High-Resolution Estimation of Groundwater Recharge for the Entire State of New Mexico using a Soil Water Balance Model

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The Driving Question and What We Did

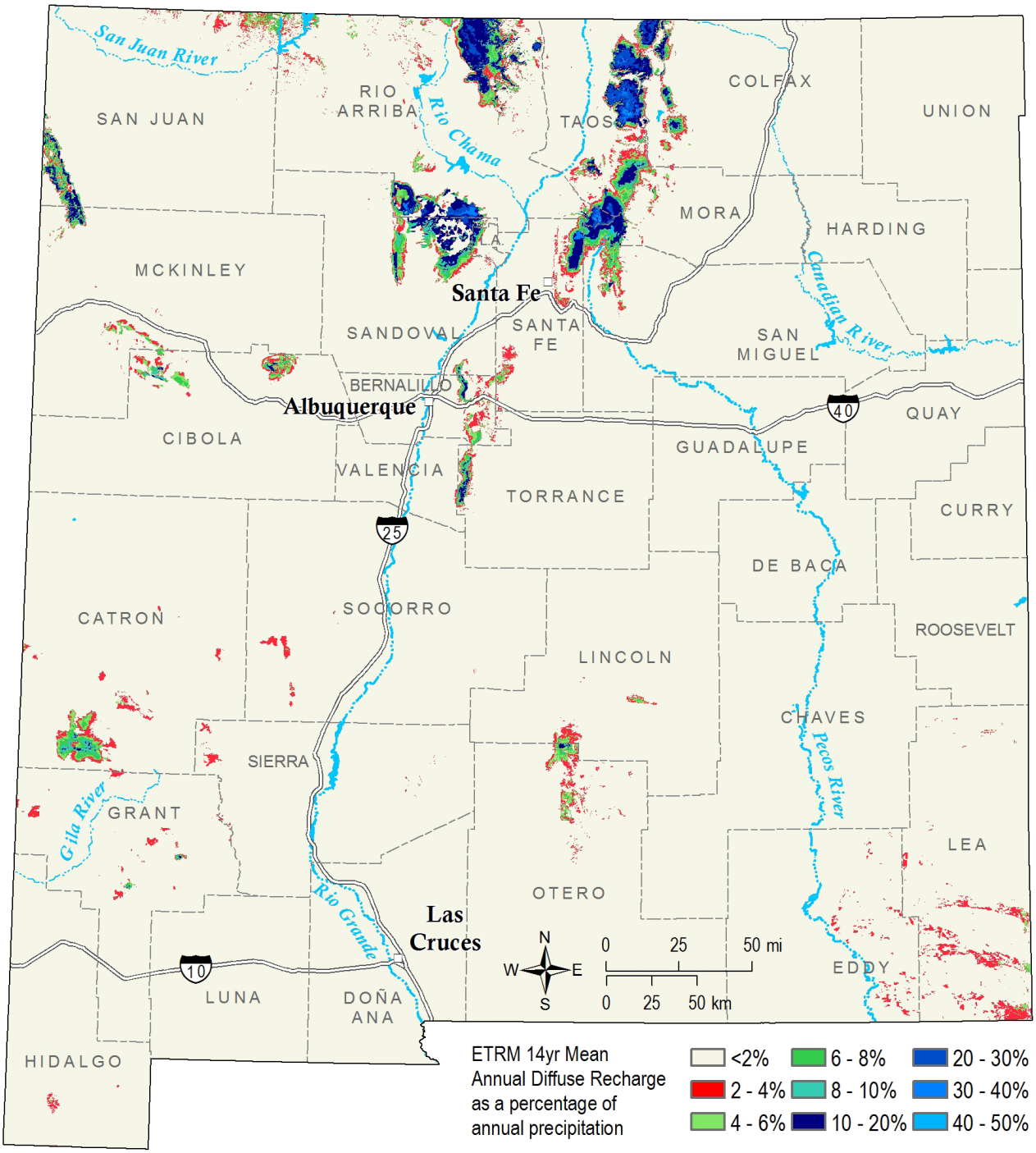
We constructed a model that estimates diffuse groundwater recharge for the entire state of New Mexico. Diffuse recharge is the proportion of precipitation that infiltrates vertically through the soil and past the root zone to potentially contribute water to the groundwater system. In arid and semiarid regions, groundwater recharge largely defines a limit for the availability of water for humans and ecosystems; therefore, estimating recharge for the state of New Mexico is necessary for effective water resource management. However, quantification of groundwater recharge represents a significant gap in current understanding of the New Mexico water budget. Other important components of the water budget (e.g., precipitation, surface-water flows) have been systematically studied for well over 100 years, but no such systematic effort has been attempted for recharge. This is largely due to the difficulty in estimating recharge rates, especially at a statewide scale. The amount of recharge within New Mexico is extremely variable, both spatially and temporally, due to large topographic relief, localized and extreme precipitation patterns, complex geology, and diverse vegetation cover.

How We Did It

We divided the entire state into 250 meter by 250 meter grids cells and calculated a daily soil water balance in each cell. A soil water balance is a simple way of accounting for the amount of water that enters, leaves and is stored in the root zone. Precipitation is the input and the precipitation amount puts a limit on the other water balance components, which include runoff, evapotranspiration and the change in storage in the root zone. Of the precipitation that reaches the ground, some may runoff to into local streams, while the remainder of this water infiltrates into the soil. During and immediately after a storm or snowmelt event, if enough water enters the soil to increase the water content above a threshold amount that the soil can hold, some water will percolate past the root zone to recharge the underlying aquifer. Water that is stored in the soil evaporates and is extracted by vegetation (transpiration). We used existing GIS models and datasets to estimate precipitation amounts, runoff, and the amount of water that evaporated or was used by plants on a daily basis in each cell. From these estimates, we were able to calculate daily diffuse recharge. We have calculated recharge on a daily time step for the entire state from the year 2000 through 2014.

What We Found Out And Why It's Important

Results show that there is very little to no recharge in much of the state (See Figure). Most of the recharge occurs in the mountains, where we observe higher precipitation rates, and lower average temperatures. This observation is common in arid and semiarid regions. The model still needs work to produce more accurate recharge estimates. At this time, the model only estimates diffuse or "in-place" recharge. In arid regions, ephemeral streams and arroyos are important in terms of groundwater recharge. Runoff from large areas accumulates in these streams and infiltrates through the streambeds to recharge the groundwater system. This type of recharge is called "focused" recharge. We are currently working on improving the model by estimating focused recharge. About 50% of water use in New Mexico comes from groundwater, which is the principal supply source for most municipalities and for much of agriculture, especially in periods of drought. While extensive areas of New Mexico have been affected by drought for several years, heavy pumping has continued. While pumping has resulted in groundwater level decreases in areas of the state, recently we have observed groundwater declines that are directly related to the drought. With projected population increases in the state, it is important to understand and to be able to predict groundwater recharge amount in New Mexico.



The above map show modeled average annual diffuse recharge between 2001 and 2014. Little-to-no recharge occurs in much of the state. Most of the recharge occurs in the high mountains where precipitation rates are higher and average temperatures are lower.

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