# Dynamic Sociocultural Feedbacks Influence Acequia Response During Water Scarcity

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## Motivation

- By incorporating interdisciplinary physical and social insights, sociohydrological studies have increased our understanding of emergent and paradoxical system behaviors
- However, intangible social concepts such as community values, norms, and behaviors have often been overlooked in modeling studies
- Many long-lasting agrarian communities, including acequias, indicate their ability to co-adapt with natural and social shocks reflect values centered around social cohesion
- Increasing pressure on water resources from changing climate patterns and social stressors of population growth and changing lifestyles underscore the need for this work

## Objectives

1. Develop an upland model that can simulate streamflow under climate change and link it to a valley model focused on acequia dynamics
2. Assess the response of acequias to water scarcity from physical and social drivers

## Study Area

- Valdez acequia is the most upstream community on the Rio Hondo (Fig 1)
- This region is allowed to divert up to 22% of headwater streamflow
- Primary crops grown in the area are alfalfa, hay, orchards, and vegetables

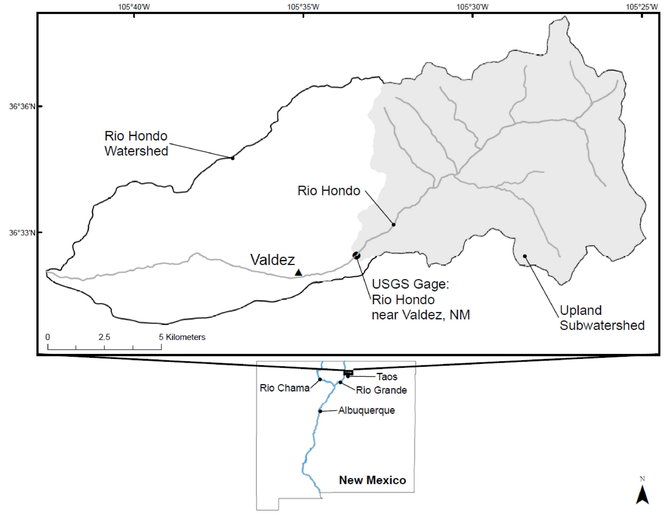


**Fig 1.** Location of upland subwatershed and Valdez acequia in northern NM

## Methods

- A system dynamics platform was used to facilitate engagement with community members and interdisciplinary academic experts
- Two models were developed:
  - An upland hydrological model (Fig 2: blue, dashed box)
  - Valley model capturing acequia dynamics
- Valley model incorporates sociocultural dynamics (purple), biophysical (green), socioeconomic (orange), sociohydrological (light blue), hydrological (dark blue), and interconnecting variables (black)
- Scenarios include upland pressures simulated by changes in the climate conditions and the additional downstream pressures simulated by changes in headgate closures

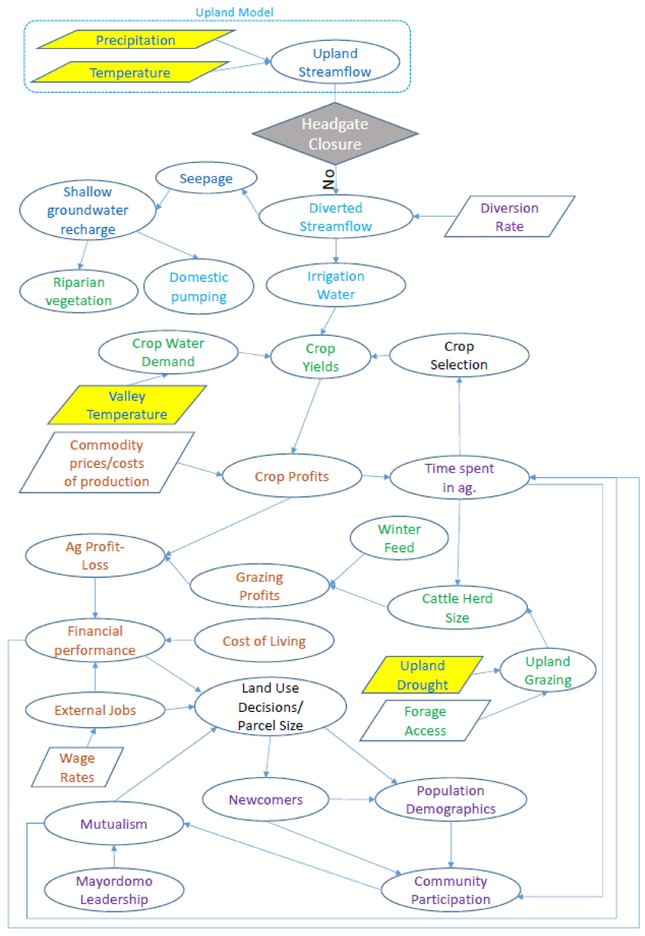


**Fig 2.** Influence diagram summarizing models' structure and linkages. The shapes indicate whether a variable is an exogenous input (parallelogram and diamond) or process within a model (oval). The colors of the shapes indicate the variables modified for the different scenarios: upland pressures (filled in yellow) and the additional downstream pressures (filled in gray)

## Results & Discussion

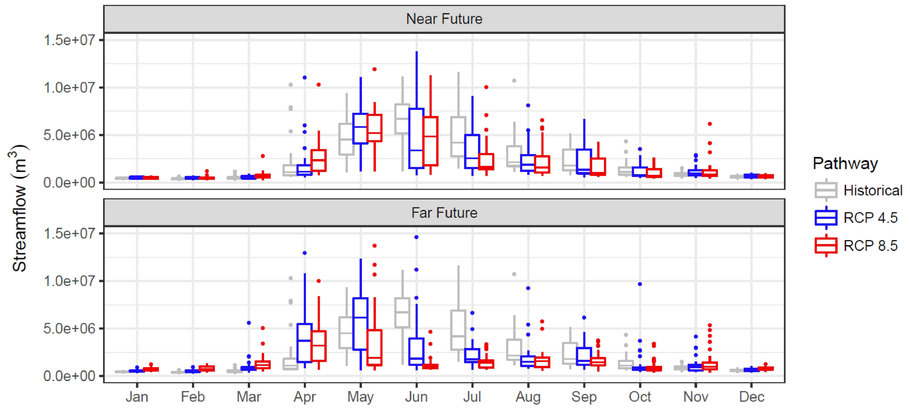


**Fig 3.** Simulated monthly streamflow under climate change using the upland model. Relative to the historical period, peak flow occurs earlier in the year due to higher spring runoff and lower summer runoff under the two representative concentration pathways (RCPs)

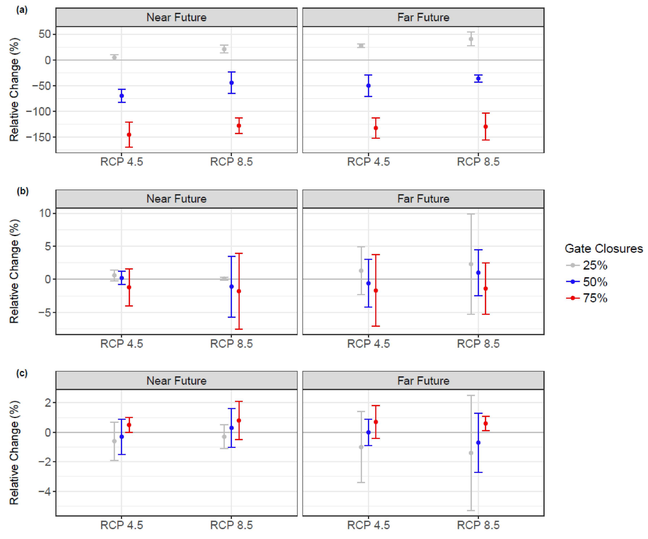


**Fig 4.** Comparison of (a) agricultural profitability per parciante parcel, (b) parciante parcel size, and (c) community size under the different climate pathways and head gate closure scenarios. Points indicate the normalized difference in mean from the historical, calibrated values and the bars represent +/- 1 standard deviation, normalized relative to the standard deviation of the historical values. Relative to the 50% and 75% gate closure scenarios, agricultural profitability and mean parcel size are larger while community size is smaller in the 25% gate closure scenario: vegetable production drove increased profitability and increased time in agriculture, which reduced pressures to leave the acequia, causing land parcels to increase and reduced opportunities for newcomers, causing reductions in community size

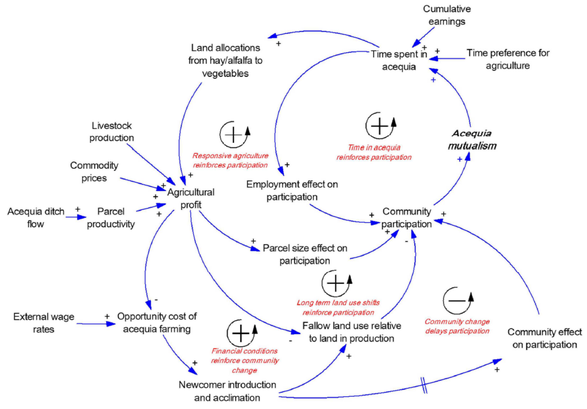


**Fig 5.** Summary of socioeconomic dynamics surrounding acequia mutualism in the valley model. The "+" symbol on each causal link indicates that changes (either an increase or decrease) in the tail variable creates a change in the same direction for the variable on the arrow. Generally, feedbacks associated with members' participation in acequia activities enabled the community to continue to stay together because their livelihoods are driven more by mutualism than by profit, which has important implications for community resilience, (i.e., that members could stay together long enough to develop new adaptation strategies)

**Additional details about the data, models, and results are available in the associated 2018 WRR publication: https://agupubs.onlinelibrary.wiley.com/doi/10.1002/2017WR021223**

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