U.S. Geological Survey (USGS) Investigations of National and Regional Trends in Ground-Water Quality in the United States

We would like to inform you of the September/October issue of Journal of Environmental Quality (JEQ), which features in-depth U.S. Geological Survey (USGS) investigations of national and regional trends in ground-water quality in the United States. The release of these investigations, primarily focusing on nitrate, pesticides, and pesticide degradates, marks the first of many trends-studies to follow by the USGS National Water-Quality Assessment (NAWQA) Program, which has collected consistent and comparable data for a large number of chemical constituents at wells across the Nation since its inception in 1991.

The NAWQA design allows for the integration of water chemical data with spatial features—such as land use, geo-chemical conditions, aquifer type, and soils—that may affect quality and the transport and fate of selected chemicals within ground-water systems. Wells included in these investigations represent diverse aquifers, environmental settings, and land uses across the U.S. so that findings can be compared within and among the sampled aquifers and throughout broad regions. In addition, the NAWQA design highlights the role of physical factors controlling water quality, including when the water entered (or "recharged") the ground-water system and the timing and nature of ground-water flow.

Findings highlight national trends over the last 10-15 years, including increasing concentrations of nitrate in ground water in selected aquifers underlying agricultural areas associated with oxygenated conditions and well-drained soils. National analyses also show decreasing trends, overall, in selected agricultural pesticides, such as atrazine. Detailed studies in specific regions of the Nation, however, demonstrate that trends vary geographically and by aquifer, and depend on many factors, including chemical use, aquifer type, age of the ground-water recharge, and geo-chemical conditions.

The papers can be accessed at http://jeq.scijournals.org/content/vol37/5_Supplement/ by scrolling down 17 citations in the "Special Submissions." Highlights include:

National investigations

Rosen and Lapham provide an overview of the NAWQA trends study design and data-collection methods, along with a comparison to other national ground-water quality monitoring programs by the NAWQA program.

Rosen and others analyzed quarterly sampling data for one year to assess seasonal variability in ground-water quality and the cost-effectiveness of quarterly monitoring, concluding that monitoring funds may be better spent on other trend study efforts, including age dating and modeling.

Rupert reports on national trends in nitrate, and Bexfield reports on national trends in pesticides. Findings show significant increases in nitrate concentrations over the last 10-15 years, mainly in agricultural areas. Detection frequencies of six frequently detected herbicides did not change; however, small but statistically significant decreases were observed in concentrations of two of the herbicides (atrazine and prometon) and one herbicide degradate (deethylatrazine). Patterns in nutrient and pesticide concentrations over time generally reflect overall trends in fertilizer and pesticide use. The Bexfield report also demonstrates the benefits of normalizing pesticide concentrations for laboratory spike recoveries over time to accurately assess trends in compounds that are infrequently detected at low levels.

Regional investigations

Burow and others show increases in concentrations in nitrate and pesticides in the alluvial aquifer underlying the eastern San Joaquin Valley in California since the 1950's, which correlate with increases in applications of fertilizer and pesticides in the Central Valley over the last several decades. Increasing concentrations of nitrate and selected pesticides were observed in domestic drinking-water wells, which tap the relatively shallow (less than 36 m deep) alluvial ground-water system. Concentrations of

contaminants in the deep part of the aquifer system, where public-supply wells are typically screened, may increase as the proportion of young (recently recharged) water moves vertically to these wells over time.

Frans shows increases in concentrations of deethylatrazine (a degradate of atrazine) in ground water beneath row-crop agriculture in the Columbia Basin, Washington, which correlate negatively with soil hydrologic group and drainage class.

Paschke and others demonstrate the importance of redox conditions when evaluating nitrate, and specifically, show increasing nitrate concentrations in aerobic ground water underlying agriculture in the South Platte alluvial aquifer in Colorado. Nitrogen isotope ratios suggest that synthetic fertilizer is the predominant nitrate source.

Saad shows increasing concentrations of nitrate in the glacial deposits of Wisconsin since the 1970's, and increasing concentrations of atrazine and deethylatrazine from 1970 to 1980, followed by decreases. Trends in concentrations generally correlate to historical patterns of fertilizer and atrazine use in the region. Other factors affecting observed patterns include well depth below the water table, levels of dissolved oxygen, and precipitation.

Dalton and Frick show greater detections of parent pesticide compounds than their degradates in the unconfined parts of the carbonate aquifer used for drinking water in southwest Georgia. This is, in large part, due to the rapid transport of pesticides through the shallow surficial aquifer to unconfined parts of the carbonate aquifer, allowing minimal time for breakdown.

Debrewer and others show no changes in nitrate concentrations in the Great Valley aquifer in Maryland and Virginia between 1993 and 2002, which is consistent with relatively steady fertilizer applications and a drought during the recharge period. They also found decreasing concentrations in atrazine and prometon, which reflect reported changes in land use and pesticide use. In contrast, findings show increasing nitrate concentrations in shallow aerobic ground water underlying the Coastal Plain aquifers of the Delmarva Peninsula over a similar time period (1988 to 2001), reflecting increasing fertilizer applications. Observed trends in the two settings demonstrate the importance of evaluating hydrogeology and recharge date along with changing land and chemical uses when interpreting trends in regional ground-water quality.

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