Watershed influences on fluvial and internal loadings of Methylmercury in Near-Shore marine systems

Chad R. HAMMERSCHMIDT [1*], William F. FITZGERALD [2] & Prentiss H. BALCOM [2]

[1] Department of Earth & Environmental Sciences, Wright State University, Dayton, Ohio 45435, USA
*E-mail: chad.hammerschmidt@wright.edu

[2] Department of Marine Sciences, University of Connecticut, Groton, Connecticut 06320, USA

Coastal embayments and associated watersheds are contaminated with mercury (Hg) from modern discharges and the pollution legacy of the Industrial Revolution, and there is concern related to the transport, transformation, and fate of toxic methylmercury (MeHg) in these systems. Here, we present a well-constrained assessment of the behavior and fate of Hg and MeHg in the watersheds, coastal waters, and sediments of New York Harbor (NYH) and Long Island Sound (LIS) in the northeastern United States. Both of these "urban estuaries" support active commercial and recreational fisheries, and are impacted significantly by heavy metals, organic carbon, and nutrient loadings from their watersheds. Rivers are the primary source of Hg to both systems (60-70% of total inputs), with lesser inputs from water pollution control facilities and direct atmospheric deposition. Most (60-70%) of the fluvial Hg input to the Sound can be attributed to atmospheric deposition and subsequent leaching from the watershed, whereas runoff of atmospheric Hg to the Harbor is less certain (22-69% of fluvial flux). MeHg in coastal marine systems is derived from production in the watershed and *in situ*. Fluvial loadings of MeHg to NYH (18 ± 3 mol y^{-1}) are similar to those in LIS (15± 5) and not unexpected given the comparable sizes of their watersheds (~42000 km^2) and similar land use. Rates of *in situ* sedimentary production and mobilization of MeHg also are comparable between NYH (16± 8 nmol m^{-2} y^{-1}) and LIS (17± 6). This result is surprising because loadings of inorganic Hg (Hg(II)) substrate to sediments of NYH (1640 nmol m^{-2} y^{-1}) are about 8× greater than those in LIS (210). This indicates that Hg methylation and/or MeHg mobilization is inhibited in sediments of the Harbor relative to the Sound. Organic matter largely controls the sedimentwater partitioning and bioavailability of Hg(II) to methylating bacteria in both systems; partitioning coefficients (K_D) for MeHg and Hg(II) are related positively to the organic content of sediments with less than 10 μ M dissolved sulfide. Potential gross rates of Hg methylation, assayed by experimental addition of an isotopic tracer (^{200}Hg) to intact sediment cores, are related inversely with K_D of Hg(II) in both LIS and NYH. However, K_D values for MeHg and Hg(II) in sediments of NYH are about 10× greater than those in deposits of LIS and the adjacent continental shelf, suggesting differences in the affinity of Hg for allochthonous (Harbor) and planktonic organic material (LIS and shelf). Dissolved sulfide affects the speciation and inhibits methylation of Hg(II) in both systems. Hence, it appears that loadings of allochthonous organic matter (terrestrial and/or sewage) to the Harbor, as well as associated production of sulfide by benthic respiration of this material, reduces the bioavailability of Hg and attenuates MeHg production in the Harbor relative to LIS. Watershed inputs of labile organic matter and nutrients also affect distributions of dissolved oxygen in coastal marine systems and thereby influence the mobilization of MeHg from sediments. Flux chamber investigations show that sedimentwater exchange of MeHg is largely diffusional when dissolved oxygen is less than about 80% saturation and enhanced at greater levels, which may be linked to increased abundance and/or activity of infauna that irrigate sediment. Thus, management programs intended to minimize allochthonous organic matter and nutrient loadings to coastal systems, in an attempt to curb eutrophication and hypoxia/anoxia in the water column, may inadvertently enhance the production and mobilization of MeHg from underlying deposits by both reducing the reservoir of organic material and sulfide and increasing the abundance and activity of infauna.

References

Balcom P H, Fitzgerald W F, Vandal G. M, Lamborg C H, Rolfhus K R, Langer C S, Hammerschmidt C R (2004). Mercury sources and cycling in the Connecticut River and Long Island Sound. Marine Chemistry, 90: 53—74

Balcom P H, Hammerschmidt C R, Fitzgerald W F, Lamborg C H, O'Connor J S (2008). Seasonal distributions and cycling of mercury and methylmercury in the waters of New York/New Jersey Harbor Estuary. Marine Chemistry, 109: 1—17

Hammerschmidt C R, Fitzgerald W F (2004). Geochemical controls on the production and distribution of methylmercury in near-shore marine sediments. Environmental Science & Technology, 38: 1487—1495

Hammerschmidt C R, Fitzgerald W F (2006). Methylmercury cycling in sediments on the continental shelf of southern New England. Geochimica et Cosmochimica Acta, 70: 918—930

Hammerschmidt C R, Fitzgerald W F (2008). Sediment-water exchange of methylmercury determined from shipboard benthic flux chambers. Marine Chemistry, 109: 86—97

Hammerschmidt C R, Fitzgerald W F, Lamborg C H, Balcom P H, Visscher P T (2004). Biogeochemistry of methylmercury in sediments of Long Island Sound. Marine Chemistry, 90: 31—52

Hammerschmidt C R, Fitzgerald W F, Balcom P H, Visscher P T (2008). Organic matter and sulfide inhibit methylmercury production in sediments of New York/New Jersey Harbor. Marine Chemistry, 109: 165—182

Some issues on water resources system of the Changjiang River Delta in China

Dong WANG [1*], Ying WANG [2], Jichun WU [1], Lachun WANG [2] & Yunliang SHI [2]

[1] Department of Hydrosciences, Department of Earth Sciences, Nanjing University, Nanjing 210093, China
*E-mail: wangdong@nju.edu.cn

[2] the Key Lab of Ministry of Education of Coast & Island Development, Nanjing University, Nanjing 210093, China

Water resources system is a complicated large system, which contains certain regional background, as well as specific framework, function and dynamic balance. The Changjiang River Delta is a very important area in China. As the local water resources are concerned, the Delta is an area lack of water as a matter of fact. The water resources system of the Delta experiences a long, intricate and degenerate period. The lacking of water due to resources shortage in 1950's changes into that due to water quality from 1980's. Furthermore the status of water shortage sharpens gradually. The representations are summarized as follows: firstly, the discharge amount of wastewater and polluted water is large all along. Secondly, the pollution status of rivers, which involve the Changjiang River, the Grand Canal, the rivers in city and the rivers in small towns and villages, is noticeable. Thirdly, water quality of Taihu Lake is worth of more attention. Therefore, the countermeasures on the reconditioning and regulating of water resources system in the Delta demands the following new strategies, such as to treat the rivers, the lakes and the seas as an overall system, to improve, harmonize and counterpoise water resources system carrying capacity, to implement the integrated management of water resources, which means the integrated management of drainage area along with the regional area, especially the integrated management of city water, and to carry on water saving and scientific using to increase the efficiency of water use, and so on. Consequently, human can coexist with water harmoniously in the Delta. And the objective to ensure the sustainable social and economic development with the sustainable usage of water resources can be implemented.

Simulation of coastal currents and river discharges in the South-eastern Black Sea

*Ercan KÖSE, Coşkun ERÜZ, Kadir SEYHAN

Faculty of Marine Science, Karadeniz Technical University, Trabzon, Turkey
E-mail: ekose@ktu.edu.tr

In this study, development and evaluation of buoyant river plumes under the influence of the coastal currents and the guidance of topography in the south eastern Black Sea coast (Solak1 and SÜrmene) rivers were analyzed. For simulation, the rivers are inputted as source of zero salinity in computer based simulation model CARDINAL, which uses depth averaged shallow water equation for two-dimensional conditions and the equations of non-steady boundary layer for three-dimensional conditions. The river plumes are examined with realistic topography and idealized wind conditions. In order to check accuracy of the simulation, temperature, salinity, current speed and directions were measured in 22 stations and then density was calculated by using UNESCO formulae. Comparison of the measurements and modeling of currents showed good agreement. When both buoyancy and wind are employed as external forcing, the circulation is influenced by the opposing tendencies for stratification. The present findings suggest that transport of low salinity waters depends on buoyancy in the vicinity of rivers and wind components away from river mouths.

Remotely-sensed suspended sediment dynamics in the Yangtze River Estuary

Fang SHEN [1*], Yunxuan ZHOU [1], Suhyb SALAMA [2], Bob(Z) SU [2] & Xuezhong JIANG [1]