DECISION SUPPORT SYSTEM TO ENHANCE SOURCE WATER QUALITY MODELING AND MONITORING USING REMOTE SENSING DATA

Applied Sciences Program
Project 13-WATER13-0073

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HAZEN AND SAWYER
Environmental Engineers & Scientists

UMBC
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RIVERSIDE
global science solutions

OUR TEAM

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- Riverside Technology, Inc.
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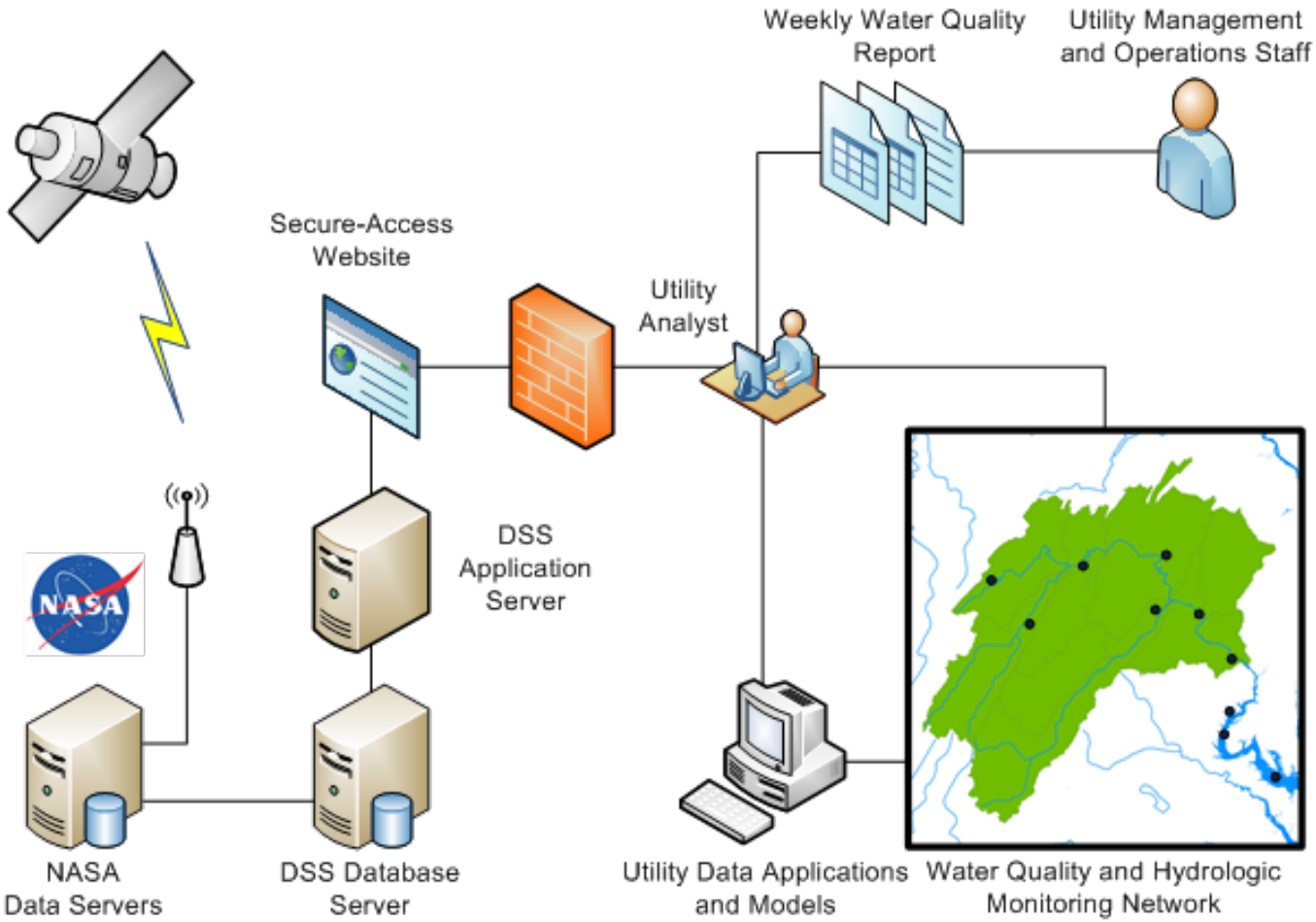
  - Dave Reckhow (UMASS)
  - Greg Schwarz, Kernell Ries (USGS)
- Water Research Foundation
- Utility partners:

City Of Raleigh
NORTH CAROLINA

NYC Environmental Protection

Northern Water
Northern Colorado Water Conservancy District

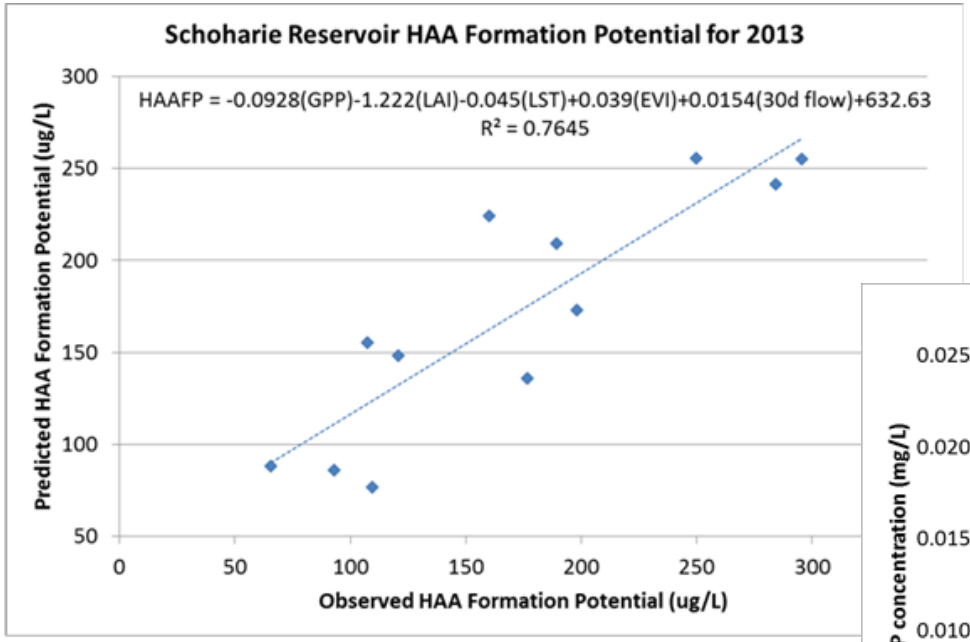
FACILITATE ACCESS AND USE OF REMOTE SENSING PRODUCTS FOR WATER UTILITIES



TYPICAL WATER QUALITY MONITORING AND MODELING BY WATER UTILITIES

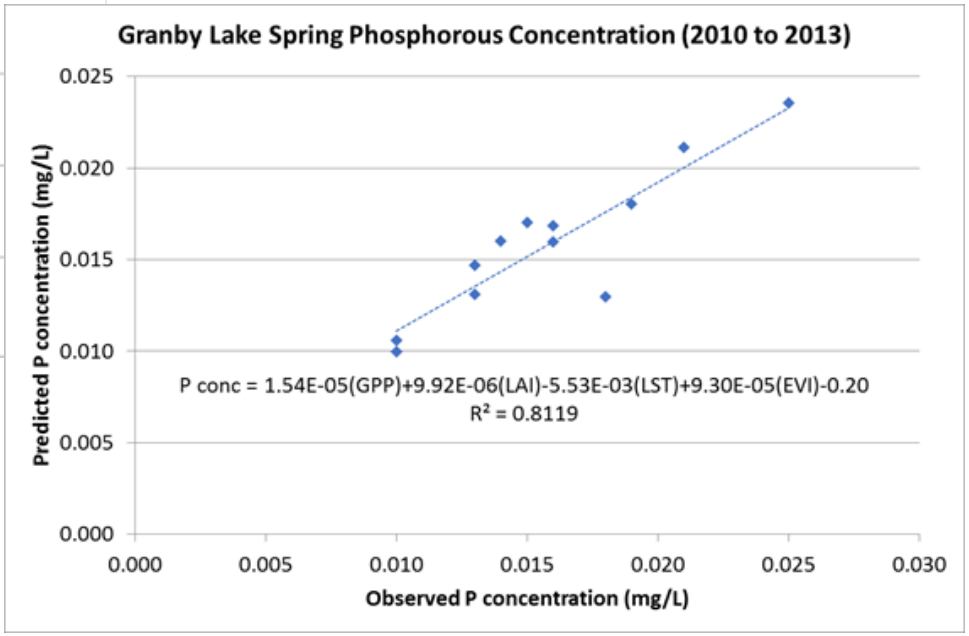
- Financial, staffing, and practical limitations
- Often consists of irregular, regulatory-based compliance monitoring
- Low temporal, spatial resolution
- Little "upstream" monitoring of watershed processes that impact water quality
- Lack of predictive capabilities
- Many utilities lack technical expertise for WQ modeling

CAN REMOTE SENSING OF WATERSHED PARAMETERS HELP FILL IN THE GAPS?



MODIS-based HAA Formation Potential model for New York City DEP's Schoharie Reservoir

MODIS-based Phosphorus model for Granby Lake, Colorado



ADVANTAGES OF LAND-BASED REMOTE SENSING DATA FOR WATER UTILITIES

- Low cost (to the utilities!)
- High spatial and temporal coverage
- Can contribute to better understanding of the relationship between the watershed and the water source(s)
- Enhanced overall data set for seasonal and long-term management decisions

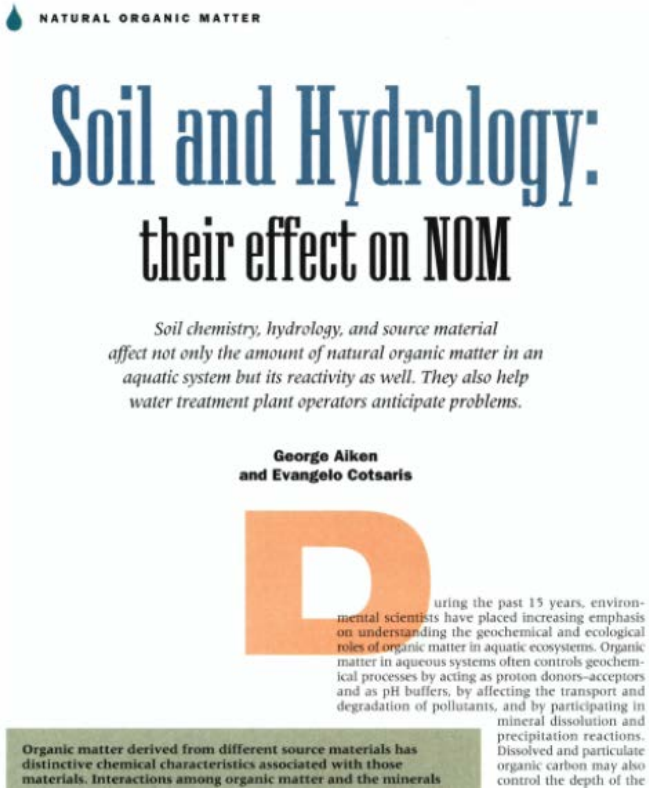
EXAMPLE:
NATURAL ORGANIC MATTER (NOM)

- Primary concern for water utilities is formation of carcinogenic disinfection by-products (DBPs):

  NOM + disinfectant + Br = Cl-DBPs + Br-DBPs

- NOM character, reactivity, and treatability highly influenced by terrestrial environmental processes
- EPA currently regulates several combined DBP groups – many utilities struggle to keep up with regulatory advances

EXAMPLE:
NATURAL ORGANIC MATTER (NOM)



NATURAL ORGANIC MATTER

Soil and Hydrology: their effect on NOM

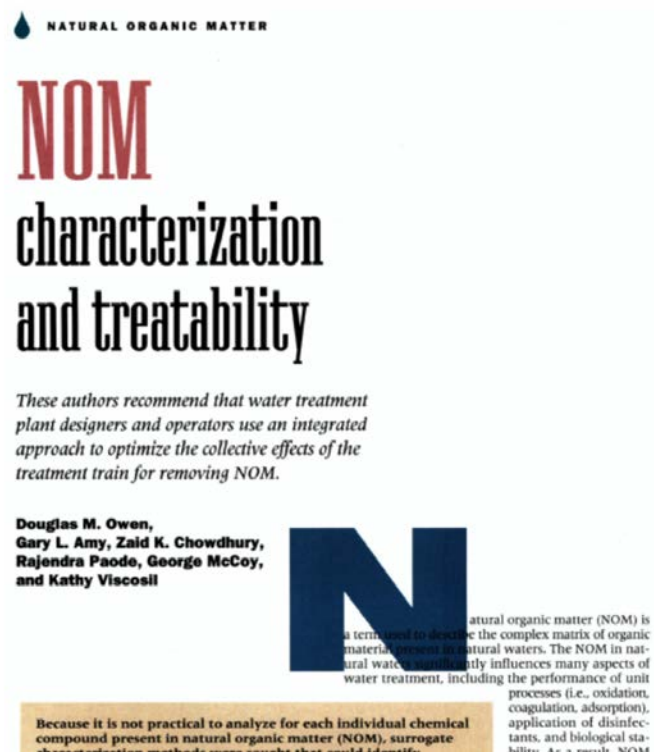
Soil chemistry, hydrology, and source material affect not only the amount of natural organic matter in an aquatic system but its reactivity as well. They also help water treatment plant operators anticipate problems.

George Aiken and Evangelo Cotsaris

During the past 15 years, environmental scientists have placed increasing emphasis on understanding the geochemical and ecological roles of organic matter in aquatic ecosystems. Organic matter in aqueous systems often controls geochemical processes by acting as proton donors–acceptors and as pH buffers, by affecting the transport and degradation of pollutants, and by participating in mineral dissolution and precipitation reactions. Dissolved and particulate organic carbon may also control the depth of the

Organic matter derived from different source materials has distinctive chemical characteristics associated with those materials. Interactions among organic matter and the minerals

Aiken, G., & Cotsaris, E. (1995). Soil and hydrology: their effect on NOM: Natural organic matter. *Journal-American Water Works Association*, *87*(1), 36-45.



NATURAL ORGANIC MATTER

NOM characterization and treatability

These authors recommend that water treatment plant designers and operators use an integrated approach to optimize the collective effects of the treatment train for removing NOM.

Douglas M. Owen, Gary L. Amy, Zaid K. Chowdhury, Rajendra Paode, George McCoy, and Kathy Viscosil

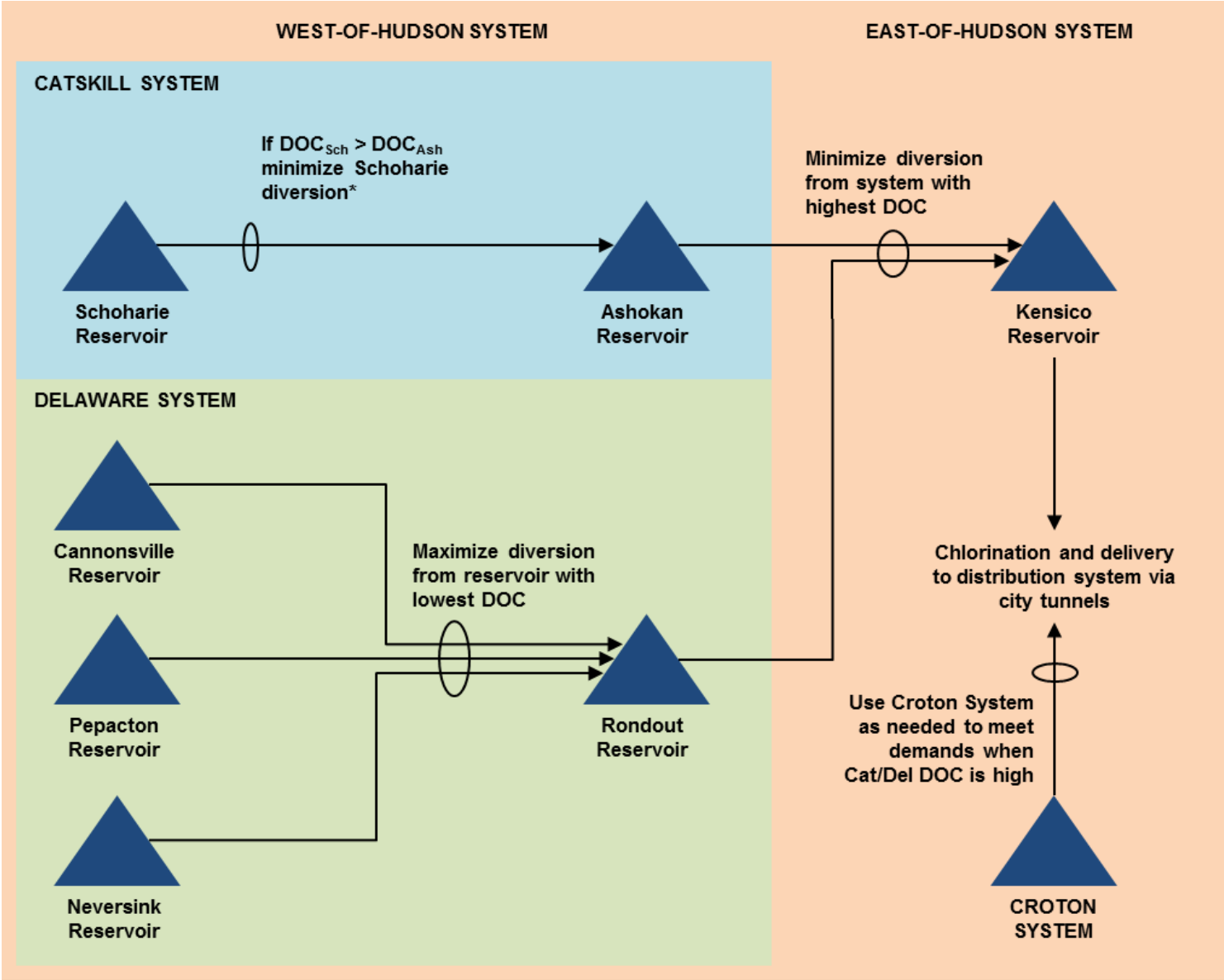
Natural organic matter (NOM) is a term used to describe the complex matrix of organic material present in natural waters. The NOM in natural waters significantly influences many aspects of water treatment, including the performance of unit processes (i.e., oxidation, coagulation, adsorption), application of disinfectants, and biological sta-

Because it is not practical to analyze for each individual chemical compound present in natural organic matter (NOM), surrogate

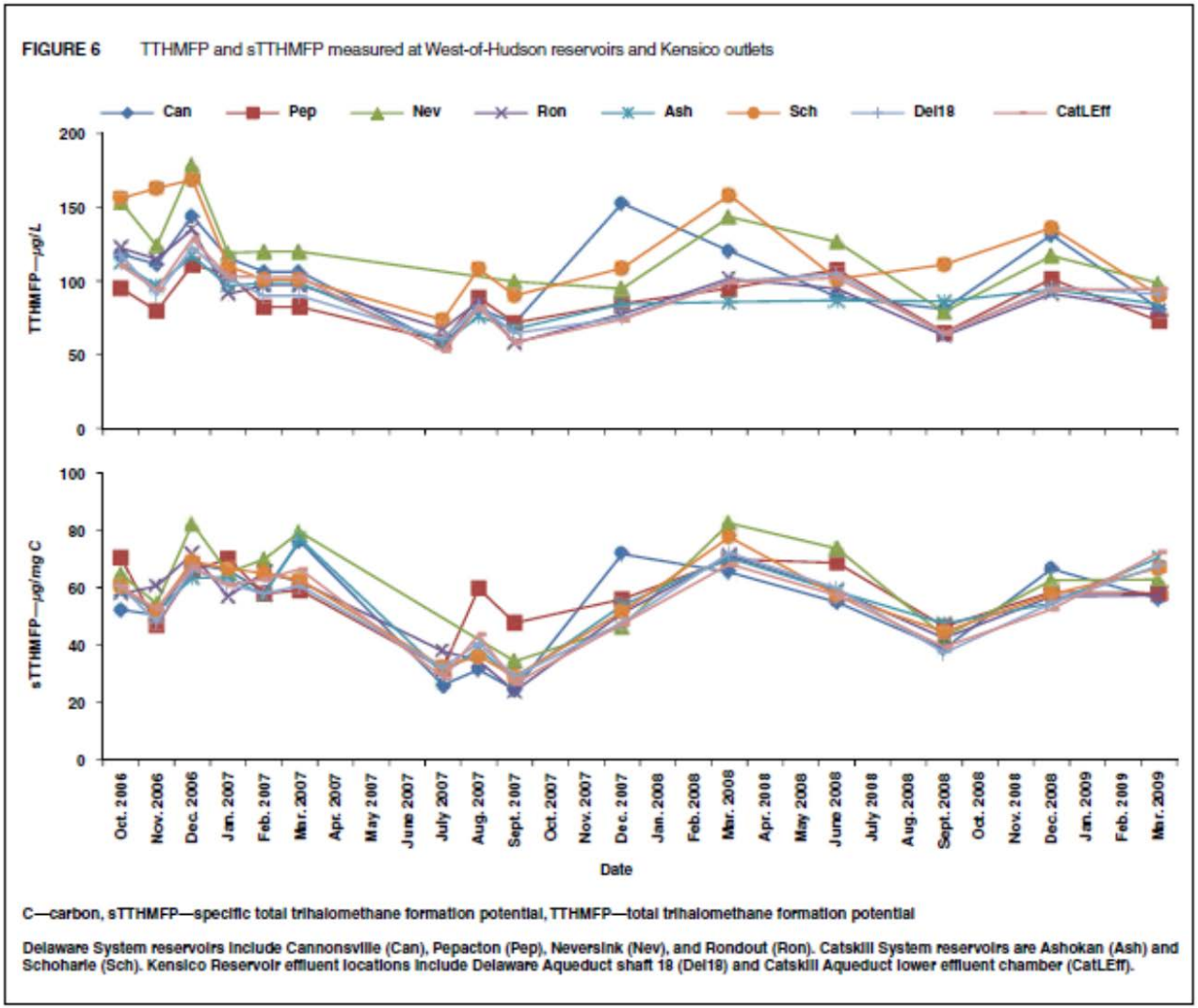
Owen, D. M., Amy, G. L., Chowdhury, Z. K., Paode, R., McCoy, G., & Viscosil, K. (1995). NOM: characterization and treatability: Natural organic matter. *Journal-American Water Works Association*, *87*(1), 46-63.

WATERSHED-LEVEL PROCESSES GREATLY AFFECT PRODUCTION OF DRINKING WATER

Watershed Changes	Source Water Quality Impacts	Water Utility Impacts	Societal Water Use Impacts
• Seasonal cycles • Climate/weather • Extreme events • Land use changes • Acute contamination	• Natural organic matter • Nutrients (N, P) • Sediment/ turbidity • Pathogens	• Treatment cost • Risk to regulatory compliance • Reduced delivery capacity • Emergency outages/ boil water alerts	• Increased cost of water • Water use restrictions • Public health impacts • Reduced public confidence in municipal supplies

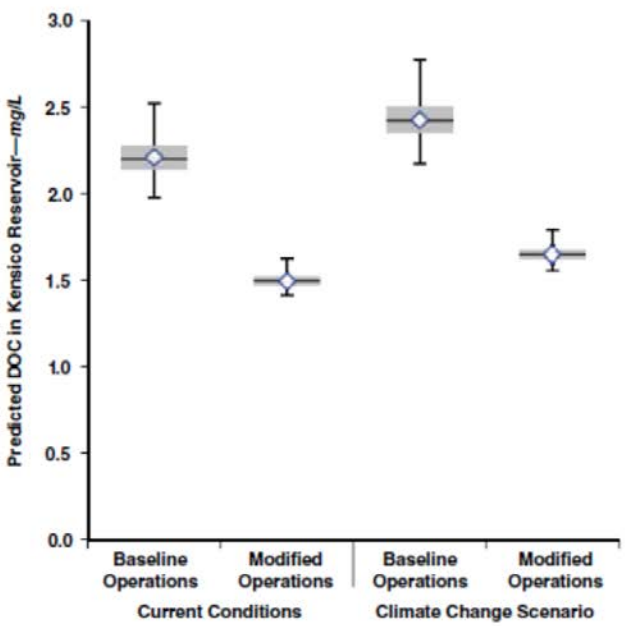


*Minimum Schoharie diversion needed to maintain minimum streamflow for fisheries habitat is defined by 6 NYCRR Part 670 (NYCRR, 1977)



Weiss, W.J. et al. (2013). Minimizing Raw Water NOM Concentration through Optimized Source Selection. *Journal AWWA*, 105(10).

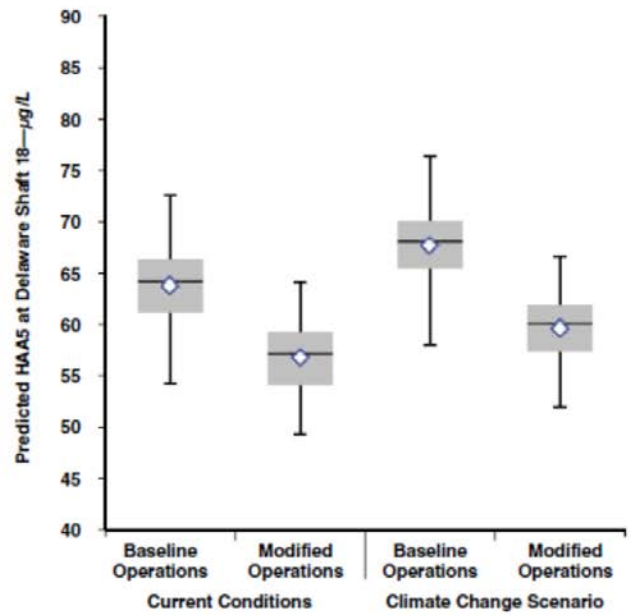
FIGURE 9 Predicted range of DOC concentrations at Kensico Reservoir for the four OST simulation scenarios



DOC—dissolved organic carbon, OST—Operations Support Tool

Boxes indicate the interquartile range (25th, 50th, and 75th percentiles); whiskers indicate the 1.5 interquartile range.

FIGURE 10 Predicted range of HAA5 at high-water-age location for the four OST simulation scenarios



HAA5—the sum of five haloacetic acids, OST—Operations Support Tool

Boxes indicate the interquartile range (25th, 50th, and 75th percentiles); whiskers indicate the 1.5 interquartile range. Delaware shaft 18 represents a high-water-age location in the distribution system for water delivered from Kensico Reservoir via the Delaware Aqueduct.

Weiss, W.J. et al. (2013). Minimizing Raw Water NOM Concentration through Optimized Source Selection. *Journal AWWA*, 105(10).

PROJECT OBJECTIVES

- Increase water utility awareness and use of NASA remote sensing products to guide dynamic, proactive management plans and operating policies
- Provide an efficient, easy-to-use, web interface for water utility staff to access, process, and use remote sensing data to enhance water quality monitoring
- Develop a set of statistical algorithms that utilities can execute to identify surrogate parameters for water quality parameters of concern
- Guide parameter selection, spatial and temporal aggregation approaches, and statistical methodologies for finding correlations among remote sensing and source water quality data sets

THANK YOU!

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