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Monday, March 29
3:30 PM – 5:00 PM
SESSION 7: Groundwater II

Use of GIS-Based Data for Modeling Complex Groundwater Systems in Michigan - Mehmet Oztan, Michigan State University, East Lansing, MI (co-authors: Huasheng Liao, Shu-Guang Li, Richard Mandle)

In this paper we illustrate the use of hierarchical patch dynamics in conjunction with a GIS-based groundwater database recently assembled by the Michigan Department of Environmental Quality (MDEQ), and show how this integration makes it computationally possible to model the entire state of Michigan quickly and hierarchically. Over the past decade, the MDEQ has been engaged in a major statewide data integration effort for improved environmental and water resources management. In this process, the MDEQ has created a statewide GIS-based groundwater database that contains virtually all data needed for typical regional-scale flow simulations. The database contains data for defining model areas (e.g., watershed delineations), aquifer elevations (e.g., digital elevation model - DEM, lithologies), aquifer properties (e.g., specific capacities, lithologies), aquifer stresses (e.g., estimated recharge, streams, lakes, wetlands, drains, and wells), surface water levels (e.g., DEM), and contamination sources (e.g., industrial sites, landfills, leaky underground storage tanks), as well as data for model calibration (e.g., static water levels, estimated baseflows, aquifer test hydrographs, and hydrographs from long-term USGS monitoring wells). To enable the systematic use of this vast new data source, we have recently created an intelligent and seamless linkage between the hierarchical patch dynamic environment and Michigan's statewide database. The result is a multiscale groundwater modeling system live-linked in a hierarchical fashion to Michigan's streams, lakes, geology, and water wells. We present in this paper recent developments in our GIS-based statewide groundwater modeling effort, especially in refining the GIS database, improving conceptual representations, and systematically evaluating the accuracy and effectiveness of GIS-based hierarchical modeling.

Application of a GIS-enabled Modeling System to Protect Michigan's Groundwater and Groundwater Dependent Ecosystems - Hassan Abbas, Michigan State University, Lansing, MI (co-authors: Huasheng Liao, Shu-Guang Li, Richard Mandel)

This paper demonstrates the use of Michigan's statewide GIS databases in a fully integrated interactive groundwater (IGW) modeling system. IGW allows zooming in any part of the state and modeling the local groundwater systems on the fly. The scale of the modeling domain can be anywhere from a large river watershed to a property scale site. The GIS-enabled IGW environment is illustrated by three application examples. The first one deals with protecting the public drinking water-supply wells by delineating wellhead protection areas using statewide data sets. Traditionally, such delineation relies on site-specific data collection and costs an average of $36,000 in Michigan. Using the statewide GIS data in the IGW environment, such delineation can be done with comparable accuracy in a matter of hours. The second example illustrates the use of statewide GIS data to model the impact of groundwater extraction on surface water ecosystems. It also illustrates how this approach can help implement Michigan's new water protection bill to assess and/or mitigate the adverse impacts of groundwater pumping on surface water sources. The final example presented here demonstrates the use of GIS data for modeling ecologically unique, geologically rare and biologically diverse fens in southern Michigan. The fens are home to a host of unique and rare animal and plant life - as well as provide habitat to the endangered Mitchell's satyr butterfly. GIS data is used in IGW for understanding the dynamics of these complicated groundwater dependent ecosystems. The improved understanding of such systems is critical to protect endangered species and manage their habitat.

Off-Stream Storage Analysis with HydroGeoSphere (HGS) - Lisa Rainger and Lorri Peltz-Lewis, U.S. Bureau of Reclamation, Sacramento, CA

Water demand continues to grow among competing interests in the western United States. Conflicts over water inevitably arise unless more water could be stored. HydroGeoSphere (HGS) is being used in the Bureau of Reclamation to evaluate offstream storage options to address the water demands and provide potential solutions. HGS is a three-dimensional numerical model describing fully-integrated subsurface and surface flow and solute transport by the Groundwater Simulation Group (University of Laval and University of Waterloo) and Hydrogeologic, Inc. The subsurface module is based on the FRAC3DVS subsurface flow and transport code by the University of Waterloo and University of Laval and the Surface Flow Package of MODHMS which provides the surface flow. Results to date have shown the offstream storage option considered is technically viable, but further detailed studies will be needed. This presentation will provide insights on geographic information system data integration into HGS, HGS modeling methods, interpretation, and future work efforts.

Application of the Geographic Information System on a Regional Transient Groundwater Flow Model of East Central Florida - Oscar Vera, Parsons Brinckerhoff, Orlando, FL

Parsons Brinckerhoff (PB) assisted the City of St. Cloud, the Tohopekaliga Water Authority, Orange County, Polk County and the Reedy Creek Improvement District (STOPR Group) with the development of a regional-scale transient groundwater flow model (STOPR model) of East Central Florida (ECF). The STOPR model was used as a tool to simulate groundwater level changes in the surficial aquifer system (SAS) and the Floridan aquifer system (FAS) resulting from wellfield operations, and to evaluate alternative water supply (AWS) scenarios in the study area. The STOPR model was a numeric transient groundwater model created using the Modular Three-Dimensional Finite-Difference Groundwater Flow Model (MODFLOW) code developed by the United States Geological Survey (USGS). The STOPR model was derived from an existing ECF regional steady-state groundwater flow model created by the St. Johns River Water Management District (SJRWMD). The Geographic Information System (GIS) was an integral part of the development of the STOPR model. The GIS was used to visualize the location of STOPR Group's wellfields and water service areas, and to map these locations to the model grid. Also, the GIS was used to develop wells and recharge databases comprised of several quantitative and qualitative attributes which assisted with the creation of input files for the model. Discharge and recharge components were adjusted spatially through the entire model domain using the GIS to assess the extent of any potential adverse impacts in the study area. Simulated transient drawdowns computed by the STOPR model were imported into the GIS and mapped on top of water bodies' coverages (e.g., lakes, wetlands, rivers, springs, etc.). Contour maps of drawdowns were prepared using the GIS to identify potential areas of concern in the SAS and the FAS. The GIS also assisted with the development of a groundwater monitoring network in ECF based on results from the STOPR model. This paper highlights the benefits of using the GIS as a useful tool to manipulate, store, query, and retrieve data relevant to the analysis of transient groundwater flow model at a regional-scale.