Level 3: The Impact of Drought on the Hudson River

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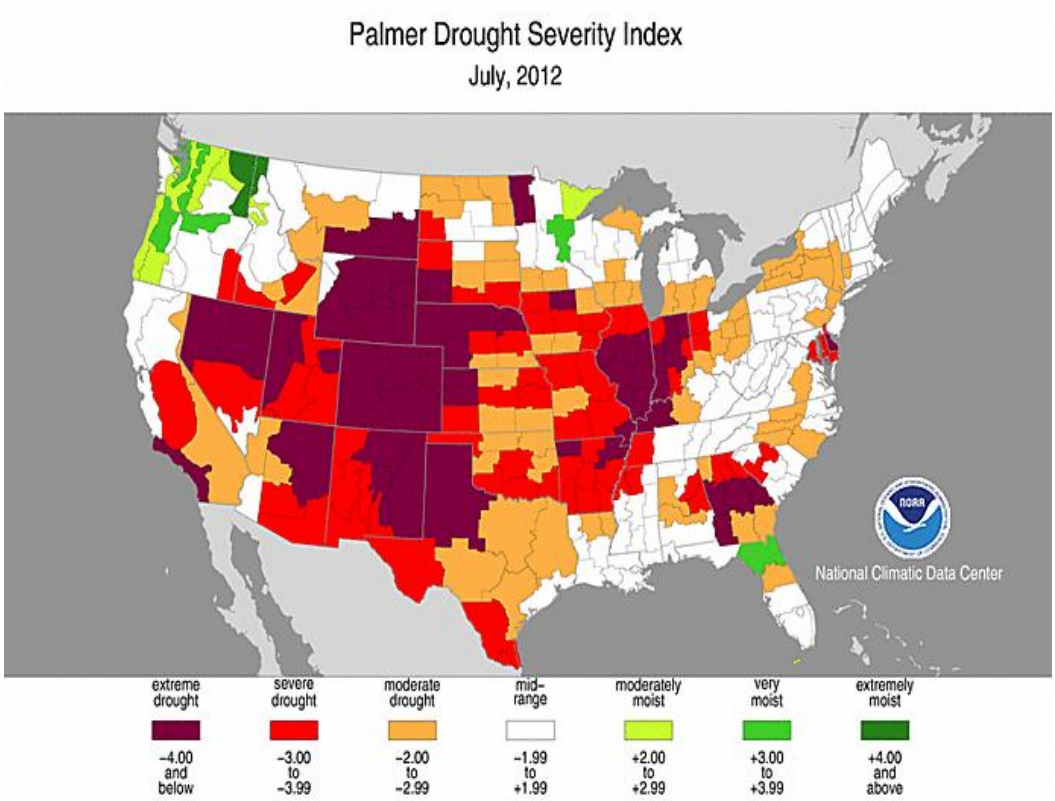
❖ **Background Information:**

Drought is a defined as a deficiency in precipitation over a period of time. It can be an event that happens in all parts of the country, or only in certain regions. The length of a drought can also vary. It can extend over a few short months or over a longer period of time, sometimes years or even decades. The duration may also vary from area to area. There are many well documented historical droughts throughout the history of the United States.

Aerial view of the Hudson River. Photo from brittanica.com.

One of the most widely used ways to identify if a drought is occurring in an area is by using the Palmer Drought Severity Index (PDSI) developed in the 1960's. This measurement uses available temperature and precipitation data and soil moisture retention to estimate the relative dryness of an area or region. It is a standardized index that spans -10 (dry) to +10 (wet). These are two extremes; in the scale of the



index, negative numbers represent drier than normal conditions and positive numbers represent wetter than normal conditions. The scale separates the drought conditions into the following categories; extreme drought (-4 and lower) severe drought (-3 to -3.99) moderate drought (-2 to -2.99) mid-range (-1.99 to 1.99) moderately moist (+2 to 2.99) very moist (+3.00 to +3.99) and finally extremely moist (+4 and above). The Palmer Drought Severity Index is based on measurements recorded as the local averages for that region.

Droughts can lower water levels and affect other conditions in lakes and rivers. Drought level will influence the amount of water flowing into the Hudson River from the surrounding watershed, which is measured using gages. Other factors may include (but are not limited to) dissolved oxygen (DO), specific conductance, water temperature, and turbidity. Using this dataset you will compare conditions in the Hudson River during a drought year (2012) and non-drought year (2015).

- **Dataset Timeframe:**
  - Daily averages were collected in the months of July and August for the years 2012 and 2015. According to the Palmer Drought Severity Index, 2012 was considered a moderate drought, and 2015 was considered in mid-range, which means that it was not a drought year.

- **Information About Sites:**
  - Both sites of interest are within the tidal portion of the Hudson River. The southernmost portion of the river is saline because of its proximity to the ocean. Salt levels decrease as you go northward up the river, until you reach the salt front. The river is freshwater above the salt front. Salt levels in the Hudson River are approximated by measuring specific conductance (see the Dataset Variables section for more information). A salt front is characterized as having a measurement of at least 100 mg/L of sodium chloride present in the water with a specific conductance of at least 0.510 milliSiemens per centimeter (mS/cm) at 25 degrees Celsius. Port of Albany is consistently above the salt front in the Hudson River, and Piermont Pier is consistently below the salt front. In the Hudson River, the exact location of the salt front may change on a daily basis as the tides and amount of flow fluctuate.

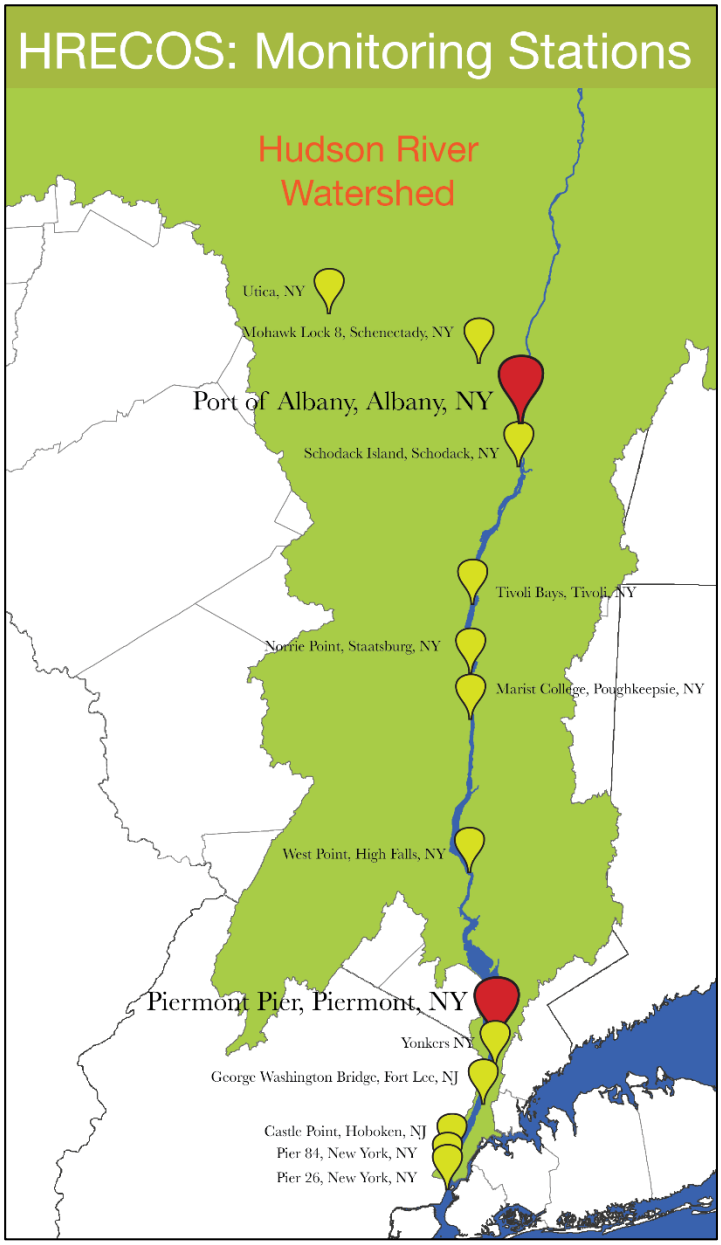
  - There is a gage that measures discharge in the Hudson River operated by the US Geological Survey on Green Island, which is slightly north of Albany. This data is a quantitative way of studying water levels in the Hudson River as a whole, and can be compared with variables from other parts of the river.

  - The Port of Albany HRECOS hydrologic station is mounted on a concrete piling on the western shore line of the Hudson River at the port of Albany. The channel depth is 32 feet.

  - The station at Piermont Pier is situated on the end of a mile long pier stretching into the Hudson River. It is located just north of a tidal salt marsh. The local tidal range is between 3-5 feet.

❖ **Data Collection Methods**:

Data were collected using submerged probes that recorded measurements at the following sites every 15 minutes: Port of Albany and Piermont Pier. These values were averaged daily to produce the provided dataset.



❖ **Dataset Variables:**

- **Location:** Location of the HRCEOS probe along the Hudson River (Port of Albany and Piermont Pier).
- **Date:** Date the sample was collected. Dates range from July 1- August 31, 2012 and July 1-August 31, 2015.
- **Drought Level (PDSI):** the category of Palmer Drought Severity Index for that year.
- **Discharge (m3/s):** the rate of water flowing out of the USGS gage on Green Island, which is north of the Port of Albany and Piermont. A gage measures how much water is flowing in the Hudson River, which is related to how much water is in the environment.
- **Dissolved Oxygen Percent:** The amount of oxygen dissolved in the water compared to the amount it could hold when it is at equilibrium with the atmosphere. This is dependent on temperature. Because animals need oxygen to survive, it is an indicator of water quality.
- **Specific Conductance (mS/cm):** Specific conductance measures how well water conducts an electrical current. Specific conductance increases as the amount and mobility of ions increases. It is measured in milliSiemens/centimeter (mS/cm). This is often used to approximate the salt levels in a body of water. Specific conductance usually changes in the Hudson River as water levels rise and fall.
- **Water Temperature (F):** Water temperature at the probe, measured in degrees Fahrenheit.
- **Turbidity (NTU)**: The amount of suspended solids in water solution. It is measured in Nephelometric Turbidity Units (NTU), which measures how light is scattered when passing through the water.

❖ **Source of Dataset:** Hudson River Environmental Conditions Observing System http://hudson.dl.stevens-tech.edu/hrecos/d/index.shtml

❖ **Inquiry Idea Starters:**

Here are some sample questions you could ask using these datasets. These are just suggestions, and we hope you'll come up with many interesting questions on your own!

- How is specific conductance at Piermont related to discharge during a drought, compared to non-drought conditions? Is this same relationship true at Albany?
- Is the percent of dissolved oxygen in the river influenced by drought conditions at either site?
- Are any of the variables correlated with each other, meaning they change together?

❖ **Additional Resources:**

- For information on previous droughts in the Hudson Valley, see the Rockland Superfund site page: http://superfund.ciesin.columbia.edu/Rocklandwater/supply_droughts
- For information on the relationship between drought and climate change in the Hudson River Valley, see resources from the Water Resources Institute: https://wri.cals.cornell.edu/hudson-river-estuary/climate-change-hudson-river-estuary
- For a story on the impact of the salt front moving up to Poughkeepsie, NY in 1985 from the New York Times: http://www.nytimes.com/1985/08/25/nyregion/salt-in-hudson-imperils-poughkeepsie-water.html?mcubz=3

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