

ABSTRACT OF THE DISSERTATION

A SPATIAL DECISION SUPPORT SYSTEM FOR BASIN SCALE ASSESSMENT OF IMPROVED MANAGEMENT OF WATER QUANTITY AND QUALITY IN STREAM- AQUIFER SYSTEMS

Challenges in river basin management have intensified over the years, with expanding competition among water demands and emerging environmental concerns, increasing the complexity of the decision making framework. A State-of-the-art spatial-decision support system (*River GeoDSS*) is developed herein to provide assistance in evaluating management alternatives towards optimal utilization of water resources, providing a comprehensive treatment of water quantity and quality objectives based on conjunctive surface and groundwater modeling within the complex administrative and legal framework of river basin management.

The *River GeoDSS* provides sophisticated tools that allow accurate system simulations and evaluation of strategies while minimizing the technological burden on the user. A unique characteristic of the *River GeoDSS* is the integration of models, tools, user interfaces and modules, all seamlessly incorporated in a geographic information system (GIS) environment that encourages the user to focus on interpreting and understanding system behavior to better design remediation strategies and solutions. The *River GeoDSS* incorporates Geo-MODSIM, a fully functional implementation of MODSIM within the ArcMap interface (ESRI, Inc.), and Geo-MODFLOW, a new MODFLOW-MT3DMS results analysis tool in the ArcMap interface. The modeling system is complemented with a new artificial neural networks (ANN) module for natural and irrigation return flow quantity and quality evaluation and salt transport through reservoirs, as well as with a new water

quality module (WQM) for conservative salt transport modeling of conjunctive use of surface water and groundwater resources in the river basin network. In this research, innovative methodologies are developed for applying ANNs in efficiently coupling surface and groundwater models for basin-scale modeling of stream-aquifer interactions.

The core *River GeoDSS* is customized to provide comprehensive analysis of alternative solutions to achieving agricultural, environmental, and water savings goals in the Lower Arkansas River Basin in Colorado while assuring physical, legal and administrative compliance. The *River GeoDSS* applied to the Arkansas River Valley allowed comparing benefits and improvements of management strategies, illustrated their potential to reduce waterlogging and soil salinity, salt load to the river, and non-beneficial evapotranspiration in a strategic planning environment.

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