# Real-Time Distributed Runoff Estimation

# Using NEXRAD Precipitation Data

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# Research Proposal

# Submitted to the Texas Water Resources Institute

February 6, 2002

**1. Title:** Real-Time Distributed Runoff Estimation Using NEXRAD Precipitation Data

**2. Focus Categories (to be completed by Institution personnel):**

**3. Keywords:** distributed hydrologic model, real-time runoff, NEXRAD

**4. Duration:** 1-year

**5. Federal Funds Requested:** $4,764.20

**6. Non-Federal (matching) Funds Pledged:** $26,329.73

**7. Principal Investigator (graduate student):** Jennifer Hadley

**Co-Principal Investigator (faculty advisor):** Raghavan Srinivasan

**8. Congressional District:** 8th

**9. Problem Statement:**

Texas has experienced some of the largest rainfall and flood events in the United States. Heavy flooding during the rainy season causes extensive property damage and loss of human life (Smith et al., 2000). Real-time data processing and flood forecasting can play a vital role in minimizing such damages. However, in order to forecast these conditions it is necessary to first obtain reliable rainfall data. Rain gage networks are generally sparse and insufficient to capture the spatial variability across a single watershed, let alone the entire state. These networks are also limited in providing the real-time data necessary for flood studies. The use of data from weather radar systems in conjunction with a distributed model would help alleviate these problems.

**10. Nature, Scope, and Objectives of the Research:**

The objective of this study is to develop near real-time runoff estimation for Texas using precipitation data from the Next Generation Weather Radar (NEXRAD) network. This will provide information useful for flood mitigation, reservoir operation, and watershed and water resource management practices.

NEXRAD, established by the National Weather Service (NWS), is a system that provides precipitation estimates using remote sensing techniques. By transmitting and receiving electromagnetic signals, this system can provide estimates with better spatial and temporal resolution than rain gage networks. Furthermore, it can supply data over substantial areas in real-time.

Once reliable rainfall data has been collected, hydrologic models can be used to simulate the responses of systems to recorded rainfall events. Studies on the use of high-resolution rainfall data from radars, such as NEXRAD, with detailed distributed parameter hydrologic models are very limited. Most of the studies used simple conceptual or lumped parameter hydrologic models. However, lumped hydrologic models consider only a spatially averaged hydrologic system; distributed models allow for variability of model parameters and inputs in space across a system, which is a more accurate representation of natural hydrologic processes. Therefore, the use of distributed models can be expected to improve short-term and long-term simulation results.

The model to be used with the NEXRAD data should be able to use the spatial and temporal resolution of that data and should be detailed enough to simulate all components and processes in a watershed with reasonable accuracy (Arnold et al., 1998). Considering these points, the Soil and Water Assessment Tool (SWAT) model's hydrologic component will be used for runoff estimations in this study.

**11. Methodology:**

First, the state will be divided into a 4km _ 4km grid, corresponding with the NEXRAD grid, and the dominant land use (USGS Multi-Resolution Land Characteristics, MRLC dataset) and soil type (USDA-NRCS State Soil Geographic Database, STATSGO) for each grid cell will be used for this project.

Daily runoff calculations will be made using the Soil Conservation Service (SCS) curve number method, which provides a means of estimating runoff based on various land uses, soil types, and precipitation. This calculation is based on the retention parameter, $S$, initial abstractions $I_a$ (surface storage, interception, and infiltration prior to runoff), and the rainfall depth for the day, $R_{day}$, (all in mm $H_20$).

The retention parameter is variable due to changes in soil type, land use, and soil moisture, and is defined as:

$$S = 25.4( 1000/ CN-10)$$

The daily curve number, *CN*, will be estimated based on one of three antecedent soil moisture conditions, I- dry (wilting point), II- average, and III- wet (field capacity) (Neitsch et al., 2001).

For the runoff calculation, initial abstractions are approximated as 0.2*S*, and rainfall depth will be generated from NEXRAD measurements. The equation becomes:

$$Q_{surf} = (R_{day} — 0.2S)^2 / (R_{day} + 0.8S)$$

Runoff will occur only when $R_{day} > I_a$ (Neitsch et al., 2001).

Initially, a five-day cumulative average runoff will be calculated for each grid cell to provide a more accurate existing condition. Once these existing conditions are established, the process will be run on a daily basis with the updated NEXRAD inputs.

**12. Expected Results:**

The expected outcome of this research is a daily surface runoff map of Texas at a resolution of 4km _ 4km. This study will stimulate further research in development of real-time water balance processes for forecasting flood events, and will also aid in water management and resource planning. Once calibration and validation procedures are complete, these runoff maps would be made available on the World Wide Web (WWW) for use by public and private water resource managers and various government agencies.

## References


Arnold, J. G., R. Srinivasan, R. S. Muttiah, and J. R. Williams, 1998. Large Area Hydrologic Modeling and Assessment. Part 1: Model Development. Journal of American Water Resources Association. 34(1):73-89.

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, J.R. Williams, 2001. Soil and Water Assessment Tool Theoretical Documentation. Blackland Research Center, Texas Agricultural Experiment Station. Temple, Texas. 93-115.

Smith, J. A., M. L. Baeck, J. E. Morrison, and P. Sturdevant-Rees, 2000. Catastrophic Rainfall and Flooding in Texas. Journal of Hydrometeorology. American Meteorological Society. 1:5-25.