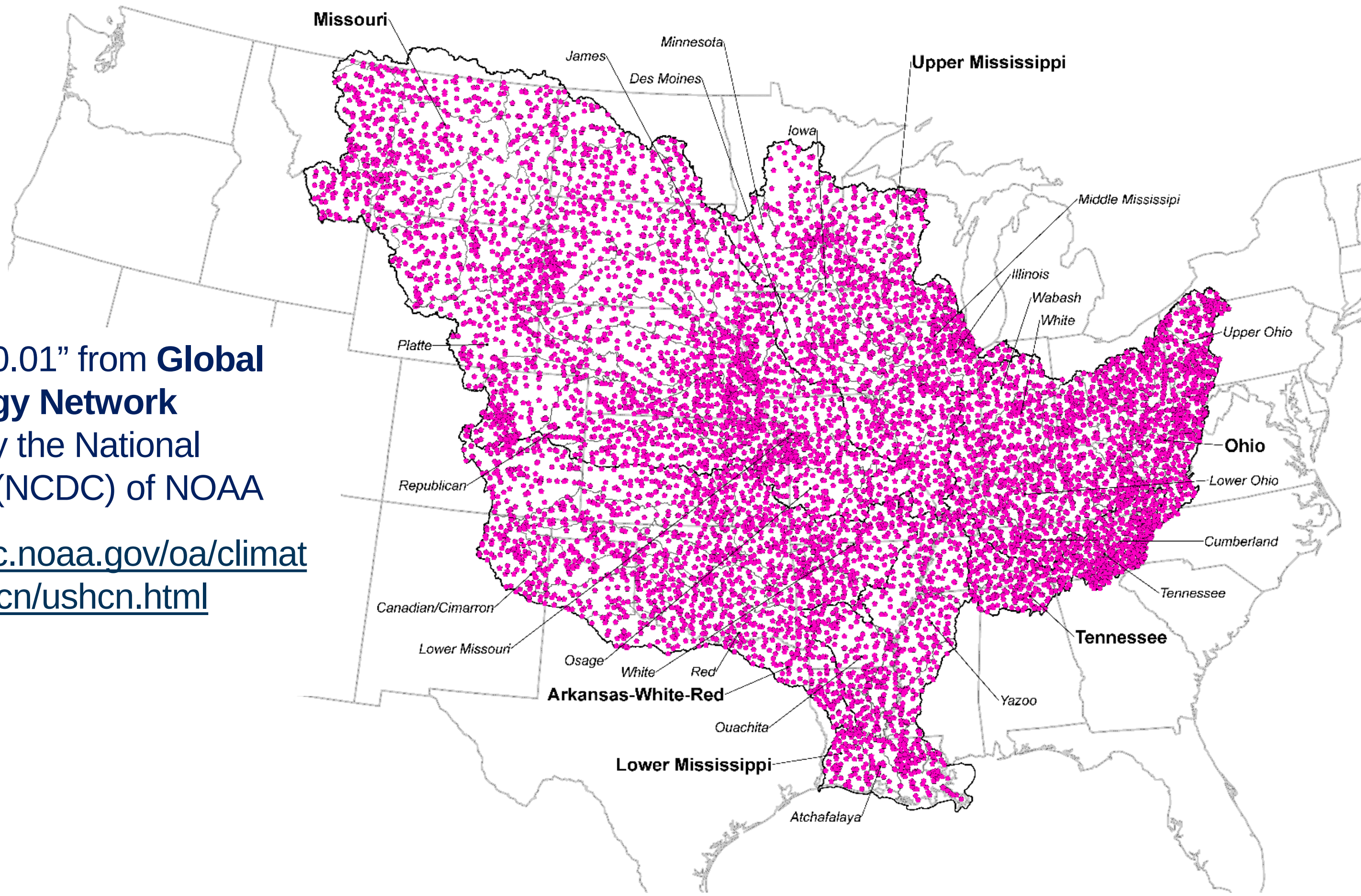
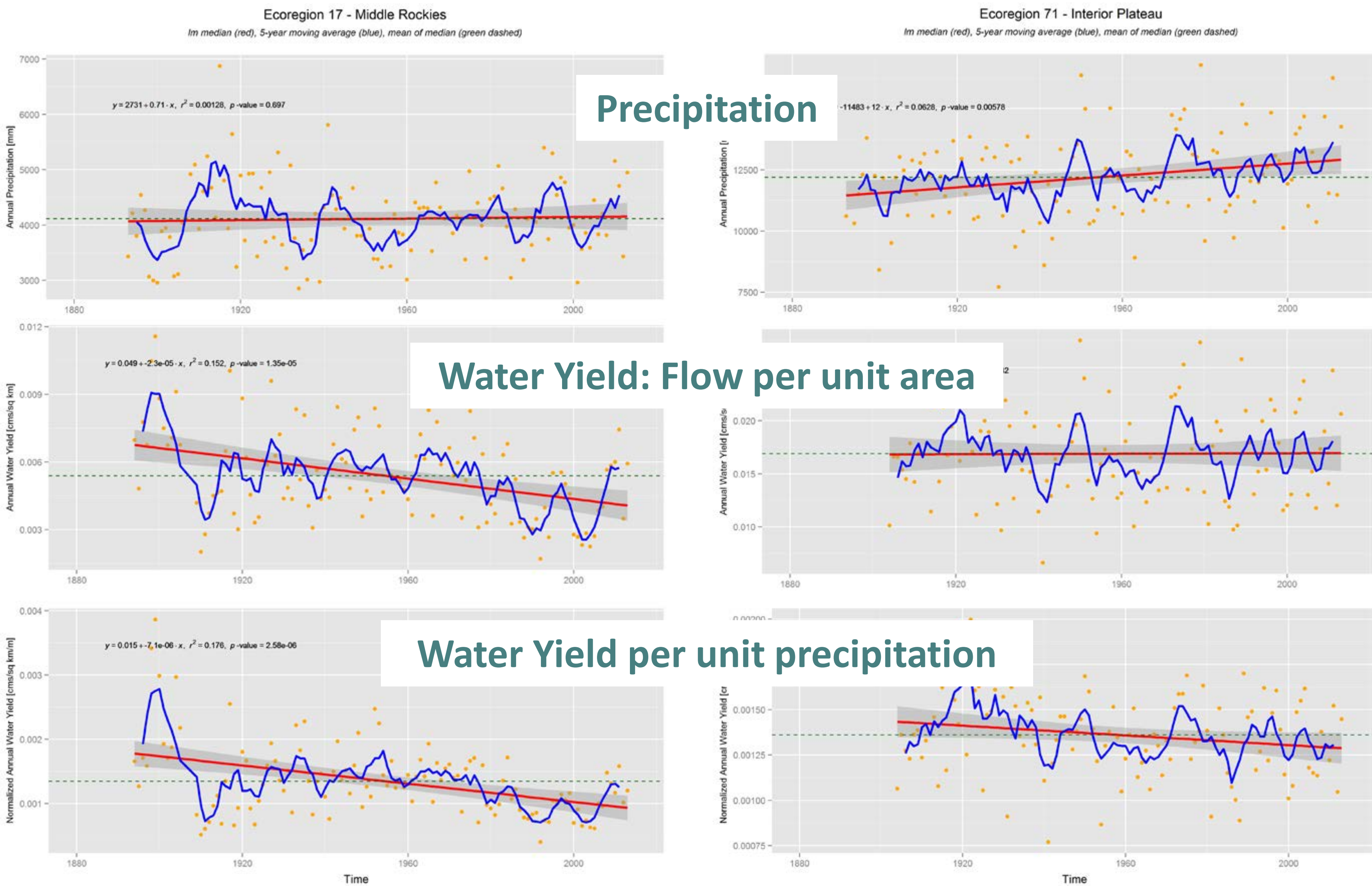
Precipitation Data

Daily data to nearest 0.01" from **Global Historical Climatology Network (GHCND)** operated by the National Climatic Data Center (NCDC) of NOAA

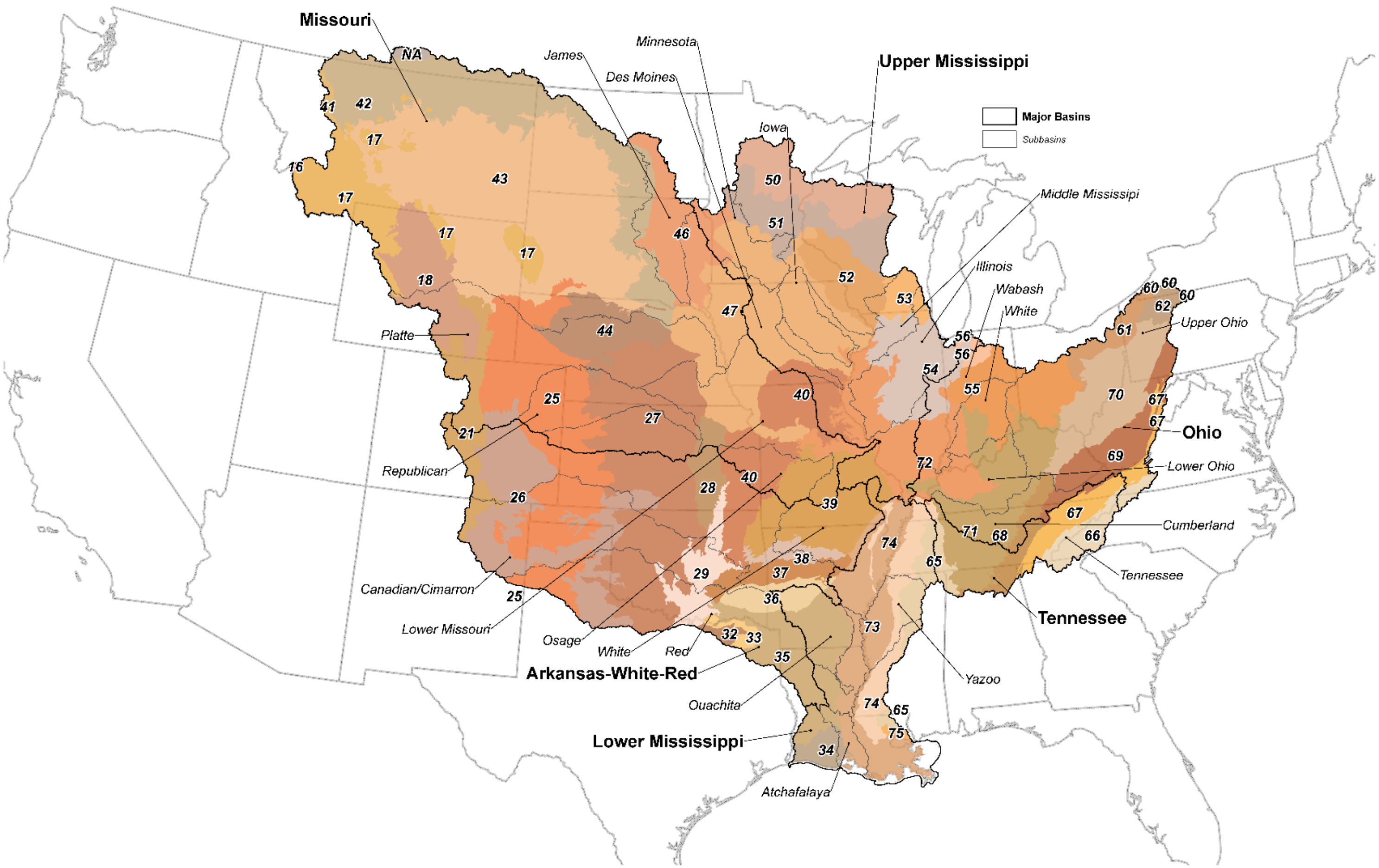
- http://www.ncdc.noaa.gov/oa/climate/research/ushcn/ushcn.html
- **7,831 stations**



Example Trends



Annual Trends by Ecoregion



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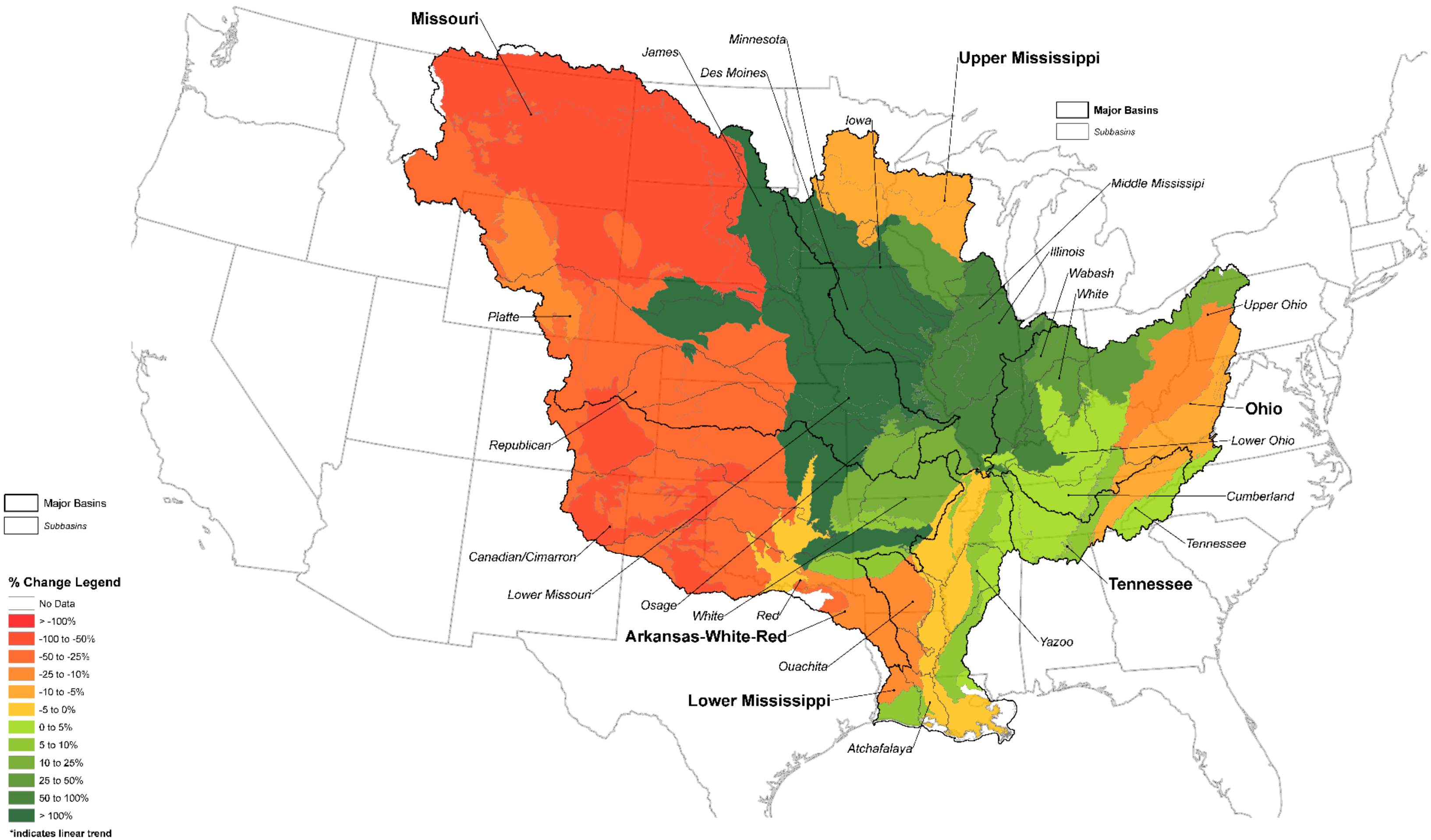
Annual Trends by Ecoregion – *Water Yield*



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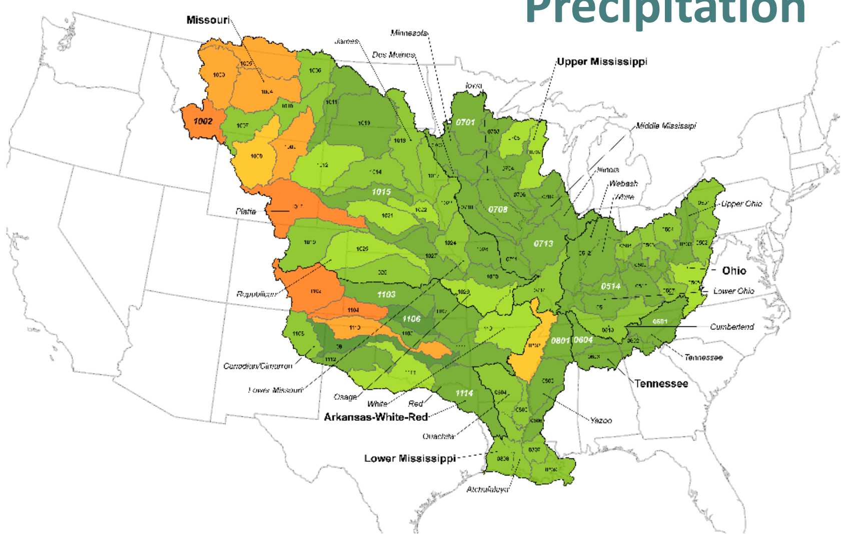
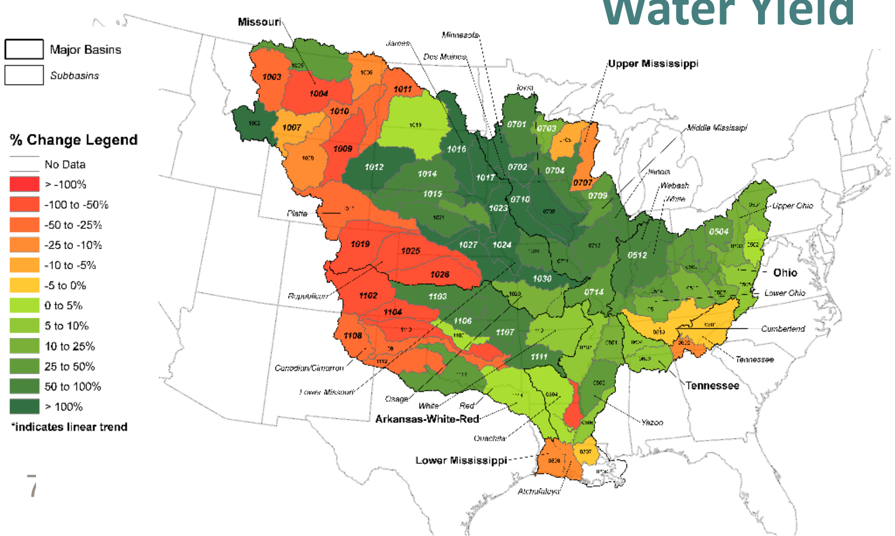
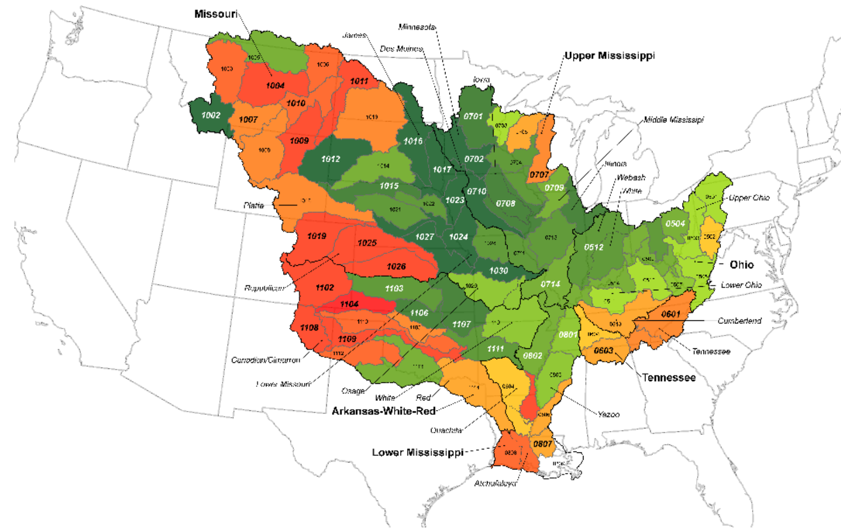
Annual Trends by HUC4

Precipitation



Water Yield





Water Yield per unit precipitation

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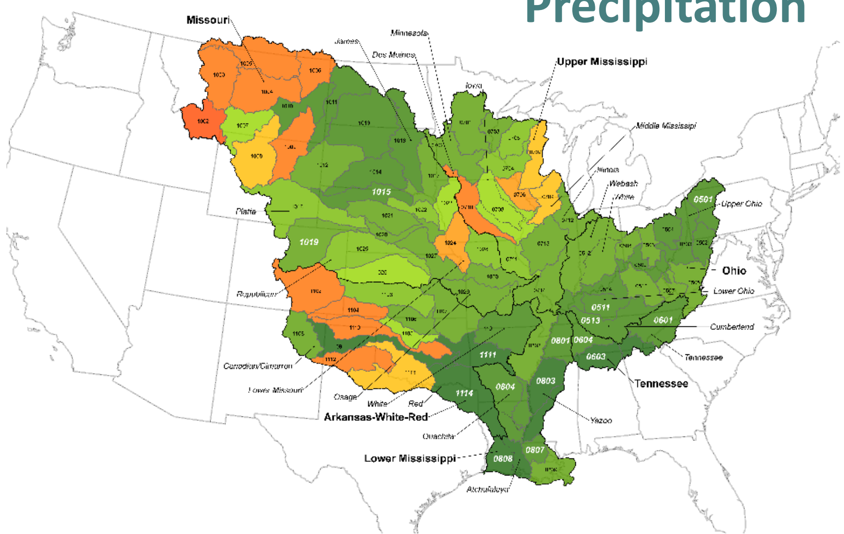
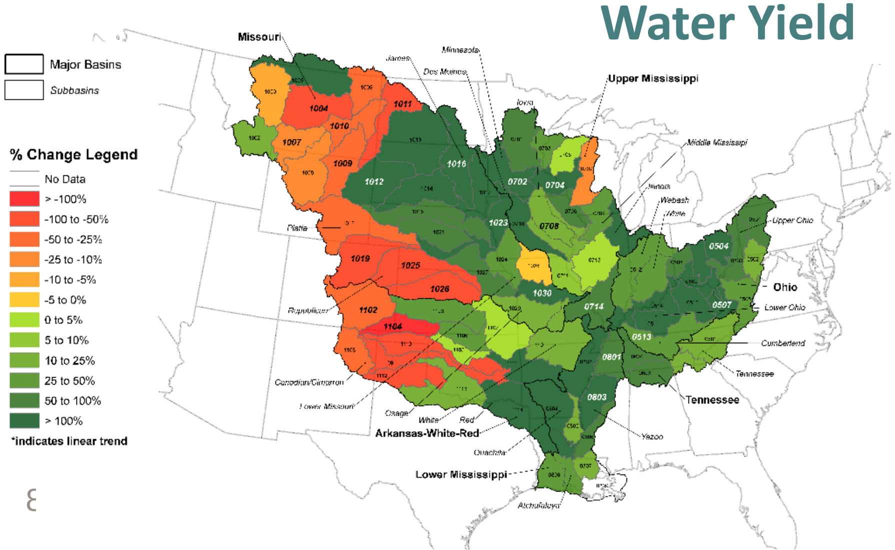
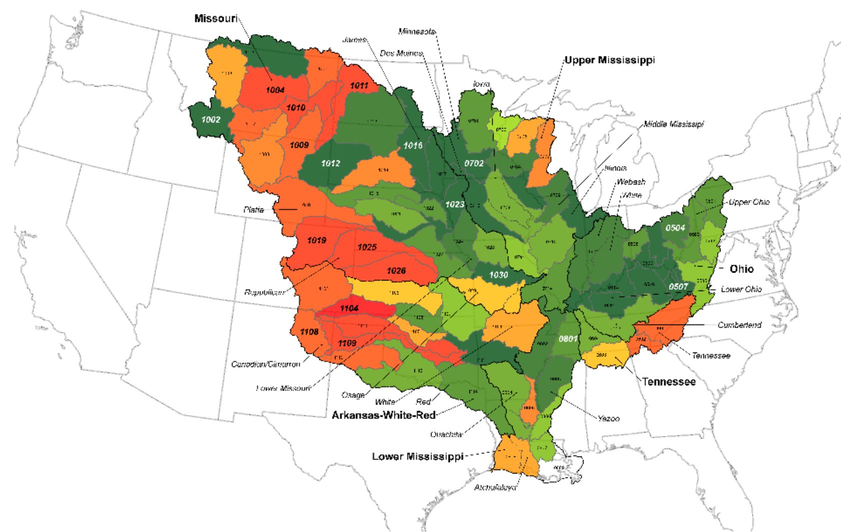
Seasonal Trends by HUC4: *Fall*

Precipitation



Water Yield

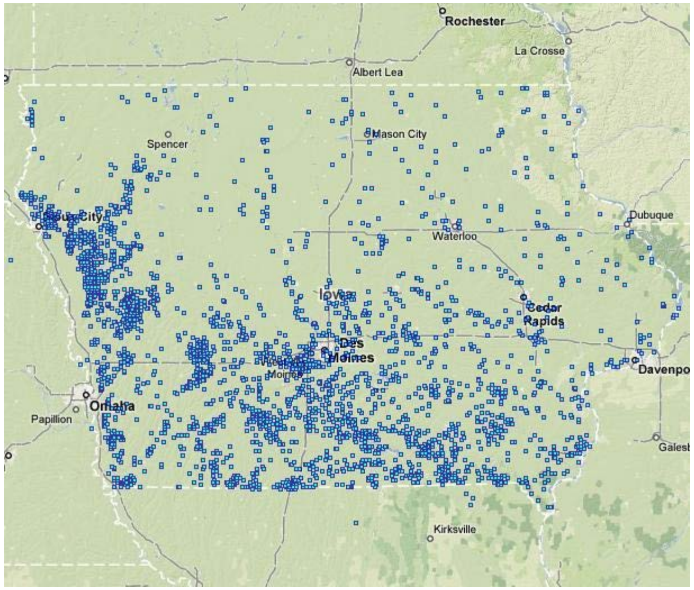


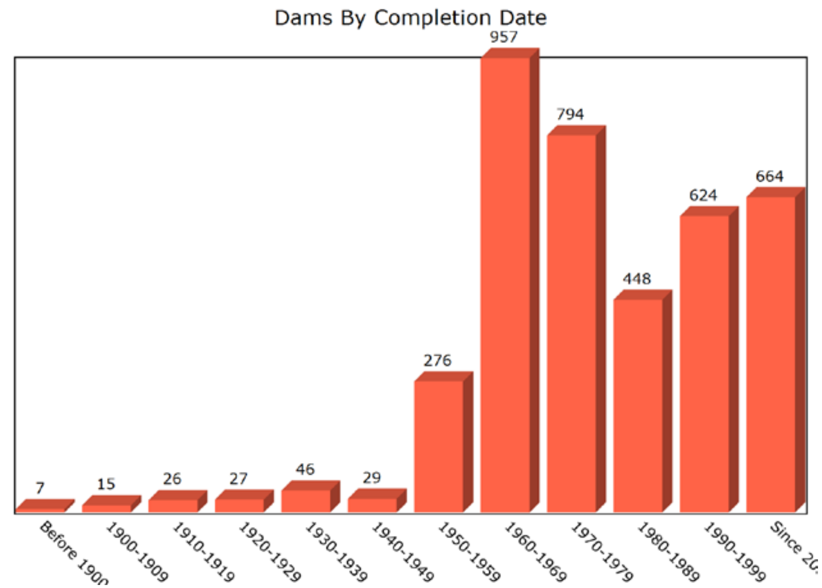


Water Yield per unit precipitation

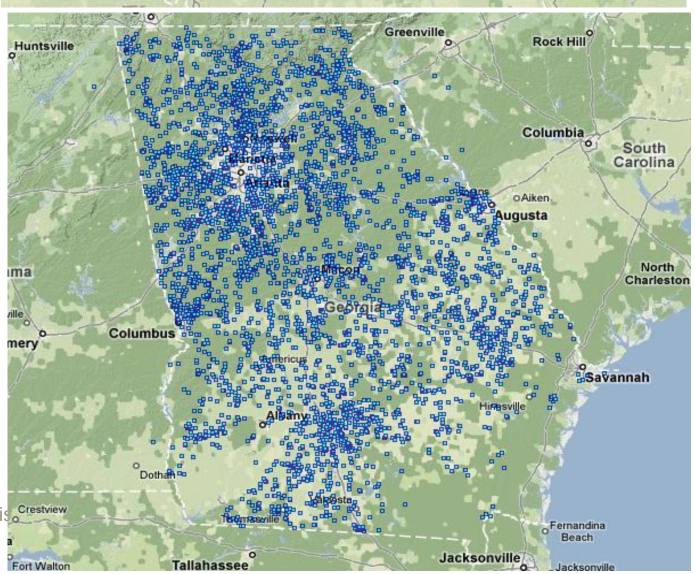
National Inventory of Dams

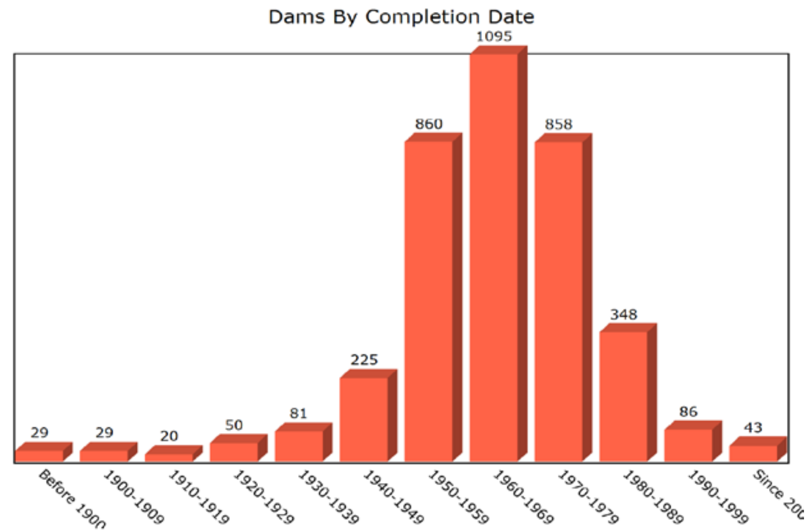
Iowa: 3,927



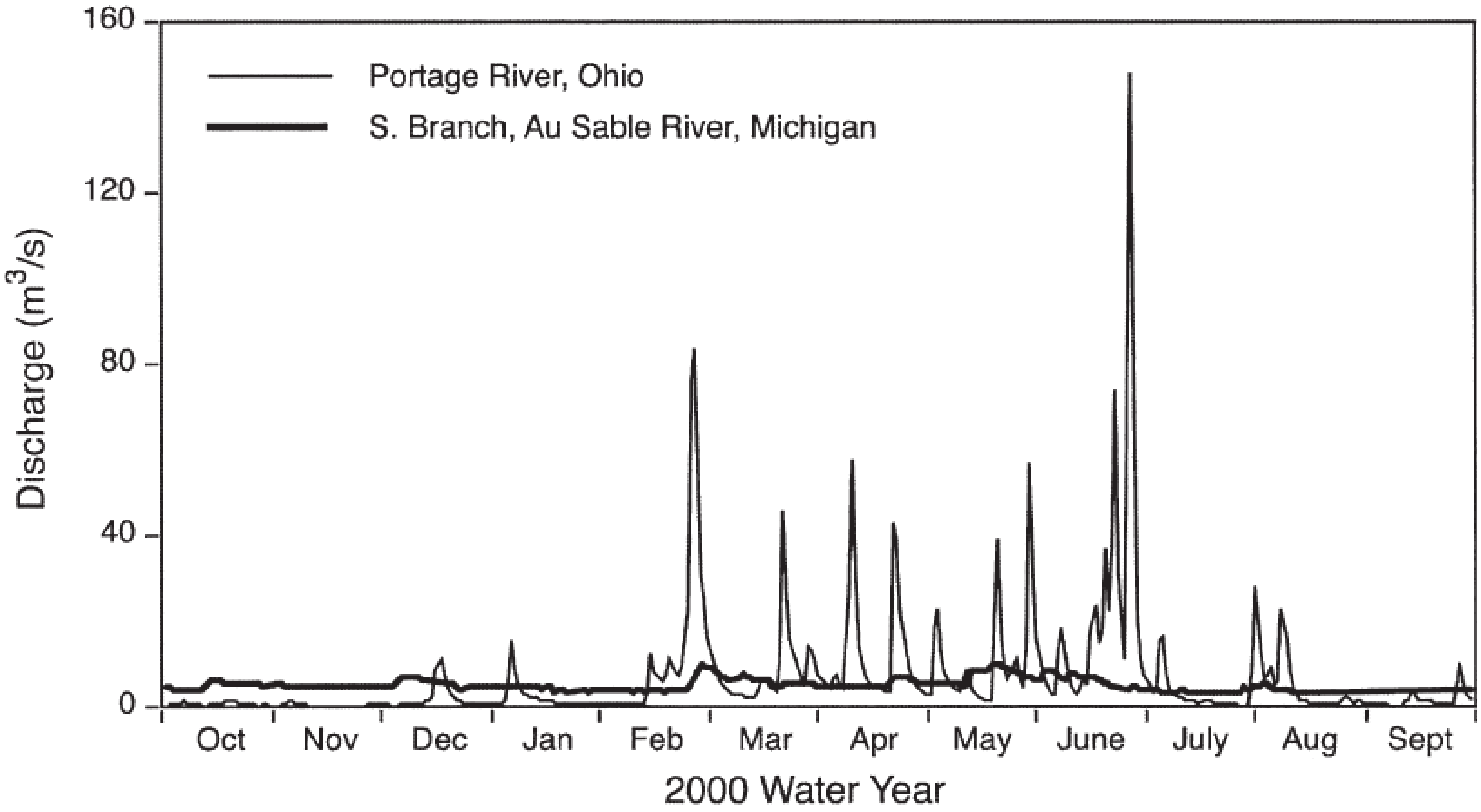


Georgia: 5,132





Flashiness: Basins of Similar Size



From Baker *et al.*, 2004

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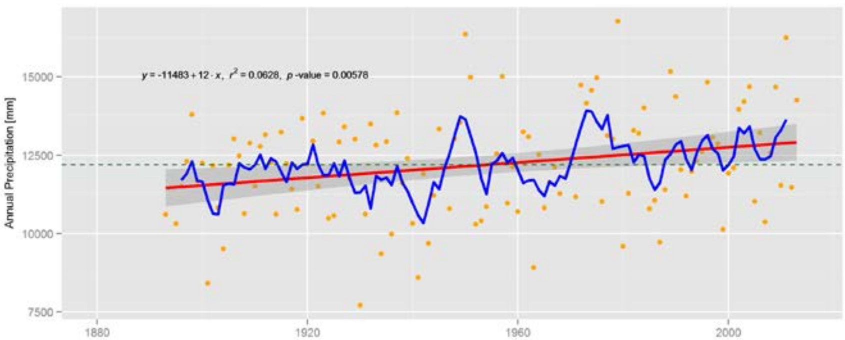
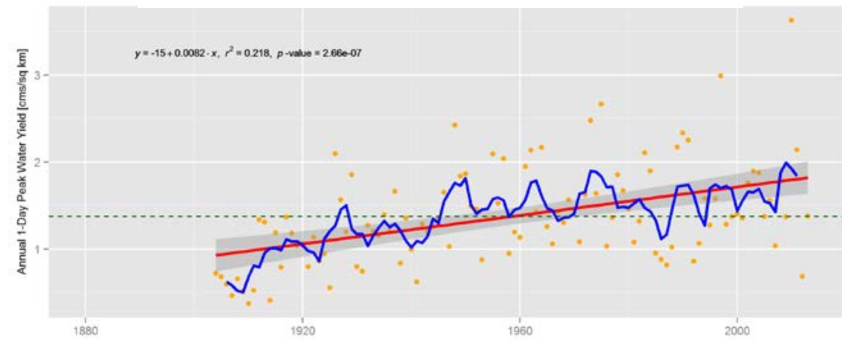
Ecoregion 71 – Interior Plateau

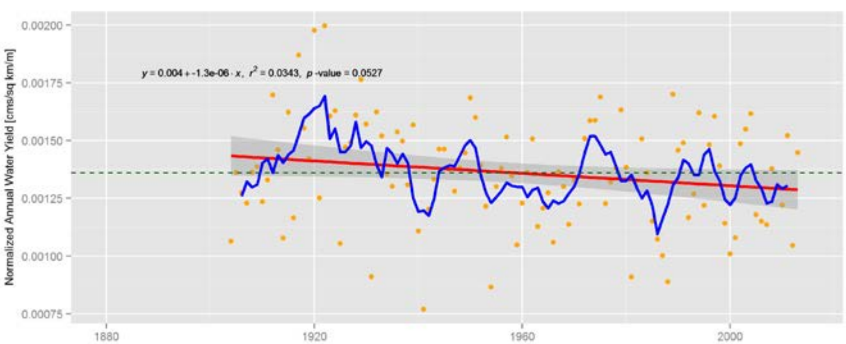
Precipitation



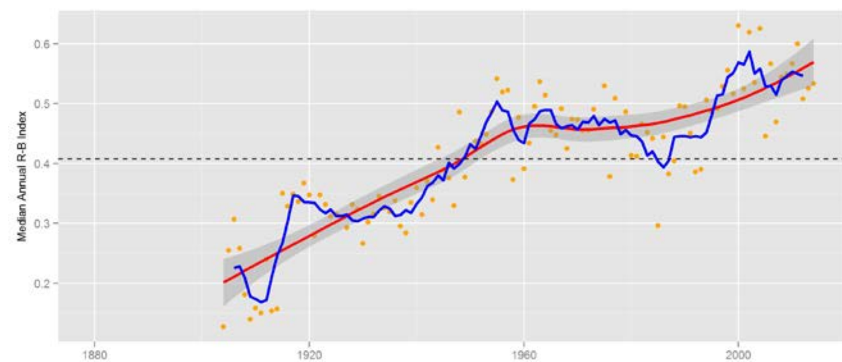
Peak 5-day Water Yield



Water Yield per unit precipitation



R-B Index



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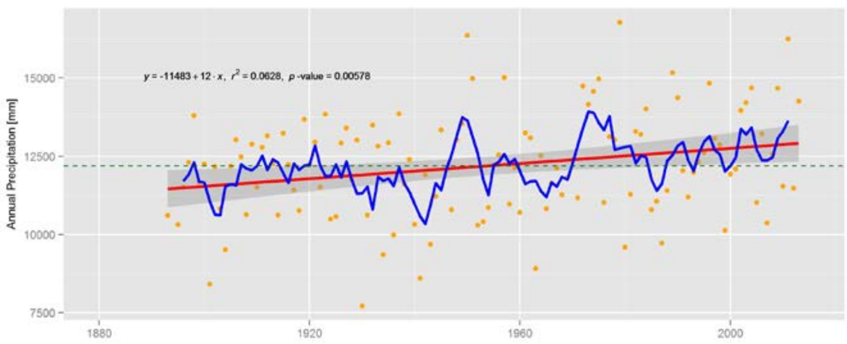
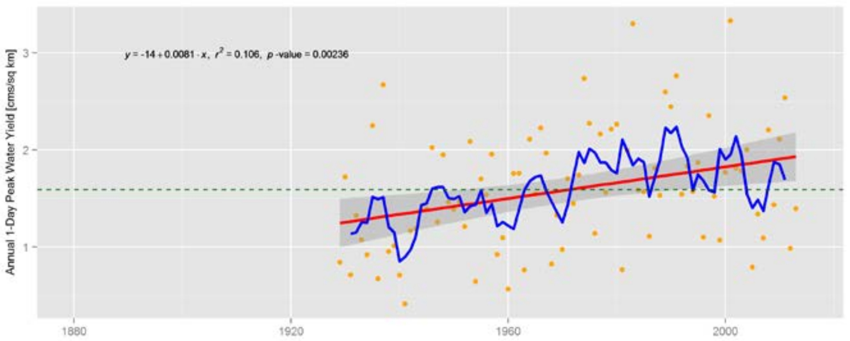
Ecoregion 74 – Mississippi Loess Plains

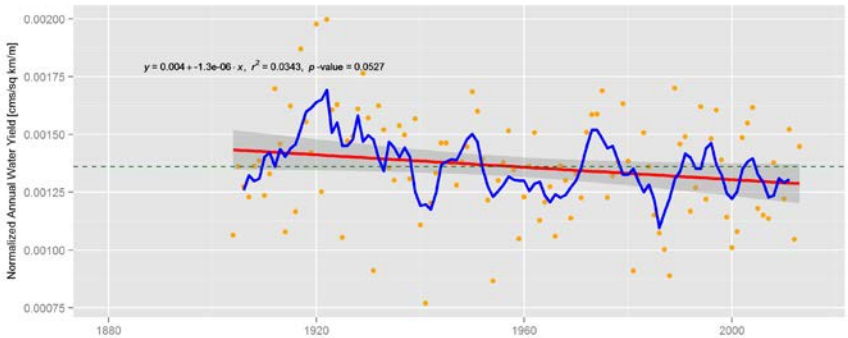
Precipitation



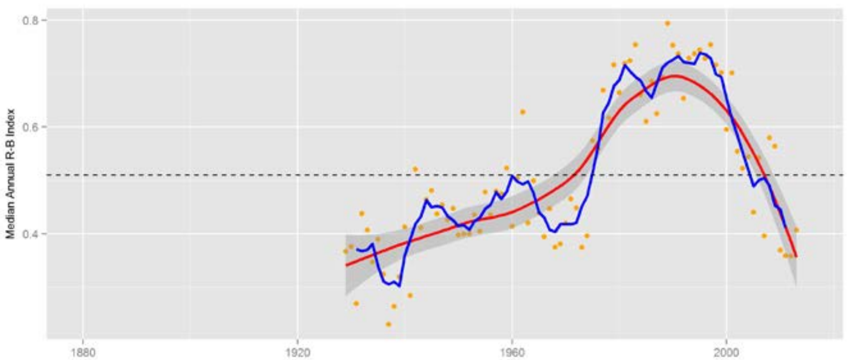
Peak 5-day Water Yield



Water Yield per unit precipitation



R-B Index



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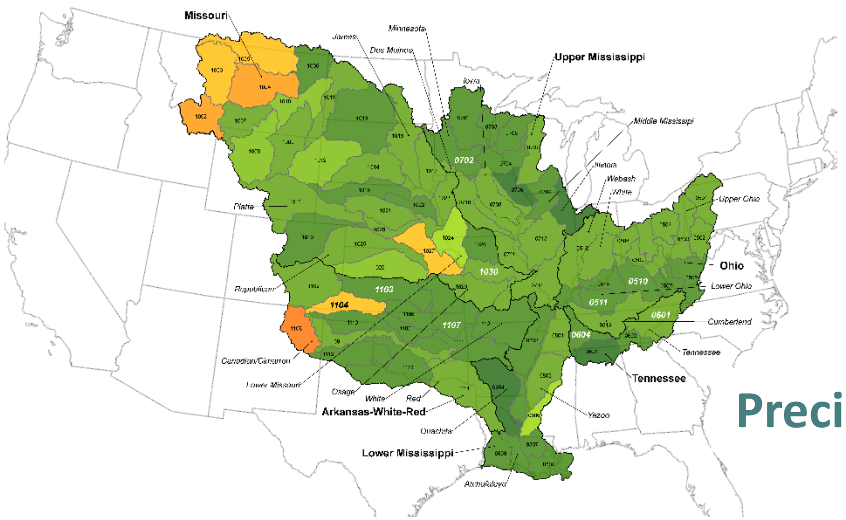
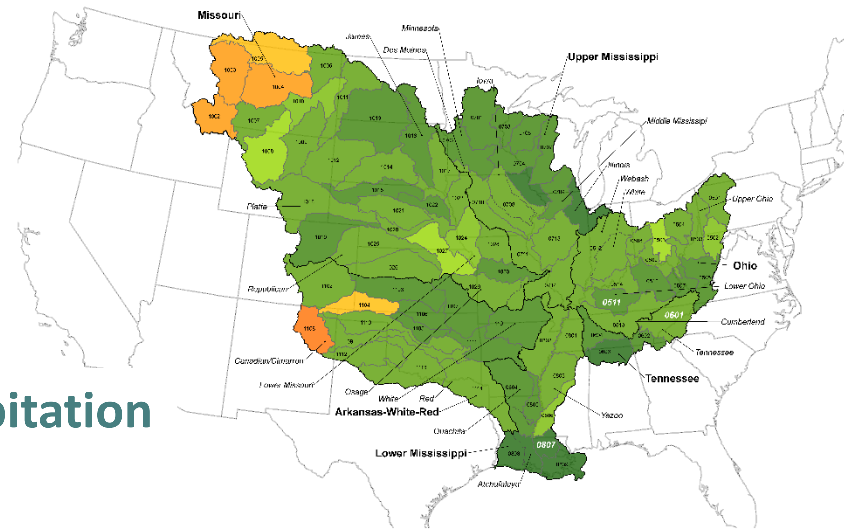
Trends in Peak Precipitation and Water Yield

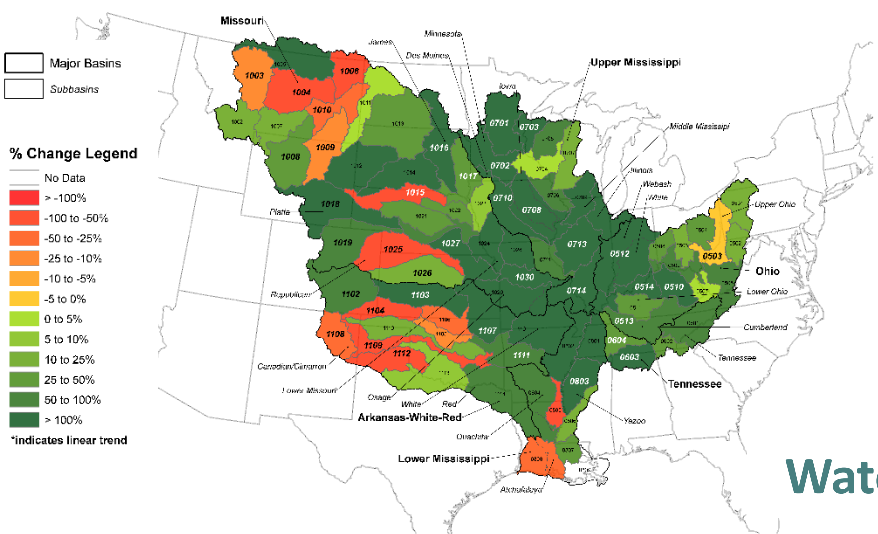
Peak Daily

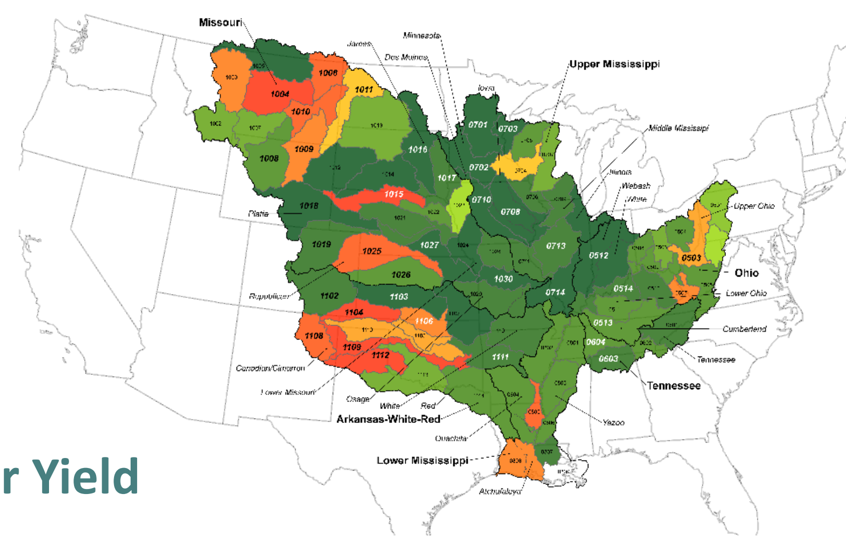
Peak 5-day





Precipitation



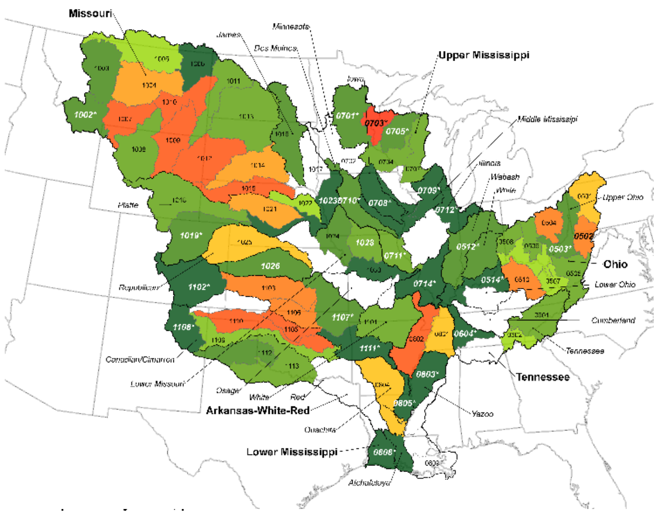


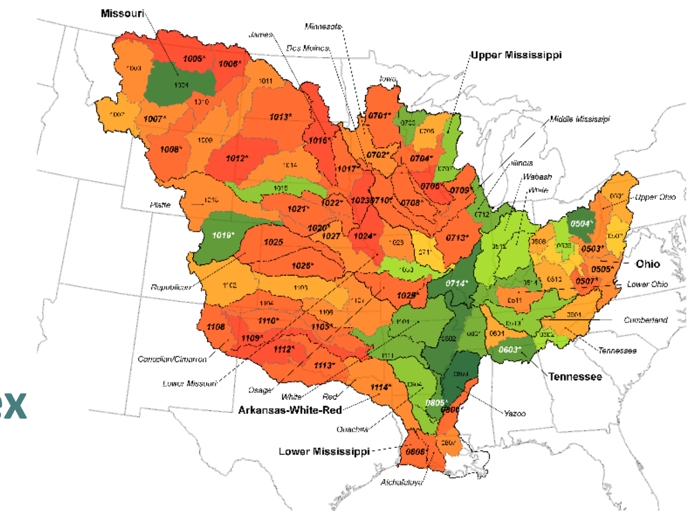
Water Yield

Trends Pre- and Post-1955

Pre-1955

Post-1955





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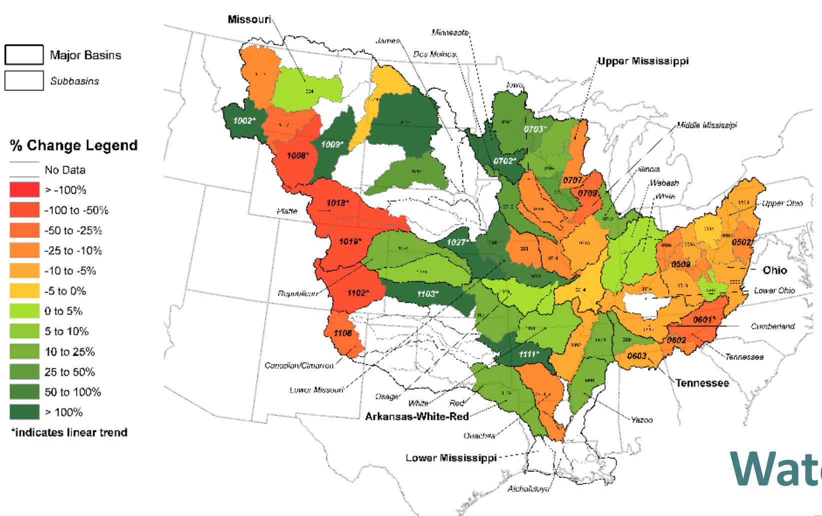
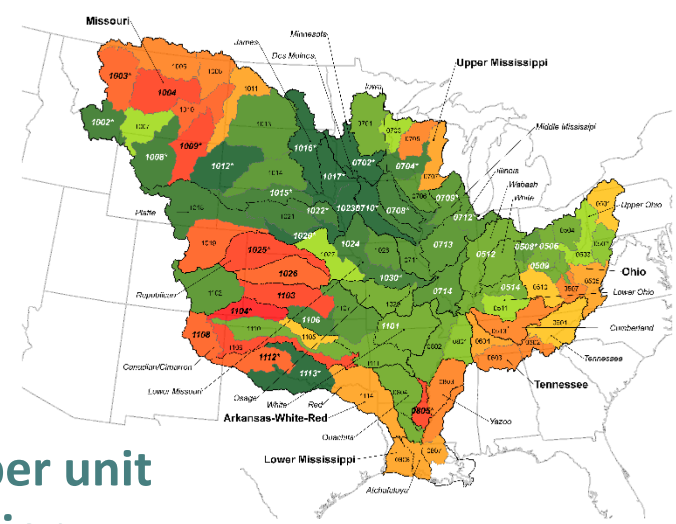
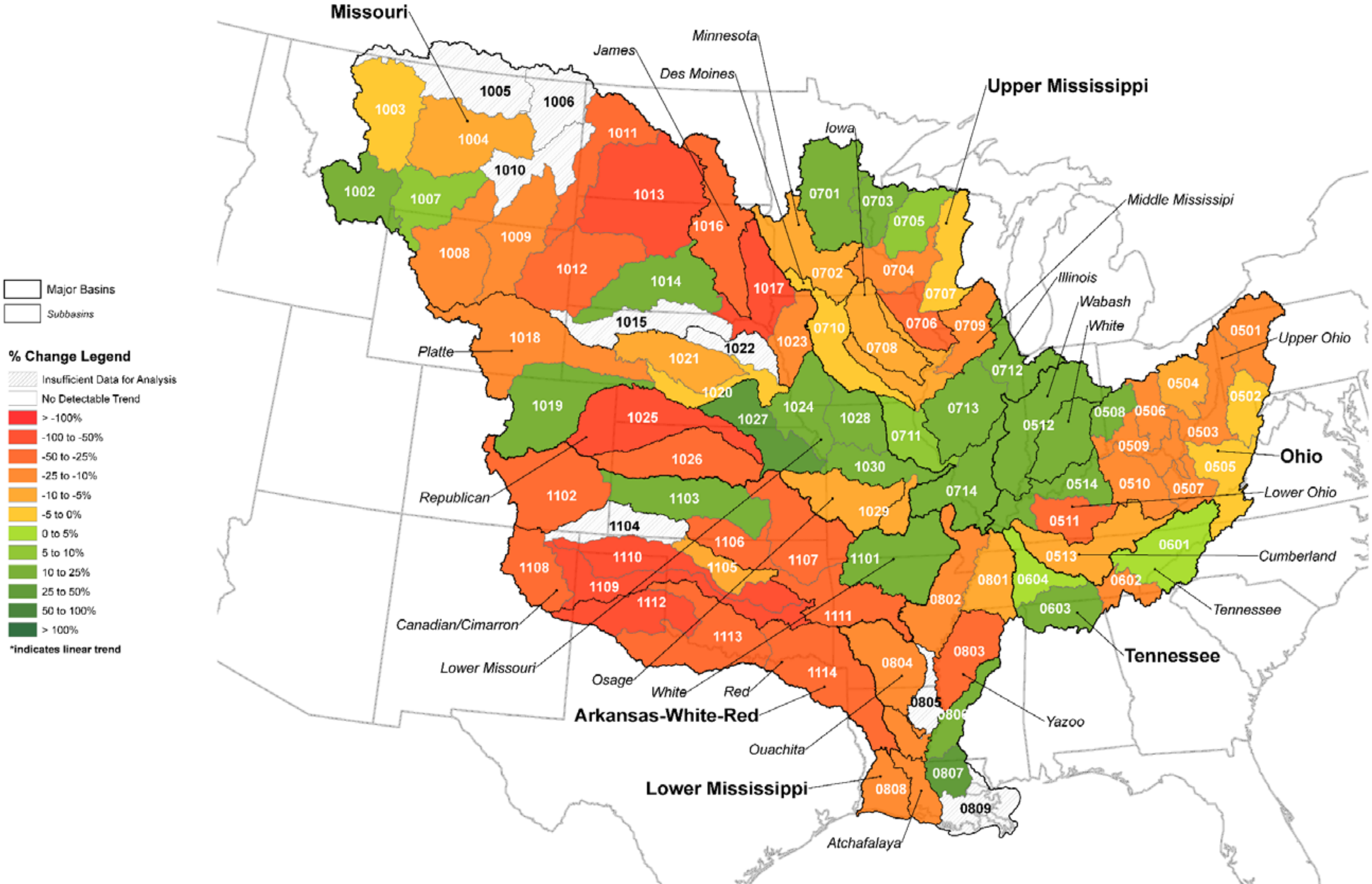


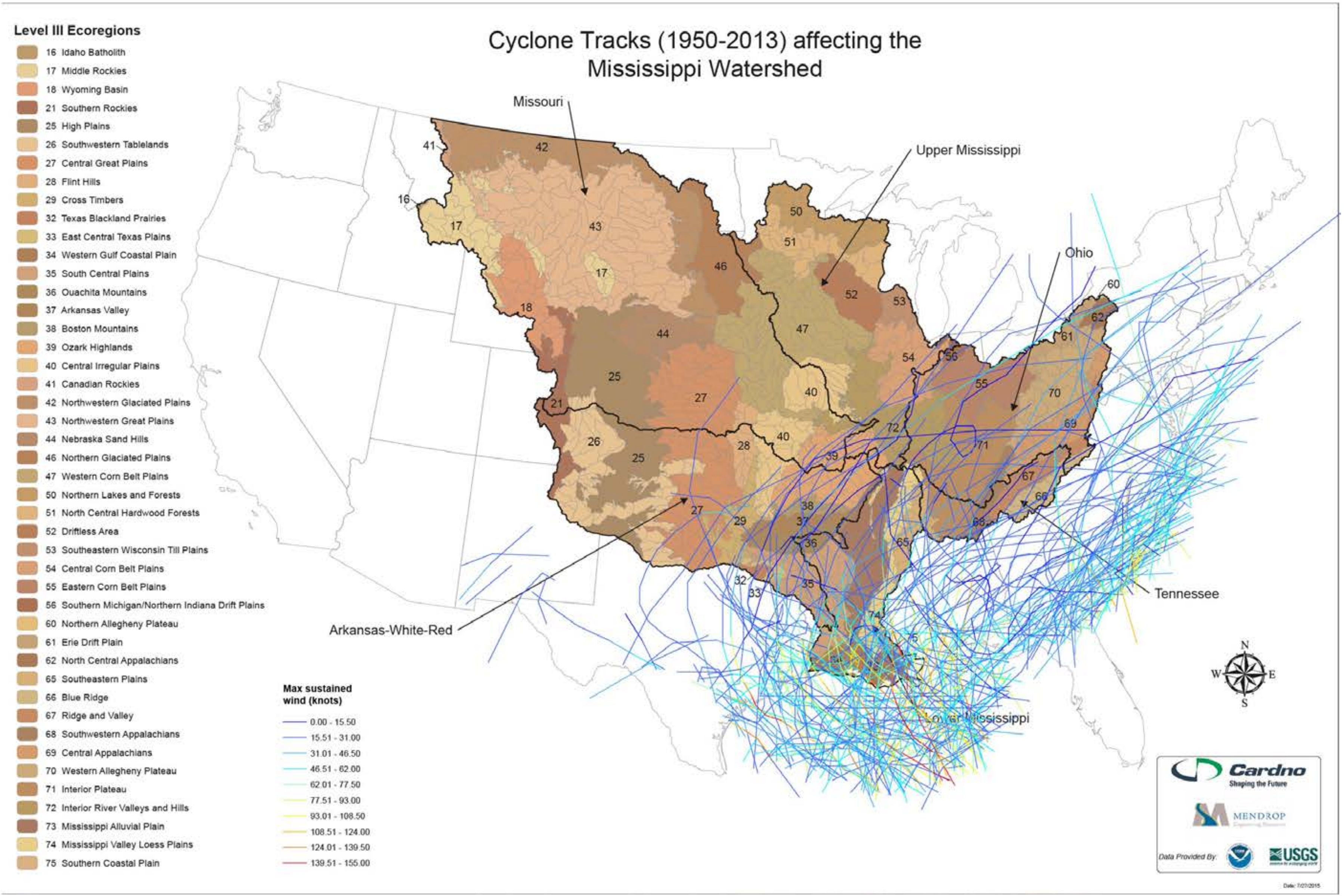


Water Yield per unit Precipitation

Changes Between Pre-1955 and Post-1955 $Q_{1.5}$



Integration of Hurricane Data



Additional Flow Analysis

> Investigate the use of additional flow parameters to describe trends in water discharge, particularly for peak flows (*i.e.*, recurrence intervals);

> Sort stations by drainage area within each HUC4 to determine trends for basins of different size;

> Integrate with locations and density of dams

> Investigate parameters to quantify and describe changes to downstream transfer of water throughout the Basin in the context for flood control.

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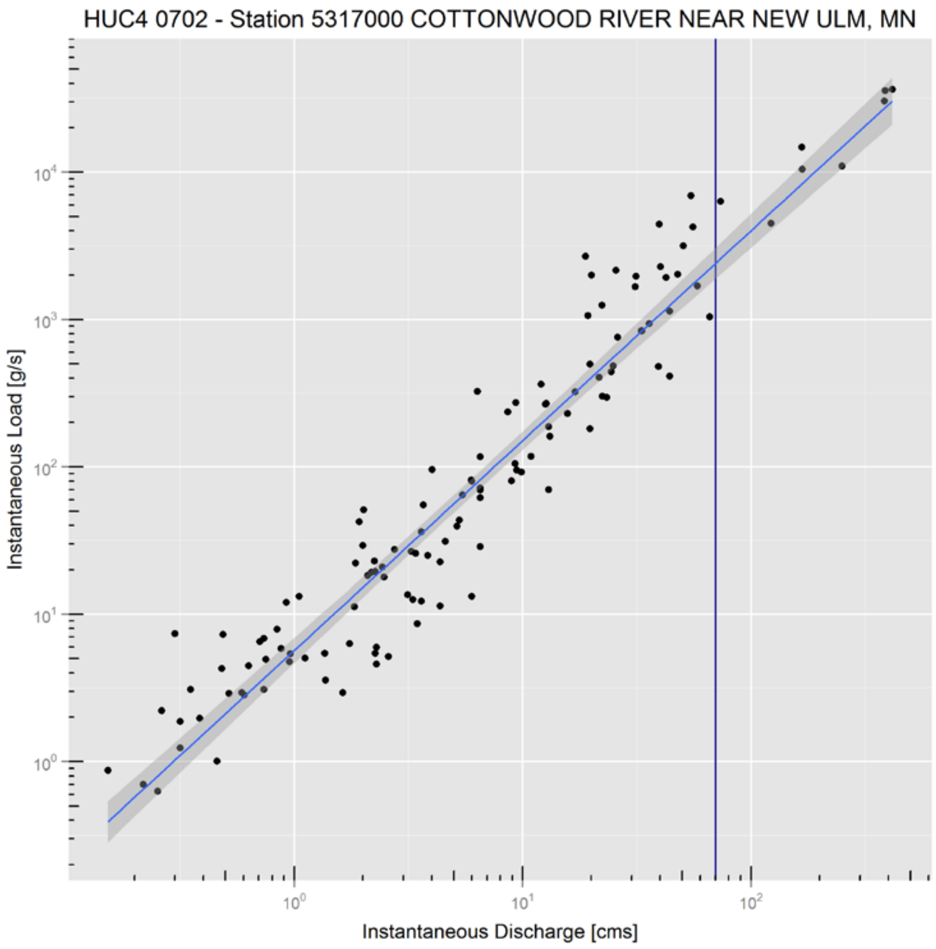
Suspended-Sediment Loads

- Obtain unit values of flow and suspended sediment
- Develop transport ratings and daily loads using flow data
- Identify trends by station (ratings shifts) and by region (HUC-4 and Ecoregion)
- Sum for annual values and determine annual trends
- Normalize by drainage area to compare basins of variable size
- Analyze downstream-most stations on main stem and/or HUC-4 to determine contributions to major streams.
- Compare and integrate results with Mississippi River sediment-budget work currently underway by CoE.



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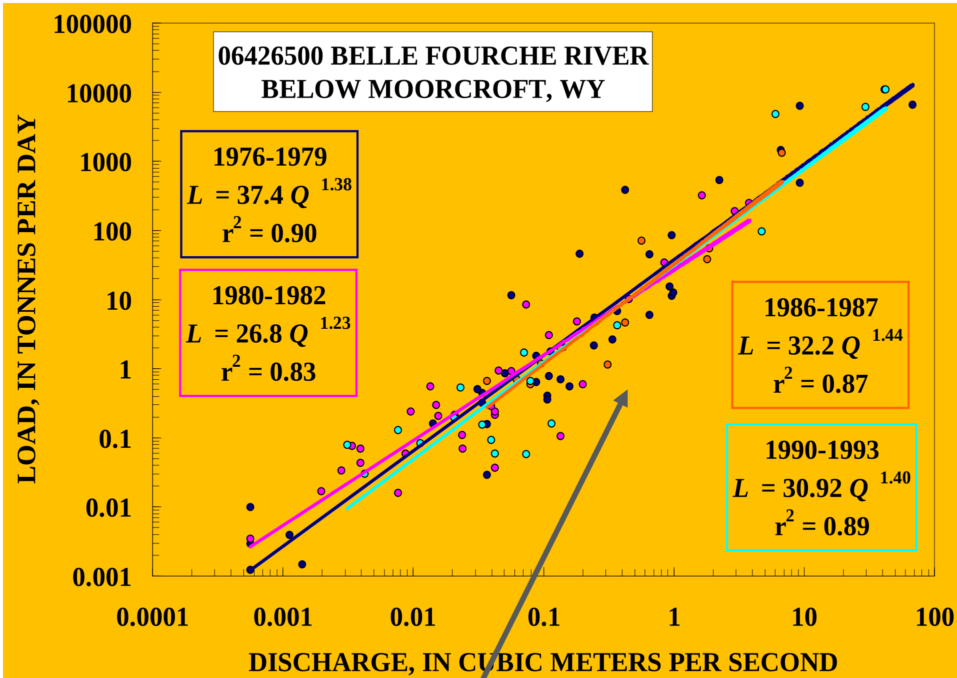
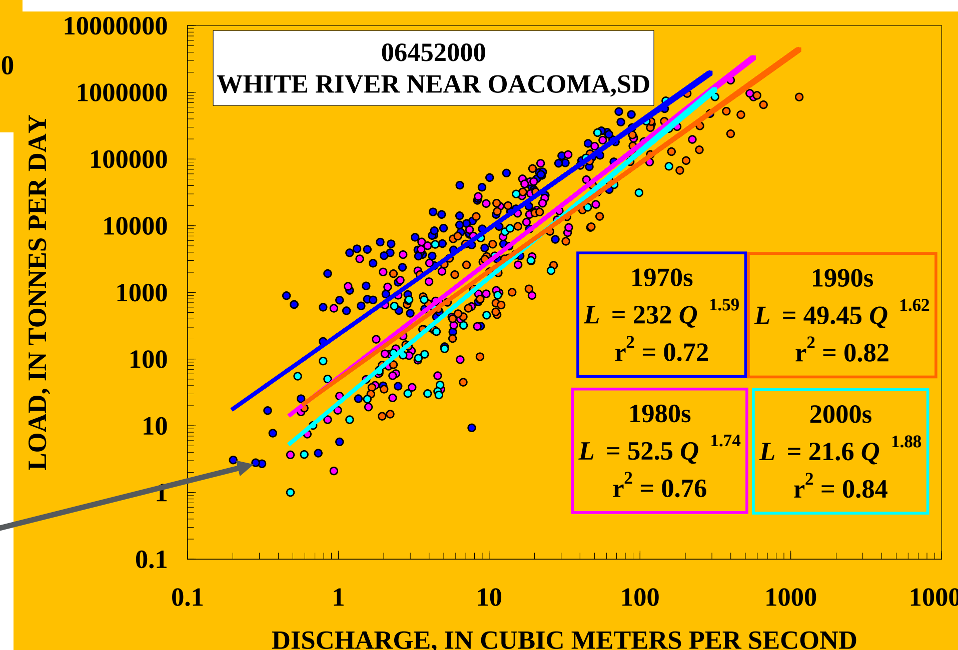
Sediment Transport Ratings

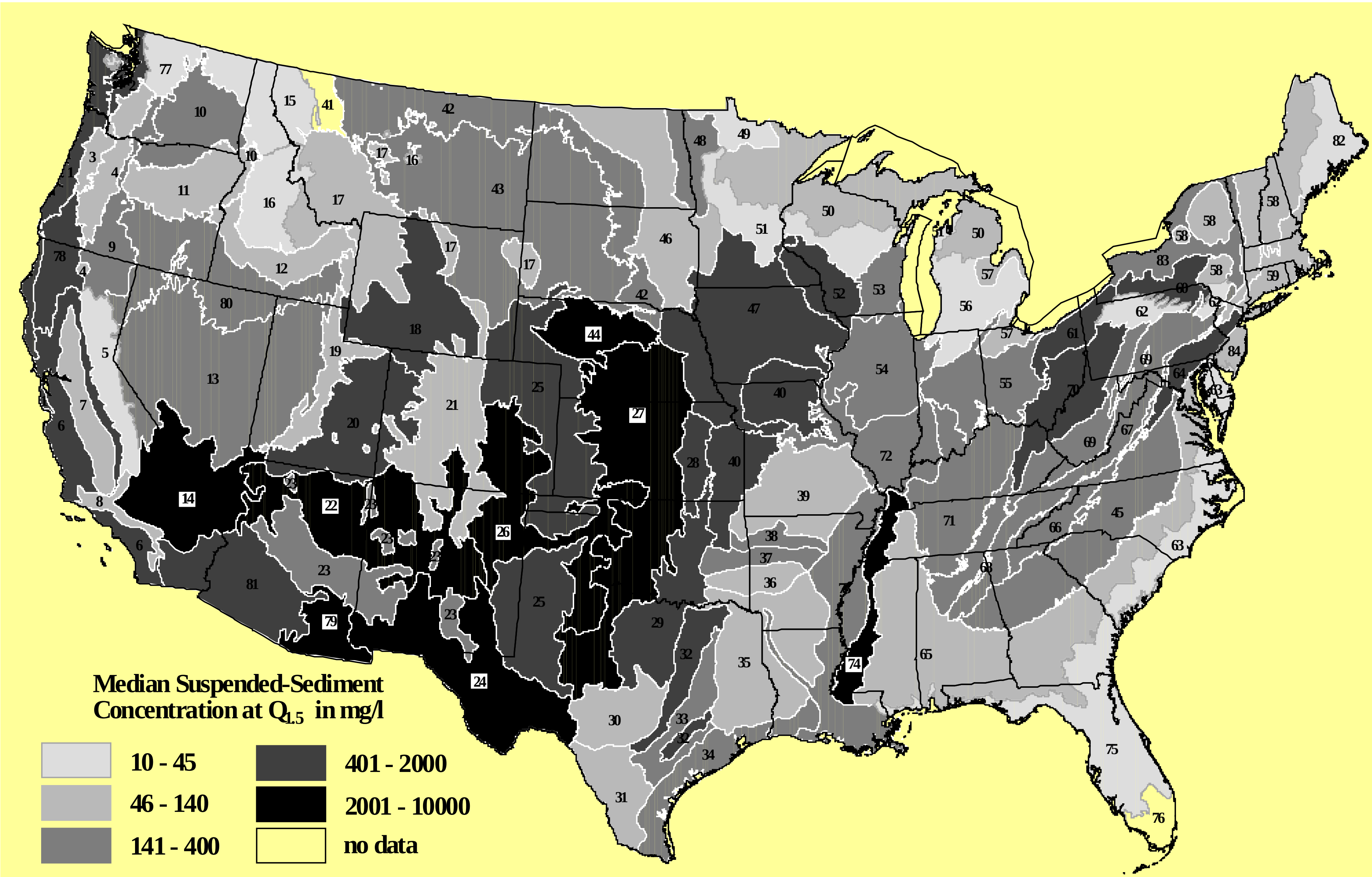




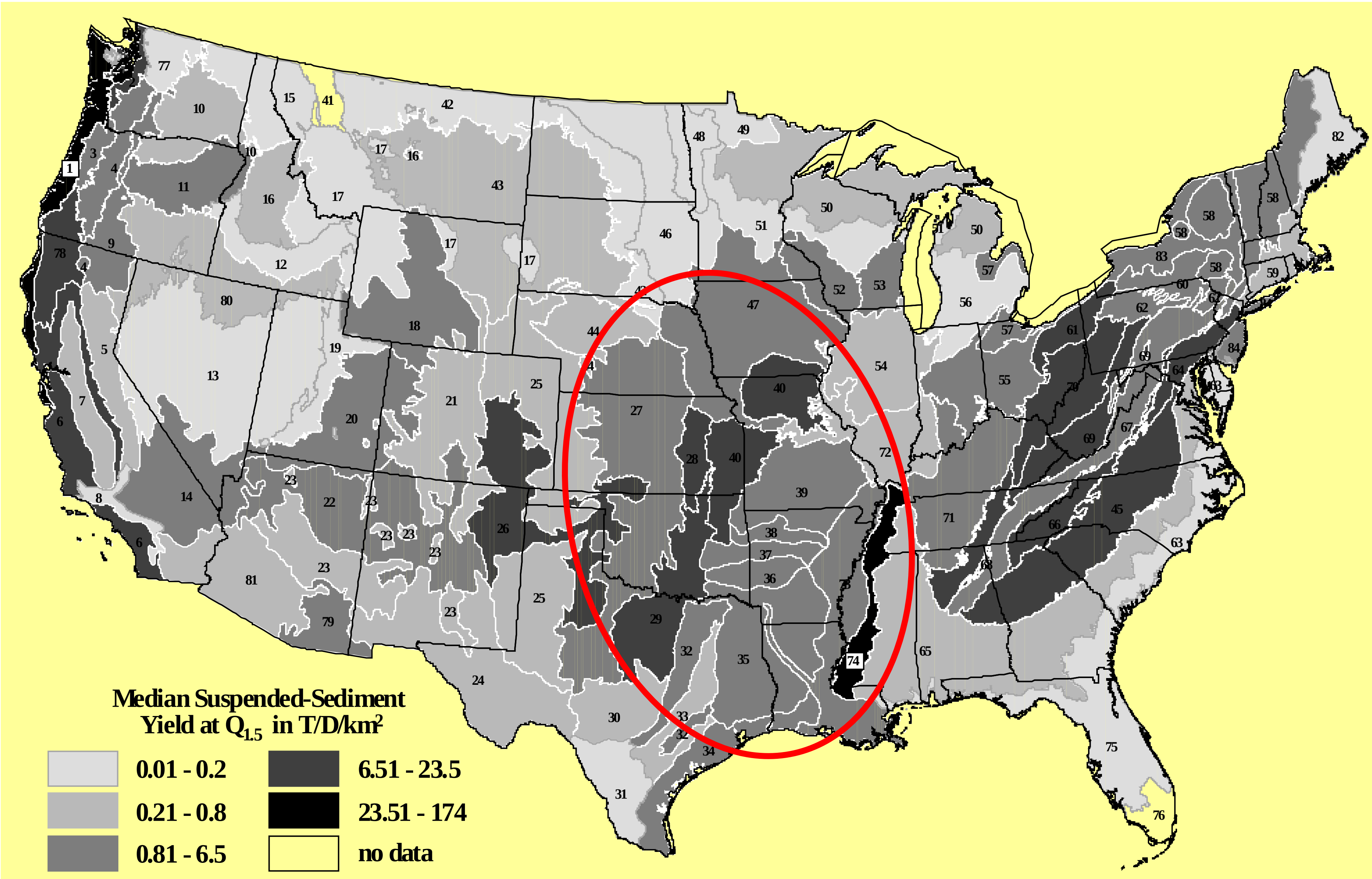
Stable Ratings

Unstable Ratings

Median Suspended Sediment Concentrations



Median Suspended-Sediment Yields



Results

> Most of Mississippi River Basin receiving more rainfall than 100 years ago

> Precipitation generally shifted temporally

> Water yields:

- Decreased significantly, particularly in western part of basin and particularly in spring
- Pronounced increases (25 to > 50%) include north-south slice of central US bounded on the west by the Dakotas, Nebraska, Kansas and Oklahoma and on the east by Lake Michigan, Illinois and lower Mississippi Valley

> Increase in water yield can be partly attributed to increases in precipitation (5-25%), but also to improved drainage conditions

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Implications for Ecosystem Restoration

> Changes in precipitation/water yield result in changes to:
  - channel geometry (affecting sediment and nutrient transport)
  - wildlife and vegetation community alterations

> Adaptive Management?

> Design for predicted shifts in:
  - Precipitation, water yield and temperature
  - Landuse and landcover

> Accommodate for:
  - Ecosystem communities
  - Flow regimes
  - Grading
  - “Escape routes”

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