High-Resolution Statewide Modeling of Groundwater Recharge in New Mexico

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Main Objectives

- Identify areas of probable recharge using existing spatial data and daily soil water balance modeling.
- Validate recharge estimates with field measurements.

Motivation

The rate and distribution of groundwater recharge to New Mexico's aquifers is the least understood aspect of the state's water budget. Despite a history of precise and distributed measurements quantifying surface water flow, water table elevations, and precipitation amounts, as well as current models that describe evapotranspiration (ET), a statewide assessment of recharge has not been completed. This project aims to model recharge using a daily soil water balance (SWB) approach and assess results using previous estimates and mountain recharge estimates made using the chloride mass balance technique.

Soil Water Balance (SWB)

The SWB model calculates a daily soil water depletion (D) based on soil inputs (precipitation, P), and outputs (runoff, RO; recharge, R; evapotranspiration, ET) to account for daily changes in water stored in the soil:

$$D = RO + R + ET - P$$

The SWB uses the dual crop coefficient method (Allen et al. 1998) to calculate ET on a daily time step. This ET calculation is constrained by available water and incoming solar radiation and is found by partitioning the *reference* ET into three soil layers: the skin layer at the very surface of the soil (1-2 mm), the stage one evaporation layer (2- 10 mm), and the transpirative layer, or root zone (to 2000 mm). Reference ET is simply the amount of ET experienced by a well watered crop of alfalfa, which depends on the day's conditions.

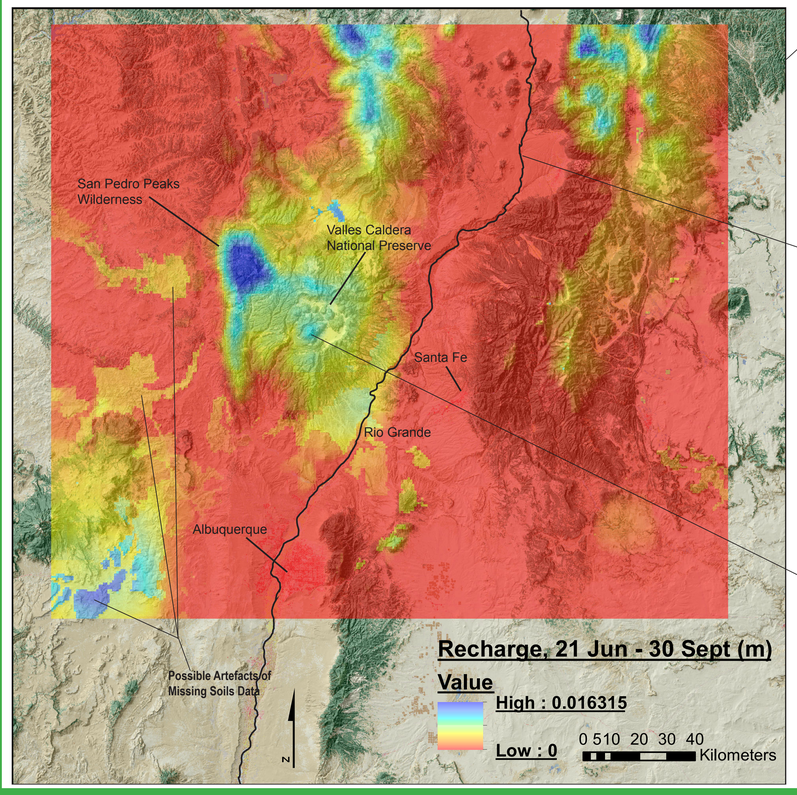
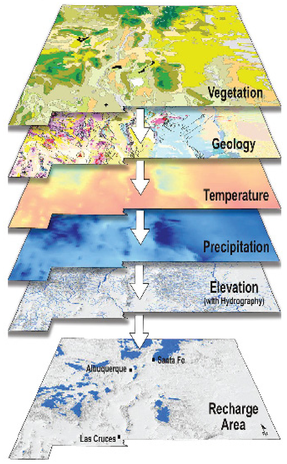


Figure 1. Preliminary recharge modeling of northern New Mexico (monsoon 2000) shows high recharge rates along the mountain ranges, an expected result of the orographic effect on precipitation, a salient feature of New Mexico climate.

Figure 2. GIS conceptual model.



Current Focus

Current work focuses on soil and reference ET data. The model now uses STATSGO, the National Resource Conservation Department's soil survey. This data is of a small scale (1:250,000) and has significant gaps. Implementation of a more advanced soil survey and eventually a soil water capacity map based on remotely sensed data is planned. A higher resolution dataset which represents variations in potential ET over New Mexico's varied terrain is also planned.

Reference ET (ETo)

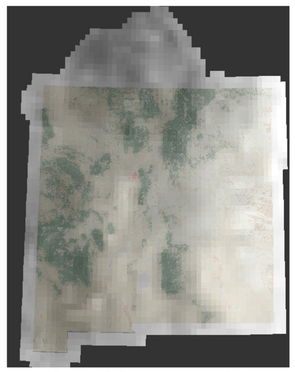


Figure 4. Reference evapotranspiration quantities are interpolated by NOAA using ground stations. Note the low resolution (12 km) of this critical product.

PRISM

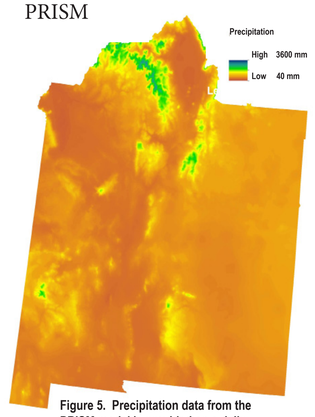


Figure 5. Precipitation data from the PRISM model is provided on a daily basis. Resolution is 800m.

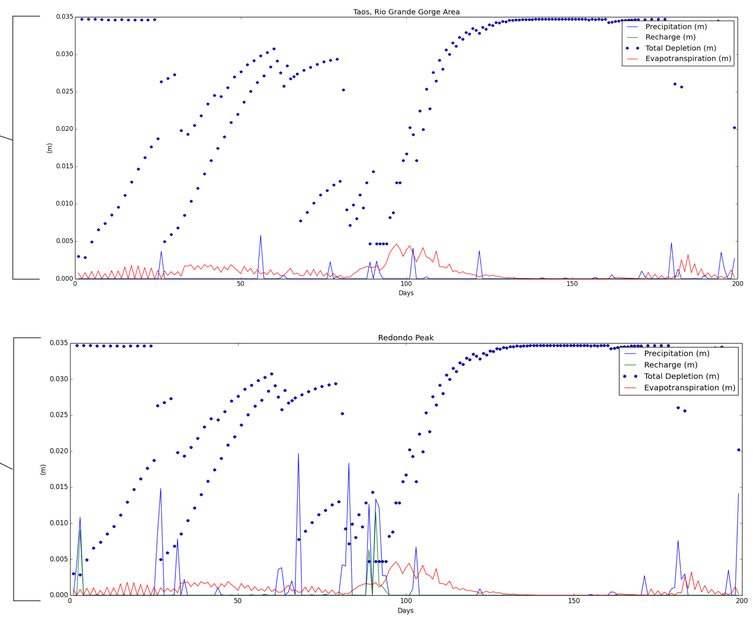


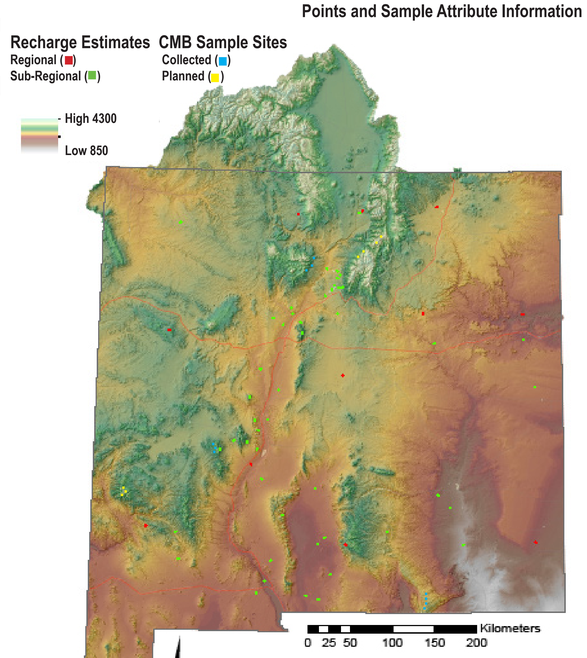
Figure 6. Daily time series data from model simulations shows the relationship between soil water depletion, precipitation, recharge, and actual evapotranspriation.

Chloride Mass Balance (CMB)

Meteoric water (precipitation) falls with a baseline concentration of salts, including chloride (Cl) and bromide (Br). The precipitated water is subject to evaporation at the surface and to transpiration by plants via root uptake in the subsurface. ET consists of pure water, the Cl and Br is left behind, increasing concentrations. The elevated levels of Cl and Br in the ground water indicates what fraction of precipitation has been lost to ET and thus reveals the rate of groundwater recharge. Using the CL/Br ratio, we can see whether the water has been involved in significant chemical weathering, which would indicate non-meteoric sources of Cl/Br. By taking discharging groundwater from near watershed boundaries (upper slopes of high mountains), we constrain the possible weathering or non-meteoric Cl/Br sources, and estimate recharge in areas considered important sources of recharge to regional groundwater systems. This spring, we take advantage of the pulse of groundwater recharging from the snowmelt by collecting discharging ground water from mountain seeps and springs.

Using funds provided by NMGS, we will analyze the collected groundwater and estimate recharge in mountainous areas that lack previous recharge estimates and which could be important sources of recharge for our state.

Figure 1. New Mexico Recharge Estimate Points and Sample Attribute Information



This map shows the Statewide Water Assessment headwaters mask, including basins in Colorado and Arizona which contribute stream flow to New Mexico.

Possible Use in Planning

Timely groundwater recharge estimates could inform the resource planning process by providing information on important recharge areas and potential reacharge quantities. Accurate models could inform planners, educators, and the public about water processes and scarcity in the state.

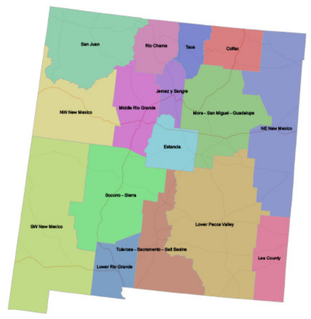


Figure 9. New Mexico Water Resource Planning Regions.