ILLINOIS GROUNDWATER ASSOCIATION

http://www.illinoisgroundwater.org/

2015 Fall Meeting

October 9, 2015

Northern Illinois University
Naperville Meeting and Conference Center
Naperville, IL 60563

Agenda and Abstracts

Illinois Groundwater Association (IGA) Fall 2015 Program Speakers and Topics
Northern Illinois University – Naperville Meeting and Conference Center
October 9, 2015

7:30 – 8:00 **Registration**

8:00 – 9:30 **Webinar, Midwest Geosciences:** *"TAKING THE MYSTERY OUT OF COMPLEX GLACIAL SEQUENCES AT ENVIRONMENTAL AND GEOTECHNICAL SITES, Part III: Managing Unanticipated Subsurface Conditions in the Field: Confident Characterizations When Budgets Matter Most"* **Tim Kemmis, PhD, PG and Dan Kelleher, PG, CIPM**

9:30 – 9:45 **Break**

9:45 – 10:00 **Welcome and Opening Remarks**

10:00 – 10:30 **Steven Esling and Joseph Krienert,** Southern Illinois University – *"Graphic Groundwater Excel; MODFLOW and MODPATH Modeling in a Spreadsheet"*

10:30 – 11:00 **Joseph Krienert and Steven Esling,** Southern Illinois University – *"Graphic Groundwater GIS; MODFLOW and MODPATH modeling in an open source Geographic Information System"*

11:00 – 11:30 **Charles Hostetler**, PDC Technical Services, Inc. – "*Coupled Vadose Zone/Saturated Zone Models for Nearfield Analysis"*

11:30 – 12:00 **Al Wehrmann**, INTERA, Inc. – *"Water Withdrawals and Water Demand Estimates for East Central Illinois: 2015 Update"*

12:00 – 1:00 **Lunch**

1:00 – 1:15 **Open Mic/Current Issues**

1:15 – 1:45 **Devin Mannix**, Illinois State Water Survey – *"Risk of Desaturation of the Sandstone Aquifers in Northeastern Illinois"*

1:45 – 2:15 **Daniel Abrams**, Illinois State Water Survey – *"Review of the 2005–2050 Water Demands for Northeastern Illinois with Updated Model Simulations"*

2:15 – 2:30 **Break**

2:30 – 3:00 **Katelyn Kane**, Northern Illinois University – *"Impacts of Water Quality due to Bison Reintroduction to the Nachusa Grasslands Preserve"*

3:00 – 3:30 **Zachary Kisfalusi,** Illinois State University – *"The Effects of Tile Drain Input on a Gaining Stream Using a Thermal Tracer"*

3:30 **Close Meeting**

Our Spring 2016 Meeting will be held in Champaign, Illinois on Wednesday, April 20 (in conjunction with GSA North Central Meeting). Additional Event Details TBA. See you there!

Graphic Groundwater Excel; MODFLOW and MODPATH Modeling in a Spreadsheet

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The United States Geological Survey (USGS) programs for modeling groundwater flow and transport (MODFLOW and MODPATH) require tables of data as input and produce tables of data as output. Creating the input files and interpreting the results for large models is a tedious process and soon after the development of the USGS software, numerous pre- and post-processors arrived on the scene. Pre- and post-processors allow the user to graphically manipulate model input and output. Some of the pre and post-processors have become highly sophisticated with features that integrate them with a geographic information system (GIS). However, they often contain features many modelers do not need, have long learning curves, and suffer from rather large price tags.

Microsoft Excel includes Visual Basic, a macro language that can access the spreadsheets and graphical elements of the program. We developed Graphic Groundwater Excel, an open-source collection of Visual Basic macros that seamlessly communicates with MODFLOW 2005 and MODPATH Version 6. Graphic Groundwater Excel implements most features of the USGS programs, allowing the user to develop complex three-dimensional models and evaluate the results, all in the Excel graphical environment. For example, the modeler can efficiently modify model input, superimpose model grids over map images, contour results, and track particles. They also can access standard Excel options to annotate the spreadsheets and change the style of graphical elements to enhance model presentation.

Graphic Groundwater GIS: MODFLOW and MODPATH Modeling with an Open-Source Geographic Information System

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QGIS is powerful open-source geographic information system that includes a Python macro language that can access the application programming interface (PyQGIS). We created Graphic Groundwater GIS, a collection of Python macros, or scripts, that seamlessly communicate with MODFLOW 2005 and MODPATH Version 6. Graphic Groundwater GIS implements most features of the USGS programs, allowing the user to develop complex three-dimensional models and evaluate the results, all in the graphical environment of QGIS. The files associated with the models have a comma-separated values (CSV) format, so that the user may modify and share the files outside of QGIS. In addition to PyQGIS, Graphic Groundwater GIS also incorporates other Python programs, including Matplotlib and NumPy to more efficiently handle graphical, spatial, and numeric data.

References

SciPy Community. *NumPy API.* Scipy Developers, 2015. Computer Language.

Dobias, T. *PyQGIS API.* Open Source Geospatial Foundation Project. V2.11.0-Master, 2015. Computer Language.

Hunter, John, D. Dale, and M. Droettboom. *Matplotlib API: a Python 2D plotting library*, 2008. Computer Language.

McDonald, Michael G., and Arlen W. Harbaugh. *MODFLOW PC/EXT a Modular Three-dimensional Finite Difference Flow Model*. Golden, CO: International Ground Water Modeling Center. V1.11.00, 2005. Computer software.

Pollock, David W. *MODPATH a Particle Tracking Postprocessing Model for MODFLOW*. Reston, VA: Water Resources Division. V6.0.01, 2006. Computer software.

Riverbank Computing. *PyQt API.* Nokia: Qt. V4.8.7, 2015. Computer Language.

QGIS Team. *QGIS Geographic Information System.* Open Source Geospatial Foundation Project. V2.10.1 Pisa, 2015. Computer software.

Coupled Vadose Zone/Saturated Zone Models for Nearfield Analysis

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With continued advances in processing efficiency, over the last ten years it has become computationally feasible to solve three-dimensional combined vadose zone/saturated zone models in the context of a probabilistic assessment framework. These models are conceptually satisfying because they have no artificial boundaries separating model components. These models are also more difficult to develop, parameterize, and evaluate. This paper discusses several approaches to boundary conditions for combined models and their strengths and weaknesses. It also considers the different approaches and tradeoffs associated with calibration. The third major topic is the model structures that are required to report groundwater concentrations that are meaningful in regulatory and permitting contexts. Application of the combined model to sites of varying complexity and comparison with other model approaches allows site managers and modelers some general rules to determine under what conditions the additional detail and complexity of combined models are worth the increased costs associated with development and parameterization.

Water Withdrawals and Water Demand Estimates for East-Central Illinois: 2015 Update

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Total water withdrawals estimated by the U.S. Geological Survey (USGS) for 2010 for the 15-county east-central Illinois regional water supply planning area, excluding withdrawals for power generation, were 328 million gallons per day (mgd), approximately 140 mgd less than in 2005. Comparison of the USGS estimated 2010 withdrawals with 2010 withdrawals modeled in 2008 (WHPA, 2008) found generally good agreement across all water use sectors. Such comparison should be viewed cautiously because there has been only one year (2010) with which to compare estimated and modeled withdrawals.

Whenever possible, plausible explanations are provided for major differences between the reported uses and the predicted water use. For two priority sectors, public water supply and irrigation, the 2010 scenario withdrawals were recalculated with updated input to the equations used to calculate the scenario withdrawals. This generally resulted in improved withdrawal estimates, suggesting the models are structurally correct and the greatest uncertainty involves the prediction of input variables, such as population and climate.

Recommendations are made to improve water withdrawal data collection and subsequent sector classification, and for modeling irrigation withdrawals in Mason and Tazewell Counties. Given the unpredictability of predicting the weather, and hence irrigation withdrawals in any given year, it seems more appropriate to assess water resource impacts from irrigation under a range of conditions based on historical experience, particularly recent drought conditions

Risk of Desaturation of the Sandstone Aquifers in Northeastern Illinois

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Water levels in the Cambrian-Ordovician sandstone aquifers have decreased throughout northern Illinois since predevelopment. Water levels are currently lowest in eastern Kendall and western Will Counties. The large withdrawals in this area are just north of the Sandwich Fault Zone, which restricts flow from the south, magnifying drawdown. One impact of the low water levels in Kendall/Will Counties is the increased risk of desaturation of the sandstone aquifers. Partial desaturation of a sandstone aquifer can create a number of water supply issues, including reduced well yield for high capacity wells and changes in aquifer chemistry. Partial desaturation of the sandstone aquifers has been observed throughout Will, Kendall, and southeastern Kane Counties. The second potential impact of low water levels is the increased pressure gradient between the sandstone aquifers and the underlying Mt. Simon Sandstone, which is saline. Any pathway that connects the Mt. Simon Sandstone with the overlying sandstone aquifers would result in upwelling of saline water, contaminating freshwater supply. Such pathways may already exist within the Sandwich Fault Zone. While no direct evidence of increased salinity has been observed at existing public supply wells, the migration of saline water may take many years or decades.

Review of the 2005–2050 Water Demands for Northeastern Illinois with Updated Model Simulations

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A major outcome of water supply planning for northeastern Illinois was the development of water demand projections out to 2050. Three projections were developed, least resource intensive (LRI), baseline (BL), and most resource intensive (MRI), all based off of 2005 data. Subsequently, the Illinois State Water Survey (ISWS) has collected water usage data for 2006-2012. This newer data was compared to the projections on a regional, county, and municipality level. A few trends were evident when comparing projected groundwater demands with actual demands. For the public water sector, reported usage of groundwater generally tracked closely to LRI. However, a few rapidly growing communities reported water usage that was consistently above the MRI projections. In contrast, reported industrial usage consistently fell below LRI over this period.

Water use projections are used by the ISWS to simulate future water availability using groundwater flow models. Model simulations indicate that water availability from the sandstone aquifers may become threatened under the three projection scenarios. Alternative scenarios were developed whereby some communities or industries switched from groundwater to an alternative source. Model simulations using these alternative scenarios indicate a reduced stress on the sandstone aquifers, although a coordinated regional effort to reduce withdrawals is necessary to reach a sustainable level.

Impacts of Water Quality due to Bison Reintroduction to the Nachusa Grasslands Preserve

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The Nachusa Grasslands Nature Preserve is considered to be a pristine nature area. The parks geological surficial deposit is the St. Peters Sandstone. The park is also home to distinct natural habitats containing natural prairies, marshes, deciduous forests, and a fen. The park in October of 2014 reintroduced bison to a 500 acre section of prairie and woodland. The goal for bringing back the bison is they will rehabilitate the prairie to a state similar to before European settlement. The study conducted started in October 2014 before the bison were present and is ongoing. There are six water sampling locations throughout the park. Currently only one site is liable to be impacted by the bison. However, with the expansion of the bison pen the other five sites are soon to possibly see an effect. The sites are tested for pH, conductivity, dissolved oxygen, REDOX potential, turbidity, ammonia, nitrite, nitrate, phosphate, alkalinity, suspended solids, total Coliform and E.coli bacteria, and pharmaceutical presence. So far there seems to be little to no water quality changes due to the bison presence.

The Effects of Tile Drain Input on a Gaining Stream: Using a Thermal End Member Mixing Model and a Statistical Analysis Approach

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Tile drains take excess water out of agricultural fields and channel it directly to the nearest surface water body decoupling the system from the natural flow paths. Although widely used, the impact of tile drains is not completely understood on the local and regional level. One way to measure the effects of these tiled waters is to look at the thermal energy of the stream compared that of the stream with the addition of tile water. Stream's thermal signature experiences large fluctuations seasonally in the temperate climate along with small diurnal changes. Groundwater temperature does not show these small scale changes and the seasonal changes are often muted and lagged in comparison to meteoric water. This project looks to quantify any hydrologic change to the stream caused by the additional flow from a tile drain. Thermal signatures of the stream, streambed, tile and groundwater at the interface were measured using data loggers in 15 minute intervals. Interactions along the streambed were collected throughout an 80 meter stretch of the streambed and within the hyporheic zone. These relationships are thus quantified and correlated using an ANOVA and paired t-tests. The tile has shown a more constant temperature over data collection from January to July of 2015 with a lack of statistically significant diurnal effects. However, seasonal cycles are evident from the tile data. The results have shown the tile flow to be an additional component to correlate the hydrologic effects of the tile on the stream. The tile flow was consistent from January to May before a larger flux throughout the early summer. Initial data suggests the tile has a minimal thermal effect on the stream during baseflow, thus this tile is not a source of concern volumetrically on the stream.