**Nationally Consistent Discrete and Continuous Water Quality Samples**

**Discrete Water Quality Sampling and Analysis**

National Water Quality Network Nitrate Sites, n=116
- Additional discrete nitrate sites, n=1,809

**Continuous water-quality data show changing environmental conditions that may be missed with discrete samples**

Potomac River, Little Falls Washington, DC

From Pellerin et al. (2016)

Real-Time Nitrate, in mg/L as N
- 138 lake and river sites

YSI-Sonde

https://waterwatch.usgs.gov/wqwatch/
Fast Limnology Automated Measurement (FLAMe): Sensor technology + a mobile sampling platform shows changing environmental conditions that may be missed with either discrete or fixed-continuous sensors.

- FLAMe has a Multiparameter Sonde + Optical Nitrate Sensor + Portable Greenhouse Gas Analyzer
- Flow-through water-quality sampling system
- Works at low (0 to 10 km hr\(^{-1}\)) and high speeds (10 to > 45 km hr\(^{-1}\))
- Useful to identifying transition zones in aquatic systems and potential identification of terrestrial - aquatic linkages

From Crawford et al. (2014)
Integrating Water Quality & Remote Sensing

Identify anomalous water quality issues and/or expand spatial coverage for routine monitoring

Algal Blooms, Harmful & Beneficial
Wildlife Habitat
Drinking water supply

Guy Foster and Jennifer Graham
Brent Knights, USGS, Upper Midwest Environmental Science Center
California Department of Water Resources
Anomalous WQ Issue: Identify changes to ecosystem state in large rivers to assess the quality of essential habitat to support both recreational and commercial fishing.

WQ Results: Map showing 1300 km of UMR fluorescent dissolved organic matter (fDOM) values, quinine sulfate units (QSU) using FLAMe mobile sensor platform. Navigational infrastructure and nutrient enrichment caused changes in water quality, including increased phytoplankton production.

From Crawford et al. (2016)

Potential Link to Remote Sensing: Use remote sensing imagery (Landsat 8 or Sentinel 2) to determine variability in timing of onset and/or duration of eutrophic state.

(a) Satellite-retrieved chlorophyll-a estimated in the Google Earth Engine platform using the ratio of reflectance in the blue and green bands of the Landsat 8 OLI sensor.
(b) In situ chlorophyll-a underway transect measurements taken in July 2016 using the FLAMe platform.
(c) Scatterplot showing the relationship between the in situ and satellite remote sensing measurements for the John Day river. From Kuhn et al. (2017)
**Routine WQ Issue:** Monitoring of point and nonpoint source pollution in the San Francisco Bay-Delta Estuary, a key water supply for a major urban area.

**Remote Sensing:** Hyperspectral imaging with airborne portable remote imaging spectrometer (PRISM).

**Methods:** Link measurement of in situ organic matter optical properties with remote sensing data to develop maps of a surrogate water quality parameter of interest, methylmercury.

**Results:**

Measured DOC proxy (sensor DOC) has a strong positive relationship with discrete samples of DOC.

Relationship between DOC concentrations and methylmercury from discrete samples (left). A map of methylmercury was derived from the remotely sensed DOC concentrations (right).
**Anomalous WQ Issue:** Map wastewater and sediment plumes in New York and New Jersey resulting from infrastructure damage following Hurricane Sandy.

**Remote Sensing:** Landsat and USGS Earth Resources Observation and Science Center (EROS) surface reflectance data product (for atmospheric correction).

**Methods:** Used pre-established reflectance band ratios (Kutser et al. 2005) to create maps of relative differences in colored dissolved organic matter (CDOM) absorption before and after a major storm event.

**Results:** Anomalous and potentially hazardous regional-scale water quality conditions were detected using Landsat remote sensing imagery.

From Slonecker et al. (2016)
Challenges and Needs for Successful Integration of Water Quality & Remote Sensing for Inland Waters

Challenges:

• Temporal mismatch of data: Matching up timing of water quality sampling for inland waters with remote sensing pass is difficult because changes in water quality are highly variable over space and time, e.g. estuaries vary with the tide, rivers change with streamflow, and lakes change with precipitation and wind events.

• Spatial mismatch of data: Many inland waters are too small to be observable with remote sensing technology.

Needs:

• A national program calibrating remote sensing data with ground truth data, including a standardization of terms and methods
  • The link between remote sensing and water quality requires cross-walking between water quality lab methods which focus on absorbance, in situ sensors that are based on fluorescence, and remote sensing that is based on reflectance.
  • The effect of particles on light attenuation needs to be accounted for in field deployable sensors measuring optical properties of water quality.

• A standardized atmospheric correction methodology for application of satellite – derived remote sensing data to water quality data for inland waters

• Surrogate models that relate optically active components of water quality with the constituent of interest as many important attributes of water quality are not detectable with remote sensing, i.e. metal contaminants.

• Good communication between the water quality and remote sensing communities to identify anomalous and potentially hazardous water quality issues and improve the spatial coverage of routine water quality monitoring.
Acknowledgements

Brian Bergamaschi (USGS, California Water Science Center)
David Butman and Catherine Kuhn (University of Washington - Seattle)
John Crawford, Jack Eggleston, Brian Pellerin, Gary Rowe, Ted Stets, and Dick Smith (USGS, Water Mission Area)
Jennifer Graham, Guy Foster, Casey Lee, Keith Loftin (USGS, Kansas Water Science Center)
Jennifer Rover (USGS, Earth Resources Observation and Science Center)
John Dwyer, Jonathan Smith, and Zhuoting Wu (USGS, Land Resources Mission Area)
Terry Slonecker (USGS, Eastern Region Geographic Sciences Center)
Emily Stanley and Luke Loken (University of Wisconsin - Madison)
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