Report as of FY2006 for 2005CA137G: "Model Development for Conjunctive Use Planning and Aquifer Protection in Semi-arid Regions"

Publications

- Articles in Refereed Scientific Journals:
  - Tu, M-Y, F. T-C. Tsai and W. W-G. Yeh, 2005, "Optimization of Water Distribution and Water Quality by Hybrid Genetic Algorithm," Journal of Water Resources Planning and Management, ASCE, 131 (6): 431-440.
  - McPhee, J. and W. W-G. Yeh, 2007, Groundwater Management using Model Reduction via Empirical Orthogonal Functions, to appear in Journal of Water Resources Planning and Management.

Report Follows

Project summary:

In the semi-arid region of the Southwestern U.S., population and economic growth are making increasing demands on the water supply. For example, almost 40% of the water supply in Southern California is from groundwater. To protect groundwater from over-pumping and contamination, there is a critical need to develop surface water and groundwater management tools that can be used to predict water level variations and solute concentrations in the aquifer under different management scenarios. By controlling the total water resources of a region, conjunctive use planning can increase the efficiency, reliability, and cost-effectiveness of water use, particularly in river basins with spatial and temporal imbalances in water demand and natural supplies.

Typical of Southern California, the Warren Basin, located in San Bernardino County, has seen sustained population growth and increased water demands since the 1950's. Since groundwater is the only local source of water supply available, water levels experienced a steady decline of up to 300 ft in some areas between 1956 and 1994. In 1995, the Hi-Desert Water District (HDWD) implemented a recharge program using imported State Water Project (SWP) water and two recharge pond sites. As a consequence, water levels rose up to 200 ft in some areas. However, nitrate concentrations increased drastically, from a baseline level of approximately $10\,mg/l$ to values in excess of $100\,mg/l$. A study conducted by the USGS showed that the increase in nitrate concentrations is due to entrainment of seepage from septic tanks and irrigation, previously stored in the unsaturated zone, by the artificially elevated water table.

The goal of this research is to develop a decision support system (DSS) for sustainable groundwater management, including conjunctive use planning of surface water and groundwater, and aquifer protection. The proposed DSS will encompass a management framework that links simulation to optimization. We will use the geological information and historical data collected by the USGS for the Warren Basin for the development of the simulation model. The developed simulation model will be linked to an optimization model for conjunctive use planning and aquifer protection. Additionally, we will develop algorithms for parameter structure identification, model reliability analysis, data sufficiency evaluation and monitoring network design.
Currently, we have completed the development and calibration of a flow and transport simulation model for the Warren Basin. We are in the process of linking the developed simulation model to an optimization model for conjunctive use planning.