American Water Resources Association
2009 SPRING SPECIALTY CONFERENCE
Managing Water Resources Development in a Changing Climate
May 4-6, 2009
Anchorage, AK

Tuesday, May 5
1:30 PM – 3:00 PM
Session 20: Impacts to Ground Water

1. Climate Change and Potential Impacts on Groundwater Levels Along the Rio Grande - Kelly Isaacson, University of New Mexico, Albuquerque, NM (co-author: Julie Coonrod)

A GIS based tool developed to predict depth to groundwater as a function of river discharge is used to study climate change altered groundwater levels for the Rio Grande riparian corridor in Albuquerque, NM. Previous work in the Rio Grande basin indicates decreased stream flow for an average 8 months a year over a range of climate change scenarios. The predicted percent reductions in stream flow are applied to the current stream record to predict groundwater level changes within the riparian corridor. The change in depth to groundwater is quantified by subtracting water surfaces from a terrain model; changes to the water surface gradient from the river are also documented. Increased depth to groundwater can negatively affect native species of cottonwoods with minimal impacts to non-native species such as salt cedar and Russian olive. Areas vulnerable to significant groundwater decline within the riparian corridor are identified and potential changes to dominant riparian vegetation are discussed. This process facilitates a “big picture” evaluation of groundwater – surface water interaction that can be used to study restoration projects and evaluate water resource management decisions. The comprehensive water surfaces (groundwater + river surface + riverside drain) created in this study are paired with a terrain model in GIS to create visualization tools. These pictures show the relationship between river stage and groundwater elevation and have multiple uses: improving understanding of the importance of surface water – groundwater interaction, demonstrating the groundwater impacts of various water resource management decisions (e.g. dam releases) to facilitate adaptive management, and improving bare soil evaporation estimates for water budgeting. Displaying these water surfaces through time with the predicted impacts to riparian vegetation creates a powerful tool for understanding and communicating how climate change threatens to impact shallow groundwater resources in semi-arid regions.

2. Building Coupled Ground-Water/Surface-Water Models to Simulate Climate Change – Randall J. Hunt, U.S. Geological Survey, Middleton, WI (co-authors: John Doherty, John F. Walker, Steven M. Westenbroek, Lauren E. Hay,)

Numerical models are used to investigate potential hydrological effects of climate change. Parameter estimation (PE) has been widely recognized a necessary component for effective modeling, but has had differing degrees of use in hydrologic models. PE of ground-water models has been a focus of research for a relatively long period of time, helped in part by the overlying unsaturated zone which can act as a low-pass filter that dampens surface transience. Surface-water model calibrations are thought to be a more difficult PE problem due to: 1) larger number of parameters, with associated insensitivity and correlation; and 2) large, transient datasets with redundant or correlated information which decreases the signal-to-noise ratio of the data. Coupled ground-water and surface water models are ideally suited for climate change simulations but add some potential modeling-related concerns. First, the run time of a coupled model is appreciable longer than either the uncoupled ground-water or surface water model, which can limit the exploration of optimal parameters and prediction uncertainty. Secondly, artifacts from calibration of parameters that conceptually overlap in the uncoupled models can color the results of the coupled model. Finally, the hydrologic memory of the ground-water system can require longer calibration periods than needed for uncoupled models. Fortunately, new PE tools have been developed that facilitate the construction of coupled models for climate change, which are applied here to the USGS Trout Lake WEBB site in Wisconsin. Parameter "identifiability" is a quick method to assess what information is, and is not, present in existing or proposed datasets. "Superobservations" provide an automatic mechanism to extract salient information from measured data, including time-series data. Finally, general linear prediction approaches facilitate estimates of prediction uncertainty, both prior to and after calibration. PE tools such as these three help ensure that the maximum amount of information is extracted from the field data. Moreover, they not only help identify what is not known, they allow evaluation of the efficiency of potential future data collection conducted to address the deficiency. Such capabilities will be important as coupled ground-water/surface-water models are used to tackle societally relevant questions such as climate change.

3. The Potential Impact of Climate Change on Groundwater Recharge: with particular emphasis on the impact on Florida - **Frederick Bloetscher**, Florida Atlantic Univeristy, Boca Raton, FL

The hydrologic cycle continuously replenishes water through precipitation, runoff, soil percolation, evaporation and condensation. Precipitation patterns vary naturally from year to year, and over the decades and centuries. A recent report on Climate Change reported that “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level. Much of the current focus on climate change is directed at changes in precipitation and loss of water storage in snow pack. Polar bears, polar ice and other warming issues are secondary issues that are noted in the popular press. But what is the effect on groundwater recharge in such scenarios? It is well understood that precipitation patterns vary naturally from year to year, and over decades. As a result, runoff varies in some relationship to rainfall quantity and intensity, depending on surface conditions. The change in land use from forests to agriculture or urban uses can have significant impacts on runoff characteristics. Agricultural removal of trees and other vegetation accelerates soil loss and increases runoff on the surface. Urban land use increases imperviousness as buildings, parking lots, roads and other improvement replace forest or grassland cover. In both cases, the result is an increase in the peaks for runoff and a shortening of the time of runoff, and a decrease in the amount of time available for infiltration, which is of particular interest in a state where 93 percent of water use comes from groundwater, and the current water infrastructure is oriented more toward the elimination of flooding through tidal discharges that water supply. 66 BGD go to tied from canals. Comparison of historical land use and rainfall mapping indicates that Florida is hotter, has 12% less rainfall, and extremes in temperatures have increased because wetlands can no longer attenuate temperature because of the loss of wetlands. Extremes in rainfall and uncertainty over effects in the southeast complicate the current picture, but where there is no topography to store water, the need to preserve groundwater sources is paramount.