Abstract

Mercury (Hg) is a toxic trace metal, that has been linked to human illness and degradation of ecosystems. Atmospheric emissions have caused widespread contamination of Hg in terrestrial and aquatic environments, including dangerously high concentrations in Adirondack lake biota. However, the linkage between atmospheric Hg deposition and contamination of aquatic biota is not well established. Additional research is necessary to determine the ultimate fate of Hg within remote ecosystems. A quantitative understanding of atmospheric Hg deposition and the factors regulating the fate, transformation, and bioavailability of such Hg within terrestrial environments and downstream aquatic ecosystems is critical research needs.

The current research examines Hg deposition and cycling within the Arbutus Lake watershed (Newcomb, NY) to clarify the atmospheric, geochemical, and biological mechanisms regulating Hg concentrations in soft-water lakes of the northeastern U.S. The effects of deposition pathway, soil retention, and landscape characteristics are being examined. Data obtained within the Arbutus watershed will provide information regarding Hg contamination and bioavailability of Adirondack ecosystems. The data may be extrapolated regionally via modeling to predict the effect of Hg deposition within similar watersheds of the Adirondacks.

Upland Transport and Fate

The transport and fate of Hg within upland forest ecosystems is important as inputs are largely via throughfall and leaf litter. Leaves have been shown to accumulate THg, likely via canopy air exchange. As leaves are deposited and biodegrade, THg enters the soil-water-plant system. The fate, transformations, and fluxes of Hg within the forest system are being assessed through instrumentation and measurements focused on two plots (Reference and Treatment).

- Soil pits
  - Soil collected from Oa, Bh, E, Bs, Bs, and C horizons
- Lysimeter pairs – Oa and Bh (both plots) and Bs (Reference)
- Plant tissue and litterfall collection – beech, sugar maple, birch
- Soil evaporation

The Treatment plot will be dosed with stable isotope, 2Hg, to investigate uptake of newly-applied THg. Each of the above samples will be analyzed for Hg speciation and isotopic distribution.

Atmospheric Deposition, Transformations, and Fate of Mercury Across a Northern Forest Landscape
JOSEPH T. BUSHEY1, PRANESH SELVENIRAN1, HYUN-DEOK CHOI2, LINGHUI HUANG1, ALEXEI NALLANA1, THOMAS M. HOLSEN2, TIM SHARAC2, SOON-ONN LAF, MICHAEL MCHELE, RON MUNSON3, and CHARLES T. DRISCOLL1
1Department of Civil and Environmental Engineering, Syracuse University, Syracuse, New York 13244
2Department of Civil and Environmental Engineering, Clarkson University, Potsdam, New York 13699
3U.S. Geological Survey, Troy, NY 12180

Figure 2. Arbutus Lake from near the outlet. The Archer Creek watershed is in the background at the far northern end of the lake. The upland plots are to the right of the picture location, approximately 300 m upstream.

Figure 3. Intensive study areas for Hg cycling within the Arbutus Lake watershed. Shown are the locations for lake in/outlet sampling, the two wetland study locations, the upland plots for soil fate and atmospheric interaction, and the Mercury Deposition Network (MDN) site.

Lake Watershed / Wetland Budgets

The effect of landscape characteristics on MeHg production and bioavailability is being investigated via stream water and shallow groundwater sampling within the Archer Creek wetland system. Comparisons are also being conducted between the Arbutus Lake data (high rT, low DOC) and that obtained from Sunday Lake (low rT, high DOC). Water chemical parameters such as DOC and SO42- concentrations have been found to affect Hg speciation and transport.

- Examine Hg transport and speciation within wetland system
  - Nested series of stream water sampling points – includes wetland and upland sites
  - Piezometer transects (n=4) across two wetlands, with two depths represented at each location

- Lake watershed budget – monitor Hg content and speciation for lake inlet/outlet

Table 1. Comparison of different chemical species concentrations for upland, wetland, and lake waters. Data represents range of values from August 2004 to February 2005. Wetland and higher DOC waters experience higher Hg concentrations and fluxes.

Future Work

- Continue current monitoring
  - Deposition, throughfall, and evasion
  - Lysimeter soil water, leaf tissue, and litterfall
  - Wetland and lake water sampling, including piezometers
  - Event sampling
    - The measurement of Hg mobility during hydrologic events
  - Upland plot dosing
    - Add 2Hg to Treatment plot
  - Track fate of newly-applied Hg

Figure 4. Annual volume-weighted concentrations of total Hg for MDN station Huntington Forest (Arbutus Lake) compared to values at Biscuit Brook in the Catskills. Note that the MeHg concentration in precipitation is typically <1% of total Hg.

Figure 5. THg concentration profile for soil horizons and soil waters. Soil was collected during pit installation. Soil solutions reflect monthly collections between September 2004 and April 2005. Concentration data for duplicate lysimeters were aggregated.