POSTER ABSTRACTS

Management, Analysis, and Optimization of Groundwater Data

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The Minnesota Dye Trace Database

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Abstract

In the karst regions of Minnesota, groundwater tracing using fluorescent dyes has proven to be an effective method for understanding groundwater flow, travel times and interconnections with surface water (streams, creeks, etc). Dye tracing in Southeast (SE) Minnesota has a long history. The first documented traces were performed by S.P. Kingston, a public safety engineer at the Minnesota Department of Health, in the late 1930s. Kingston used fluorescent dye to discover the source of an outbreak of typhoid fever in Fillmore and Olmsted Counties and published his work in the Journal of the American Water Works Association. Additionally, Ron Spong conducted over 30 traces beginning in the 1970s across several counties in SE Minnesota. Most of the dye tracing in Minnesota since that time has been a collaborative effort between the University of Minnesota and the Minnesota Department of Natural Resources but stakeholders such as towns and cities, soil and water conservation districts, the local caving community and generations of students have often been involved as well.

Dye tracing involves using fluorescent dyes to determine groundwater flow direction and velocity by pouring dye into a sinkhole or sinking stream and observing where it emerges (usually at a spring or multiple springs) after flowing through the karst conduit system. Positive sampling results allow scientists to infer approximate groundwater flowpaths, calculate minimum velocities, and begin to delineate springsheds. In general, springsheds are composed of Groundwater Springsheds (GwS), Surface Water Springsheds (SWS) and Regional Groundwater Springsheds (RGS) and understanding their combined extent is important for the protection of trout stream resources and other ecosystems in Minnesota karst areas and elsewhere. Additionally, water protection and management associated with spill response, agriculture, water demands and landscape alteration require effective means for delineating springsheds. Many dye traces and the resulting springshed delineations have been accomplished in SE Minnesota, but the results and reporting have had varying degrees of accessibility.

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The goal of the current project is to produce a web accessible database containing as many groundwater dye tracing results as possible. This effort involves mining trace reports, data tables, and field notes and organizing their contents using GIS. The DNR Dye Trace Reports webpage currently has a list of links to historic and recent dye trace reports that are catalogued and made publicly available on the University of Minnesota Digital Conservancy. Geospatial data (dye input points, inferred groundwater flowpaths and springshed delineations) are re-evaluated in some cases, quality checked, and then digitized. Eventually this data will be made available via the DNR webpage in the form of an accessible ArcGIS Online map interface where users can query, select and view the data and associated reports with the click of a button. This database is intended to be used in conjunction with the Minnesota Karst Features Database (Gao, Yongli. (2002) "Karst Feature Distribution in Southeastern Minnesota: Extending GIS-Based Database for Spatial Analysis and Resource Management.". PhD Thesis, Univ. of Minn., Geology & Geophysics Dept., 210 p.) and will likely be incorporated into an enterprise system of spatially related databases built upon the Karst Feature Database and the Minnesota Spring Inventory.

The Minnesota Dye Trace Database is an important element to manage and protect groundwater in Minnesota. Revitalizing dye tracing data, making the documentation available, and creating a user friendly interface will add context to the knowledge and expansive inventory of karst in Minnesota and will hopefully allow this significant dataset to live in perpetuity for generations of scientists and policy makers to come.

Strontium in the Silurian Aquifer of Eastern Wisconsin

Abby W. Shea
Lawrence University

Abstract

Previous work on the emerging concern of high strontium (Sr) concentrations in eastern Wisconsin drinking water focuses primarily the Cambrian-Ordovician aquifer, with limited data from the Silurian aquifer. Most of this research focuses on the introduction of Sr into the dolomitized limestone (dolostone) in this location, as well as inferences as to how the Sr dissolves into the groundwater. Since limited Silurian data exists, the information about and implications from Cambrian-Ordovician data is used to explain the existence of high Sr concentrations in both aquifers. Drinking water samples were collected from the Silurian aquifer to attempt to understand the similarities and differences between the contamination in the two aquifers. The previously established hypothesis of the dissolution of a Sr-bearing sulfate mineral ($SrSO4^{-}$) leading to high levels of Sr in drinking water in eastern Wisconsin was validated and there does not appear to be any significant differences between the two aquifers. In fact, this strengthens the hypothesis by showing corresponding phenomena in two different aged aquifers. The only difference between the results from the two aquifers lies in the extreme values of many Cambrian-Ordovician samples. This likely reflects a significant hydrogeologic difference between the two aquifers, but the presence of Sr and its connection to SrSO4 is similar.

Evaluation of Channel Change in the Whitewater River

Harmony Schaupp

Abstract

The Whitewater watershed has a history of flood, sedimentation, and erosion that has re-shaped the Whitewater River. The changes in the channel were investigated by field assessment that included channel surveys, cross-sectional surveys, and pebble counts. The data was analyzed using RiverMorph software, cumulative percentage curves, and ternary diagrams. The channel data was compared to previously collected data by the Minnesota Department of Natural Resources (DNR). The comparison shows changes in the channel dimension, width-depth ratio, and entrenchment ratio. The assessment of the channel material showed an increase in sand sized sediment to the channels. Channel succession was unconfirmed.

Development of an Environmental Screening GUI

Andrea Samuelson

Abstract
The Remediation Division within MPCA completes environmental reviews to observe vapor, and drinking water risk, direct soil exposure, and ecological sensitivity. This newly created graphical user interface (GUI) automates the process, making it more efficient than in the past by finding intersections between the parameters and specific distances. Outputs include PDF, Excel, and text files for the user to analyze instead of requiring them to add in multiple layers and assess the data from within ESRI ArcMap. This saves time and makes the review process consist allowing more time to for further and more detailed analysis.

An ArcGIS based tool for Water Table Interpolation

Catherine Christenson and Tim Cowdery
U.S. Geological Survey

Abstract
Understanding groundwater availability, groundwater and surface water interactions, and directional flow of water are essential for informed water resource management. An ArcGIS model-builder tool was developed to create a water-table surface from sets of synoptic groundwater- and surface water-level measurements. Model inputs include synoptic water-level elevations in point form, surface-water features in point form to be either dynamically or statically modeled, and a digital elevation model (DEM). The tool 1) extracts surface water point elevations from a DEM and corrects for synoptic water-level measurement, 2) merges water bodies into a single surface water body system, and 3) interpolates a surface between water bodies and groundwater well locations. The natural-neighbor interpolation was selected as the best method to maintain exact groundwater elevations at wells. The tool includes features that prevent the water-table surface from exceeding the land surface and stabilize edges of the surface by interpolating to user-determined point elevations beyond the interpolation area. The water-table surfaces generated by this tool can be used to better understand the directional flow of water in a given landscape, quantify changes in short and long term groundwater storage, and verify quality of field data.