Abstracts

Tuesday, April 29

Session E7: Century Scale Trends in Water Quality

3:30 – 5:00 pm | Room 231

The Perennial Value of Water-Quality Data for Long-Term Trend Analysis

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Abstract
Recent publications have demonstrated the irreplaceable value of historical water-quality data when united with contemporary data for century-scale trend analyses. Often, historical data are discounted for trend analysis for two reasons; data availability and perceived shortcomings in quality compared to modern standards. These challenges limit our ability to detect long-term trends. To address the availability and original quality of historical data for trend analysis, a review was made to summarize through 1965 the major data sources, purposes of collection, analyses provided, and quality relative to widely accepted standardized methods used today. Historically, the two most common purposes for water-quality monitoring were to address issues related to sanitation or to address water availability and water quality. Constituents measured at part per million levels-such as inorganic ions, nitrate, suspended and dissolved solids, dissolved oxygen (DO), biochemical oxygen demand (BOD), and colonies of indicator bacteria per milliliter, when produced by “standardized methods”-were found to be of sufficient quality to meet the historical purposes for their collection. For example, the use of chemical and microbiological data to document water pollution and pollution sources for “sanitary surveys” led to improved drinking water quality and by 1920 a precipitous decline in typhoid fever. High-quality DO, BOD, indicator bacteria, and hydrologic data collected for stream surveys and models of natural stream purification were valuable in documenting the assimilative capacity of rivers for sewage discharges and by 1948 contributed to passage of the first federal water-pollution control legislation. From the earliest decade through the 20th century, data on water availability and quality collected using standardized and consistent methods provided for the “orderly” development of public and industrial supplies and irrigation. For long-term trend analysis, the challenge of data availability is considerable because most data are preserved only in paper reports or in relatively inaccessible archives and are in danger of deterioration and loss. The challenge of data quality requires an evaluation of the quality of original and contemporary data in order to interpret signal from noise in long-term trends. When properly rescued and recovered, high-quality historical water-quality data have demonstrated their perennial value for century-scale trend analyses.

Acidifying Processes in Watersheds Inferred from Century-scale Changes in Alkalinity and Major Ion Ratios

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Abstract
Weathering of silicate and carbonate rocks proceeds from interactions with acid in the soil environment. Dissolution of these minerals mobilizes soil alkalinity, primarily in the form of bicarbonate, which can be delivered to streams and influence river chemistry. Carbonic acid derived from microbial and root respiration is most commonly responsible for chemical weathering. However, inputs of ammonium-containing fertilizers or acidic deposition can induce weathering by nitric or sulfuric acid. Recent studies suggest that the concentration and flux of alkalinity in U.S. rivers is changing due to acidic inputs to the soil environment. Acidifying processes can be inferred from temporal trends in the ratios of major ions in rivers. In this study we use water quality data collected

throughout the 20th century from 22 monitoring stations in the U.S. and examine the development of acidification as agricultural fertilizers and industrial processes became prevalent. Some of the monitoring stations also show recent recovery due to greatly reduced acid precipitation and recovery from the effects of acid mine drainage.

Using a Century of Carbon and Nitrogen Records to Quantify Social-ecological Relationships in Watersheds of the Continental U.S.

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Abstract
Centennial trends in riverine carbon and nitrogen are being increasingly demonstrated through the recovery and use of early 20th Century water chemistry records coupled with socio-economic records of the same era. Two studies will be presented here that compare nitrate, bicarbonate, and land use records in the beginning and end of the 1900s to quantify complex social and environmental interactions that determine the spatial and temporal context of nitrogen and carbon export to coastal systems. Nitrate records from Dole and Stabler's national water quality monitoring efforts through the U.S. Geological Survey (1905-1912) were compared with contemporary data retrieved from the USGS National Water Information System. Bicarbonate data for the Mississippi River were collected by the Carrollton and Algiers Water Purification Plants (1902 to present), operated by the Sewage and Water Board of New Orleans, where alkalinity is measured while processing drinking water for the city. Ten of thousands of measurements over 100 years are compiled here and represent some of the most complete high-temporal-resolution, long-term data sets of nitrogen and carbon in major rivers of the Continental U.S. In both studies, Census of Agriculture records were compiled by watershed to demonstrate historical trends in changing land use patterns. Centennial changes in the nitrate and bicarbonate data reveal substantial increases that are clearly anthropogenically driven. Cropland cover is linearly related to the nitrate concentration that exits a watershed at both the beginning and end of the 20th century, and the slope of the relationship is higher at the end of the century. These findings imply that agriculture was already affecting nitrate export by the early 1900s and that intensive management practices in modern agriculture have significantly increased the nitrate export per hectare of cropland. Furthermore, an increase in bicarbonate and water fluxes from the Mississippi River Basin is caused mainly by an increase in discharge from agricultural watersheds that have not been balanced by a rise in precipitation, which is also relevant to nutrient and pesticide fluxes to coastal systems.

Laboratory Analysis Rescue: Preserving Water-Quality Records from the Early 20th Century

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Abstract
Original water-quality records from many of the earliest national hydrologic surveys of streams, lakes, and groundwaters by the U.S. Geological Survey (USGS) in the first half of the 20th century are susceptible to deterioration and possible loss. These laboratory records, if recovered, digitized, and stored electronically, greatly improve the Nation's ability to robustly document baseline conditions for trend analysis of chemical, physical, fluvial sediment, and biological conditions. When coupled with more recent readily available electronic records, these early records fill a major gap in our understanding of century-scale trends, allow for a more complete synthesis of changes in water quality and their causes and could enhance the understanding of water-resources changes related to climate, land use, and energy development.

During the period 1918-73, the former Water Resources Division of USGS operated 22 District-based water-quality laboratories throughout the US. Total annual analytical production averaged about 480 "complete analyses" per year during 1919-28, rising to about 7,800 in 1946, and about 50,000 in 1970. These laboratories produced some of the highest quality data of their time. Unfortunately, the metadata, or data that describe the primary data, have

become disconnected from the original analyses. Although many of the analyses were entered decades ago into a predecessor of the modern National Water Information System (NWIS), the legacy computerized information system lacked the ability to store metadata that identified the sample provenance and recorded how samples were collected and analyzed.

In June 2013, the USGS began a two-year "Laboratory Records Data Rescue Project" designed to locate, preserve, and digitally archive all available water-quality records from the original District laboratories and reconnect the analytical results to their metadata. Procedures for preserving this legacy of water-quality data are in development and include a thorough records search, digital scans of original paper records, entering water-quality data and associated metadata into NWIS, and linking imagery of the original records to the analyses in NWIS. This project provides an example from which other agencies may gauge the level of effort required to rescue (*i.e.*, recover, convert, and electronically archive) and re-integrate complete historical water quality records for the Nation.