

A Longitudinal Evaluation of NOM Quality in a Water Supply Previously Affected by Chronic Acid Rain: Implications for Treatment

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Abstract. Many surface waters in Northeastern US and Atlantic Canada are sensitive to acid rain attributed to the long-range transport of SO_x emitted by power generating processes. Accordingly, acid rain control programs have resulted in substantial reductions in SO₂ emissions and SO₄ deposition in surface waters. Thus, some lakes have shown signs of recovery from acidification as evidenced by increasing pH and natural organic matter (NOM) concentration. For example, since 1999, average color concentrations in certain Atlantic Canadian water supplies have increased by up to 3.8x, while dissolved organic carbon (DOC) has increased by approximately 1 mg/L (Anderson et al., 2017). A similar phenomenon has been observed in some Scandinavian countries, where DOC has increased by up to 0.15 mg/L/year (Monteith et al., 2007). In addition, it is hypothesized that with reductions in SO₄ deposition, NOM will become more hydrophobic and colored in nature. Based on our knowledge of the literature this shift in composition has never been directly quantified. The objective of this study was to perform a longitudinal analysis (2010-2018) to quantify any changes in NOM composition (e.g. hydrophobic and hydrophilic acids, bases, and neutrals), and to understand how these changes will affect coagulation processes for removing NOM. Using resin fractionation methods described by Kent et al. (2014), we will characterize NOM composition in Pockwock Lake, which serves as the main water supply for Halifax, Nova Scotia, Canada. The composition of NOM in Pockwock Lake was characterized in 2010 (Montreuil, 2011) using the same method, and therefore will serve as a baseline for comparison with more recent data (from 2018) to determine whether specific fractions of NOM are more pronounced. We will also perform coagulation optimization experiments (e.g. jar testing) on water from Pockwock Lake for comparison with data from 2010 (Knowles, 2011). It is expected that this will help quantify how the coagulant demand has changed in response to recent increases in NOM concentration as well as the potential changes in NOM composition. Results from 2010 indicate that Pockwock Lake was comprised mainly of hydrophilic neutral and hydrophobic acid fractions. The hydrophobic fraction of NOM is typically removed through coagulation/flocculation treatment processes; however, an increase in hydrophobic content of NOM could increase coagulant demand. Preliminary results from 2017 jar tests indicate that an increased coagulant dose is required to achieve a similar DOC removal rate (40-50% removal) as was achieved in 2010 using the same experimental approach. Overall, this analysis will lead to an understanding of how global atmospheric processes including both decreased SO_x and climate change, affect drinking water treatment practices. It will also help develop treatment solutions that utilities can implement to help adapt to these evolving environmental conditions.

References.

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