Abstracts

Tuesday, April 29

Session D2: Temporal Changes in Groundwater Quality

1:30 – 3:00 pm | Room 262

Trends in Groundwater Quality in Principal Aquifers of the United States, 1988-2012

Bruce Lindsey[1] and Michael Rupert[2]
[1]US Geological Survey, New Cumberland, Pa., [2]US Geological Survey, Pueblo, Colo.

Abstract
The U.S. Geological Survey (USGS) National Water-Quality Assessment (NAWQA) Program analyzed trends in groundwater quality throughout the nation for the sampling period of 1988-2012. Trends were determined for networks (sets of wells routinely monitored by the USGS) for a subset of constituents by statistical analysis of paired water-quality measurements collected on a near-decadal time scale. The data set for chloride, dissolved solids, and nitrate consisted of 1,511 wells in 67 networks, whereas the data set for methyl *tert*-butyl ether (MTBE) consisted of 1,013 wells in 46 networks. The 25 principal aquifers represented by these networks account for about 75 percent of withdrawals of groundwater used for drinking-water supply for the nation.

Statistically significant changes in chloride, dissolved-solids, or nitrate concentrations were found in many well networks over a decadal period. Concentrations increased significantly in 48 percent of networks for chloride, 42 percent of networks for dissolved solids, and 21 percent of networks for nitrate. Chloride, dissolved solids, and nitrate concentrations decreased significantly in 3, 3, and 10 percent of the networks, respectively. The magnitude of change in concentrations was typically small in most networks; however, the magnitude of change in networks with statistically significant increases was typically much larger than the magnitude of change in networks with statistically significant decreases. The largest increases of chloride concentrations were in urban areas in the northeastern and north central United States. The largest increases of nitrate concentrations were in networks in agricultural areas.

Statistical analysis showed 42 of the 46 networks had no statistically significant changes in MTBE concentrations. The four networks with statistically significant changes in MTBE concentrations were in the northeastern United States, where MTBE was widely used. Two networks had increasing concentrations, and two networks had decreasing concentrations. Production and use of MTBE peaked in about 2000 and has been effectively banned in many areas since about 2006. The two networks that had increasing concentrations were sampled for the second time close to the peak of MTBE production, whereas the two networks that had decreasing concentrations were sampled for the second time 10 years after the peak of MTBE production.

Pesticides in Groundwater of the United States: Decadal- Scale Changes, 1993-2011

Patricia Toccalino[1], Robert Gilliom[1], Bruce Lindsey[2] and Michael Rupert[3]
[1]US Geological Survey, Sacramento, Calif., [2]US Geological Survey, New Cumberland, Pa., [3]US Geological Survey, Pueblo, Colo.

Abstract
This study by the U.S. Geological Survey's National Water-Quality Assessment Program assessed (1) the occurrence of pesticides in groundwater and (2) decadal-scale changes in pesticide concentrations over a 20-year period. Samples were collected from 1,271 wells located in 58 nationally distributed well networks and analyzed for as many as 83 pesticide compounds. Wells were sampled once during 1993–2001 and once during 2002–2011. Well

networks consisted of shallow (mostly monitoring) wells in agricultural and urban land-use areas and deeper (mostly domestic and public supply) wells in major aquifers in mixed land-use areas. Statistical analyses for identifying decadal-scale changes in pesticide concentrations incorporated adjustments to account for fluctuations in laboratory recovery. Pesticides were frequently detected (53% of all samples), but concentrations seldom (1.8% of all samples) exceeded human-health benchmarks. The five most frequently detected pesticide compounds—atrazine, deethylatrazine, simazine, metolachlor, and prometon – each had statistically significant changes in concentrations between decades in one or more land uses. For all agricultural networks combined, concentrations of atrazine, metolachlor, and prometon decreased from the first decade to the second decade. For urban networks, deethylatrazine concentrations increased and prometon concentrations decreased. For major aquifers, concentrations of deethylatrazine and simazine increased. The magnitudes of the median decadal-scale concentration changes were small – ranging from -0.09 to 0.03 µg/L – and were 35- to 230,000-fold less than human-health benchmarks. Altogether, 36 of the 58 well networks had statistically significant changes in one or more pesticide concentrations between decades. This is the most comprehensive assessment of decadal-scale changes in pesticide concentrations in groundwater in the United States; such assessments are essential for tracking long-term responses to changes in pesticide use and land-management practices.

Chloride and Nitrate Trends in Ohio's Public Water System Wells

Michael Slattery
Ohio Environmental Protection Agency, Columbus, Oh.

Abstract

The assessment of trends in ground water quality is an important step in understanding the factors that affect water quality over time. Trends in ground water quality are driven by natural geochemical evolution, climate, land use activities, ground water extraction, groundwater-surface water interaction, and inter-aquifer leakage. Small aquifers may react quickly to changing conditions (days to weeks) under high recharge conditions, while larger, deeper aquifers with much greater storage may respond many times more slowly (decades to millennia). Here, changes over the last four decades in concentrations of two key water quality parameters, chloride and nitrate, are evaluated in the raw water of public supply wells using data from Ohio EPAs Ambient Ground Water Monitoring Network (AGWMP). This dataset comprises a rich, long-term archive of Public Water System (PWS) source water data with adequate spatial and depth coverage across the main aquifer types encountered in Ohio.

Estimates of trend are evaluated using standard methods such as the Mann- Kendall trend test and lowess regression to estimate the intra-well monotonic trends of chloride and nitrate (tendency of concentration to increase or decrease over time). While numerical estimates of slope and significance help to document variation over time, they do not imply cause and effect relationships to land use activity or contamination source, nor are they predictive in that regard. To help interpret the physical significance of the trend results, the slopes are evaluated by well depth, aquifer type, and land use category to determine if any spatial patterns emerge as significant, although such patterns are often difficult to discern in well networks. Based on the nature of PWS wells in general (deep and large), slower water quality changes over time might be expected in these wells than in networks of smaller, shallower wells.

Temporal Variations in Temperature, Water Level, and Specific Conductivity in Groundwater and Combined Storm Sewers in a Sustainable Streetscapes Best Management Practice (BMP) Area in Chicago, Illinois

William Morrow[1], James Duncker[1] and Kuldip Kumar[2]
[1]US Geological Survey, Urbana, Ill., [2]Metropolitan Water Reclamation District of Greater Chicago, Chicago, Ill.

Abstract

The City of Chicago's "Sustainable Streetscapes" program's hydrologic objective is to reduce storm runoff to combined sewers by increasing groundwater recharge capability. The infrastructure changes used to accomplish

this goal are best management practices (BMPs) designed to divert 80 percent of the average rainfall runoff to groundwater recharge. This goal is to be accomplished through the use of permeable pavement along parking areas, bioswales, and infiltration planters along a 2.1 mile stretch of mixed commercial/light industrial area. Observation wells were installed and sewers were monitored to collect background/pre-construction data for groundwater water levels, sewer water-levels and discharge, temperature, and specific conductance. Data at this network of monitored sewers and observation wells are being used to determine the effectiveness of these BMPs.

Monitoring of sewers and groundwater originally was intended to address groundwater-surface water interactions, which preliminary data indicates is not occurring to a measurable extent. Changes in water levels, specific conductivity, and temperature indicate different factors are effecting changes in groundwater and sewers. Water level and specific conductivity changes, while generally synchronous during summer are not necessarily synchronous during winter months of salt application. During winter, interdependent factors including snow volume, salt application rates, and temperature affect the chronology and magnitude of temperature, water level, and specific conductivity peaks. Small changes in observed water level (near the resolution level of the meters) in sewers also correlated with diurnal fluctuations in specific conductivity and temperature.