Session D5: Studying Groundwater/Surface Water Interactions

Room C123
8:00 – 9:30 am

0139
D5-1

Using Real-Time Geochemical Monitoring and Flood Inundation Mapping to Identify Groundwater Under the Influence of Surface Water

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Groundwater that is under the influence of surface water is particularly susceptible to contamination. Because surface water inflows to groundwater might be brief in duration, neither random or periodic sampling of wells for surface water indicators are likely to accurately characterize the groundwater quality, particularly at locations where surface water influence is sporadic. This study demonstrates that real-time monitoring of geochemical indicators of surface water influence can be used in conjunction with microscopic particulate analysis (MPA) and flood inundation mapping to evaluate potential hydraulic connections between groundwater and surface water. The US Geological Survey, in cooperation with the Texas Commission on Environmental Quality, continuously monitored pH, specific conductance, temperature, and turbidity at selected public water supply wells throughout Texas from 2007 to 2011 to measure geochemical variation in response to surface-water inflow. Geochemical data obtained were used to determine the timing of sample collection for MPA because these results were used historically as the exclusive criteria to determine if groundwater was under the influence of surface water. However, analysis of real- time geochemical monitoring data collected during this study provided sufficient evidence to declare a site under the influence of surface water without supporting evidence provided by MPA results. Flood inundation mapping, an indicator of wellhead compromise, was incorporated as supporting evidence of surface water influence; flood inundation maps were derived from modeling real-time US Geological Survey streamflow data relative to a 10- meter digital elevation model. The use of all three methods (real-time geochemical monitoring, MPA, and flood inundation mapping) provides the most defensible procedure for determining if a groundwater source is under the influence of surface water.

0178
D5-2

Stormwater: Benefit of Detriment to Groundwater?

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Stormwater is widely viewed as a source of contamination to public water ways. The City of Portland Oregon (City) currently has approximately 9,000 Underground Injection Control systems (UICs) that collect stormwater from public rights-of-way and discharge it to the subsurface. For a substantial portion of the city, UICs are the only available form of stormwater disposal.

In 2005, the City was issued the first Water Pollution Control Facility permit in the nation for their Underground Injection Control Devices (UICs) used for disposal of stormwater from public rights-of-way. The permit requires a robust monitoring program representative of the City's UICs for the purpose of demonstrating groundwater protection. To perform long-term trend analysis and evaluate permit compliance during the 10-year permit term, UICs needed to be sampled to assess the spatial and temporal range of data.

It is not technically practicable or financially feasible to collect and analyze stormwater for each of the estimated 9,000 active City-owned UICs during every storm event. Therefore, a statistically robust method, the Generalized Random Tessellation Stratified (GRTS) survey design was used to identify a representative subset of the City's UICs for monitoring. This allows the characteristics of the entire UIC population to be estimated using the measured results of a representative sampling subset

We will present stormwater data from 5 years of stormwater sampling for a wide range of constituents including total and dissolved metals, volatile organic compounds, polycyclic aromatic hydrocarbons, phthalates, pentachlorophenol, and selected herbicides and pesticides collected from over 75 unique UICs. Findings include low concentrations of pollutants protective of groundwater as a drinking water resource are detected in stormwater; consistent and narrow ranges in concentrations for each pollutant; and concentrations for the >1,000 TPD traffic category appear to be slightly higher than the <1,000 TPD traffic category with both categories protective of groundwater.

0239
D5-3

Groundwater Studies with Atmospheric Trace Gases: Current Techniques, Applications, and Future Directions

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Dissolved atmospheric gases can be important tools for understanding groundwater processes. Entrained atmospheric chlorofluorocarbons (CFCs) are useful for determining groundwater residence time. In addition to groundwater-age estimation, they can be used to determine mixing of waters from different sources. They can also be used to refine hydrological models. These, in turn, can provide information about water-supply and recharge history. Atmospheric CFC concentrations peaked during the mid-1990s, decreasing the utility of the technique for post-1990 waters and encouraging measurement of other atmospheric tracers. Sulfur hexafluoride (SF_6) can be used as a tracer, however, SF_6, requires larger sample sizes (1 L vs. 125 mL) and sometimes can be influenced by local enhancement in background SF_6 from terrigenic sources.

Looking beyond SF_6, there are other compounds with well known, monotonically increasing atmospheric concentrations that could be used as tracers for groundwater age. These include SF_5CF_3, CFC-13, and other halogenated compounds. Measuring concentrations of these compounds in groundwater requires the development of new instrumentation and methods to accommodate lower levels of solubility and instrumental sensitivity in comparison to the CFCs.

In addition to groundwater dating, trace halogenated compounds are beginning to be used as source tracers. Many human activities use specific compounds that can act as a point source in an aquifer. By mapping the occurrences of ultra-trace level compounds, the area of influence of a specific activity can be determined. The utility of measurements of halogenated compounds is improved by supporting measurements of major fixed atmospheric gases (N_2, O_2, He, Ne, Ar, Kr, and Xe). These provide information about the amount of trace gases originally entrained in the water when it entered the aquifer, as well as the rate of denitrification and other reactions in the aquifer. To enhance the quality of our groundwater-age determinations, a noble gas mass-spectrometer system has been developed that will enable determination of recharge temperature and excess air, which are then used to improve estimates of groundwater age.

0489
D5-4

Water-Table and Nutrient Fluctuations within the Floodplain of the Upper Cape Fear River, North Carolina

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River floodplains provide important ecosystem functions, including flood water and sediment storage, groundwater recharge, pollution treatment, and habitat diversity. Many studies have demonstrated that during extended periods of submergence, floodplains retain or convert nutrients through groundwater-surface water exchange. Seasonal variation and non-flooded periods are less well documented. As part of a larger investigation, a one-year study was conducted from December 2009 to November 2010 on two upper Cape Fear River reaches in Chatham and Harnett Counties, North Carolina. The objective of the study was to determine if floodplain nutrient concentrations were affected by hydrologic condition (influent or effluent), season, and duration of dry periods. Near stream groundwater-surface water exchange within the floodplain at both river reaches was examined by monitoring water level and temperature every 15-minutes in piezometers on 6- or 12-m-long transects installed perpendicular to river flow. Water-quality samples were collected twice monthly from each piezometer and the river to determine concentrations of dissolved organic carbon (DOC), NH_4-N, organic N, NO_3-N, and PO_4-P during flooding and drying periods. Groundwater levels varied in response to river stage, rainfall, and evapotranspiration. Concentrations of DOC, NH_4-N, and organic N were higher in groundwater than in the river and fluctuated with season, dryness or inundation period, sample depth, and river proximity. Concentrations of NO_3-N and PO_4-P were generally lower in groundwater than in the river and were affected by changes in hydrologic condition. By understanding effects of hydrologic condition, flooding or dryness duration, and seasonal changes on groundwater-surface water interaction within river floodplains, we can better evaluate effectiveness of riparian management efforts.