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Welcome to the USGS NAWQA Program Quarterly Highlights, January - March 2012

Highlights are from the USGS National Water-Quality Assessment Program (NAWQA), which has assessed the physical, chemical and biological characteristics of streams, rivers, and groundwater across the Nation since 1991.

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In this quarter's highlights:

Groundwater

- **Regression models for estimating concentrations of atrazine plus deethylatrazine in shallow groundwater in agricultural areas of the United States –** Access the featured article in the January 2012 issue of Journal of Environmental Quality online. Learn about other NAWQA pesticide assessments. For more information on the study, contact Paul Stackelberg.

Tobit regression models were developed to predict the summed concentration of atrazine and its degradate deethylatrazine (termed atrazine residues) in 1,298 shallow groundwater wells that underlie agricultural settings across the conterminous United States. These newly developed models predict concentrations (rather than detection frequency), which can be compared with water quality benchmarks. Model results indicate that variability in the concentration of atrazine residues in groundwater underlying agricultural areas is more strongly controlled by the history of atrazine use in relation to the timing of recharge (groundwater age) than by processes that control the dispersion, adsorption, or degradation of these compounds in the saturated zone. These models are not developed for regulatory purposes but rather can be used to (i) identify areas of potential concern, (ii) provide conservative estimates of the concentrations of atrazine residues in deeper potential drinking water supplies, and (iii) set priorities among areas for future groundwater monitoring.

- **Methods for simulating solute breakthrough curves in pumping groundwater wells –** Access the featured article in the January 2012 issue of Computers & Geoscience online. Learn about other NAWQA transport of contaminants to supply well studies. For more information on the study, contact Jeff Starn.

Several embedded analytical expressions for improving particle tracking near a pumping well are described and compared with a finely gridded finite-difference solution in terms of accuracy and CPU usage. Even though the embedded analytical approach can improve particle tracking near a well, particle methods reduce, but do not eliminate, reliance on a grid because velocity fields typically are calculated on a grid, and additional error is incurred using linear interpolation of velocity. Embedded analytical expressions increase accuracy but add significantly to CPU usage. Structural error introduced by the numerical solution method may affect parameter estimates.

- **Phosphorus and Groundwater: Establishing links between agricultural use and transport to streams –** Access the USGS Fact Sheet 2012-3004 online. For more information on the study, contact Joseph Domagalski. Learn about other NAWQA agricultural chemical studies.

Findings demonstrate that saturation of the soil or groundwater system with respect to phosphorus is possible and should be taken into account to protect downstream water bodies from excess phosphorus. The potential for groundwater transport of phosphorus can be evaluated with basic geochemical information, such as measurements of pH, dissolved oxygen, and dissolved phosphorus in samples of shallow ground water. In some cases, a simple management practice, such as the maintenance of a buffer strip adjacent to a stream can be effective in limiting the groundwater transport of phosphorus to the stream.

- **Principal aquifers can contribute radium to sources of drinking water under certain geochemical conditions –** Access the USGS Fact Sheet 2010-3113 online. For more information on the study, contact Zoltan Szabo.

Important factors affecting dissolved radium concentrations in principal aquifers used for drinking water in the United States include rock type and geochemical conditions. Knowledge of the geochemical conditions may help water-resource managers anticipate where radium may be elevated in groundwater and minimize exposure to radium, which contributes to cancer risk. Elevated concentrations of combined radium were more common in groundwater in the eastern and central United States than in other regions of the Nation. Three common geochemical factors are associated with the highest radium concentrations in groundwater: (1) oxygen-poor water, (2) acidic conditions (low pH), and (3) high concentrations of dissolved solids.

- **Occurrence and geochemistry of radium in water from principal drinking-water aquifer systems of the United States –** Access the featured article in the March 2012 issue of Applied Geochemistry online. For more information on the study, contact Zoltan Szabo.

A framework for evaluating radium (Ra) occurrence was developed from 1,270 groundwater samples (before treatment) that were collected from wells in 15 principal and other major aquifer systems used for drinking water and analyzed for concentrations of the Ra isotopes 224Ra, 226Ra and 228Ra. The concentration of Ra was consistently controlled by geochemical properties of the aquifer systems, with the highest concentrations most likely to be present where adsorption of the Ra was slightly decreased (aquifers with poor sorptive capacity, such as Fe-oxide-poor quartzose sands and carbonates). Radium concentration was highest in low pH and anoxic waters. Geochemical environments and low aquifer sorption capacity controlled Ra occurrence. Alpha recoil affected the presence of 224Ra in western USA principal aquifers. Differences in Ra isotope ratios depended upon geology of the principal aquifer.

Streams

- **Coal-tar-based pavement sealcoat and PAHs: Implications for the environment, human health, and stormwater management –** Access the featured article in the January 2012 issue of Environmental Science and Technology journal online. Learn more about USGS Polycylic Aromatic Hydrocarbon studies. For more information on the study, contact Barbara Mahler.

Pavement sealcoat, which is either a refined coal-tar-pitch or asphalt emulsion, can contribute to polycyclic aromatic hydrocarbons (PAHs) contamination of soils, lakes, and homes. Coal-tar-based sealcoat, which is more commonly used on the East coast, has about 1,000 times higher PAH concentration than the asphalt-based sealcoat, which is more commonly used in the western U.S. Tire and snowplow abrasion break down the sealcoat surface to fine particles or dust that contain elevated PAH concentrations and the dust is transported off the sealed pavement by stormwater runoff, wind, and snow. PAHs in sediment contaminated by coal-tar-based sealcoat are bioavailable and can adversely affect amphibians and benthic macroinvertebrates. PAH-contaminated house dust can increase exposure to these Group 1 carcinogens by 14-fold in children. Both inhalation and ingestion are possible exposure routes.

- **Characterizing mercury concentrations and fluxes in a Coastal Plain watershed: Insights from dynamic modeling and data–** Access the featured article in the January 2012 issue of Journal of Geophysical Research online. For more information on the study, contact Paul Bradley. Learn about other NAWQA Mercury studies.

Mercury cycling in a Coastal Plain system was assessed using concentrations and fluxes estimated by multiple watershed-scale models with distinct mathematical frameworks reflecting different system dynamics. Shallow subsurface flow was identified as a potentially important transport mechanism of particulate total mercury during periods when connectivity between the uplands and surface waters is maximized. Other processes (e.g., stream bank erosion, sediment re-suspension) may increase particulate total mercury in the water column.

- **Environmental settings of the South Fork Iowa River basin, Iowa, and the Bogue Phalia basin, Mississippi, 2006-10 –** Access the USGS Scientific Investigations Report 2012-5021 online. For more information on the study, contact Kathleen McCarthy. Learn about other NAWQA agricultural chemical studies.

Transport and fate of agricultural chemicals in different environmental settings were studied at seven sites across the Nation, including the South Fork Iowa River basin in central Iowa and the Bogue Phalia basin in northwestern Mississippi. The South Fork Iowa River basin is representative of midwestern agriculture, where corn and soybeans are the predominant crops and a large percentage of the cultivated land is underlain by artificial drainage. The Bogue Phalia basin is representative of corn, soybean, cotton, and rice cropping in the humid, subtropical southeastern United States.

- **Environmental settings of selected streams sampled for mercury in New York and South Carolina, 2005–09 –** Access the USGS Scientific Investigations Report 2011-1318 online. For more information on the study, contact Barbara Scudder Eikenberry. Learn about other NAWQA Mercury studies.

Environmental settings for streams in New York and South Carolina that were part of a detailed investigations into factors contributing to mercury bioaccumulation in top-predator fish and other stream organisms are described. Descriptions of location, land use/land cover, climate, precipitation, atmospheric deposition, hydrology, water temperature, and other characteristics are provided. Atmospheric deposition is the dominant mercury source in the studied basins. Biota, sediment, soil, and water were sampled for mercury and for physical and chemical characteristics believed to be important in mercury methylation and transport.

- **Landscape controls on total and methyl Hg in the upper Hudson River basin, New York, USA –** Access the featured article in the March 2012 issue of Journal of Geophysical Research online. For more information on the study, contact Douglas Burns. Learn about other NAWQA Mercury studies.

Landscape factors and chemical variables at 27 stream sites in the upper Hudson River basin that best account for the spatial variation of total mercury and methylmercury concentrations were evaluated. Multivariate linear regression relations that included metrics of (1) hydrogeomorphology, (2) riparian/wetland area, and (3) open water, explained about 66% to over 90% of spatial variation in each mercury form in spring and summer samples. Multivariate models based solely on these landscape metrics generally accounted for as much or more of the variation in mercury concentrations than models based on chemical and physical metrics, and show great promise for identifying waters with expected high mercury concentrations in the Adirondack region and similar glaciated riverine ecosystems.

- **Hydrology and Methylmercury Availability in Coastal Plain Streams –** Access Chapter 8 in the online book Water Resources Management and Modeling: InTech . For more information on the study, contact Paul Bradley. Learn about other NAWQA Mercury studies.

This chapter discusses a few specific mechanisms that illustrate the critical link between hydrology and mercury risk in the environment. Recent studies have demonstrated that Coastal Plain stream environments are particularly prone to elevated Hg concentrations in fish and other indigenous aquatic communities, but considerably less is known about the specific ecological interactions contributing to elevated mercury bioaccumulation in this physiographic setting. In this chapter, the general impact of hydrology on microbial production and in situ persistence of methylmercury in saturated sediment environments is discussed with specific emphasis on characteristics relevant to the southeast region of the USA. The role of hydrology in the transport of methylmercury from the site and matrix of production to the point of entry into the food web in Coastal Plain stream systems is illustrated by recent research in a paired basin study in South Carolina.

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