

Session B5: Monitoring and Assessing Groundwater Quality

Room C123
1:30 – 3:00 pm

0518
B5-1

The Groundwater-Ecosystem Connection: Multi-Scale Assessment Methods for Inventory, Mapping and Analysis

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Groundwater is a vital source of water and creates critical habitat conditions for a broad range of species and ecosystems. Pressure from humans on groundwater is expected to increase as communities deplete surface water resources and increasingly turn to groundwater to meet their needs. Despite the importance of groundwater to biodiversity, there is limited information on the extent to which groundwater supports aquatic species and ecosystems in different basins, and many groundwater protection and development strategies do not consider the unique water requirements of these species and ecosystems. The Nature Conservancy is developing methods to identify and characterize groundwater-dependent ecosystems (GDEs) at multiple spatial scales. This information is important for long-term inventory and monitoring, and for developing approaches to protecting groundwater for ecosystems.

At the regional scale, we developed a GIS-based screening methodology using existing datasets to identify and locate GDEs and describe threats to their integrity. The data layers include physical parameters (*e.g.*, soils, geology, hydrology), and biological data (*e.g.*, species distribution maps, land cover). As part of the assessment, new analyses were developed to determine groundwater-dependence and characterize the impact of land management activities on GDEs. The tools and methods were used to produce maps and summary information for Oregon and Washington.

At the basin scale, we are improving the resolution of GDE mapping by testing methods for identifying GDEs remotely using imagery such as NAIP and Google Earth, and developing decision trees for characterizing groundwater dependence based on landscape characteristics. In a separate effort, we are using a combination of LiDAR and a watershed model to rapidly identify GDEs. These techniques can be used to identify GDEs that are small in size and may therefore not show up in coarse-scale data layers.

At the site scale, we are working with the Forest Service to develop tools and methods to determine the amount and timing of groundwater flow required to support GDEs. We are working in the Fremont-Winema National Forest where groundwater is withdrawn from wetlands to water cattle. This process involves finding a balance between groundwater withdrawal and groundwater left in the system to support the wetlands.

0325
B5-2

Temporal Changes in Groundwater Concentrations of Pesticides and Nitrate, and Their Relation to Regional Agrichemical Usage Patterns and Other Potential Controlling Factors

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Current understanding of temporal variability of pesticides in groundwater is limited by the sparsity of long-term, repeat monitoring records. Monitoring records from a well network in Florida's ridge citrus croplands, a region underlain by sandy soils prone to pesticide leaching, exhibited both short-term variability and long-term trends in agrichemical concentrations. The monitoring network included wells screened in a surficial aquifer in citrus orchards and in non-citrus land use where water-table depths ranged from 1.5 to 30 m below land surface. Sampling occurred during 1990 through 2010, with quarterly to semi-annual sampling during 1999-2010. This period included changes in agrichemical management practices consisting of the discontinued use of bromacil (to protect water quality), and the increased usage of several pesticides (to replace discontinued chemicals, or to combat the widespread recent onset of citrus greening disease). In citrus areas, nitrate (as N) concentrations in groundwater typically exceeded 10-15 mg/L, and the most frequently detected pesticides in recent years included norflurazon (and its degradate desmethyl norflurazon), imidacloprid, the aldicarb degradates aldicarb sulfone and sulfoxide, diuron, bromacil, and simazine. Some changes in pesticides detected during the monitored period, as well as changes in their detection frequencies, appeared to reflect relatively rapid response to changes in usage patterns. Compared to non-citrus areas, the groundwater underlying citrus

areas contained higher concentrations of nitrate and pesticides, as well as several inorganic agricultural constituents (Ca, Mg, Cl, SO₄, K). Significant short-term variability in concentrations of some pesticides, such as aldicarb and its degradates, occurred at some locations; other pesticides, such as norflurazon, often exhibited more uniform trends. In a number of wells, temporal patterns in nitrate concentrations, and in some pesticide concentrations to a lesser degree, mirrored changes in chloride concentrations in groundwater, suggesting similarity in the availability of source inputs and in transport of these chemicals. Collectively, the observed changes in pesticide concentrations in samples from the network wells indicated the persistence of some chemicals within the groundwater system; temporal concentration patterns characteristic of specific pesticides; temporal changes in the pesticide mixtures detected; long-term trends in concentrations of some pesticides, and the episodic occurrence of others.

0424
B5-3

Decadal-Scale Changes of Chloride, Dissolved Solids, and Nitrate Concentrations in Groundwater in the United States, 1988-2010

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The US Geological Survey (USGS) National Water-Quality Assessment (NAWQA) Program has summarized decadal changes in groundwater quality throughout the nation for the sampling period of 1988-2010. The data set consisted of groundwater samples collected from 1,236 wells in 56 networks (sets of wells routinely monitored by the USGS) located in NAWQA study units, which represent major river basins and major aquifers throughout the nation. Water from each well was sampled twice on a decadal time scale and was analyzed for chloride, dissolved solids, and nitrate. Although the majority of comparisons revealed no statistically significant changes in chloride, dissolved solids, and nitrate concentrations over the decadal period, statistically significant increases and decreases were found in many well networks. Chloride concentrations increased significantly in 45 percent of the networks, dissolved solids concentrations increased significantly in 44 percent of the networks, and nitrate concentrations increased significantly in 28 percent of the networks. Chloride concentrations decreased significantly in 4 percent of the networks, dissolved solids concentrations decreased significantly in 2 percent of the networks, and nitrate concentrations decreased significantly in 7 percent of the networks. 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 statistically significant median increase of chloride concentration was 110 mg/L (a network in the Upper Illinois River basin), whereas the largest decrease in chloride concentration was 1 mg/L (a network in the Upper Snake River Basin). The largest statistically significant median decadal increase of dissolved solids concentration was 390 mg/L (a network in South Florida), whereas the largest decrease in dissolved solids concentration was 6 mg/L (a network in the Apalachicola-Chattahoochee-Flint River Basin). The largest statistically significant increase of nitrate concentration was 2.0 mg/L (a network in the South Platte River basin), whereas the largest decrease in nitrate concentration was 0.6 mg/L (a network in the Sacramento River Basin).

0078
B5-4

The Quality of Water in the Nation's Principal Aquifers

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During the past 20 years, the National Water Quality Assessment Program of the US Geological Survey (USGS) has analyzed water-quality data from approximately 7,000 wells in about one-half of the Nation's principal aquifers. These data are from targeted studies of specific issues and from assessments of ambient water quality. Nearly 300 water-quality parameters were analyzed, including physical properties, major ions, trace elements, radionuclides, pesticides, VOCs, and fecal-indicator bacteria. The data are synthesized at local, regional and aquifer-wide scales. A series of USGS Circulars that summarize findings for 15 principal aquifers and for all aquifers nationally will be completed in 2013. Concentrations of chemical constituents were less than human-health benchmarks in about 80% of samples from drinking-water wells, indicating that the overall quality of water in principal aquifers of the United States is good relative to available benchmarks. About 20% of samples, however, had at least one constituent-- mostly naturally occurring elements and nitrate--greater than a benchmark. Concentrations of arsenic, manganese, uranium, radon, and nitrate exceeded human-health benchmarks in 2 to 7% of samples from drinking-water wells. Differences in hydrogeology, geochemical conditions, and human activities near wells result in differences in the water quality among principal aquifers. For example, anthropogenic contaminants, such as pesticides and VOCs, were most frequently present in agricultural or urban areas, but their frequent detections at low concentrations indicates that most aquifers are vulnerable to contamination from human activities. Human activities, such as

irrigation and pumping, also can mobilize some naturally occurring constituents and increase their concentrations by altering the natural groundwater flow system. Because groundwater can contribute a substantial part of the flow in streams, the quality of groundwater in principal aquifers also is a concern for surface waters. Monitoring and modeling indicate that concentrations of nitrate, dissolved solids, and chloride are increasing in agricultural and urban areas, and that decades may be required before the effects of management actions to reduce contaminant inputs are realized in groundwater and surface-water quality.