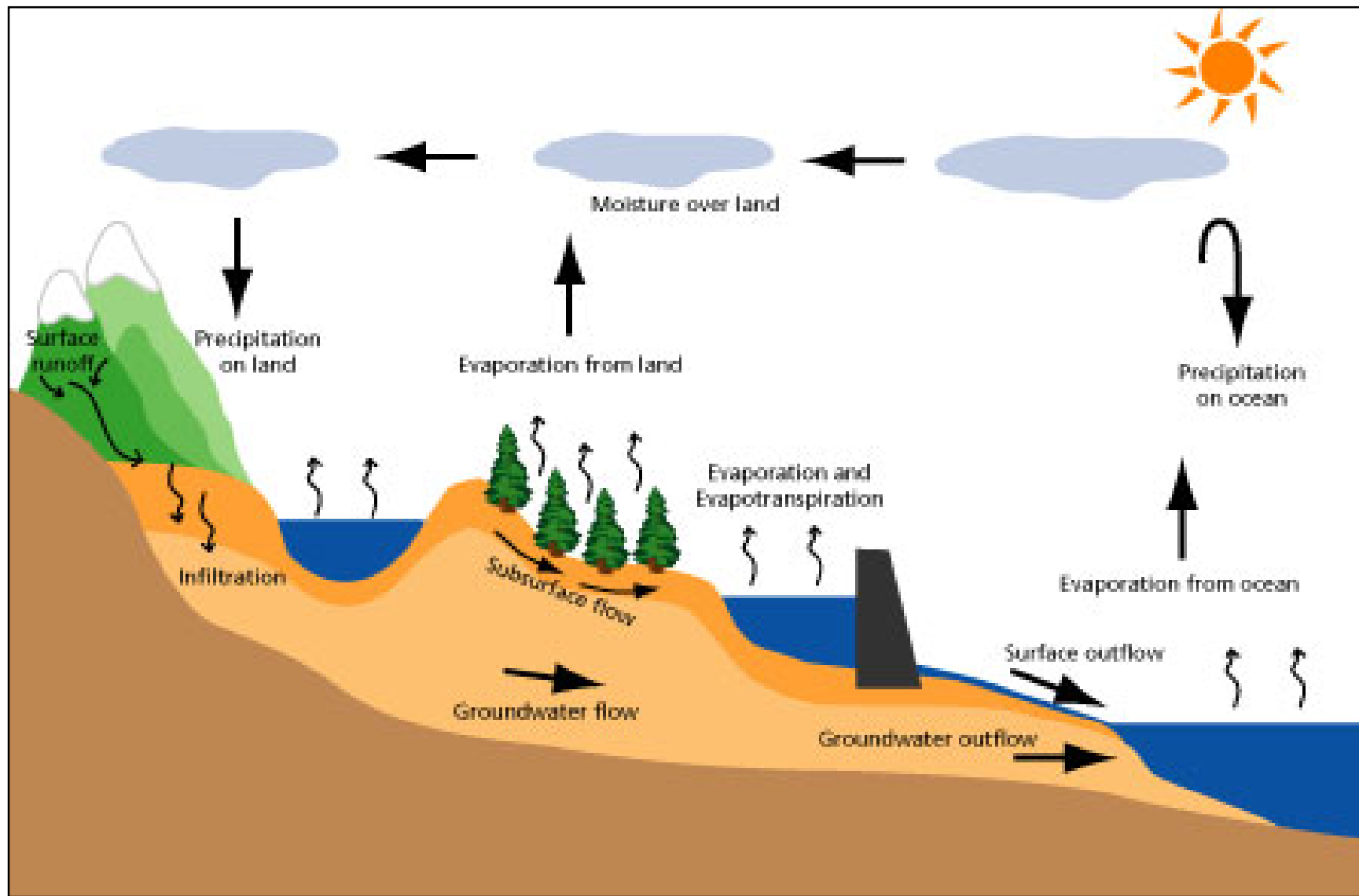
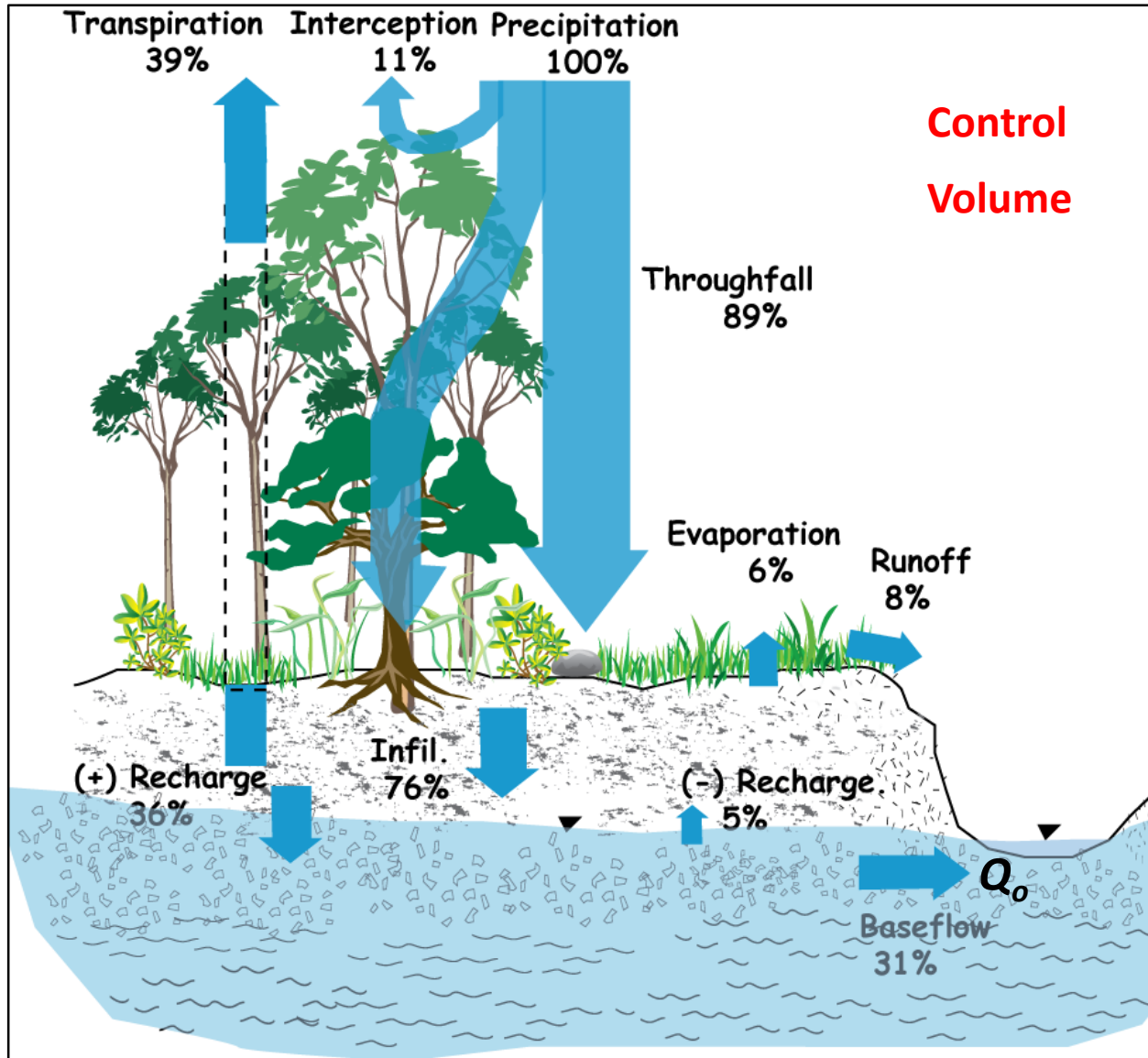


Basic Hydrologic Processes



Basic Output: Water balance



Basic Approach:

Look at the Hydrologic Budget

$$P + Q_i - Q_o - R(I) - E - T = \Delta S$$

P = Precipitation

Q_i = Inflow

Q_o = Outflow

$R(I)$ = Recharge

E = Evaporation

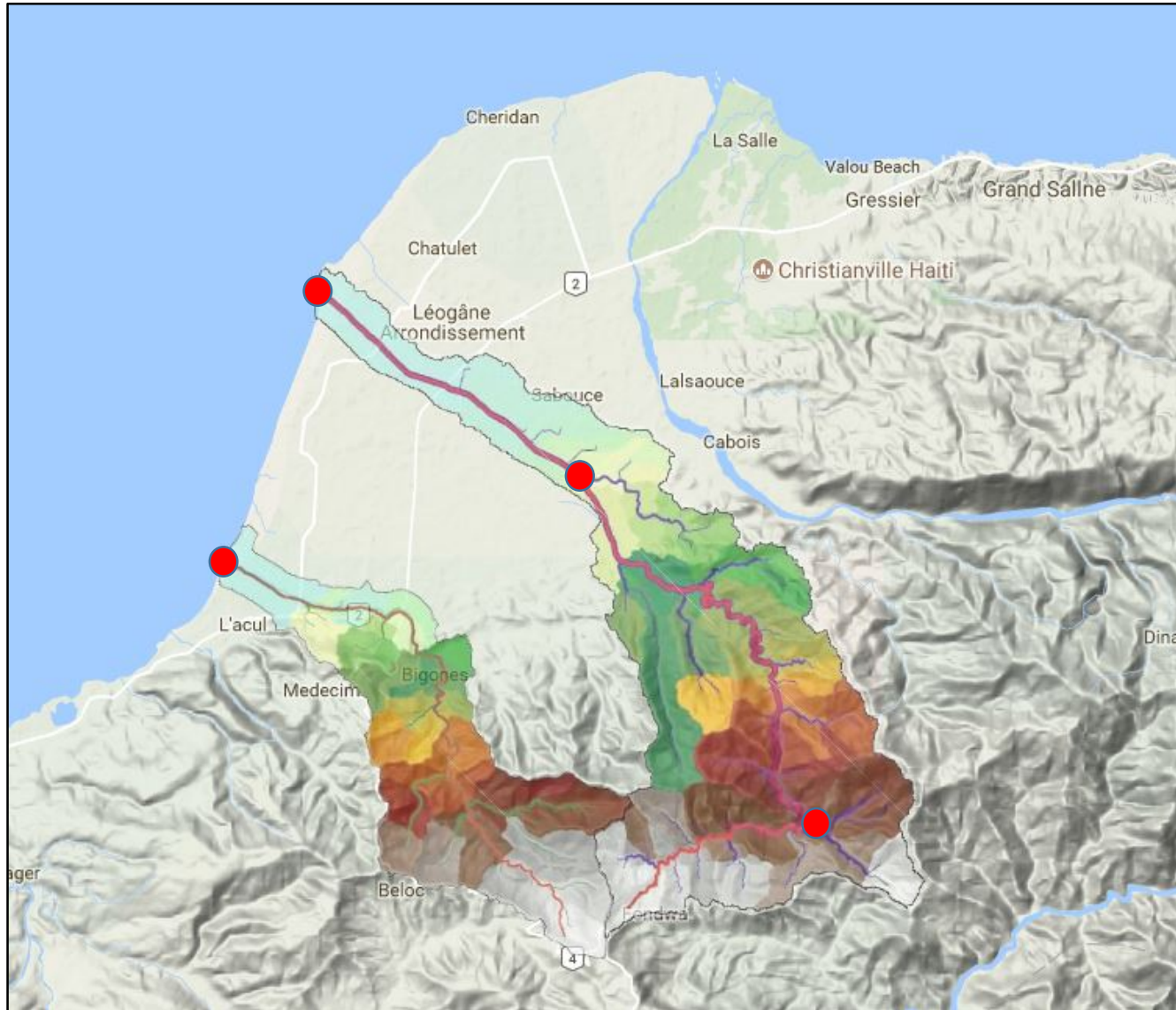
T = Transpiration

ΔS = Change in Storage

I = Infiltration is a process

$$I = T + R + Q_o$$

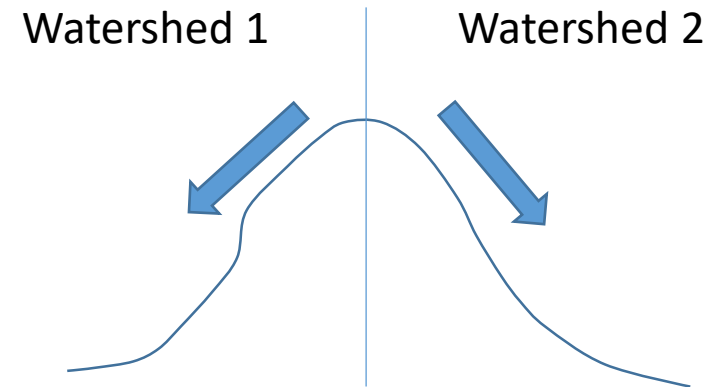
Watersheds



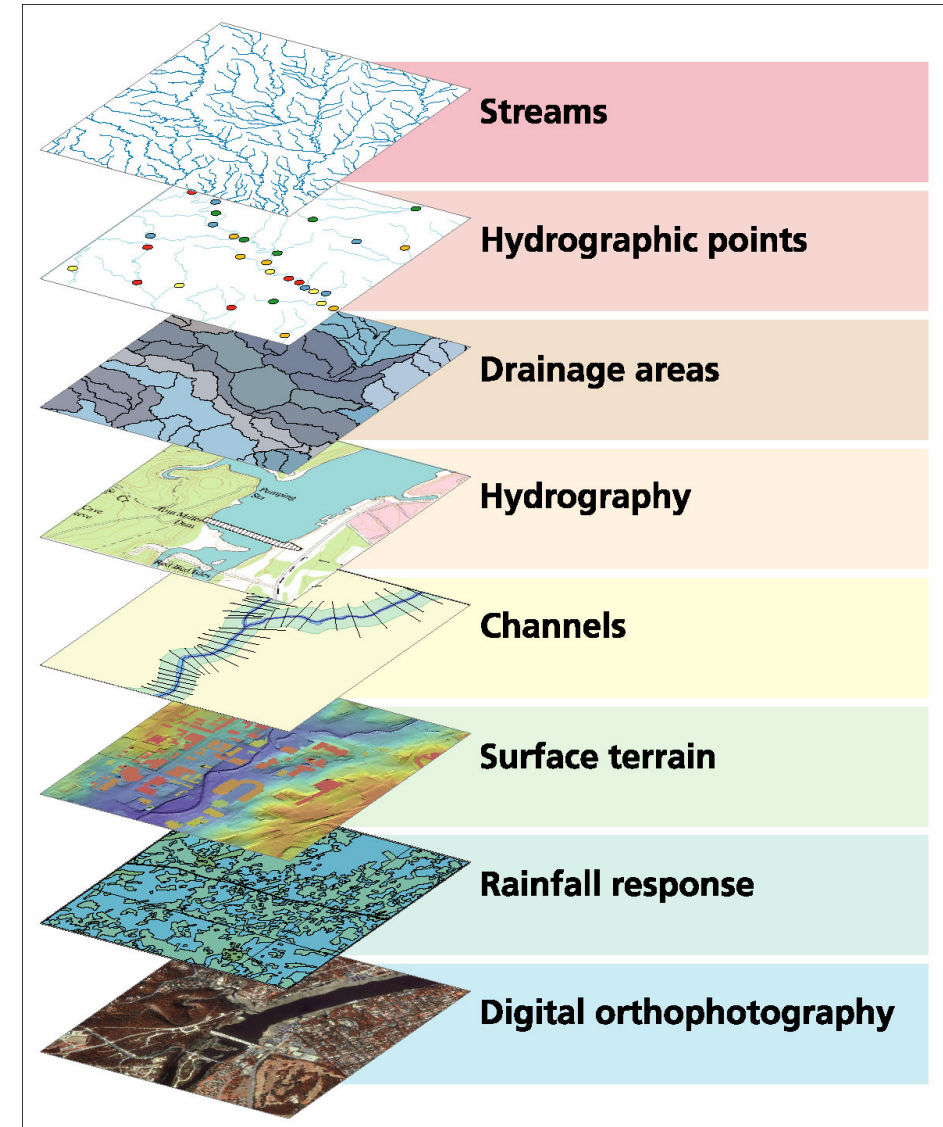
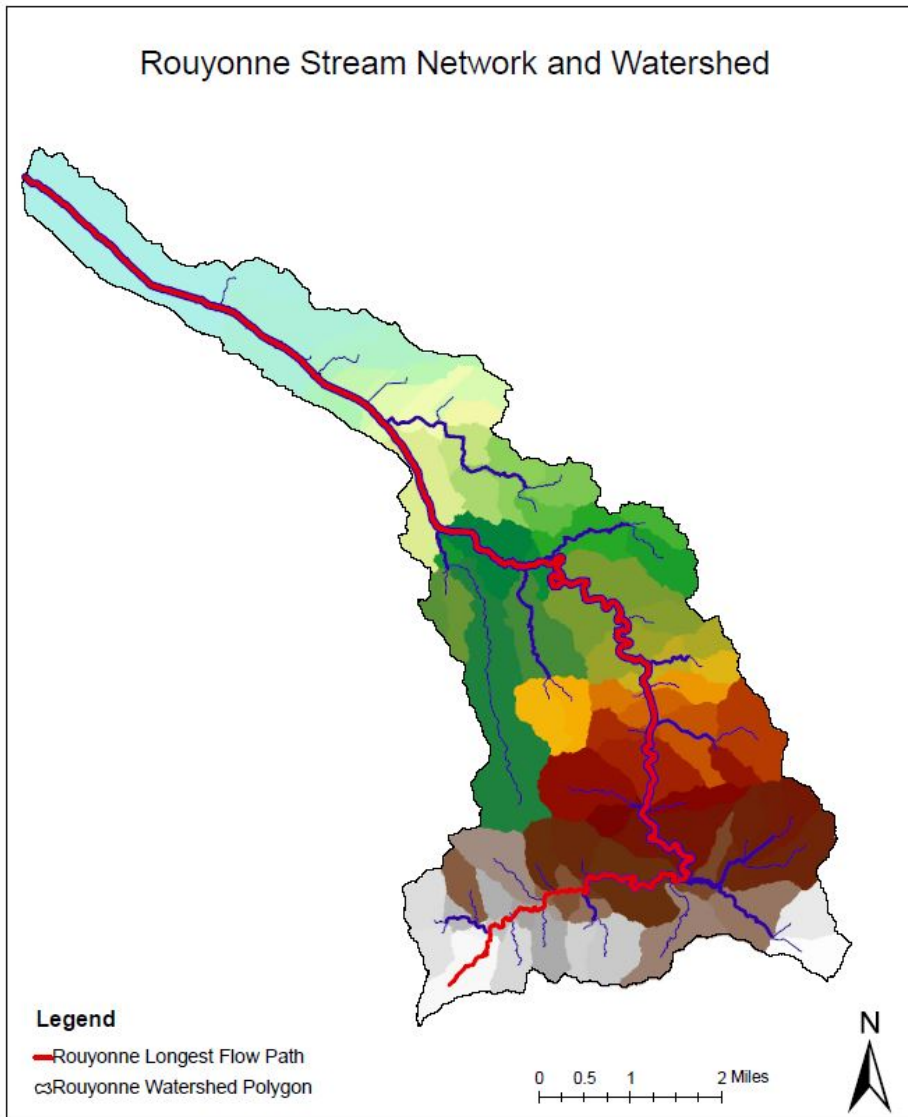
NOAA Definition:

“It is a land area that **channels Rainfall and Snowmelt** to creeks, and rivers, and eventually to **Outflow Points** such as reservoirs, bays, and the ocean”

Typically WSBs align along ridges.

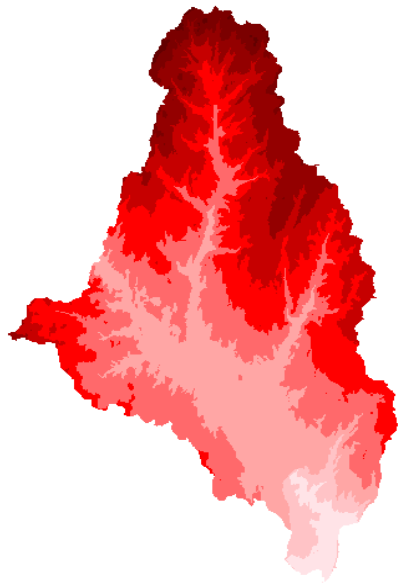


Watershed Components

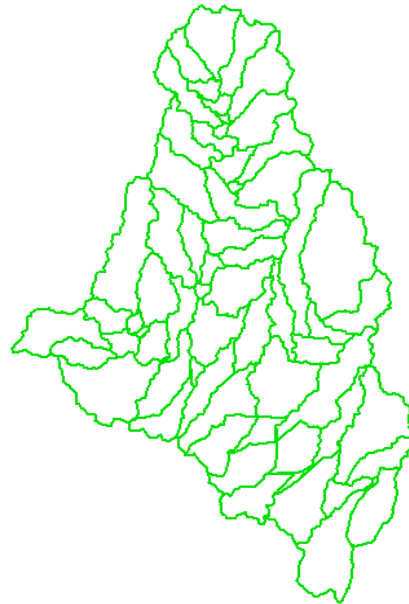


Watershed Data Layers

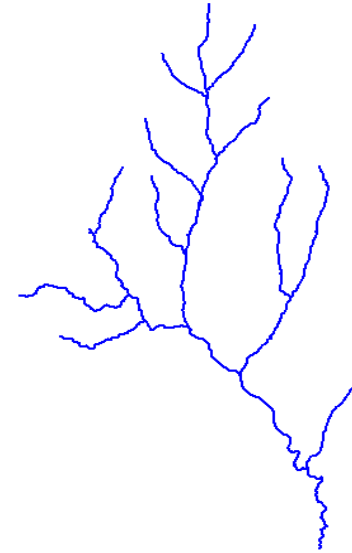
How do we combine these data?



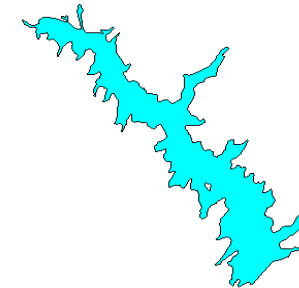
Digital Elevation
Models



Watersheds

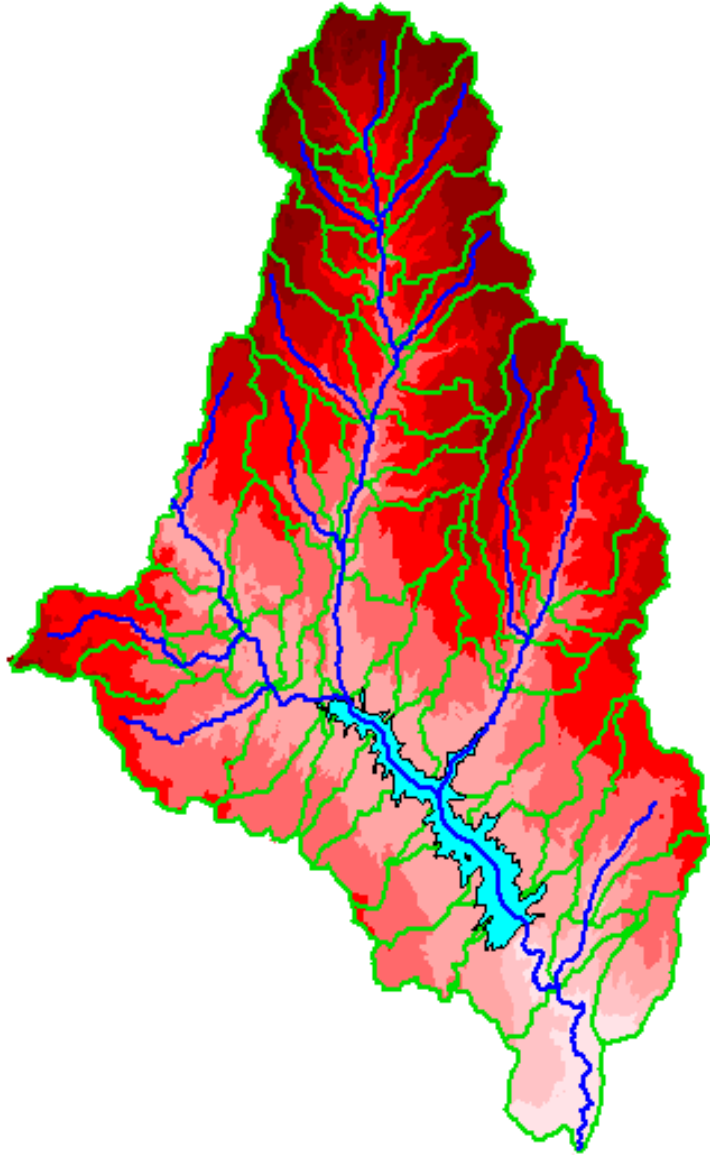


Streams

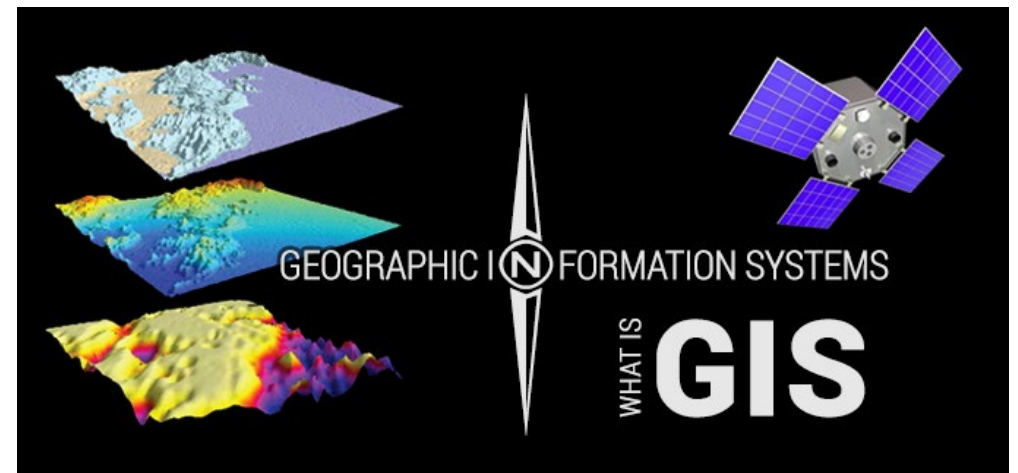
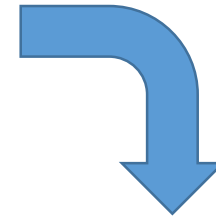


Waterbodies

Watershed Data Layers



An integrated
raster-vector
database

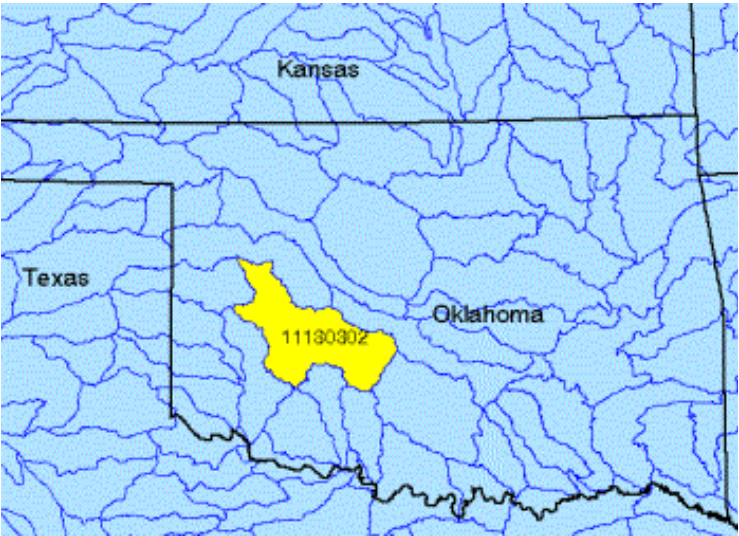
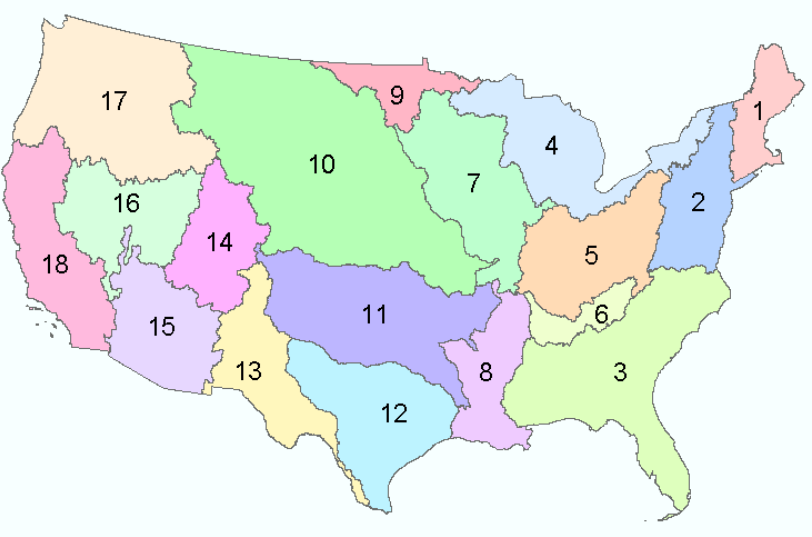


Watersheds of the US

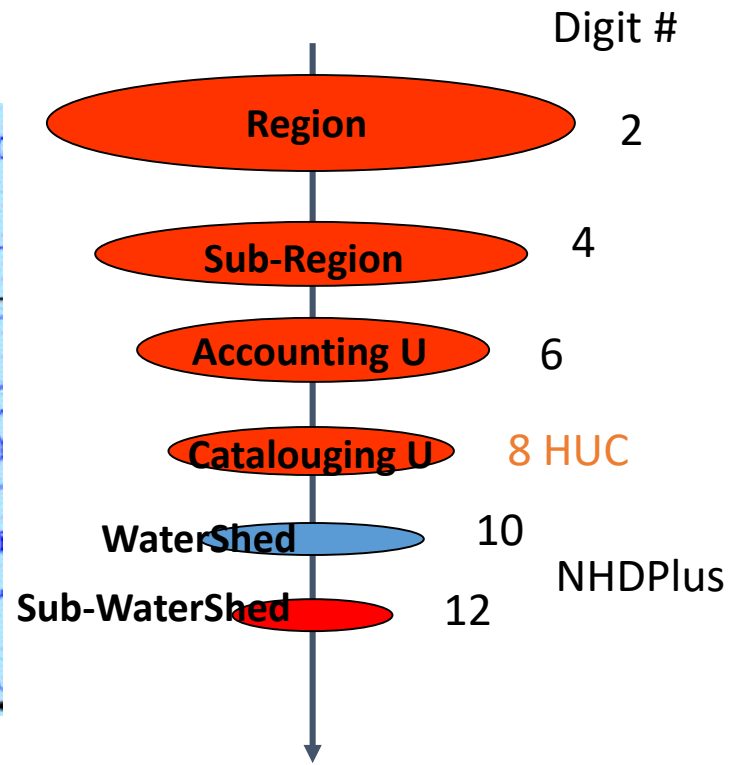
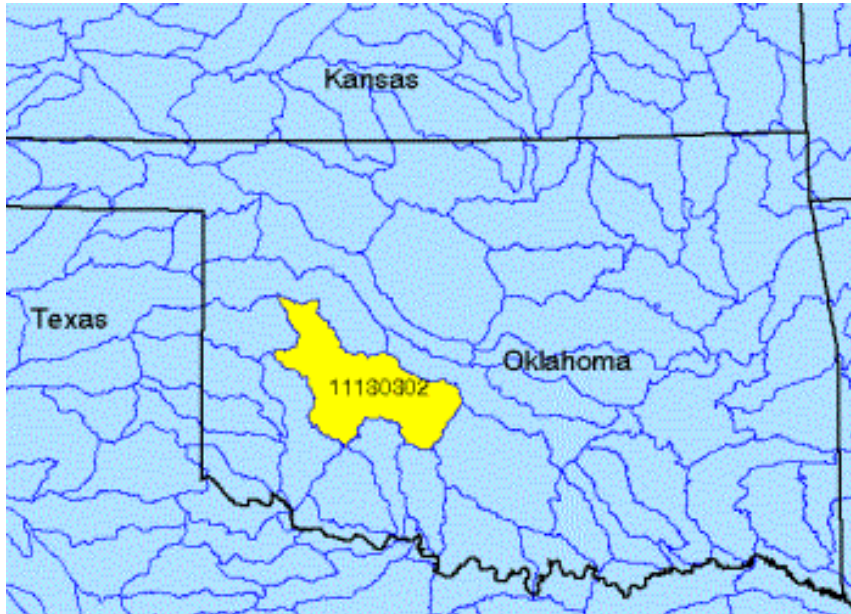
2-digit water resource regions

8-digit HUC watersheds


- [Region 01](#) New England
- [Region 02](#) Mid-Atlantic
- [Region 03](#) South Atlantic-Gulf
- [Region 04](#) Great Lakes
- [Region 05](#) Ohio
- [Region 06](#) Tennessee
- [Region 07](#) Upper Mississippi
- [Region 08](#) Lower Mississippi
- [Region 09](#) Souris-Red-Rainy
- [Region 10](#) Missouri
- [Region 11](#) Arkansas-White-Red
- [Region 12](#) Texas-Gulf
- [Region 13](#) Rio Grande
- [Region 14](#) Upper Colorado
- [Region 15](#) Lower Colorado
- [Region 16](#) Great Basin
- [Region 17](#) Pacific Northwest
- [Region 18](#) California
- [Region 19](#) Alaska (Old numbering system)
- [Region 20](#) Hawaii
- [Region 21](#) Caribbea



Watershed Hierarchy



| Digit # | Example |
|----------|---------------------|
| 02 | Mid-Atlantic Region |
| 0201 | Richelieu |
| 020100 | Richelieu, NY & VT |
| 02010001 | Lake George |
| 02010004 | Ausable |
| 02010004 | Great Chazy-Saranac |

 Available

 In Progress

Hydrologic Unit Code (8-Digit) Watersheds

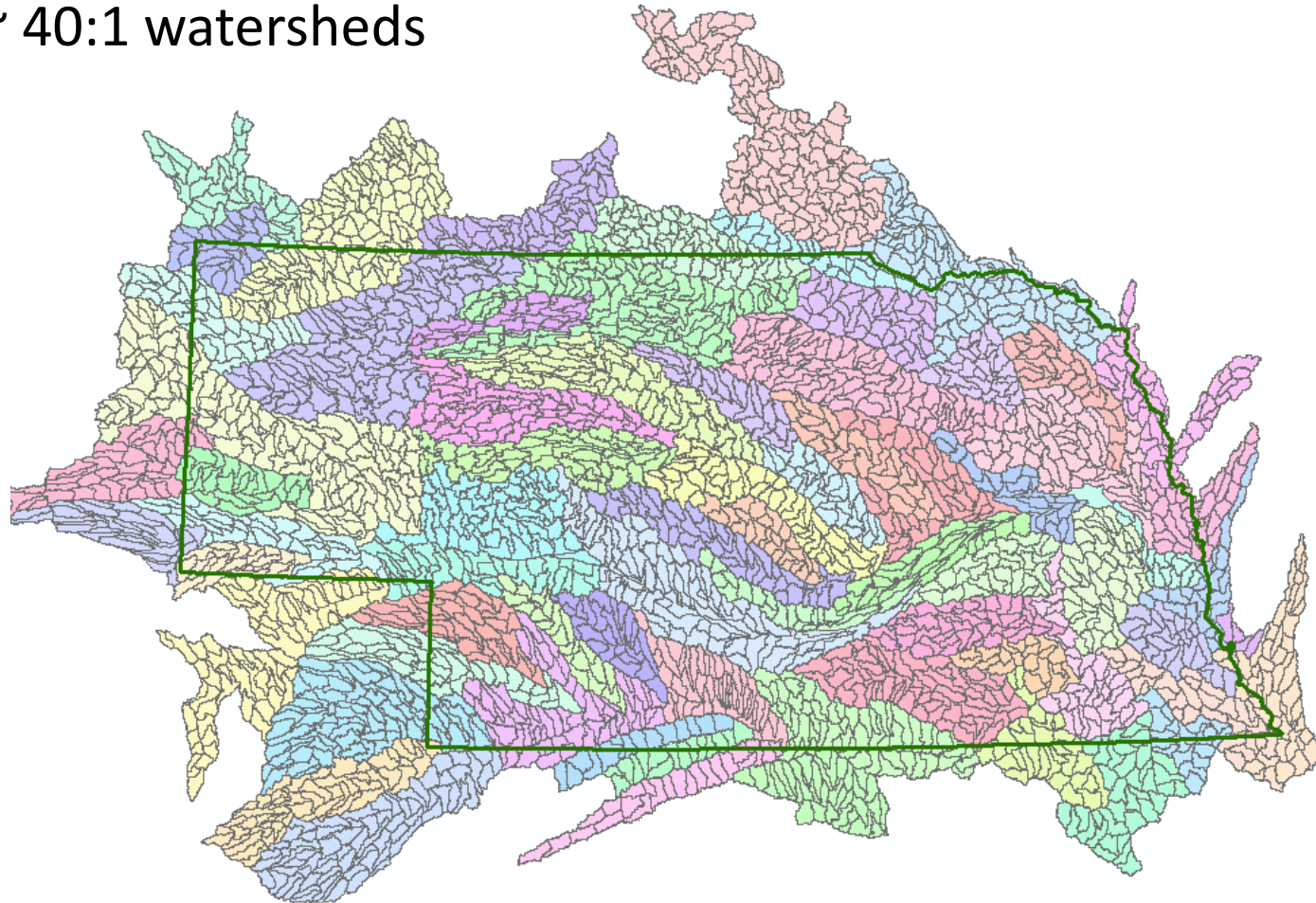
~ 2000 for US, about the size of counties



Watershed Boundary Data for Nebraska

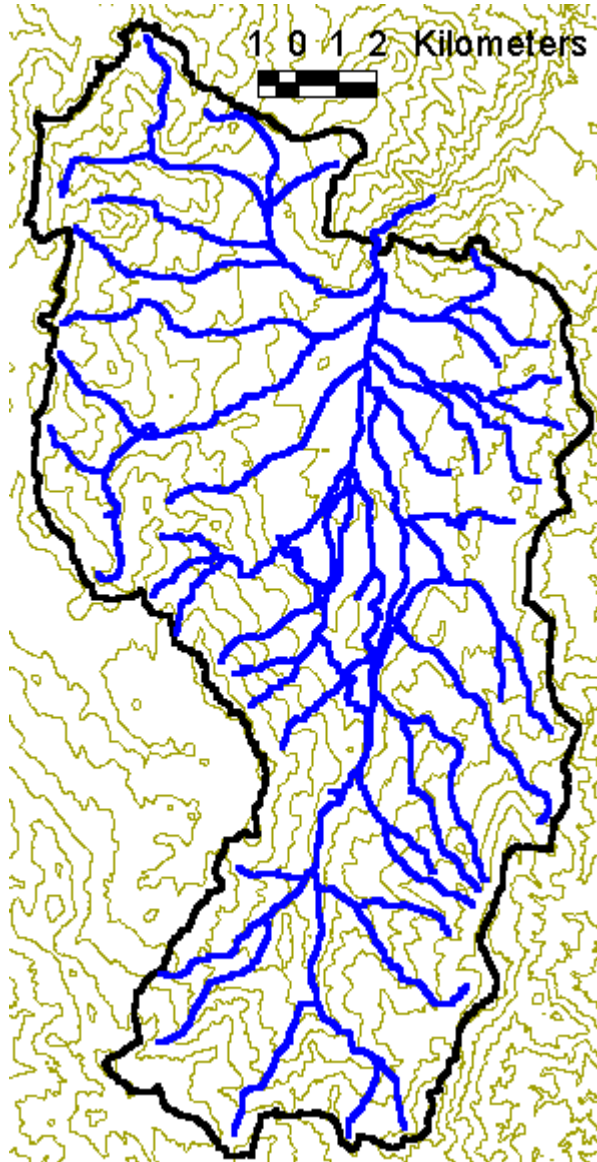
2990 HUC12 watersheds of average area 39.3 square miles

HUC12:HUC8 ~ 40:1 watersheds

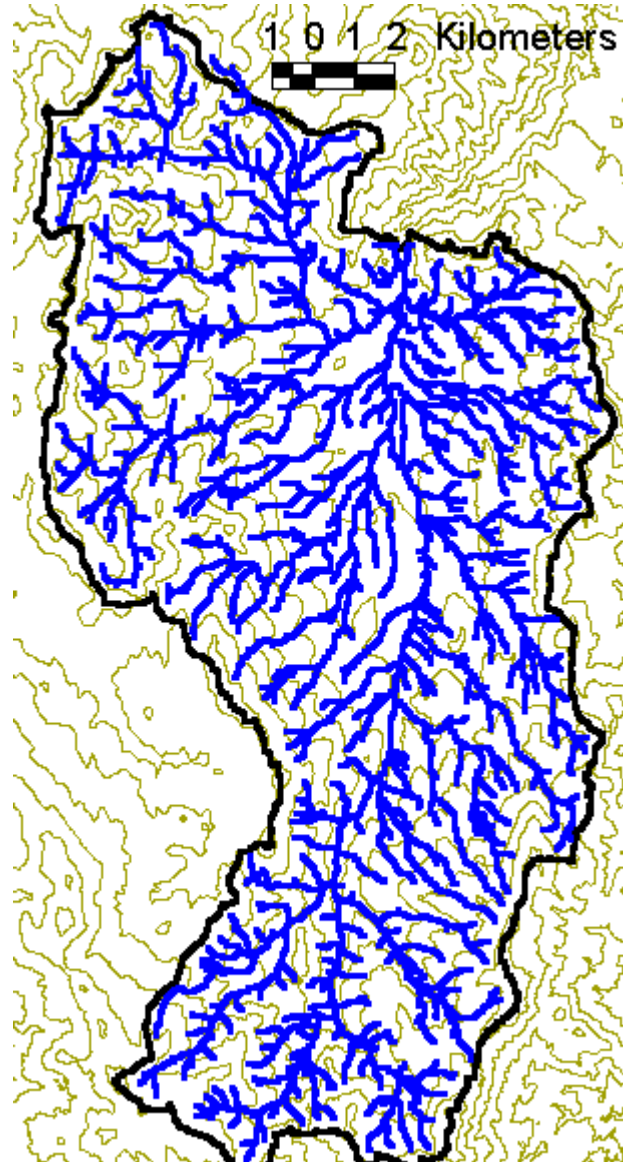


Watershed Stream Network

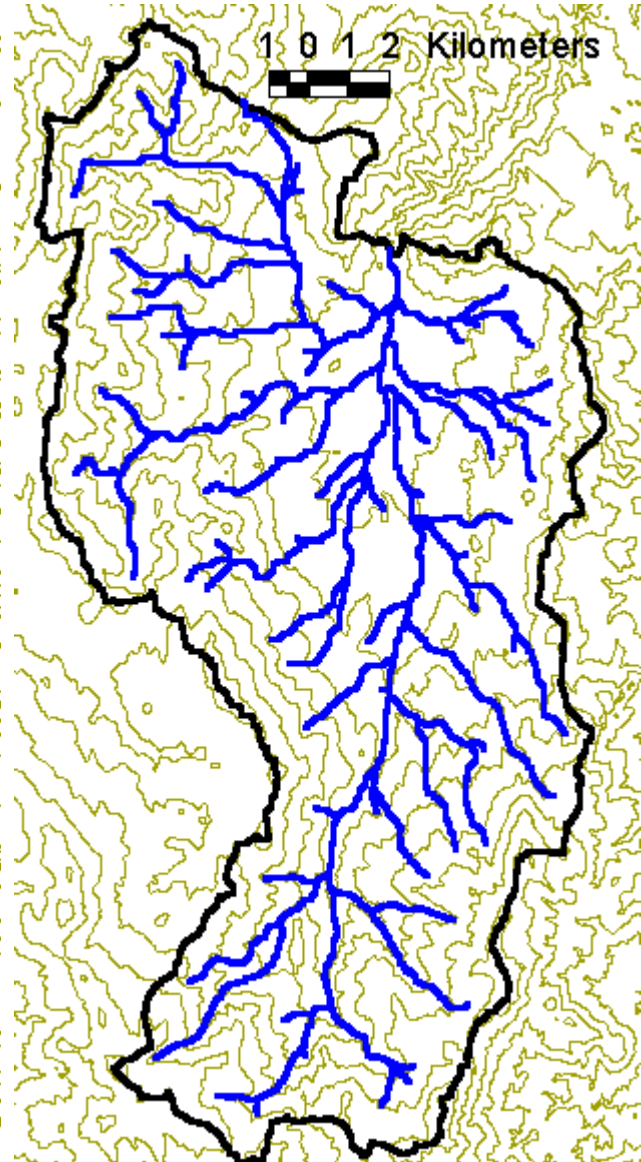
EPA Reach Files



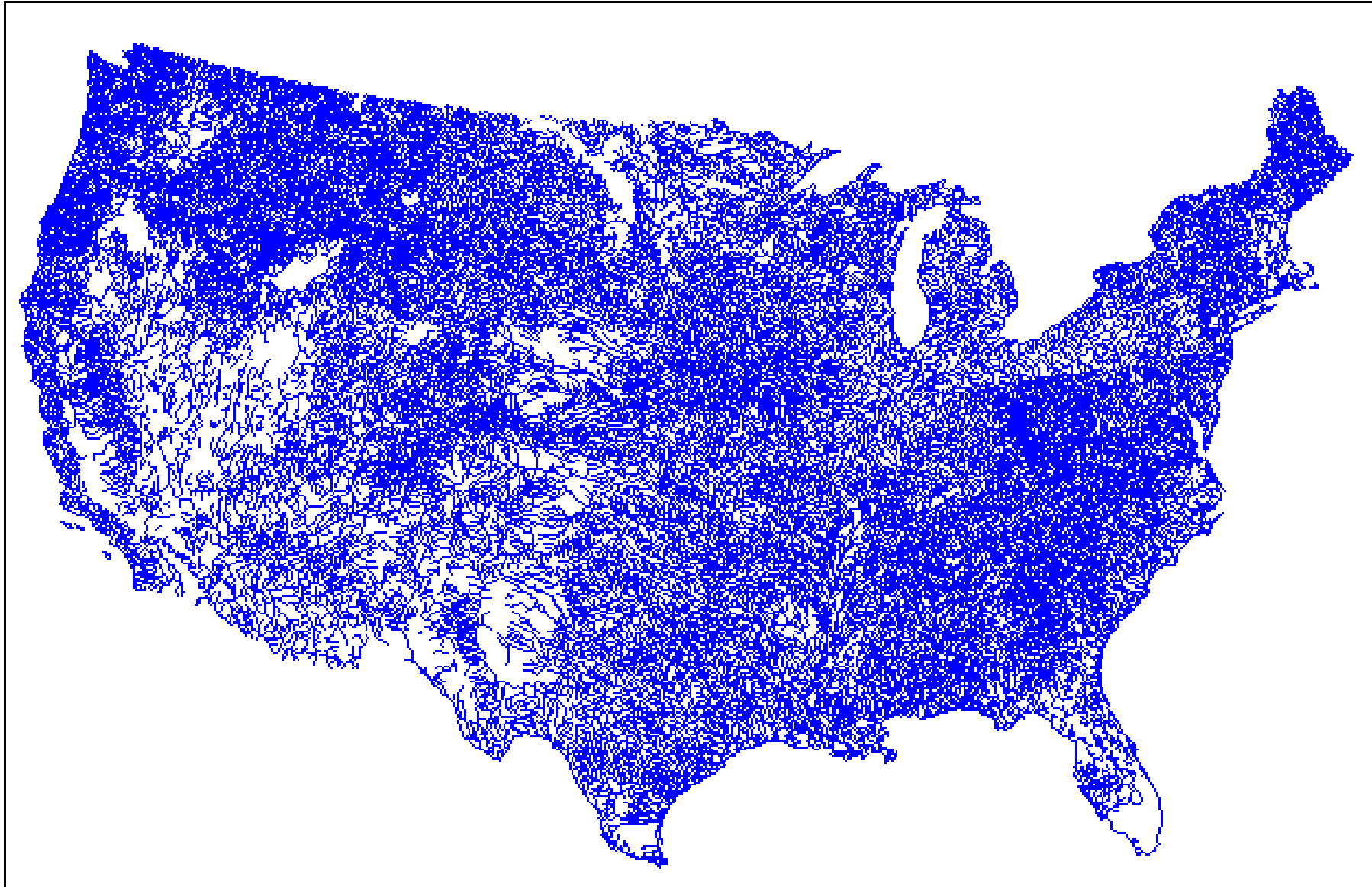
100 grid cell threshold



1000 grid cell threshold



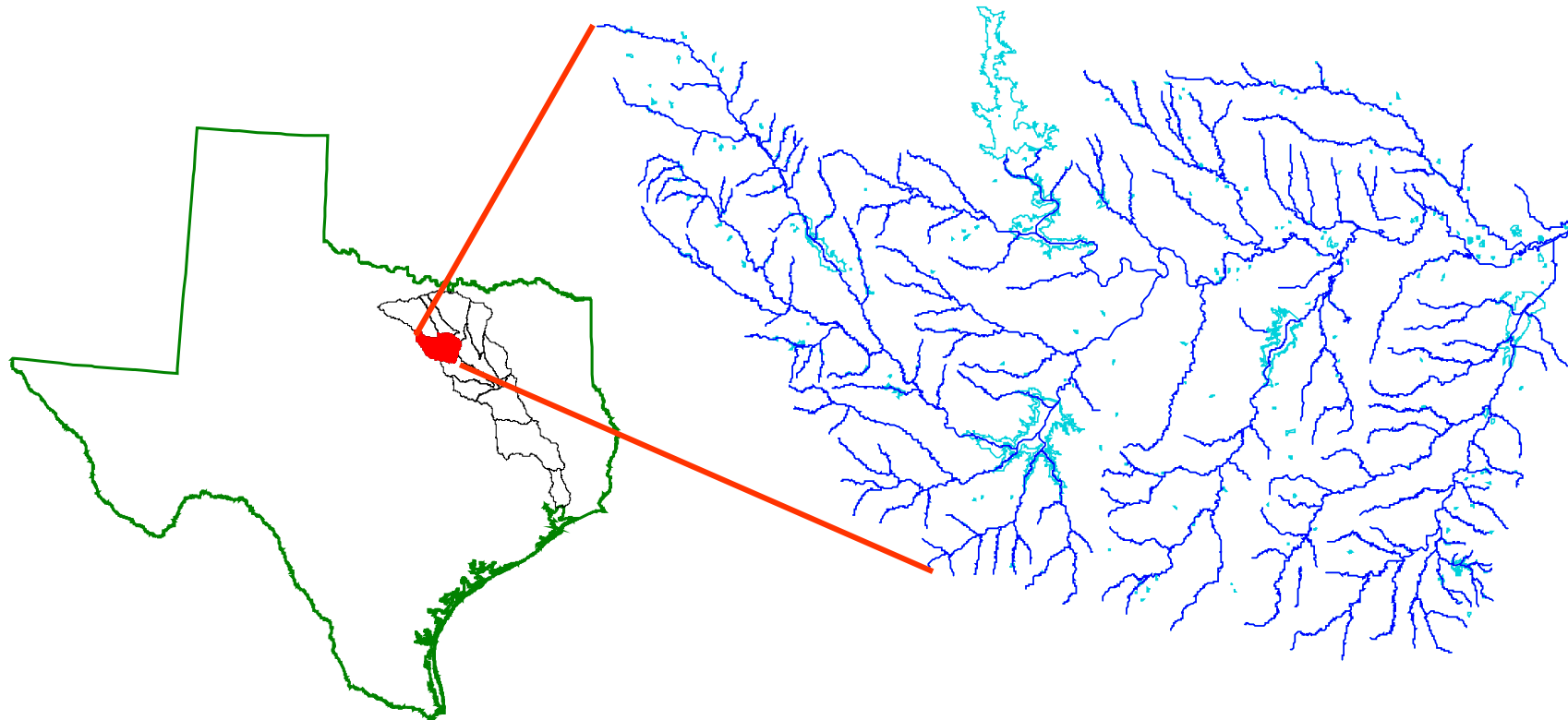
EPA River Reach File 1




National Hydrography Dataset



Lower West Fork, Trinity River Basin
HUC = 12030102

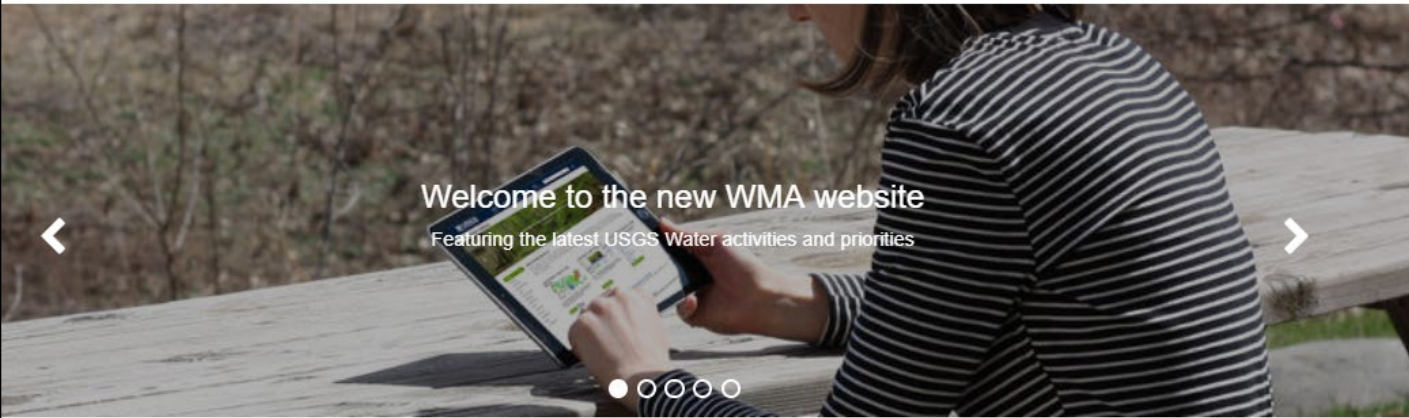


USGS Mission Area: Water Resources



- SCIENCE
Topics, centers, missions
- PRODUCTS
Maps, data, publications
- NEWS
Releases, I'm a reporter
- CONNECT
Contact, chat, social media
- ABOUT
Organization, jobs, budget

Mission Areas



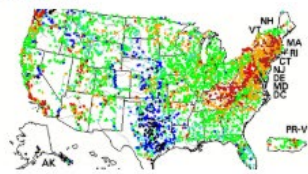
Welcome to the new WMA website
Featuring the latest USGS Water activities and priorities

- HOME
- SCIENCE
- PROGRAMS
- DATA AND TOOLS
- MAPS
- PUBLICATIONS
- SOFTWARE
- MULTIMEDIA
- NEWS
- EDUCATION
- CONNECT
- PARTNERS
- ABOUT

Water Resources

Water information is fundamental to national and local economic well-being, protection of life and property, and effective management of the Nation's water resources. The USGS works with partners to monitor, assess, conduct targeted research, and deliver information on a wide range of water resources and conditions including streamflow, groundwater, water quality, and water use and availability.

USGS Water Data for the Nation



Surface-water, groundwater, water-quality, and water-use data collected at approximately 1.9 million sites across all 50 states.

Message from the Associate Director for Water




Learn more about the WMA from Dr. Don Cline.

Popular Water Data and Tools

Explore our science by the topical areas that drive the research and projects conducted by our Programs.

- USGS Water Data for the Nation
- Water Quality Portal
- National Groundwater Monitoring Network Data Portal
- WaterWatch
- Groundwater Watch



National Water Information System: Web Interface

USGS Water Resources

* We've detected you're using a mobile device. Find our [mobile dedicated web site here](#).

- Click to hide News Bulletins
- Introducing The Next Generation of USGS Water Data for the Nation
- Full News

USGS Surface-Water Data for the Nation

Current Conditions (10,323 sites)

Current conditions at selected sites based on the most recent data from on-site automated recording equipment. Measurements are commonly recorded at a fixed interval of 15- to 60-minutes and transmitted to the USGS every hour. Values may include "Approved" (quality-assured data that may be published) and/or more recent "Provisional" data (of unverified accuracy and subject to revision). Most current data are provisional.

Historical Observations (16,933 sites)

The same data accessed by the Current Conditions link above but including both active and discontinued sites with data for any part of the period October 1, 2007, through the present. Values may include "Approved" (quality-assured data that may be published) and/or more recent "Provisional" data (of unverified accuracy and subject to revision).

Daily Data (28,162 sites)

Summary of all data for each day for the period of record and may represent the daily mean, median, maximum, minimum, and/or other derived value. Values may include "Approved" (quality-assured data that may be published) and/or more recent "Provisional" data (of unverified accuracy and subject to revision). [Example](#).

Statistics (26,569 sites)

Daily Monthly Annual

Statistics are computed from approved daily mean data at each site. These links provide summaries of approved historical daily values for daily, monthly, and annual (water year or calendar year) time periods.

Peak-Flow Data (29,233 sites)

Annual maximum instantaneous peak streamflow and gage height

Field Measurements (70,695 sites)

Manual measurements of streamflow and gage height. These measurements are used to supplement and (or) verify the accuracy of the automatically recorded observations, as well as to compute streamflow based on gage height.

Precipitation

Introduction

- Precipitation is one of the most important components of water cycle
 - Flash flood prediction (Hazards Management)
 - Long term water budget estimation (Water Resource Management)
- Precipitation spatial distribution affects the hydrologic response of a watershed
- Precipitation measurement



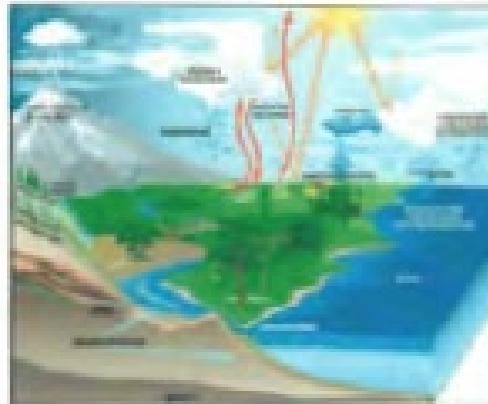
- Rain gauge data



- Radar



- Satellite



Standard way of measuring rain- or snowfall is a standard rain gauge.

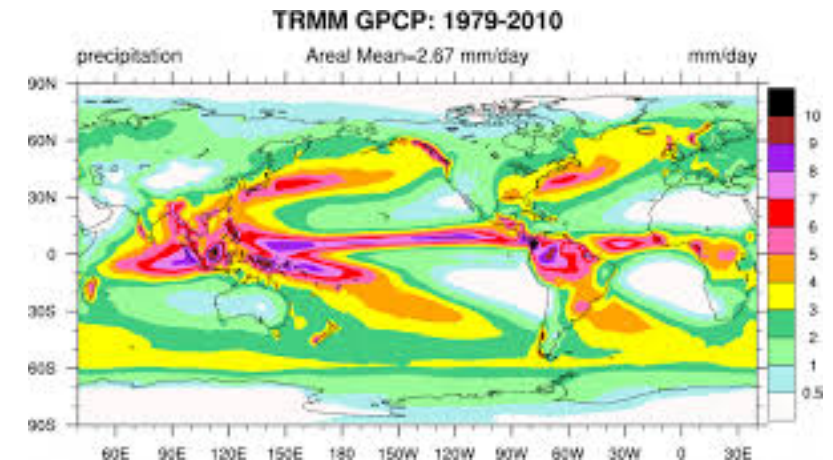
Rain Gauge or "Bucket"



Tipping Mechanism



For inaccessible areas => Satellite Imagery.



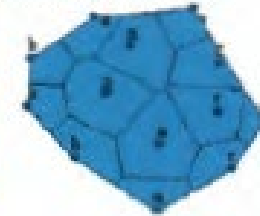
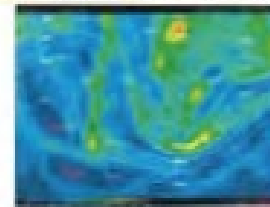
Precipitation

Rainfall Distribution

- Rainfall historical data are generally available in rain gauge stations
- Unit areal precipitation or rainfall distribution amount is needed for most hydrologic models.
- How we can obtain rainfall pattern and distribution over a watershed based on rain gauge data?

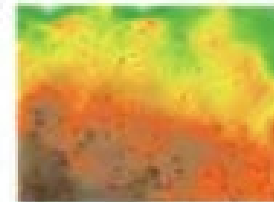
- Traditional Methods

- Thiessen Polygons
- Isohyet
- etc...



- More Advanced Methods

- Inverse Distance Weighted Average (IDW)
- Kriging
- Proximal
- B-Spline
- Fourier Series, Wavelet, etc...




Kriging method can be used when rainfall stations are not properly distributed.

Precipitation Data

The screenshot shows the NOAA National Centers for Environmental Information (NCEI) website. The page title is "U.S. Hourly Precipitation Data". It includes a navigation menu with "Home", "Access Data", "Submit Data", "Public Outreach", and "About". A search bar is present with the text "Search NCEI Data". The breadcrumb trail is "Home > Data > Metadata > gov.noaa.ncdc:C00313".

U.S. Hourly Precipitation Data

Precipitation Hourly


Hourly Precipitation Data GIS image


Hourly Precipitation Data (HPD) is digital data set DSI-3240, archived at the National Climatic Data Center (NCDC). The primary source of data for this file is approximately 5,500 US National Weather Service (NWS), Federal Aviation Administration (FAA), and cooperative observer stations in the United States of America, Puerto Rico, the US Virgin Islands, and various Pacific Islands. The earliest data dates vary considerably by state and region: Maine, Pennsylvania, and Texas have data since 1900. The western Pacific region that includes Guam, American Samoa, Marshall Islands, Micronesia, and Palau have data since 1978. Other states and regions have earliest dates between those extremes. The latest data in all states and regions is from the present day. The major parameter in DSI-3240 is precipitation amounts. [Show more...](#)

[Dataset Citation](#)

[Dataset Identifiers](#)

[ISO 19115-2 Metadata](#)

Access: [Time & Location](#) | [Documentation](#) | [Description](#) | [Credit](#) | [Keywords](#) | [Constraints](#) | [Lineage](#)

| | |
|---------------|---|
| Search Data | NCEI Climate Data Online Data Search (search) Search for the dataset via a text-based interface. |
| | NCEI Climate Data Online Map Server (search) Dynamic GIS mapping application to locate stations and data for selected layers. |
| | NCEI ArcGIS REST Services Directory (search) ArcGIS Server REST API for the dataset. |
| Download Data | NCEI FTP Server (download) Dataset files available for download via FTP. |
| | KMZ file for dataset (download) Direct download link for KMZ file. |
| | Hourly Precipitation CSV Sample  (download) This sample data file shows how the data are formatted in CSV and is for example purposes only. |

... many more!

- Gridded (various res)
- Monthly mean
- Yearly mean
- forecasts

Hourly Data for US Stations starting 1951

<https://data.nodc.noaa.gov/cgi-bin/iso?id=gov.noaa.ncdc:C00313>