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The National Water-Quality Assessment Program of the United States: Strategies for Monitoring Trends and Results from the First Two Decades of Study: 1991-2011

B. Lindsey (1), P. McMahon (2), M. Rupert (3), J. Tesoriero (4), J. Starn (5), D. Anning (6), and C. Green (7)

(1) United States Geological Survey, New Cumberland, Pennsylvania, United States (blindsey@usgs.gov, 717-730-6997), (2) United States Geological Survey, Denver, Colorado, United States, (3) United States Geological Survey, Pueblo, Colorado, United States, (4) United States Geological Survey, Portland, Oregon, United States, (5) United States Geological Survey, East Hartford, Connecticut, United States, (6) United States Geological Survey, Flagstaff, Arizona, United States, (7) United States Geological Survey, Menlo Park, California, United States

The U.S. Geological Survey National Water-Quality Assessment (NAWQA) Program was implemented in 1991 to provide long-term, consistent, and comparable information on the quality of surface and groundwater resources of the United States. Findings are used to support national, regional, state, and local information needs with respect to water quality. The three main goals of the program are to 1) assess the condition of the nation's streams, rivers, groundwater, and aquatic systems; 2) assess how conditions are changing over time; and 3) determine how natural features and human activities affect these conditions, and where those effects are most pronounced. As data collection progressed into the second decade, the emphasis of the interpretation of the data has shifted from primarily understanding status, to evaluation of trends. The program has conducted national and regional evaluations of change in the quality of water in streams, rivers, groundwater, and health of aquatic systems. Evaluating trends in environmental systems requires complex analytical and statistical methods, and a periodic re-evaluation of the monitoring methods used to collect these data. Examples given herein summarize the lessons learned from the evaluation of changes in water quality during the past two decades with an emphasis on the finding with respect to groundwater.

The analysis of trends in groundwater is based on 56 well networks located in 22 principal aquifers of the United States. Analysis has focused on 3 approaches: 1) a statistical analysis of results of sampling over various time scales, 2) studies of factors affecting trends in groundwater quality, and 3) use of models to simulate groundwater trends and forecast future trends. Data collection for analysis of changes in groundwater-quality has focused on decadal resampling of wells. Understanding the trends in groundwater quality and the factors affecting those trends has been conducted using quarterly sampling, biennial sampling, and more recently continuous monitoring of selected parameters in a small number of wells. Models such as MODFLOW have been used for simulation and forecasting of future trends.

Important outcomes from the groundwater-trends studies include issues involving statistics, sampling frequency, changes in laboratory analytical methods over time, the need for groundwater age-dating information, the value of understanding geochemical conditions and contaminant degradation, the need to understand groundwater-surface water interaction, and the value of modeling in understanding trends and forecasting potential future conditions. Statistically significant increases in chloride, dissolved solids, and nitrate concentrations were found in a large number of well networks over the first decadal sampling period. Statistically significant decreases of chloride, dissolved solids, and nitrate concentrations were found in a very small number of networks.

Trends in surface-water are analyzed within 8 large major river basins within the United States with a focus on issues of regional importance. Examples of regional surface-water issues include an analysis of trends in dissolved solids in the Southeastern United States, trends in pesticides in the north-central United States, and trends in nitrate in the Mississippi River Basin. Evaluations of ecological indicators of water quality include temporal changes in stream habitat, and aquatic-invertebrate and fish assemblages.