Level 2: Historic Pollution in the Hudson River

❖ **Background Information:**

This data was compiled by Brosnan, Stoddard, and Hetling for their paper titled "Hudson River Sewage Inputs and Impacts: Past and Present" published in 2006 in *The Hudson River Estuary*. The goal of their study was to examine past and current trends in how wastewater discharged into the Hudson River influences the water chemistry of the river, and how it relates to the human population. Wastewater enters the Hudson River from point sources including municipal and industrial wastewater treatment plants, combined sewer overflows, urban storm water, and tributaries of the Hudson River such as Fishkill Creek. Point sources are sources of chemicals that can be traced to a single location, such as a spill or a water treatment plant. There are also non-point sources that influence the Hudson, such as land runoff and atmospheric deposition.

Point source wastewater. Picture from Global Water LLC

The authors also report on wastewater management in the Hudson Valley during the 20th century (1900-2000). Several important management regulations were implemented in that time, including the Metropolitan Sewerage Commission, the New York State Environmental Bond Act, and the Federal Clean Water Act. You will need to do more research to compare the timing of regulations to the data to determine the relationship between these and other regulations and pollution loads. The authors also evaluated wastewater treatment practices, primarily focusing on the amount of treatment that sewage received before it was discharged into the Hudson and how this has changed over the century. Sewage can be treated various ways. The lowest level of treatment is when untreated sewage is discharged directly into the Hudson. Primary Treatment aims to reduce 30% of Biochemical Oxygen Demand (BOD_5) and Total Suspended Solids (TSS) from the sewage before discharge. Secondary Treatment further cleans the water before discharge, and aims for 85% reduction of BOD_5 and TSS.

❖ **Dataset Variables:**

- ➢ Year: year that the data was collected.
- ➢ Population in millions: Human population of the region served by municipal waste facilities.

- BOD_5 (mt/day): Biochemical Oxygen Demand measured in metric tons/day. This is the amount of dissolved oxygen that would be needed in water in order for microorganisms to decompose the organic matter in the water. See the "More Information" section for a detailed explanation.
- TN (mt/day): Total Nitrogen measured in metric tons/day.
- TP (mt/day): Total Phosphorus measured in metric tons/day.
- TSS (mt/day): Total Suspended Solids measured in metric tons/day.

❖ **Dataset Timeframe:**

- Water pollution and population data were collected from 1900-1999.

❖ **Data Collection Methods:**

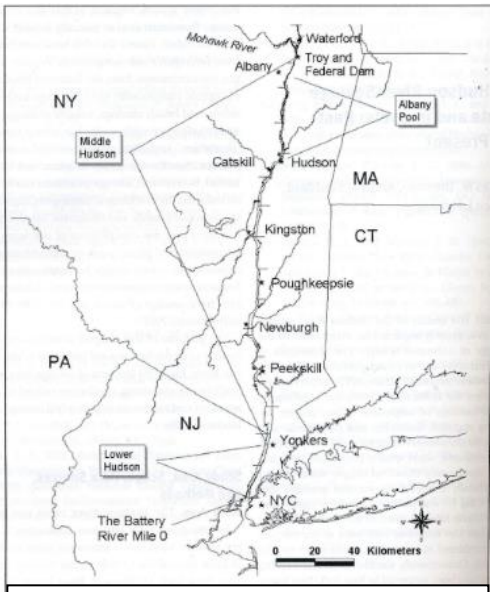
- Pollution load data was collected by a number of agencies, including the Environmental Protection Agency, NY state agencies, and private sewer companies.
  - BOD_5 is typically measured by looking at the change in pressure in a sealed container stored for 5 days in a dark room at 20 °C as CO_2 is produced and O_2 is used up.
  - Nitrogen and phosphorus are measured using meters that detect those chemicals in water samples.
  - Total Suspended Solids are measured as the weight of particles found in a given volume of sample, which are collected by a water filter and then dried and weighed.
- These are general water chemistry measurement methods; specific information on data collection for this data is provided in the Master's Thesis of Chandler Johnson at the Rensselaer Polytechnic Institute (Johnson, 1994).
- Census data and sewer building records from 1900-2000 were used to quantify the population of the study region (Hetling, 2003). Census data were collected every 10 years during the study period, and sewer building records were used as available.

❖ **Information About Sites**

- **Upper Hudson**: includes the region from the source of the Hudson to the Federal dam at Troy.
- **Lower and Mid- Hudson** includes the region from the Federal dam at Troy to the Verrazano-Narrows Bridge in the NYC harbor.

❖ **Source of Dataset**

- Brosnan, T. M., A. Stoddard, and L. J. Hetling. "Hudson River sewage inputs and impacts: past and present." *The Hudson River Estuary*. (2006): 335-348.



Map of the Lower and Mid- Hudson (Brosnan, 2006).

- If you have specific questions about this research that you would like to ask the scientists, please email caryeducation@caryinstitute.org and we will be happy to contact the scientists on your behalf.

❖ Inquiry Idea Starters

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

- How has Total Nitrogen changed in the river from 1900 to 2000?
- Is there any relationship between human population and Total Suspended Solids in the dataset?

❖ More Information

- Higher levels of BOD_5 means that there is more organic matter in the water, and the microorganisms would need more oxygen to use up the organic matter. Organic matter is typically associated with pollution, so higher levels of BOD_5 means a waterway is more polluted. It's important to remember that BOD_5 is not the same measurement as Dissolved Oxygen (DO); higher DO means less polluted water, which is the opposite from higher BOD_5. Instead, think of it like counting the number of paper towels you would need to clean up spilled juice as a way to tell how much juice there was.

BOD_5 meters. Picture from the Sustainable Sanitation Alliance.

- BOD, TSS, Nitrogen, and Phosphorus all influence the food webs in the Hudson. When these measures are higher, typically this makes it harder for plants and animals to survive. In the case of nitrogen and phosphorus, low levels support life, but high levels can throw off the balance of food webs. There are also other kinds of pollutants that can damage organisms, but this dataset focuses only on the pollutants that are associated with sewage.

❖ Additional Resources

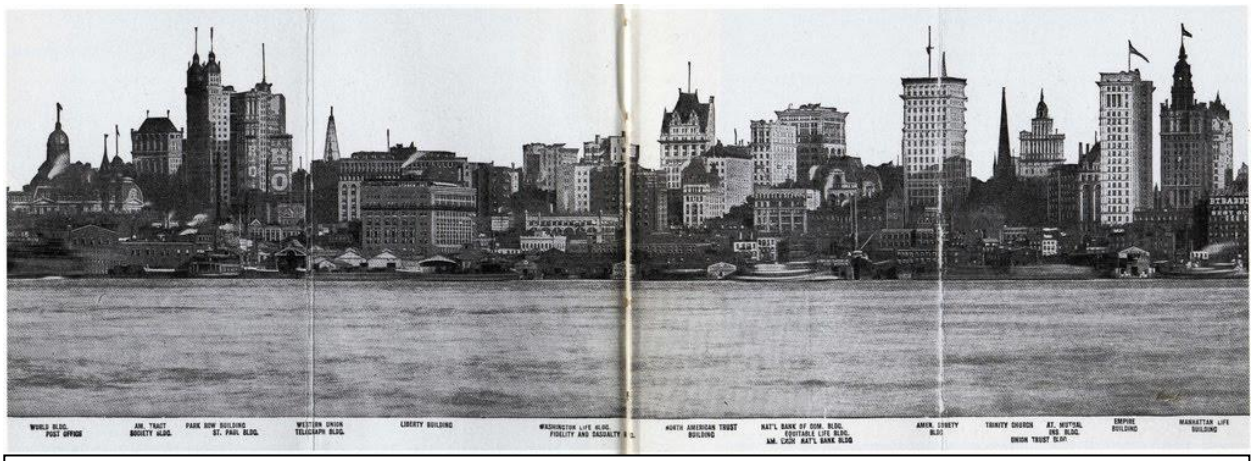
- We provide a large collection of Hudson River lessons (including several on water pollution in the Hudson) that are available through the Hudson River Ecology theme on the Cary Institute "For Educators" page: http://www.caryinstitute.org/educators/teaching-materials/hudson-river-ecology
- This website from the American Museum of Natural History includes an interactive Hudson River data graphing tool that allows students to both time and location to examine abiotic and biotic factors such as dissolved oxygen and bacterial abundance: http://www.amnh.org/education/resources/rfl/web/riverecology/graph.html

❖ References

Brosnan, T. M., A. Stoddard, and L. J. Hetling. (2006). Hudson River sewage inputs and impacts: past and present. *The Hudson River Estuary*: 335-348.

Hetling, L. J., Stoddard, A., Brosnan, T. M., Hammerman, D. A., & Norris, T. M. (2003). Effect of water quality management efforts on wastewater loadings during the past century. *Water environment research*, *75*(1), 30-38.

Johnson, C.H. (1994). Evaluation of BOD, SS, N and P loadings into Lower Hudson River Basin from point and non-point sources. Thesis (master's)--Rensselaer Polytechnic Institute.



Lower Manhattan's Financial District skyline looking east from Hudson River, April 1900. Picture from Walk in New York.