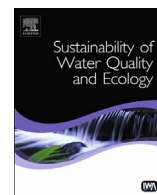




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# Environmental flow requirements in a water availability modeling system

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## ABSTRACT

The Texas Water Availability Modeling (WAM) System consists of the generalized Water Rights Analysis Package (WRAP), which is applicable for river systems located anywhere, and WRAP input datasets for the river basins of Texas. The WRAP/WAM system has been applied for over a decade in planning studies and administration of a water rights allocation system. Environmental flow standards for selected river systems in Texas have recently been established through a legislatively mandated process based on flow regimes with subsistence, base, pulse, and overbank flow components that describe the magnitude, frequency, duration, and timing of flows required to maintain sound ecosystems. WRAP and WAM capabilities for integrating environmental flow requirements in water allocation and associated water availability modeling have been greatly expanded as necessary to implement the new environmental flow standards. The modeling system and lessons learned in its implementation in Texas are relevant elsewhere.

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## 1. Introduction

The Water Rights Analysis Package (WRAP) simulates management of water resources of river/reservoir systems subject to priority-based water allocation (Wurbs, 2015b). The modeling system is used to assess hydrologic and institutional water availability and reliability for supplying for municipal, industrial, agricultural, and other off-stream uses, hydroelectric energy generation, and instream flow needs. Reservoir operations for flood control are also simulated. WRAP also includes optional salinity simulation capabilities. Basin-wide impacts of water resources development projects, water use, and management practices are evaluated in terms of supply reliability and stream flow and reservoir storage frequency metrics. Wurbs (2011) reviews the literature of modeling river/reservoir management and compares WRAP with other similar generalized modeling systems including MODSIM (Labadie and Larson, 2007), Riverware (Zagona et al., 2001), HEC-ResSim (Hydrologic Engineering Center, 2007), and CalSim (Draper et al., 2004).

WRAP has been applied by researchers and practitioners in several countries and has been applied extensively in Texas within a Water Availability Modeling (WAM) system maintained by the Texas Commission on Environmental Quality (TCEQ). The public domain software is generalized for application anywhere, with model users creating input datasets for river systems of concern. In Texas, WRAP is typically applied by modifying input datasets from the WAM system to reflect proposed changes in water use or management strategies.

The WRAP datasets in the TCEQ WAM system for the 15 major river basins and eight coastal basins of Texas (Fig. 1) simulate a water rights permit system with over 6000 permits, five interstate compacts, two international treaties, and various

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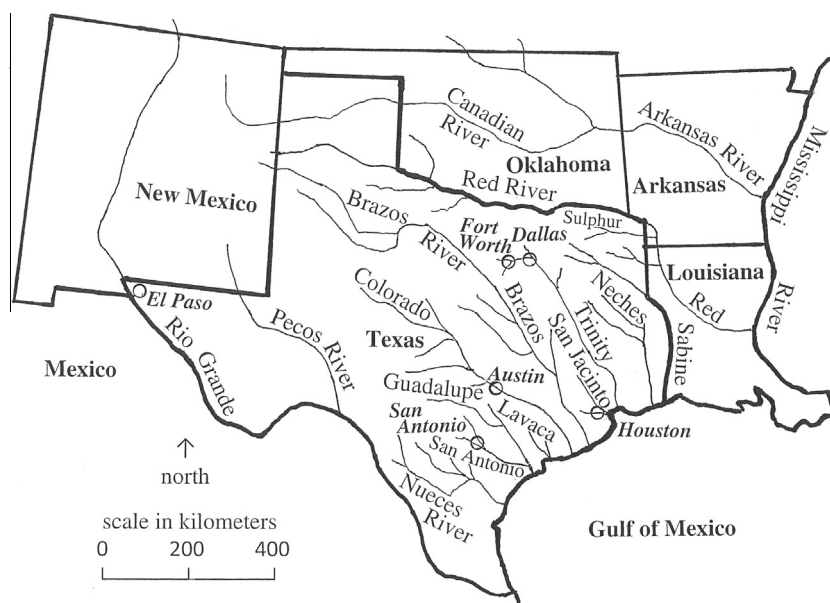


Fig. 1. Map showing largest cities and major rivers of Texas.

other agreements between water management entities, along with constructed facilities that include 3400 reservoirs and a variety of conveyance structures, hydroelectric power plants, and other infrastructure (Wurbs, 2005, 2015a). The WAM system supports planning, water right administration, and other water management activities. Modeling capabilities are being expanded to better support integration of environmental flow needs into comprehensive water allocation and management.

Protecting environmental flows in the river systems of Texas has been of concern for many years. Efforts in establishing expanded environmental flow standards have greatly intensified pursuant to recent legislation. WRAP/WAM capabilities have been expanded to incorporate flow standards in planning and water rights permitting. Interactions between environmental flow requirements and municipal, industrial, agricultural, and other water users are modeled. This paper briefly outlines the recently created institutional process for establishing environmental flow standards and then focuses on the expanded water allocation modeling capabilities developed to integrate the flow standards in comprehensive water management.

## 2. Institutional framework for water planning and allocation in Texas

The Texas Legislature in 1997 enacted major water management legislation that created a regional and statewide planning process and authorized development of the WAM system to support both the planning process and administration of the water rights permit system. Planning is based on dividing the state into 16 regions with water plans for each region being prepared and merged into a statewide plan in a five-year planning cycle. The Texas Water Development Board (TWDB) is the lead agency, and committees representing local interests have been established to guide plans for each of the 16 regions. The regional and statewide plans were initially completed in 2002 and updated in 2007 and 2012. Work is underway on the 2017 plans. The WAM system is applied by the TWDB and regional planning groups in these studies (Wurbs, 2015a).

The TCEQ, as lead agency, TWDB, Texas Parks and Wildlife Department (TPWD), university researchers, and consulting firms implemented the WAM system during 1997–2003 (Wurbs, 2005). The generalized WRAP modeling system developed at Texas A&M University (TAMU) was adopted and greatly expanded. Input datasets were developed for each of the river basins. WRAP has continued to be expanded at TAMU. The TCEQ continues to update the datasets as new and revised water right permits are approved and new modeling features are added. The TCEQ requires that water right permit applicants or their consultants apply the WAM system to determine the reliabilities at which the water needs addressed in permit applications can be supplied and to assess the impacts on all other water rights in the river system. TCEQ staff applies the modeling system to evaluate the permit applications.

Water rights in Texas are granted by a state license, or permit, which authorizes the holder to divert a specified amount of water annually at a specific location, for a specific purpose, and to store water in reservoirs of specified capacity. Any person or organization may apply for a new water right permit or a modification of an existing permit at any time. TCEQ approval of a permit application requires a beneficial use of the water, unappropriated water available with adequate reliability, demonstration that existing water rights will not be impaired, and a water conservation plan. The proposed actions must be consistent with regional water plans. Priorities are based on dates specified in the permits that were established based on historical water use and dates that permit applications are administratively approved.

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