Quantifying human behavior uncertainties in a coupled agent-based model for water resources management

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ABSTRACT

Modeling human behaviors and decisions in water resources management is a challenging issue due to its complexity and uncertain characteristics that affected by both internal (such as stakeholder's beliefs on any external information) and external factors (such as future policies and weather/climate forecast). Stakeholders' decision regarding how much water they need is usually not entirely rational in the real-world cases, so it is not quite suitable to model their decisions with a centralized (top-down) approach that assume everyone in a watershed follow the same order or pursue the same objective. Agent-based modeling (ABM) uses a decentralized approach (bottom-up) that allow each stakeholder to make his/her own decision based on his/her own objective and the belief of information acquired. In this study, we develop an ABM which incorporates the psychological human decision process by the theory of risk perception. The theory of risk perception quantifies human behaviors and decisions uncertainties using two sequential methodologies: the Bayesian Inference and the Cost-Loss Problem. The developed ABM is coupled with a regulation-based water system model: Riverware (RW) to evaluate different human decision uncertainties in water resources management. The San Juan River Basin in New Mexico (Figure 1) is chosen as a case study area, while we define 19 major irrigation districts as water use agents and their primary decision is to decide the irrigated area on an annual basis. This decision will be affected by three external factors: 1) upstream precipitation forecast (potential amount of water availability), 2) violation of the downstream minimum flow (required to support ecosystems), and 3) enforcement of a shortage sharing plan (a policy that is currently undertaken in the region for drought years). Three beliefs (as internal factors) that

correspond to these three external factors will also be considered in the modeling framework. The objective of this study is to use the two-way coupling between ABM and RW to mimic how stakeholders' uncertain decisions that have been made through the theory of risk perception will affect local and basin-wide water uses.

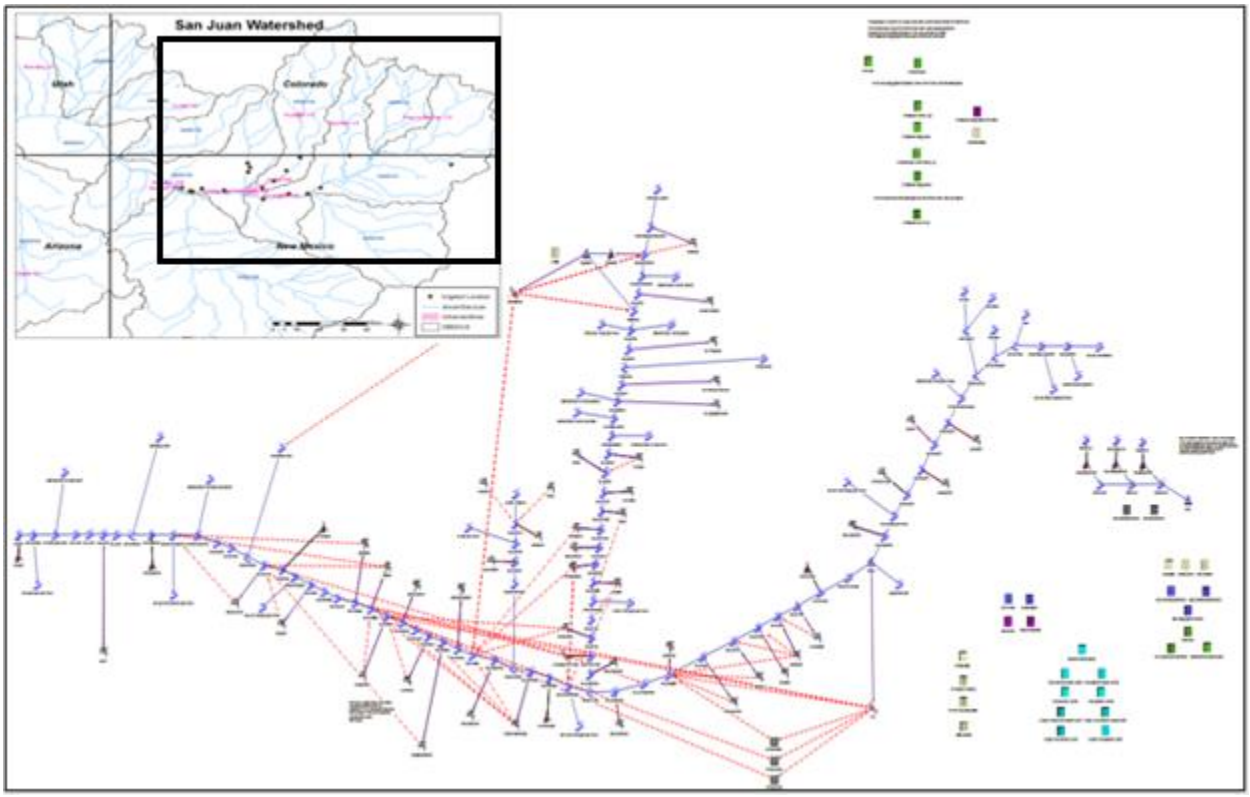

Figure 1. A map of the study area and a water system model of the San Juan River Basin in Riverware