FLORIDA AS A LABORATROY FOR SEA-LEVEL RISE AND FUTURE HEALTH RISKS OF DRINKING WATER SOURCES

T.H. Boyer*[1], E. Ged[1], L. Motz[1], J. Kurki-Fox[1], P. Chadik[1], J. Martin[2], K. Frank[3], P. Palomino[1]

[1] *Engineering School of Sustainable Infrastructure & Environment, University of Florida, Gainesville, FL, USA*

[2]*Department of Geological Sciences, University of Florida, Gainesville, FL, USA*

[3]*Department of Urban & Regional Planning, University of Florida, Gainesville, FL, USA*

*P.O. Box 116450, Gainesville, FL 32611, 352-846-3351, 352-392-3076, thboyer@ufl.edu

Sea-level rise (SLR) resulting from climate change is expected to increase saltwater intrusion and subsequent contamination of fresh groundwater. In the past the major concern with this contamination was chloride (Cl^-) and sodium ions, which are the major constituents of saltwater and cause unpalatable taste. An overlooked process during saltwater intrusion is the co-transport of bromide ion (Br^-) with Cl^-. Although Br^- is present in saltwater at much lower concentrations than Cl^-, Br^- can form toxic disinfection byproducts (DBPs) during water treatment whereas Cl^- and total dissolved solids (TDS) are predominantly an aesthetic concern. Accordingly, the objective of this research is to quantify the impact of SLR on the potential to alter groundwater chemistry and increase the formation of brominated DBPs during water treatment. The research project is underway by pursuing four specific aims:

1. Model saltwater intrusion in a coastal aquifer for one hydrogeologic region in Florida under different projections of SLR;
2. Quantify the variability in the ratio of bromide-to-chloride (Br^-/Cl^-) in a coastal aquifer in Florida under different spatial and temporal scales;
3. Model the formation of bromine-containing DBPs formed during drinking water treatment for varying degrees of saltwater intrusion;
4. Develop an applied science adaptation framework by identifying current coastal drinking water supply management practices and policies, the changes needed based on the new information about DBPs, and the barriers and opportunities for adaptation.

Aim 1: Groundwater modeling was based on hydrogeologic conditions in Broward County, FL. Numerical modeling of saltwater intrusion into an unconfined coastal aquifer was conducted using SEAWAT, which simulates three-dimensional, variable-density groundwater flow and transport. Projections for SLR were taken from the Intergovernmental Panel on Climate Change Fourth Assessment Report. The output from Aim 1 is the TDS concentration in groundwater, at a fixed location from the coast, as a function of time for different projections of SLR over a 100 y period.

Aim 2: Groundwater samples are being collected quarterly for 1 y from eight monitoring wells in Broward County, FL. The water samples are being analyzed for wide range of water quality parameters. The Br^-/Cl^- ratio and other ratios indicative of saltwater intrusion are being calculated to assess spatial and temporal variability.

Aim 3: Models that predict DBP formation from chlorine were compiled from the literature. The result was 74 different models that predicted trihalomethane (THM) or haloacetic acid (HAA) formation. The THM and HAA models were statistically evaluated using a data set that contained 16 raw and treated drinking waters (0.055 to 0.54 mg/L Br^-) that were chlorinated and analyzed for four THM and nine HAA species. The statistical analysis produced a subset of models that accurately predicted THM and HAA formation.

Aim 4: The research team is working with coastal water utilities to understand current management practices related to climate change and SLR. This will allow the research team to create an adaption strategy so water utilities can incorporate new findings on the impact of SLR on DBP formation into their planning framework.

The groundwater modeling predicted the time-varying TDS over 100 y for four scenarios of SLR (Fig. 1a). Only the highest projection of SLR (88 cm in 100 y) resulted in TDS greater than secondary maximum contaminant level (MCL) at 62 y. The TDS was converted to Cl^- and Br^- using standard seawater composition (Fig. 1b and c). (This is an assumption that is being investigated as part of Aim 2.) Similar to TDS, only the highest projection of SLR (88 cm in 100 y) resulted in Cl^- greater than secondary MCL at 60 y. The Br^- was used to model the formation of THM4 (four chlorine- and bromine-containing THMs) for chlorination of typical treated water composition (Fig. 1d). THM4 exceeded the primary MCL for all cases of SLR, e.g., at the highest projection of SLR, THM4 exceeded the primary MCL at 35 y compared with TDS and Cl^- exceeding the secondary MCL at approx. 60 y. *Thus, the preliminary results indicate that saltwater intrusion, induced by SLR, can result in elevated formation of brominated DBPs before the traditional concern of exceeding the secondary MCL for TDS or* Cl^-. This presentation will highlight modeling and field data on TDS, Cl^-, and Br^- in a coastal aquifer in the context of SLR projections over a 100 y timeframe, and discuss subsequent formation of brominated DBPs during drinking water treatment in terms of water management and health risks of chlorinated versus brominated DBPs.

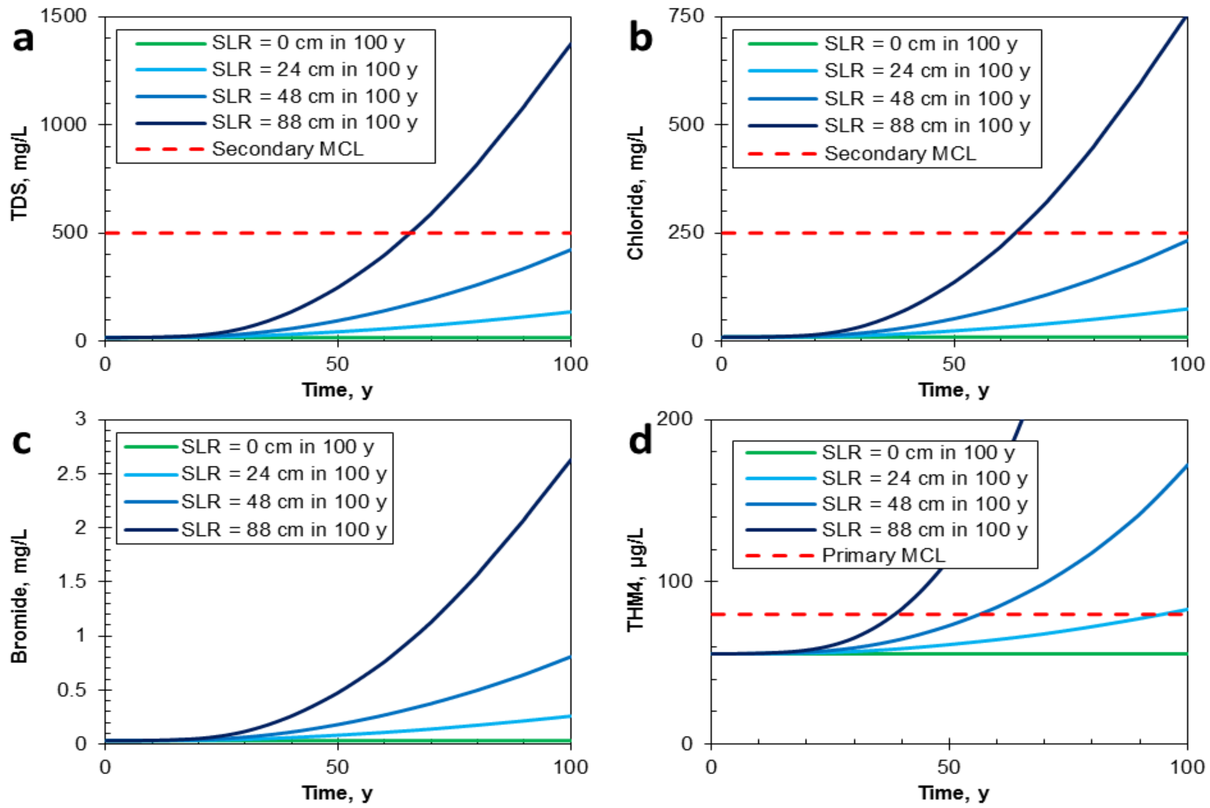

Fig. 1 – Effect of sea-level rise (SLR) on saltwater intrusion into coastal, freshwater aquifer and subsequent formation of four chlorine- and bromine-containing trihalomethanes (THM4) upon chlorination of treated drinking water. Maximum contaminant level (MCL).