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APPLICATION OF PHOTOELECTROCHEMICAL OXYGEN DEMAND FOR NOM MONITORING IN LAKES UNDERGOING RECOVERY FROM ACIDIFICATION

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Civil and Resource Engineering
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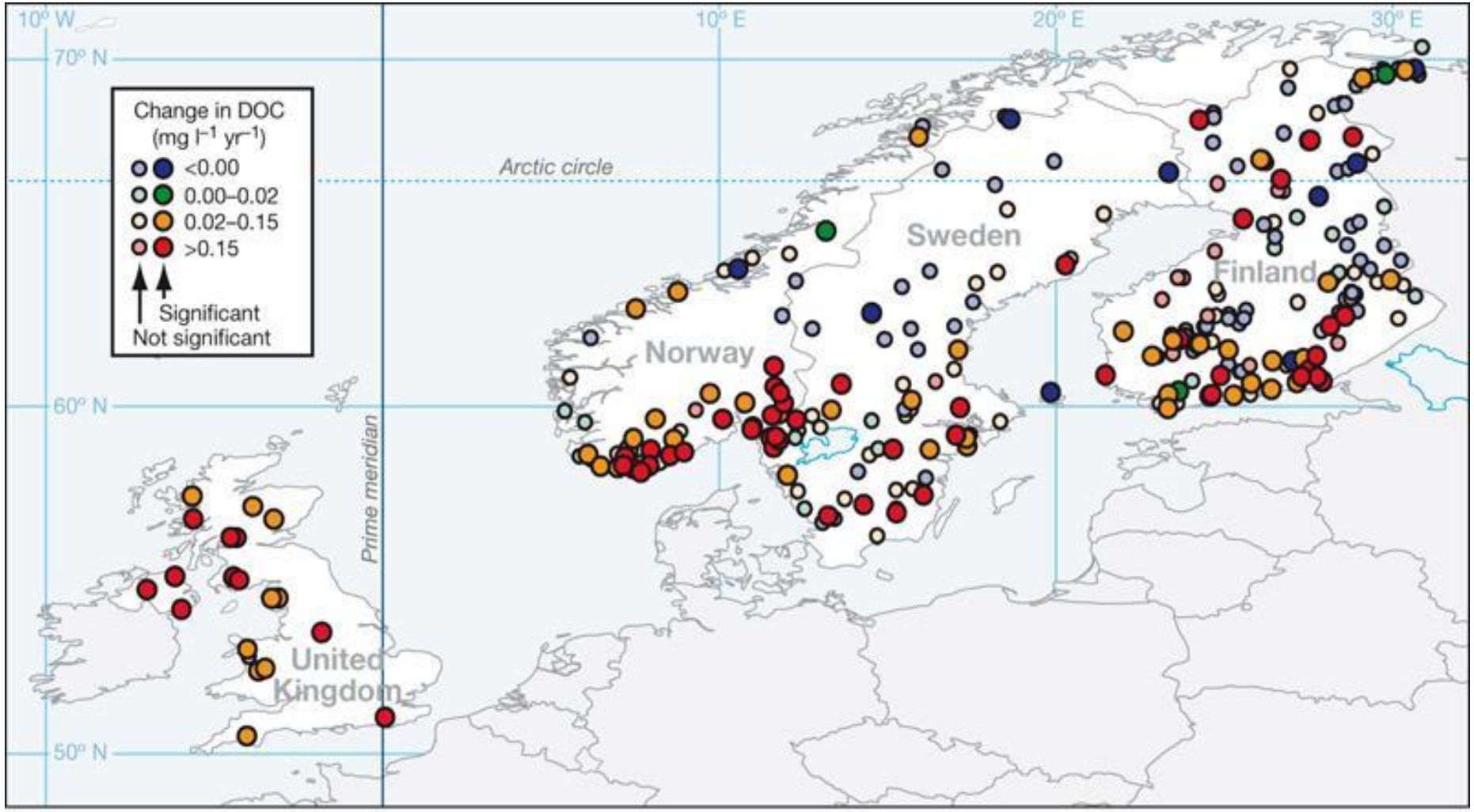
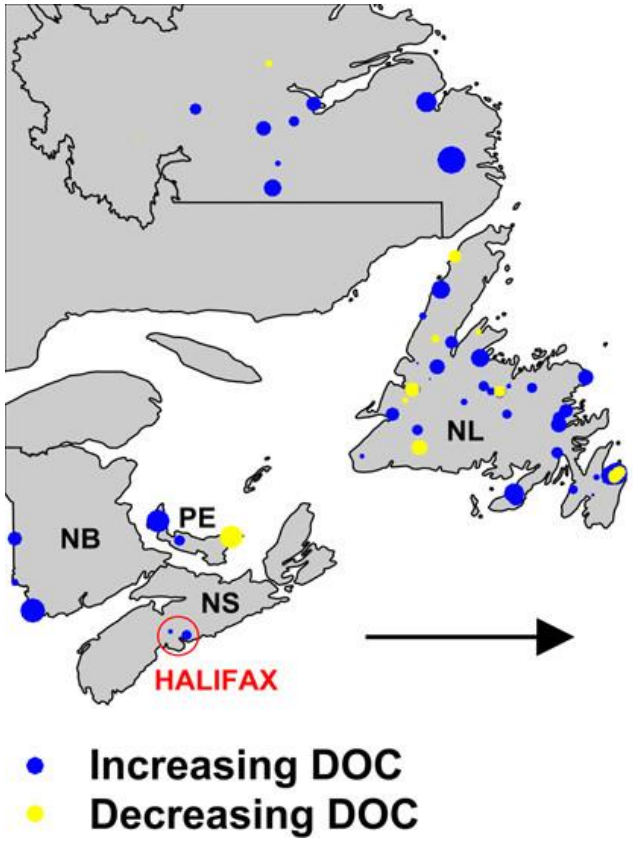
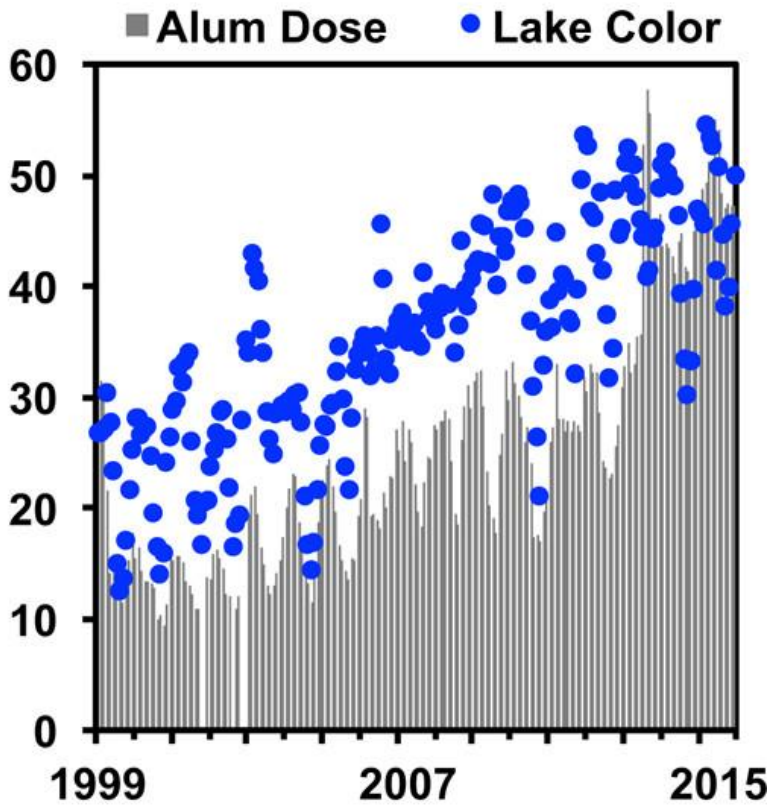
Research Motivation



1: Monteith et al. 2007 *Nature* 450(22): 537-541

Research Motivation





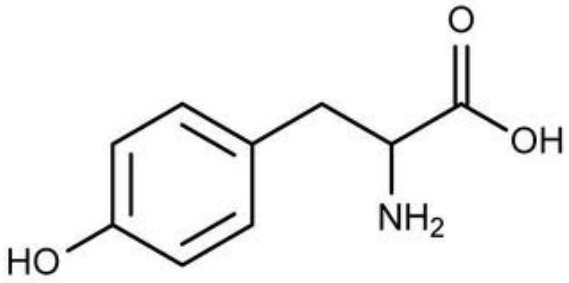
Lake Recovery Through Reduced Sulfate Deposition: A New Paradigm for Drinking Water Treatment
Lindsay E. Anderson, Wendy H. Krkošek, Amina K. Stoddart, Benjamin F. Trueman, and Graham A. Gagnon
Environmental Science & Technology **2017** *51* (3), 1414-1422

Need for new tools to monitor NOM in water supplies

- Conventional metrics like TOC do not provide information on the oxidizability of the measured carbon, or the amount of oxygen needed for its degradation
- Similar TOC concentrations can produce a wide range of DBPs depending on the oxidizability or reactivity of the NOM present
  - COD measures the chemical reactivity and associated oxidative changes in NOM

What is COD?

- Chemical oxygen demand



$$+ O_2 \rightarrow CO_2 + H_2O + NH_3$$

- Working with a new COD tool: Photoelectrochemical oxygen demand
  - Improved sensitivity for drinking water
    - Further improved sensitivity with operational changes
  - Green technology

Photoelectrochemical Oxygen Demand

- Analysis time
  - Less than 5-10 min
- Green chemistry
  - No wastes
  - Requires electrolyte
- Safe
  - No hazardous chemicals

PeCOD = Phocoelectrochemical oxygen demand

ASTM Method D8084

Measures how oxidizable or reactive NOM is

Health Canada – Guidance on NOM in drinking water

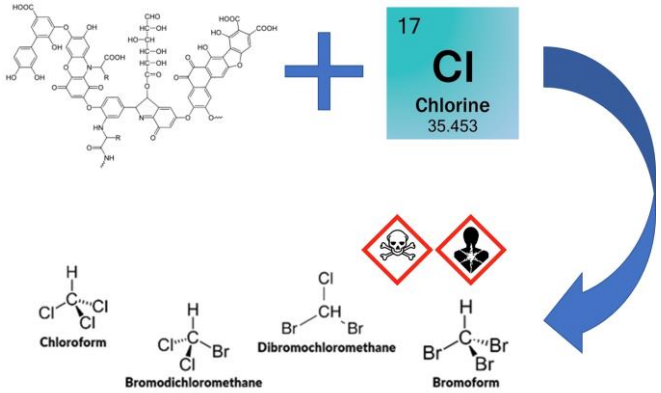
testing to determine alternative performance criteria for avoiding the use of excessive alum dosages that result in limited additional TOC removal. The rule requires monitoring of DBPs, disinfectant residuals, TOC and alkalinity. Facilities with alternative performance criteria must also monitor magnesium hardness removal, DOC, UV254 and SUVA. A monitoring plan must be developed and implemented that includes monthly sampling for TOC in the raw water and filter effluent, as well as total THM (i.e., chloroform, bromoform, bromodichloromethane, chlorodibromomethane) and HAA5 monitoring that is representative of the entire distribution system. TOC removal is calculated as a running annual average computed quarterly from monthly samples.

The World Health Organization suggests optimized NOM removal as a means to minimize biofilm growth in the distribution system (WHO, 2011). Organic carbon is also suggested as an operational parameter in water safety plans to monitor control measures.

The European Union drinking water regulations include TOC as a general water quality indicator parameter for supplies ≥10,000 m^3/d (EU, 2014). The regulations specify "no abnormal change" as the parametric value. In some jurisdictions, oxidizability (measured as chemical oxygen demand) can be used in place of TOC. A parametric guideline value of 5 mg/L O_2 is specified (EU, 2014). French regulations specify guideline limits for treated water intended for human consumption for several chemical and organoleptic parameters, including TOC (i.e., 2 mg/L and no abnormal change) and oxidizability (i.e., 5 mg/L O_2) (Government of France, 2007).

PeCOD as an indicator for DBP precursor material

- Oxidizability of NOM compounds related to DBP formation
  - Preliminary data shows linear trend with peCOD and instantaneous DBP data
  - Formation potential (standardized conditions) work required for confirmation of relationship between peCOD and DBPs



Summary

- PeCOD offers additional information to current suite of NOM monitoring parameters
  - Informs reactivity of NOM compounds
- Potential to use peCOD as a process monitoring tool
  - Higher resolution compared to conventional NOM metrics
  - Opportunity to detect subtle changes in water quality/process operations
- Continued monitoring will provide valuable information on relationship between peCOD and other parameters in lakes undergoing recovery

Acknowledgments

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