Managing Water Budgets for Resilience

WATER AND NATURAL RESOURCES COMMITTEE 8/12/2021

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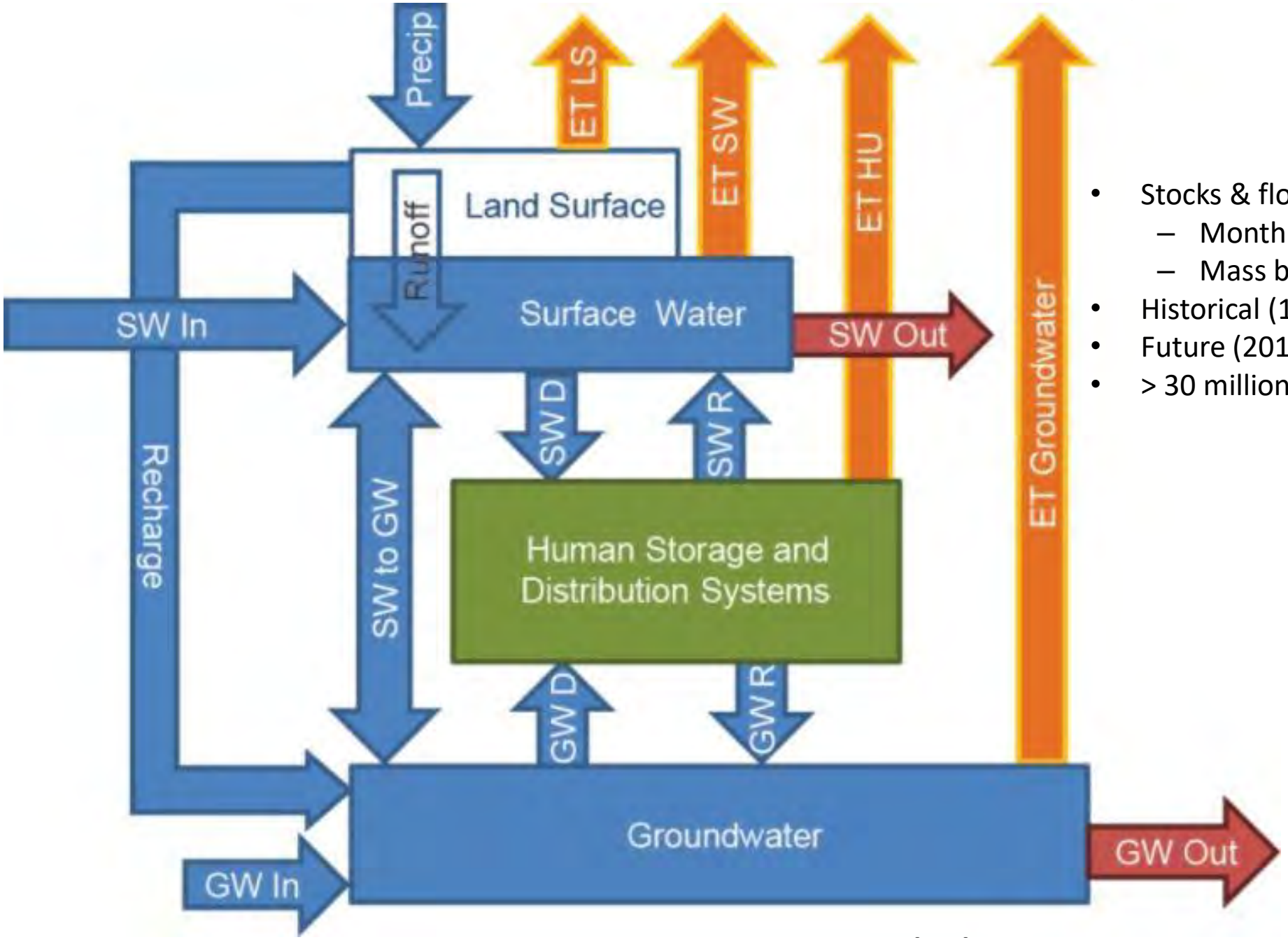
NM WRRI (est. 1963) supports water research for improved water management. It is one of 54 national water institutes supported by the USGS (US Water Resources Research Act). It is located at NMSU and serves all of NM as the water research institute of NM (Statute NMSA 1978 21-8-40).

NEW MEXICO DYNAMIC STATEWIDE WATER BUDGET (NM DSWB) 2



- Stocks & flows
  - Monthly timestep
  - Mass balance
- Historical (1975–2018)
- Future (2019–2099)
- > 30 million data points

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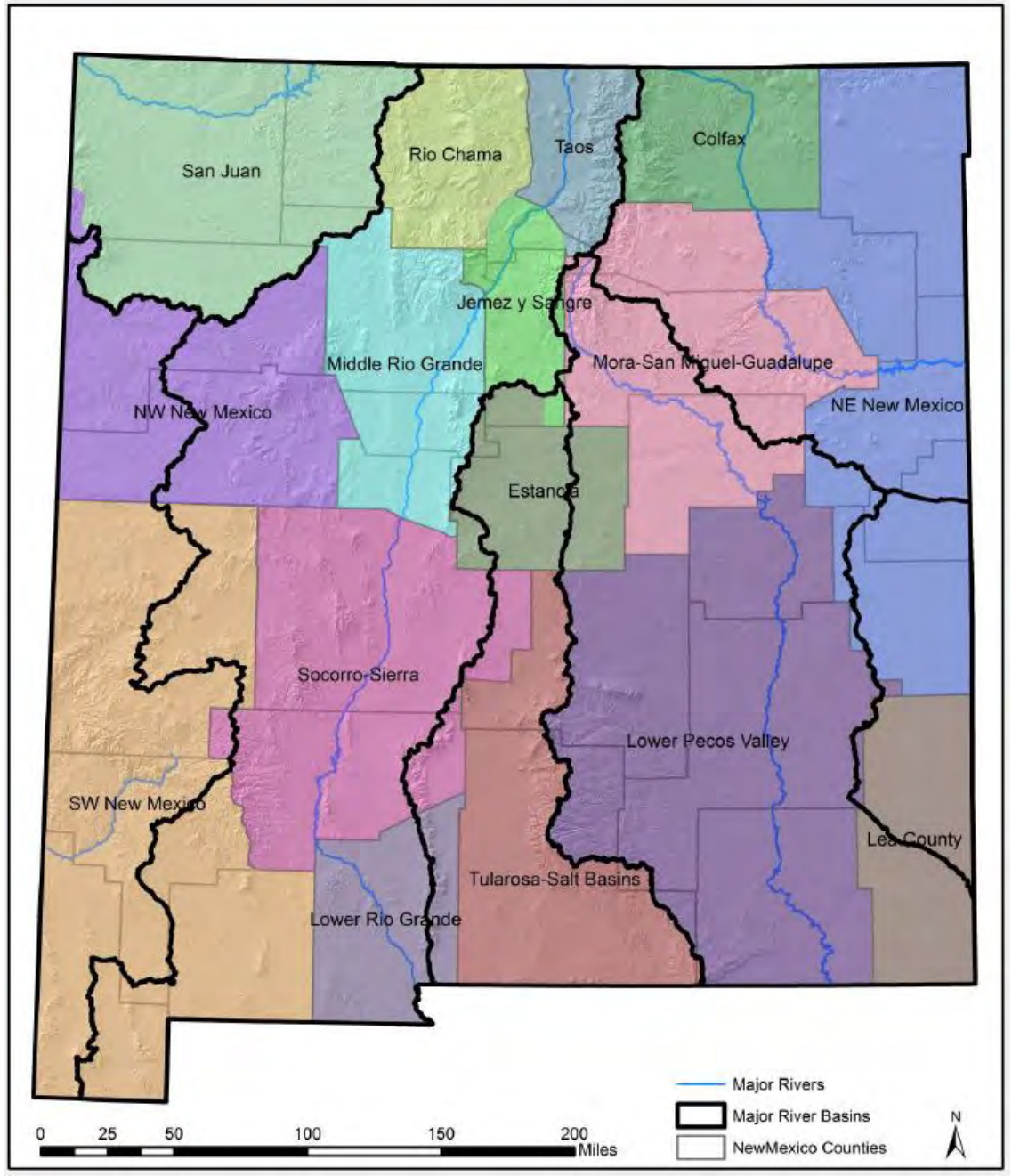
NM DSWB COVERS MULTIPLE SPATIAL SCALES



Spatial Scales

- Counties (33)
- Water Planning Regions (16)
- Major river basins (7)
- Statewide (1)

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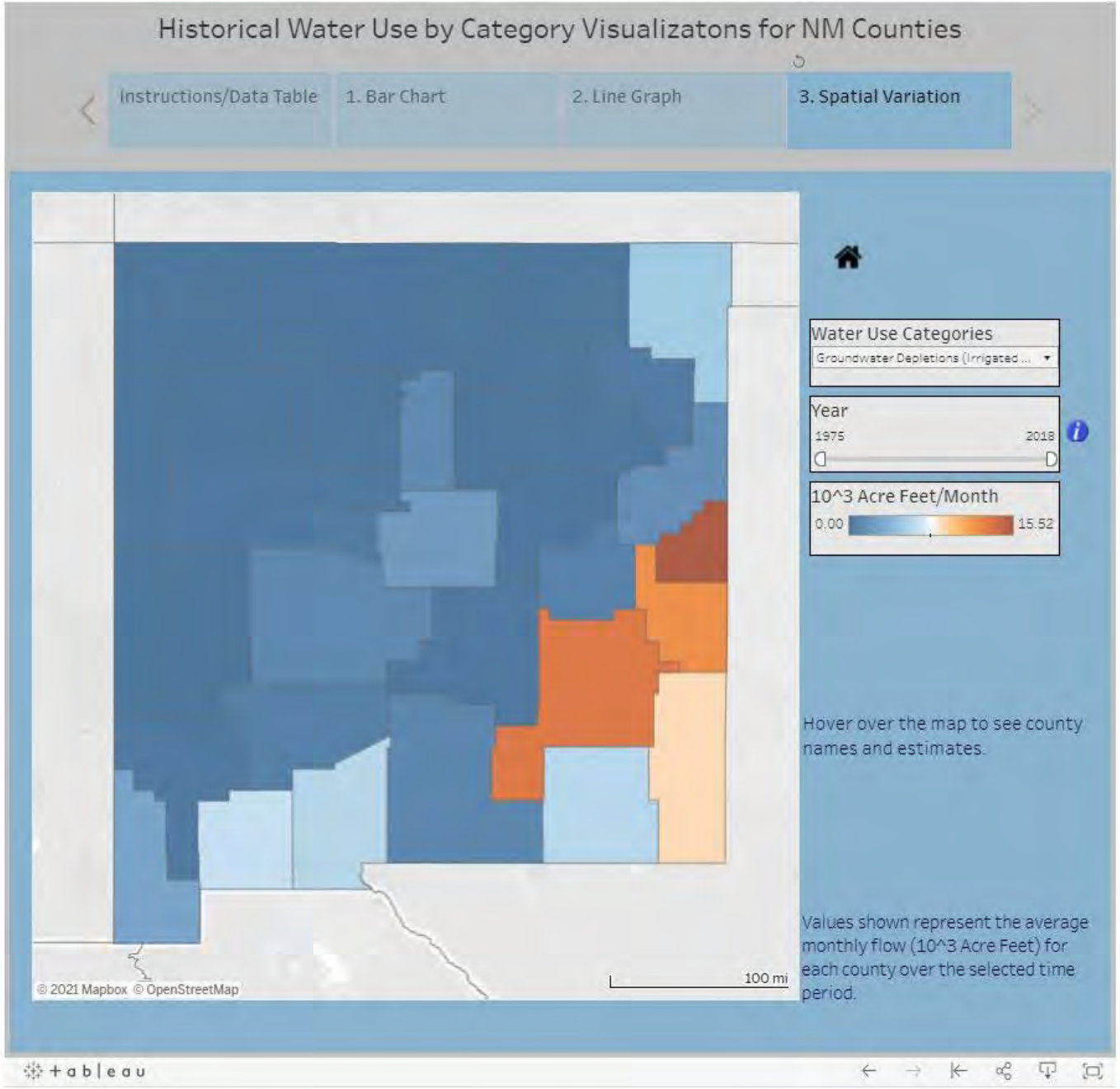
NM DSWB SHOWS DISTRIBUTION OF WATER BUDGET COMPONENTS



Link to access:
https://nmwrri.nmsu.edu/new-mexico-dynamic-statewide-water-budget-beta-version-3-0/

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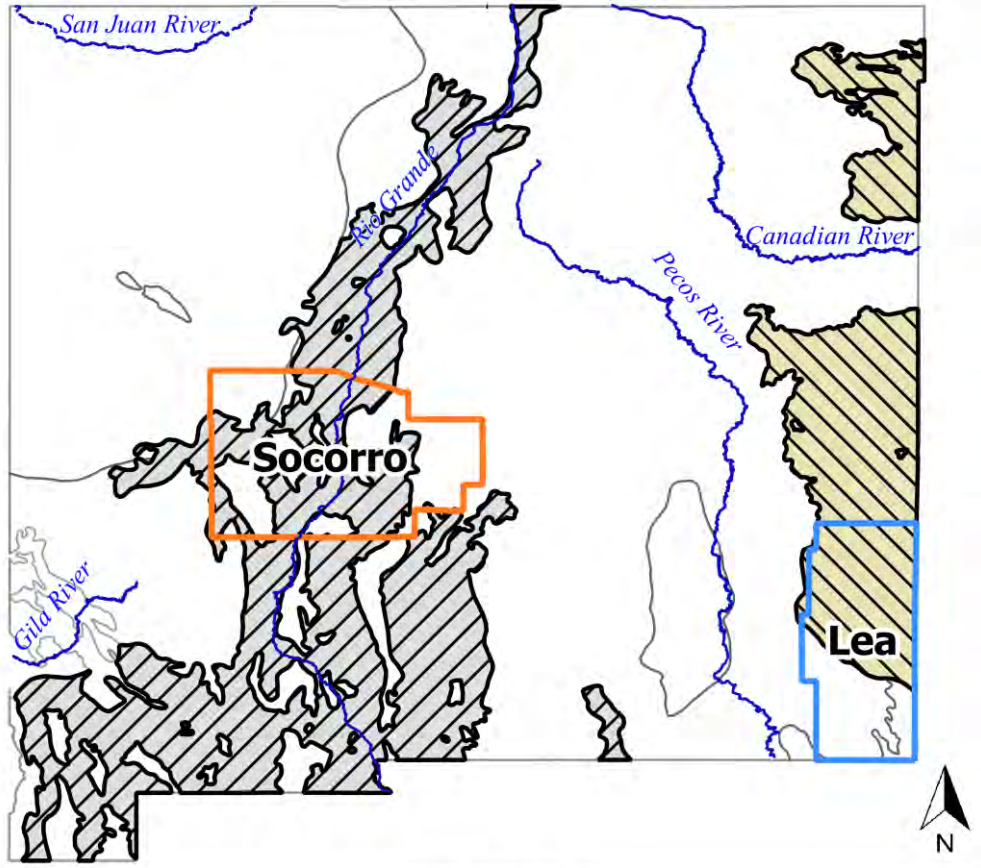
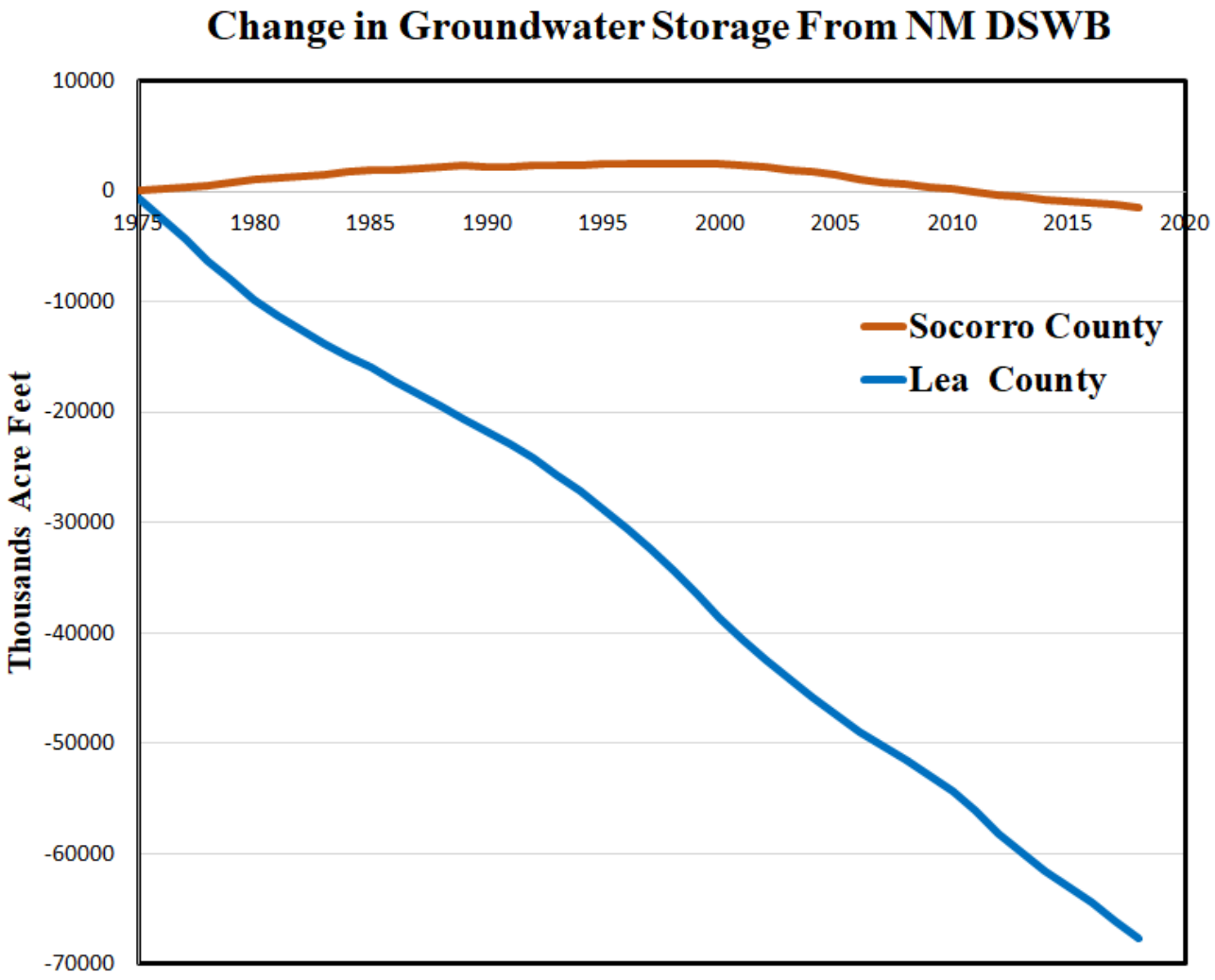
VARIABLE GROUNDWATER STORAGE TRENDS ACROSS NEW MEXICO





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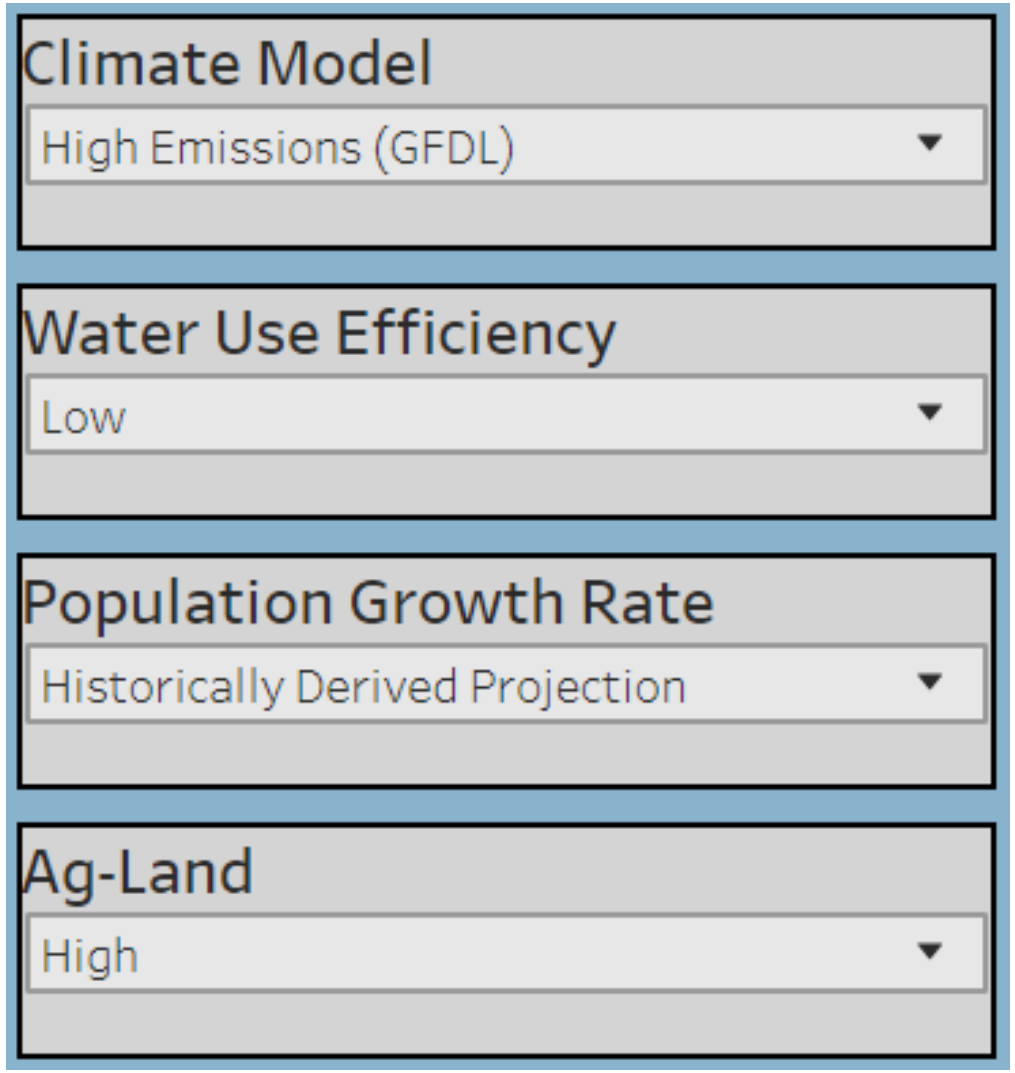
FUTURE SCENARIOS WITHIN THE NM DSWB



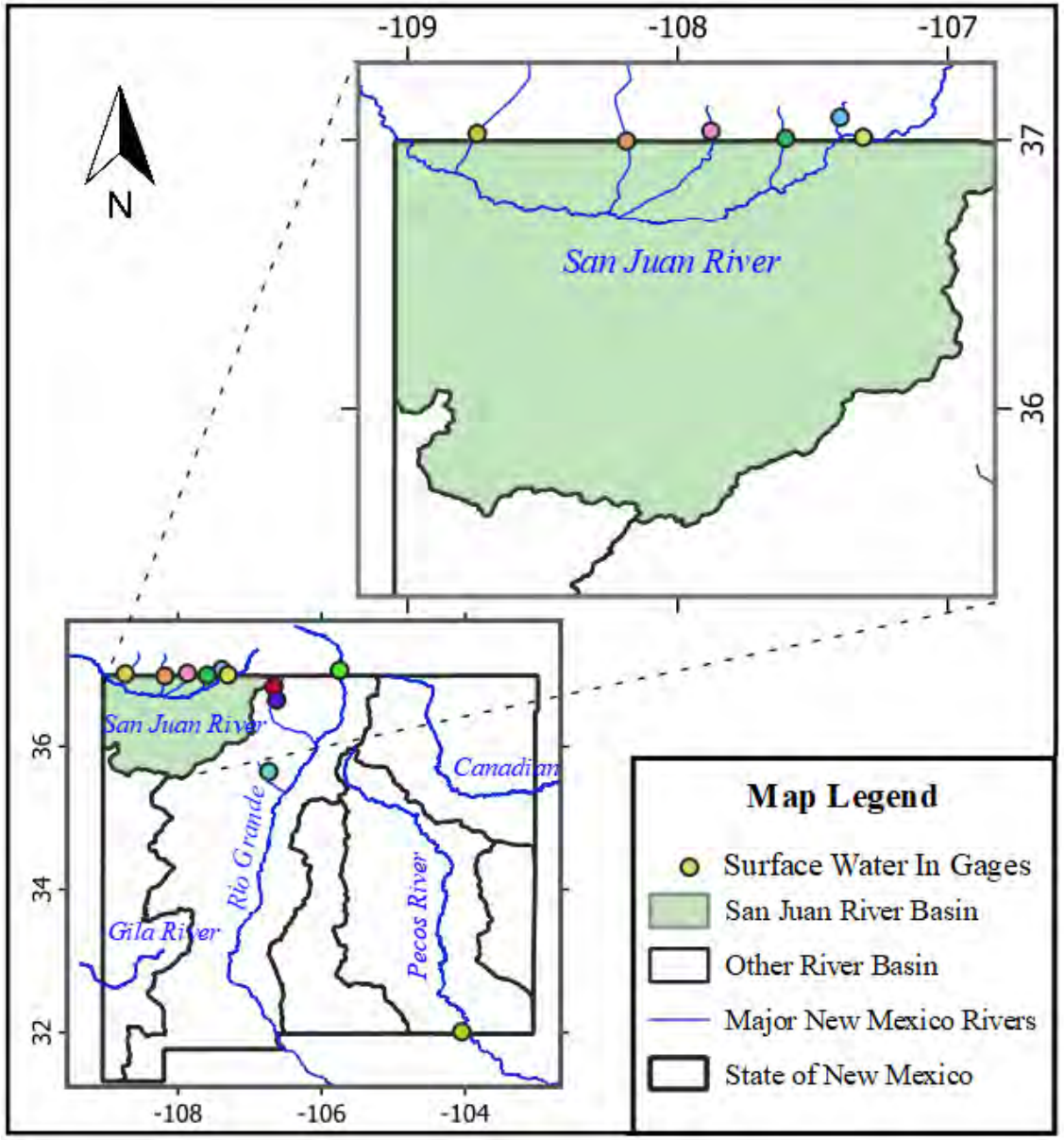
- 4 General Circulation Models
  - Temperature, precipitation, & streamflow

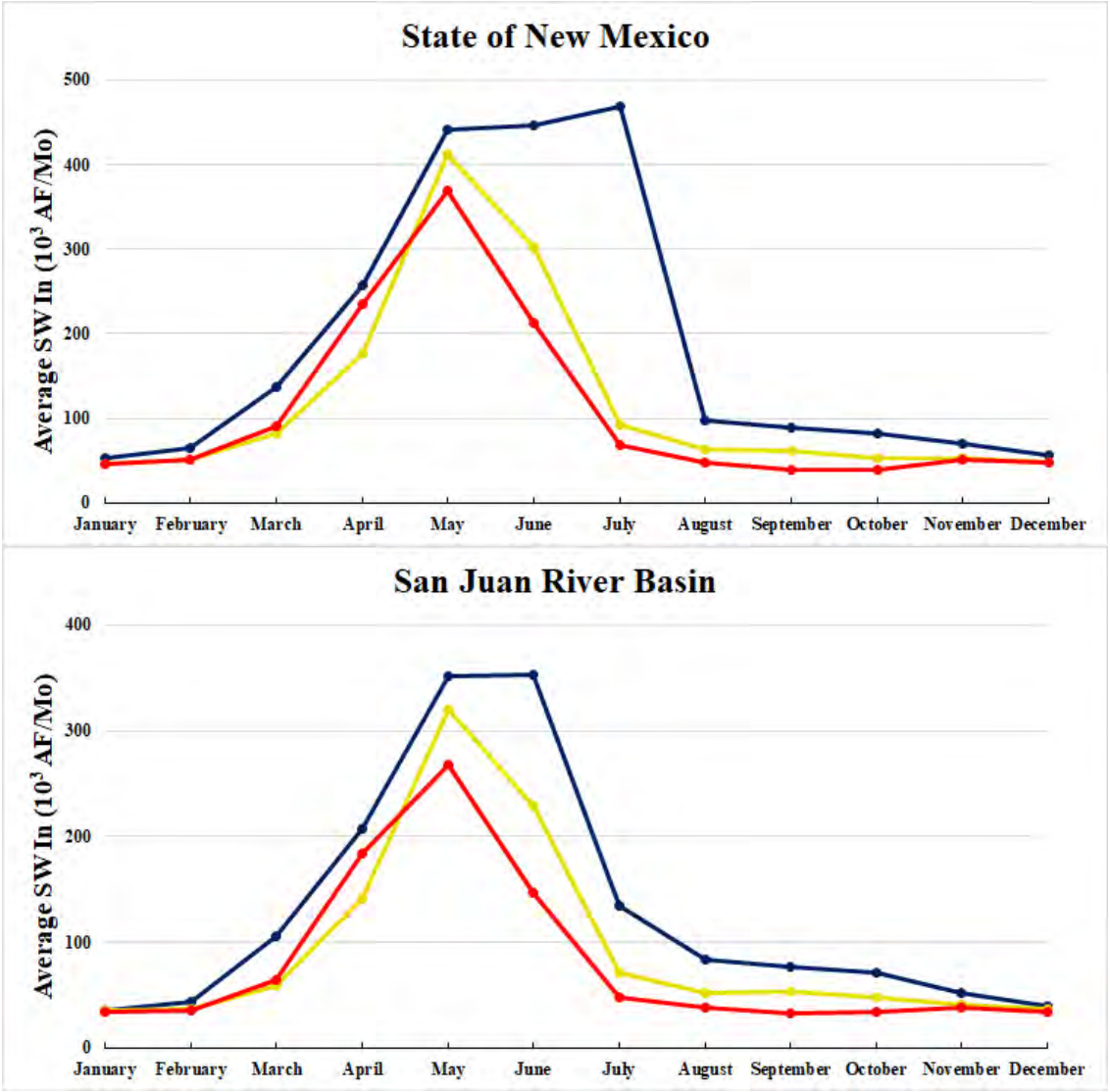
- 3 options based on the 2015 OSE Water Use by Category Report (Magnuson et al., 2019)
  - Alters per-capita self-supplied domestic & public water use

- 3 options based on the UNM Bureau of Business and Economic Research population model (UNM BBER, 2014)
  - Domestic & public water use directly related to population

- 3 options based on the 2018 USDA CropScape Cropland Data layer (USDA, 2018)
  - Alters agricultural acreage → CIR

LESS SURFACE WATER INTO NEW MEXICO IN THE FUTURE





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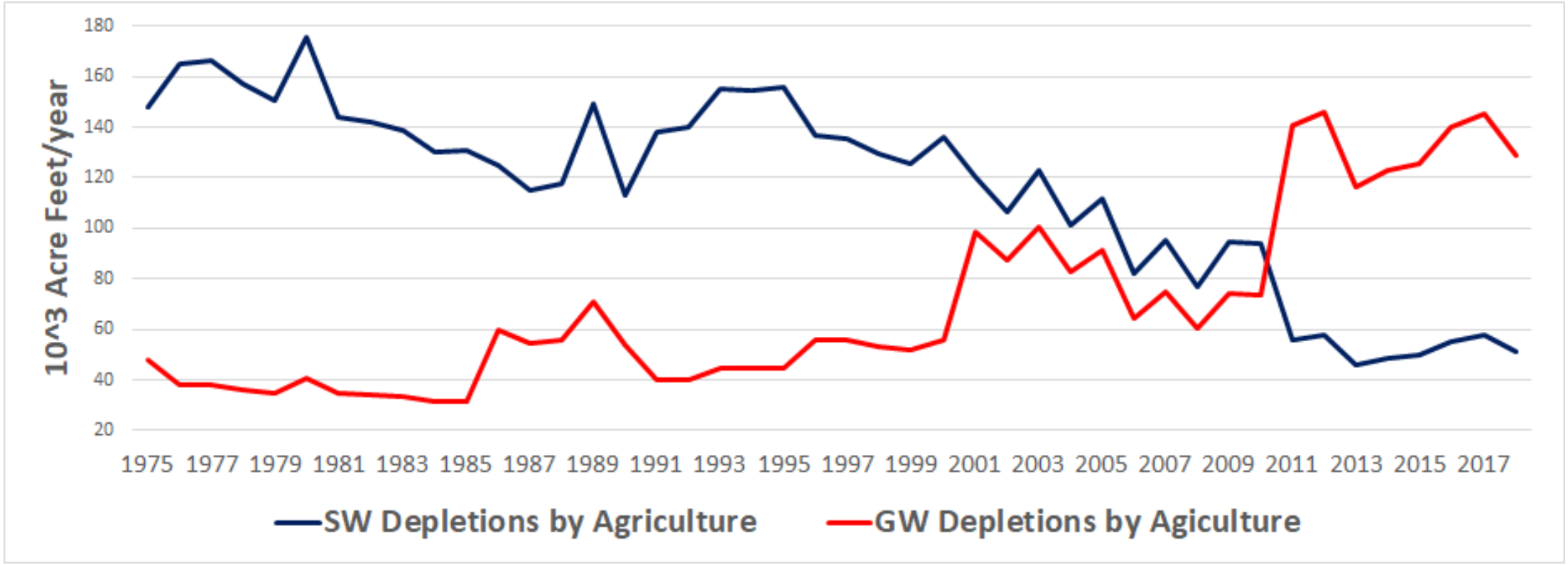
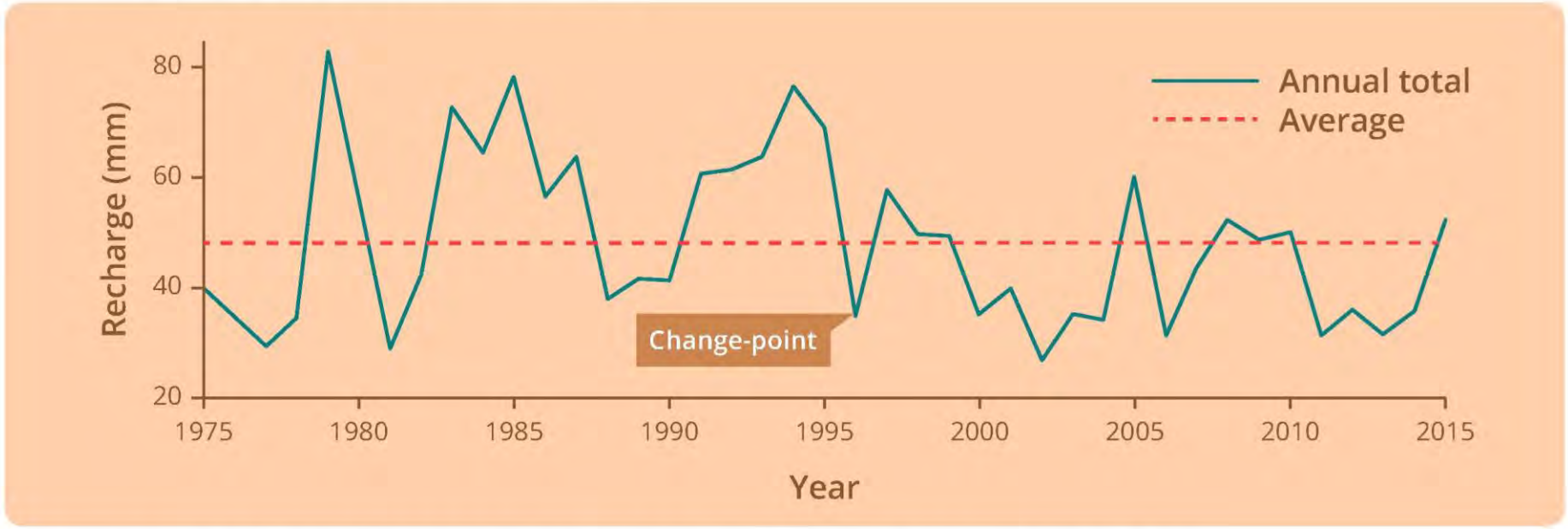
AS SURFACE WATER AVAILABILTY DECLINES, GROUNDWATER PUMPING INCREASES; DONA ANA COUNTY



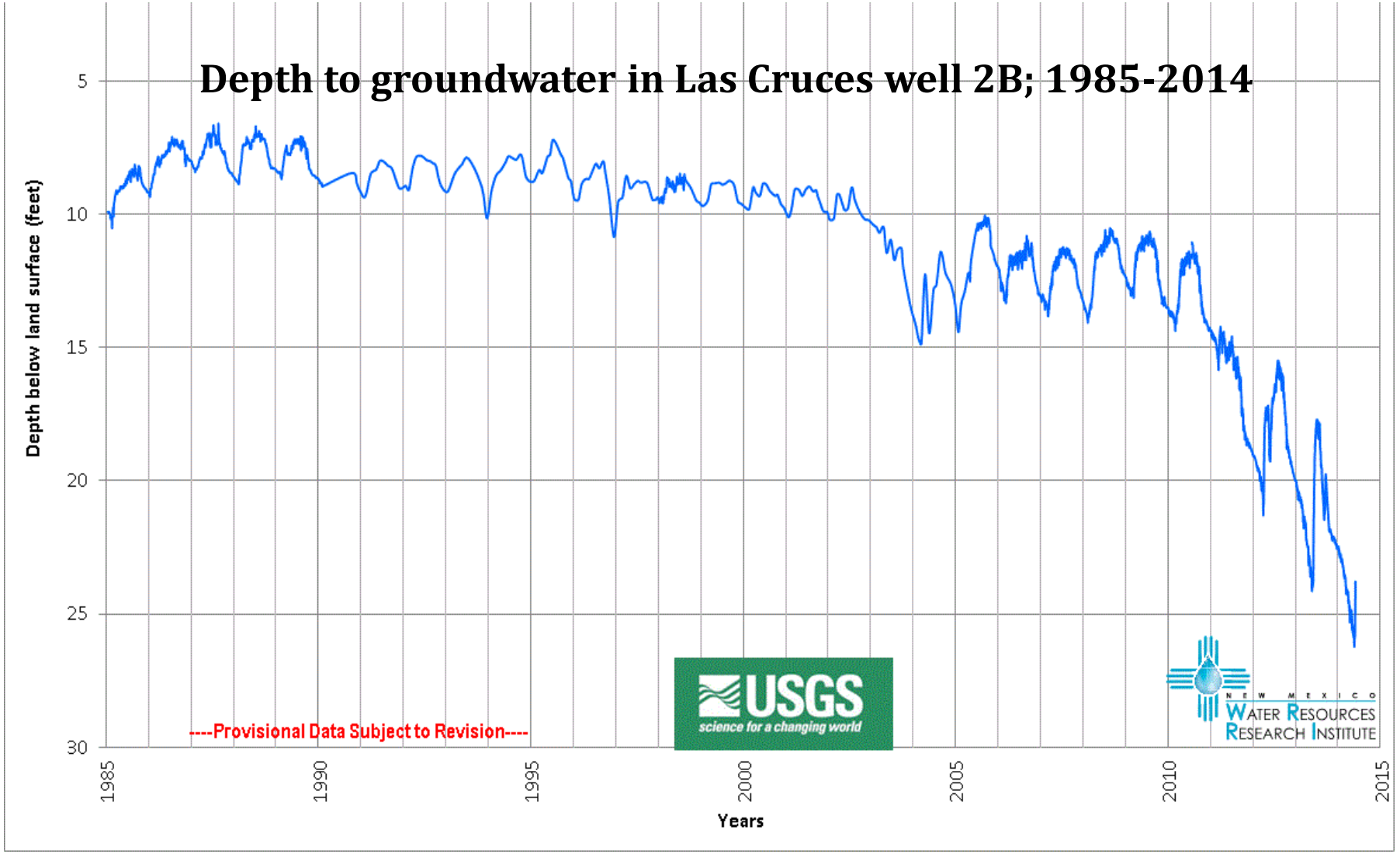
AMOUNT OF RECHARGE DECLINED STARTING IN THE MID 1990s

Statistically significant abrupt change in RE (change-point) for all counties in the 1990s

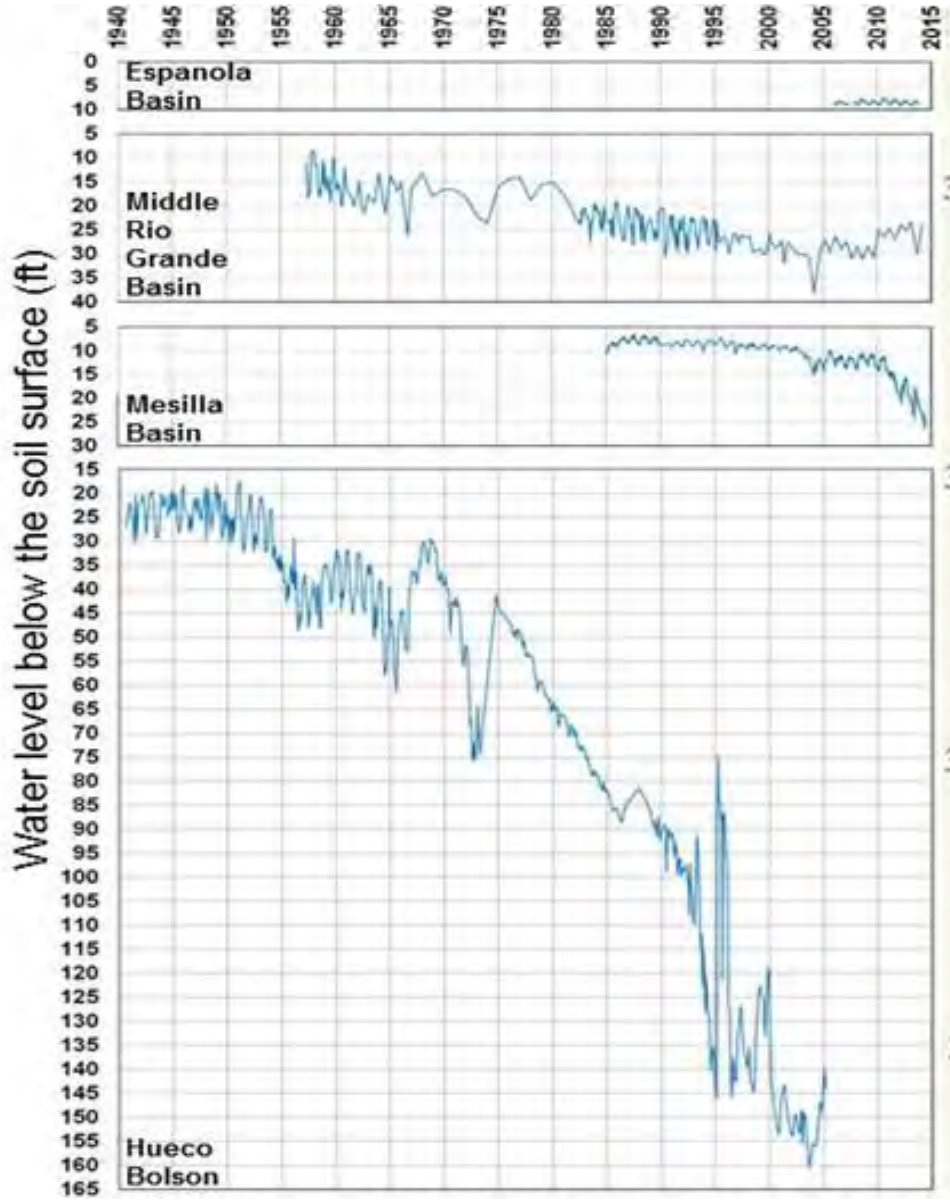


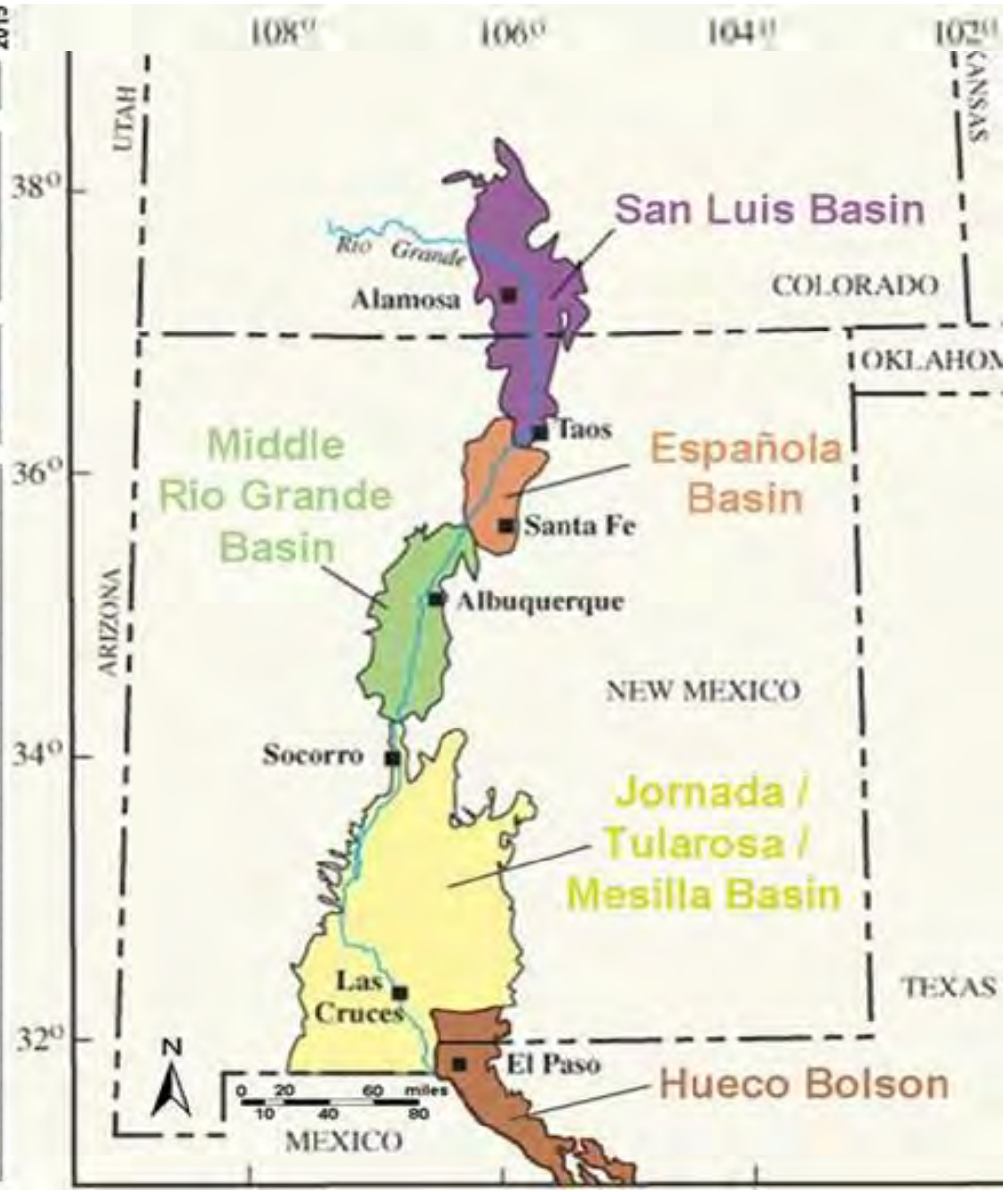
Decline in RE after the change-point in all counties

INCREASED PUMPING LEADS TO REDUCED GROUNDWATER STORAGE



GROUNDWATER EQUILIBRIUM IN NORTHERN NM AQUIFERS





Surface water, groundwater are in balance along upper Rio Grande

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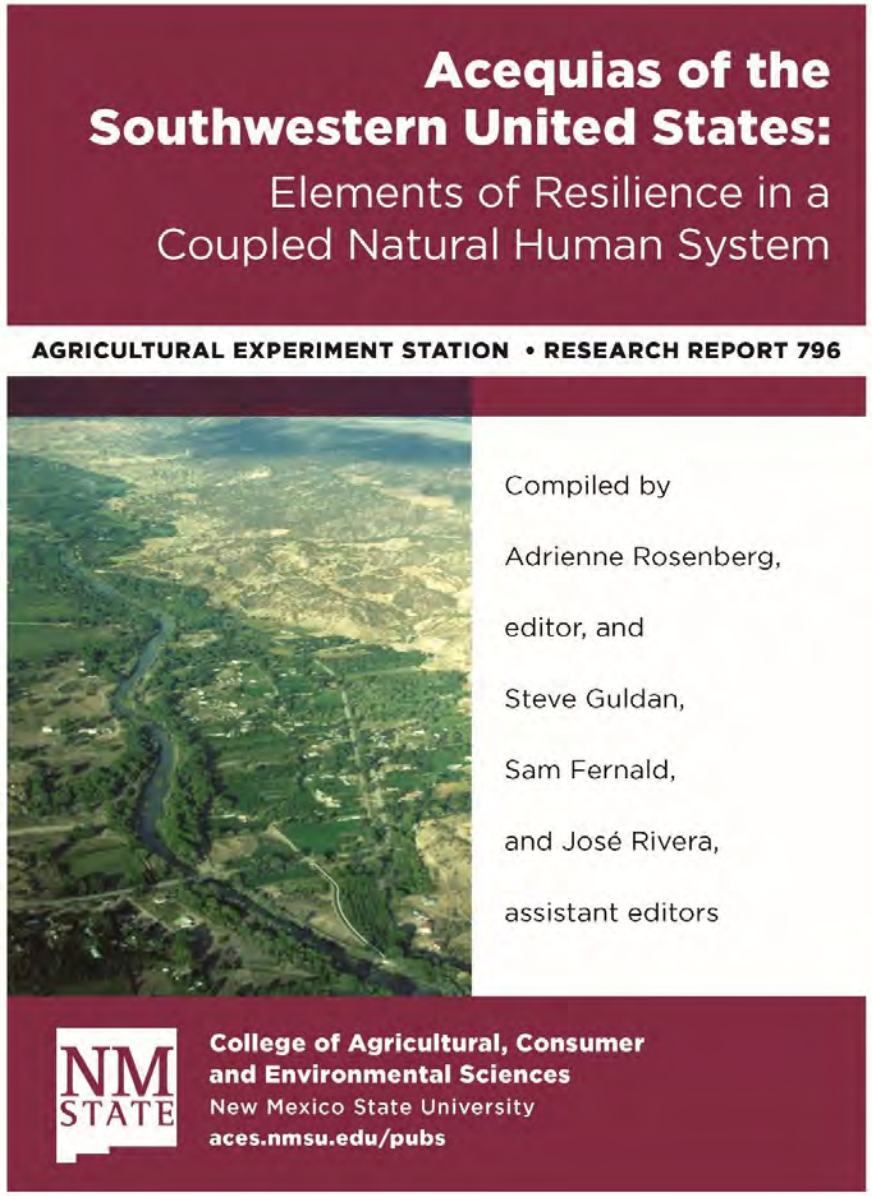
ACEQUIA IRRIGATION SYSTEM CLUES TO WATER RESILIENCE



https://aces.nmsu.edu/pubs/research/water/RR796/welcome

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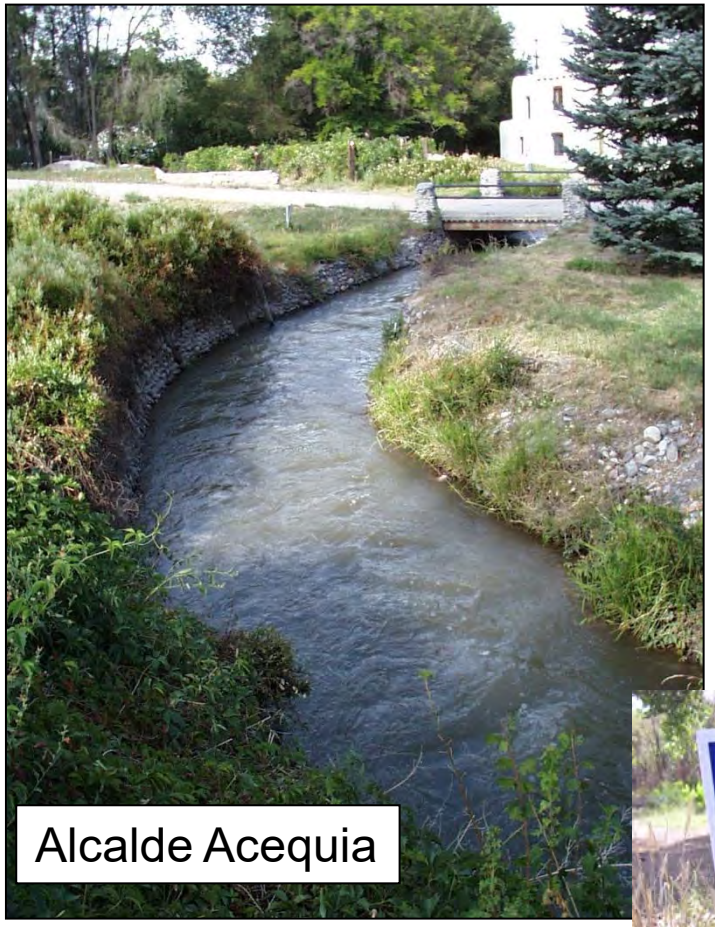
ACEQUIA CLUES TO WATER RESILIENCE

- Water managed by community associations
- Acequias maintain agricultural landscapes during dry times
- Groundwater is not used to offset surface water shortages
- Surface water and groundwater are in balance
- Surface water irrigation recharges groundwater
- Groundwater return flows maintain river flows
- Acequia return flows delay river flow hydrographs
- Repartimiento - Water shortages and abundance are shared
- Community mutualism maintains acequias

ACEQUIAS

- Ditch systems to irrigate fields
- Community associations to allocate water



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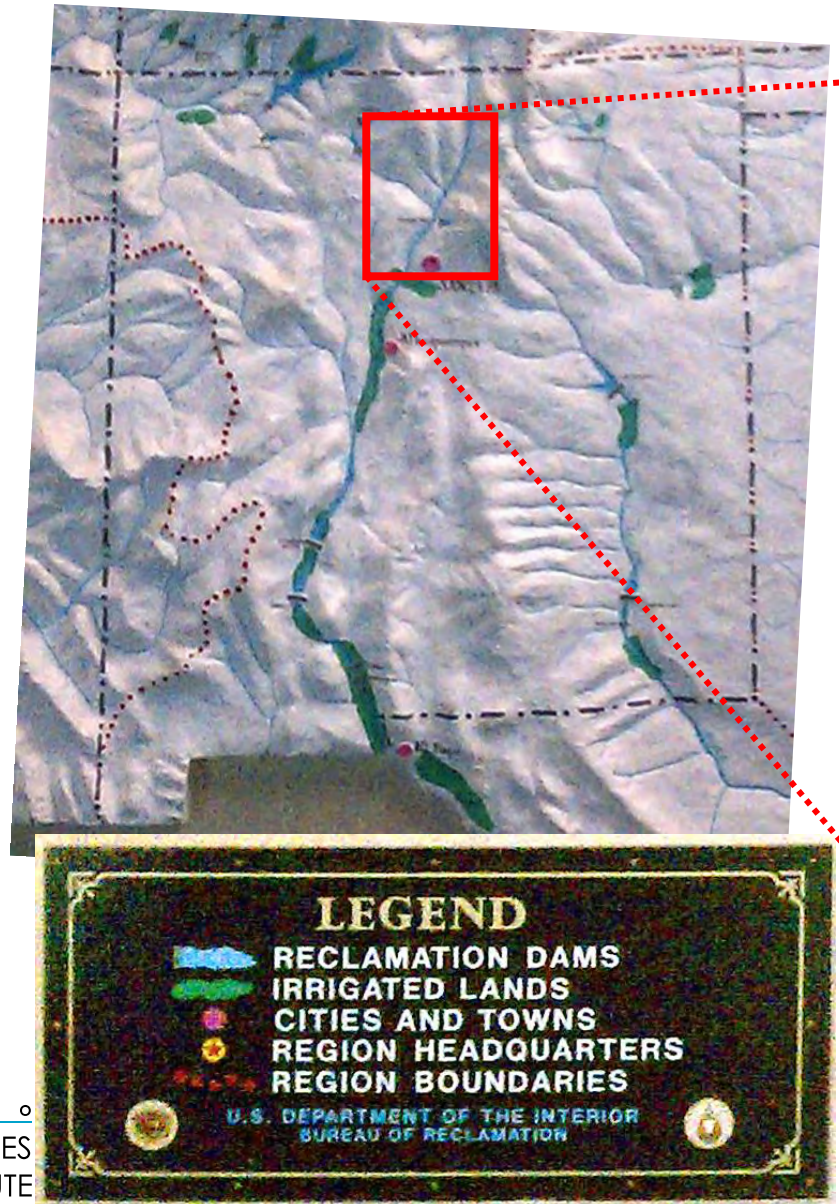
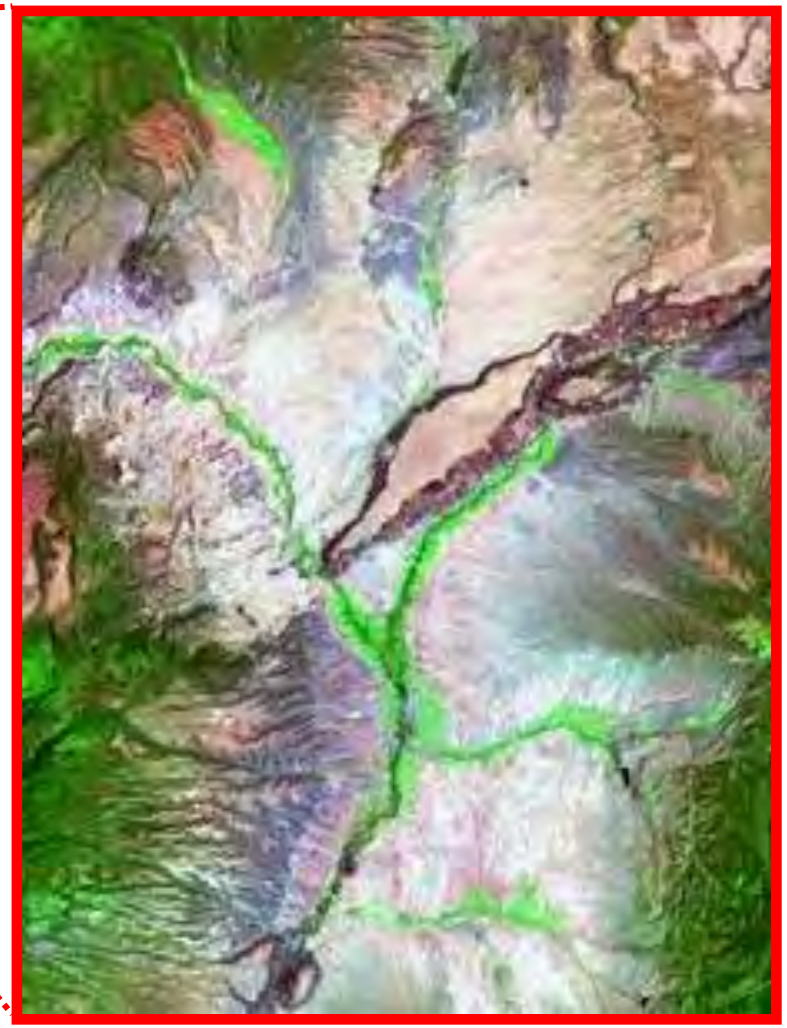
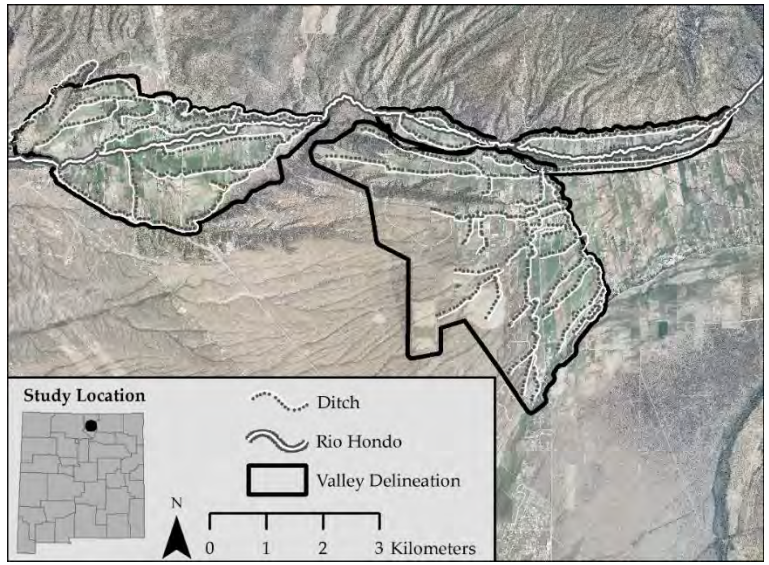
Ribbons of green

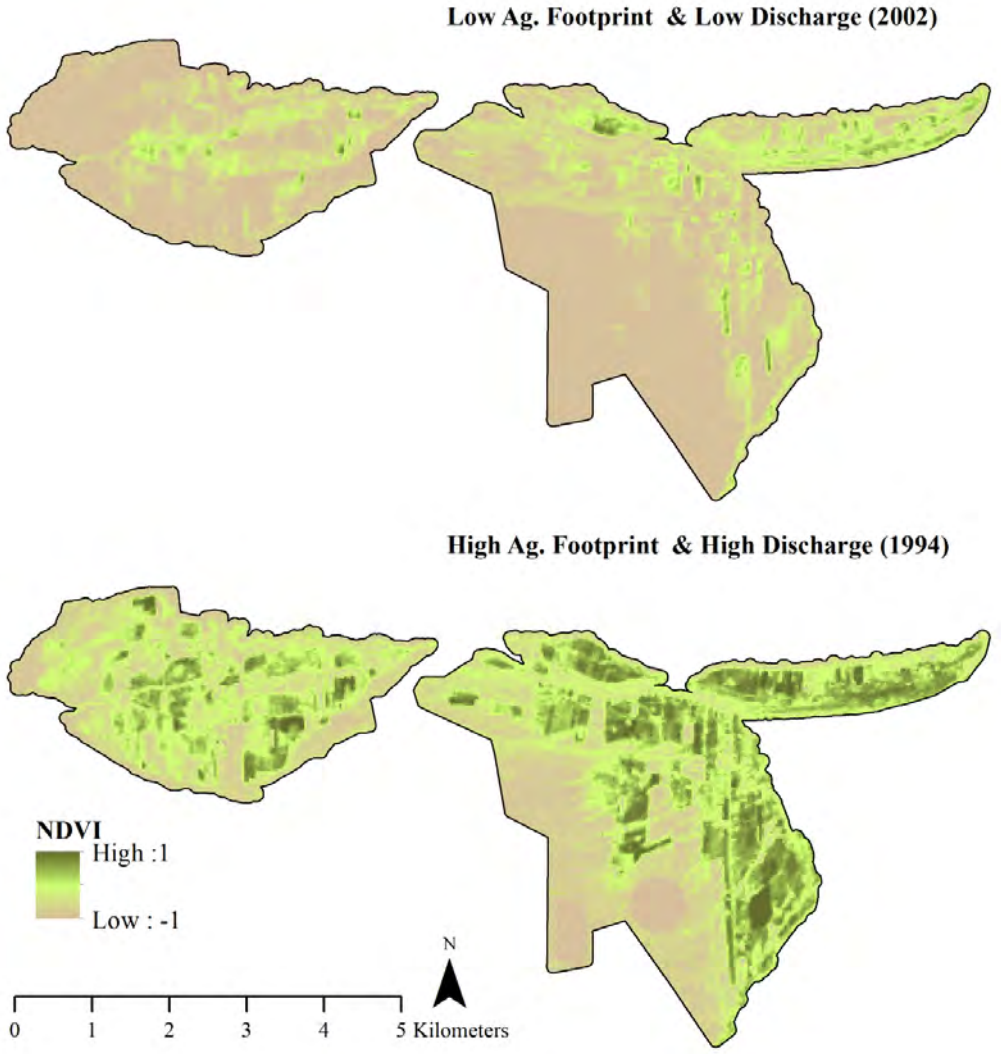
- Traditional acequias are the primary irrigation systems in northern New Mexico





ACEQUIAS PRESERVE AGRICULTURE





- Acequias maintain agricultural footprint in dry times

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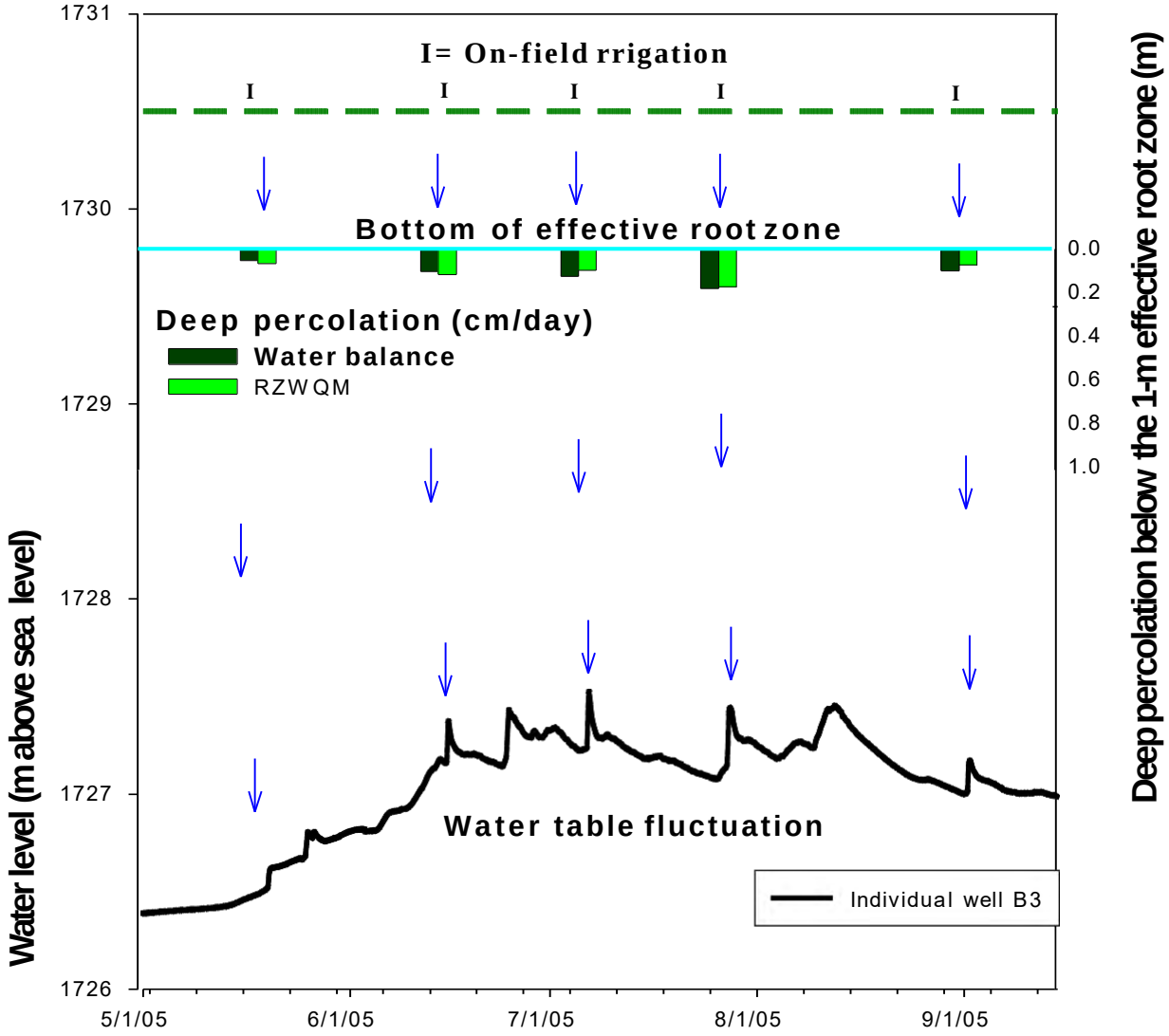
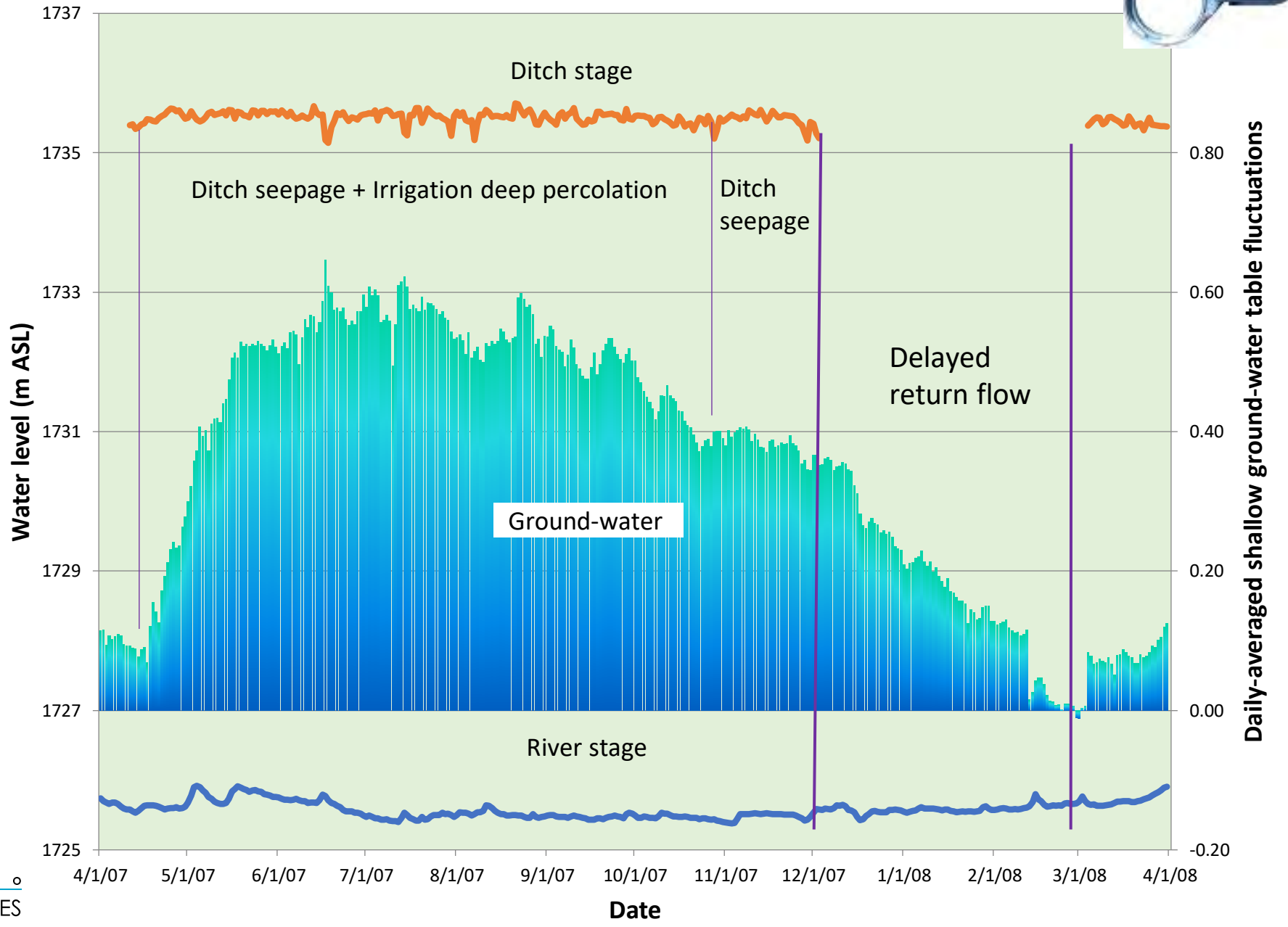
PERCOLATION BELOW CROPS

- Flood irrigation percolates past root zone and reaches shallow groundwater

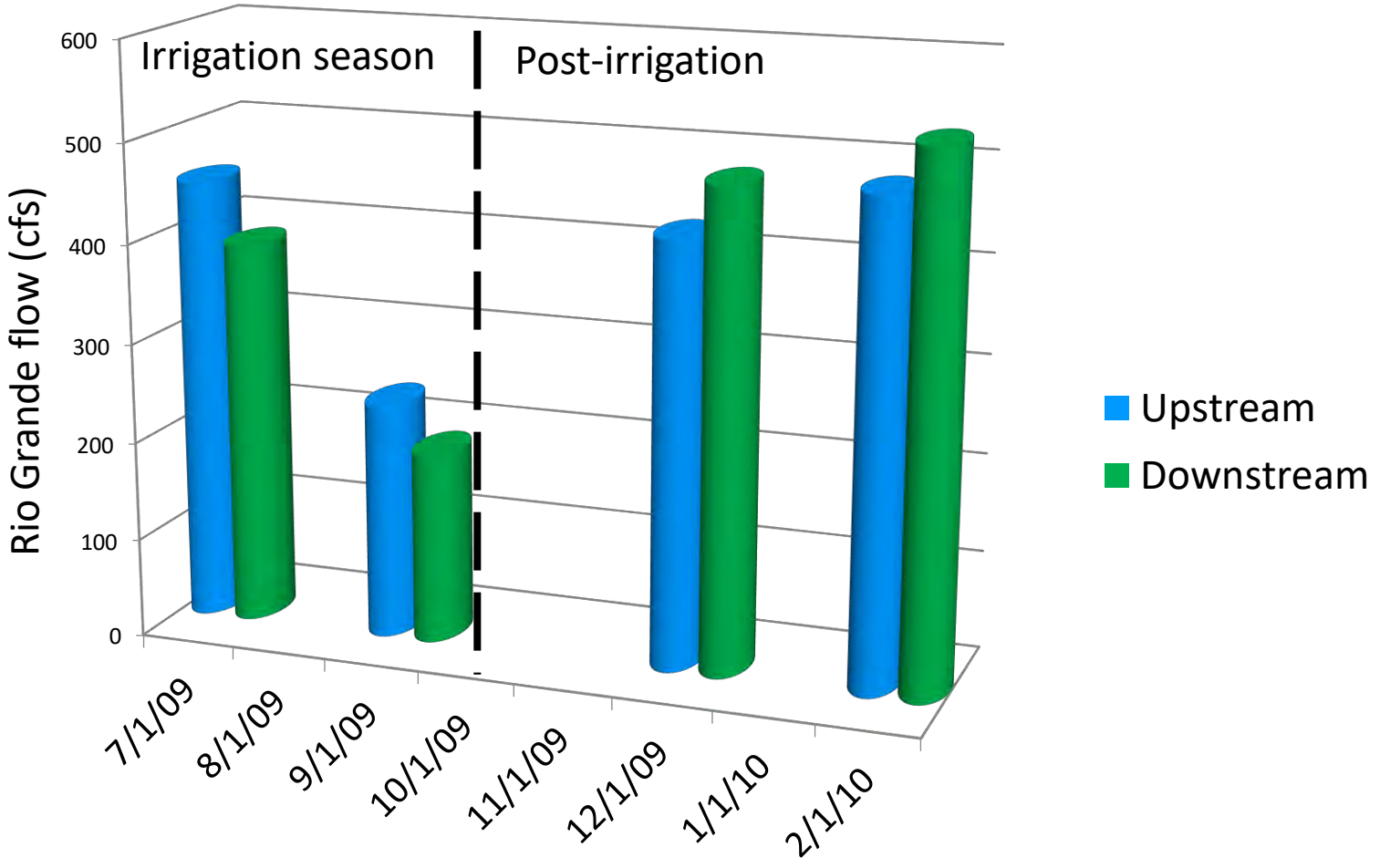
- 15-62% percolation (both measured and modeled) depending on antecedent soil moisture and irrigation amount



IRRIGATION RECHARGES GROUNDWATER

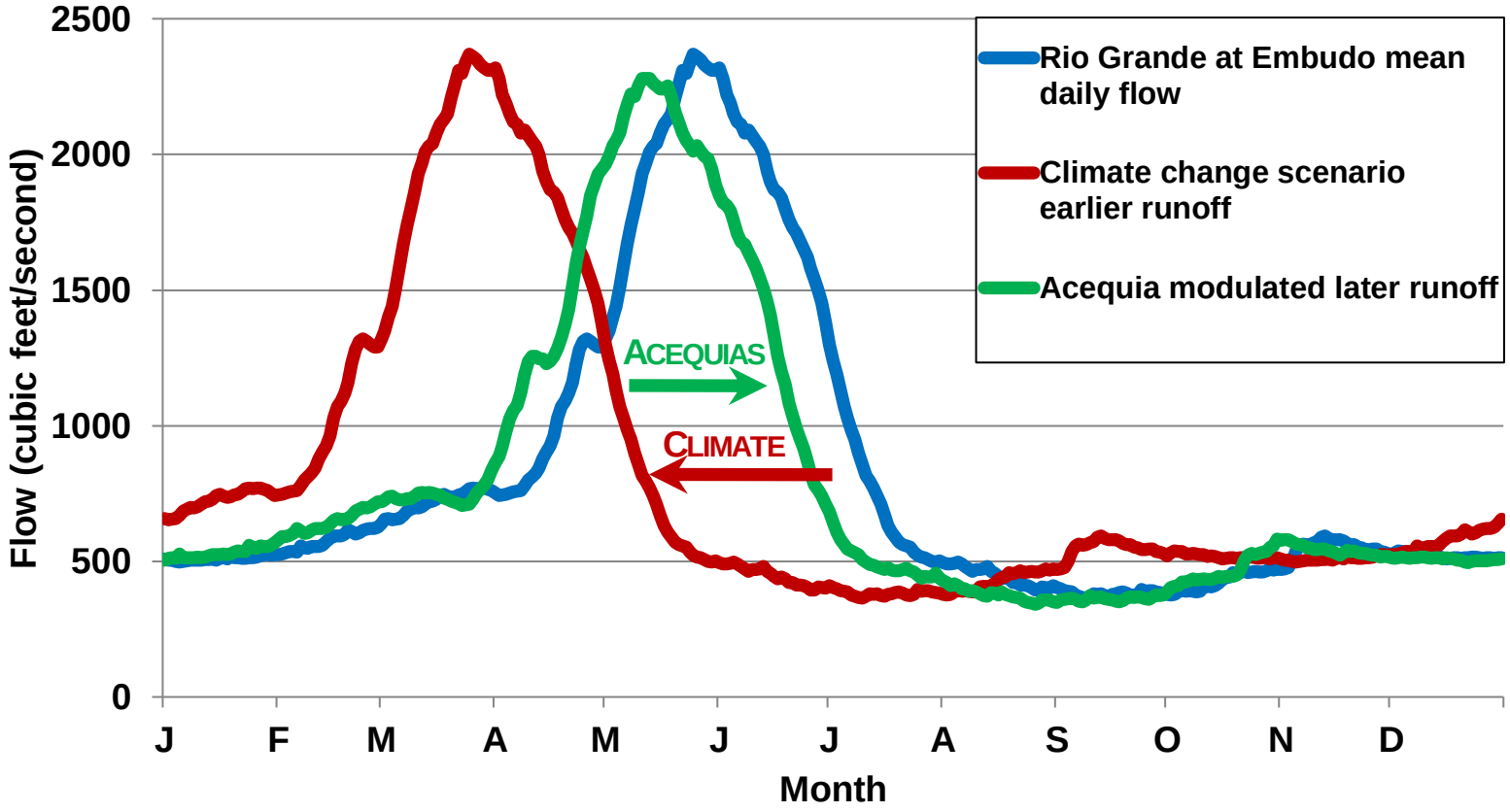


GROUNDWATER RETURN FLOW PROVIDES DOWNSTREAM RIVER FLOW



- Higher flow downstream in river in response to delayed return flow at the end of the irrigation season

ACEQUIAS DELAY SPRING RUNOFF THAT IS PROJECTED TO BE EARLIER IN THE YEAR



REPARTIMIENTO - WATER SHORTAGE AND ABUNDANCE ARE SHARED

Acequias have adapted to natural hydrologic variability and share water equally in times of water abundance and drought.

In contrast, subsequently drafted priority water law assigns more water to senior water right holders during shortages.

(photo Jose Rivera – Cuchilla Rebalse – 2/3 - 1/3)

COMMUNITY MUTUALISM MAINTAINS ACEQUIAS

- Mutualism – economic and community bonds

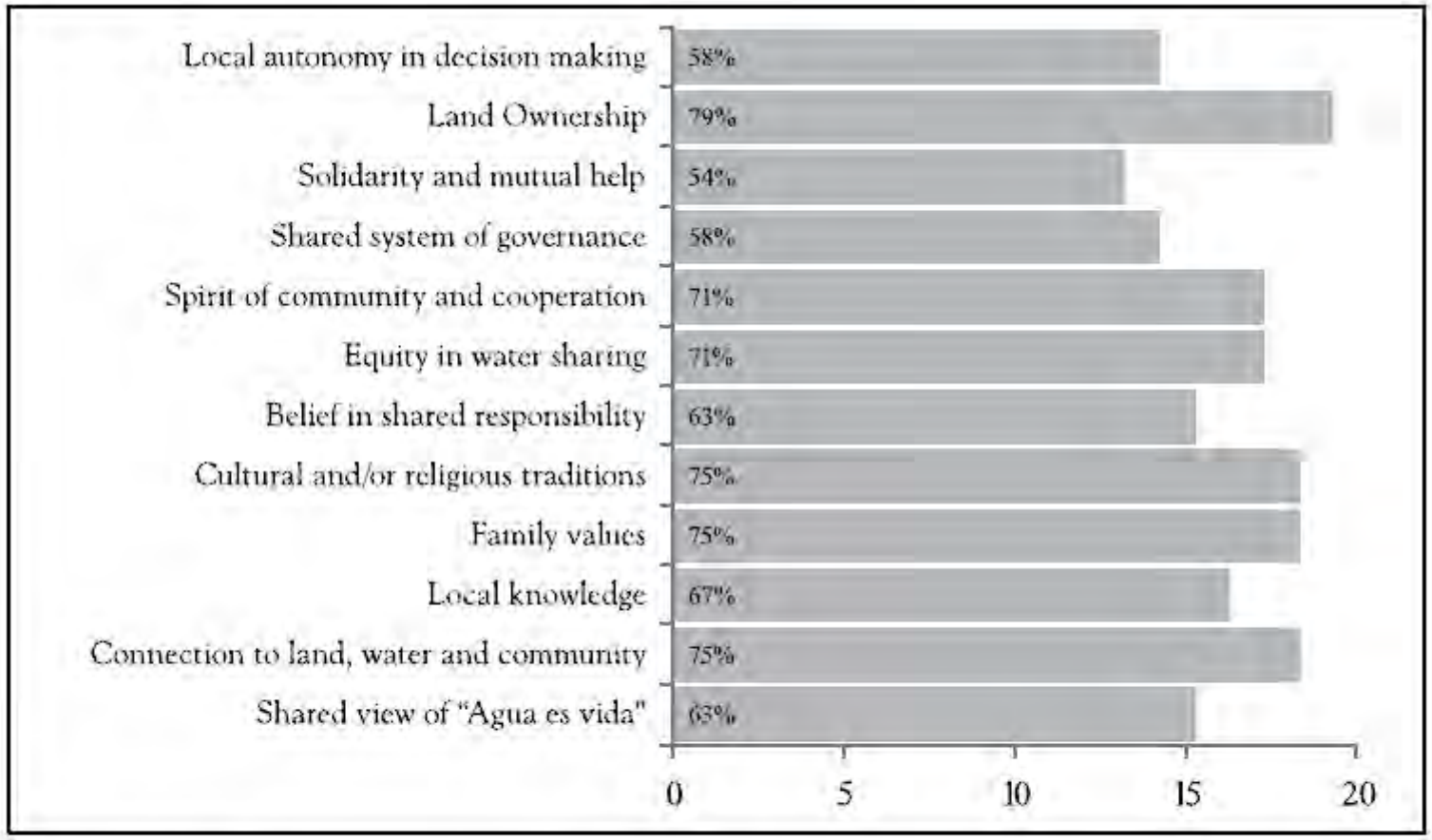
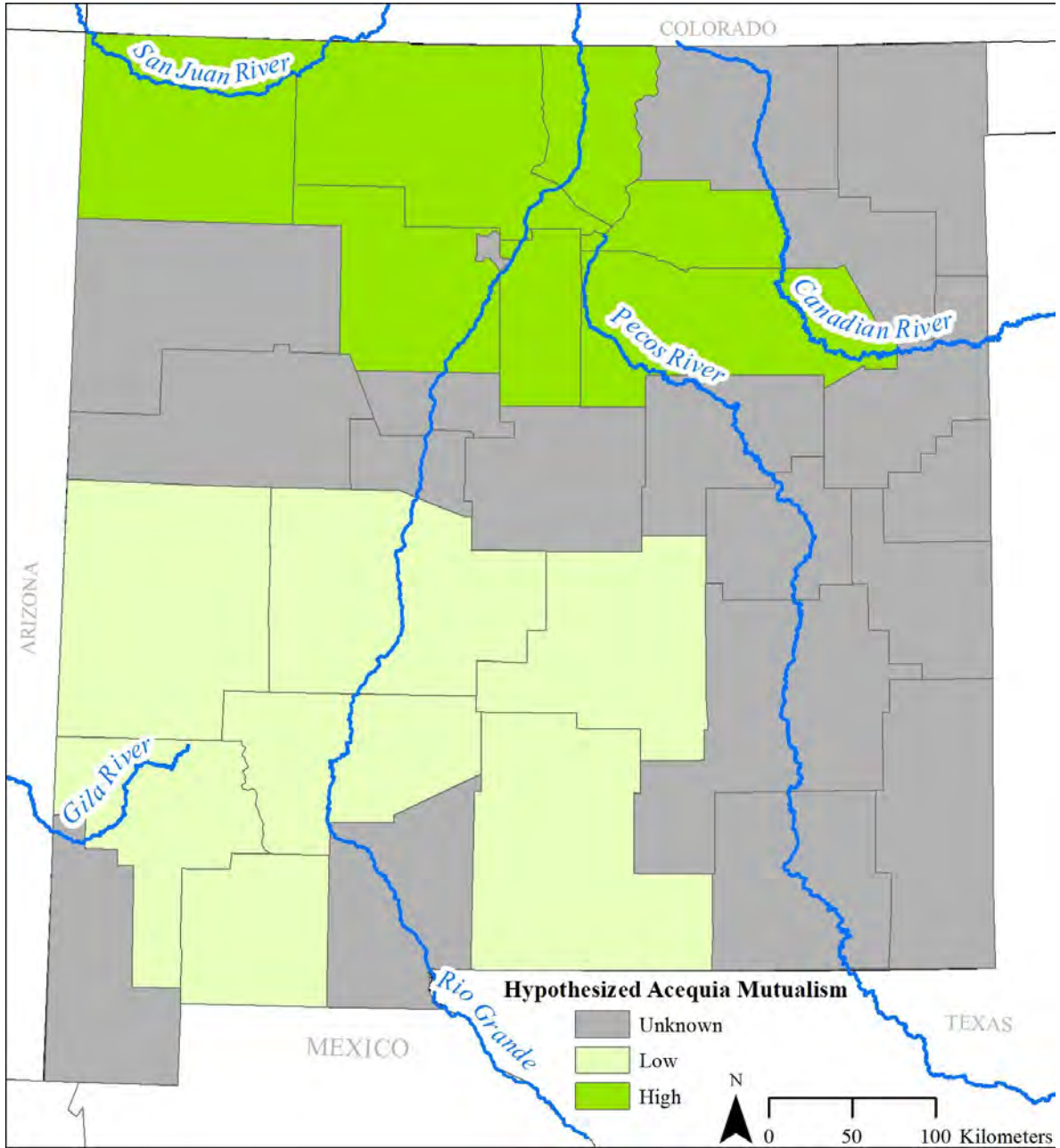


Figure 5. Acequia characteristics perceived to best contribute to acequia adaptive capacity, past adaptation, and resilience: Alcalde-Velarde region.

HYPOTHESIZED ACEQUIA MUTUALISM



NM DSWB COMMUNITY RESILIENCE CONVERSATIONS

- NM WRRI will host a series of virtual community conversations to gain insight into possible water resilience strategies from New Mexico's hydroculturally diverse landscape.
- Data points within the NM DSWB can tell the stories of different water outlook scenarios around the state.
- These stories will then encourage discussion of possible resilience strategies.
- Findings from these conversations will be presented at the 66th Annual New Mexico Water Conference, and incorporated in the NM ISC's 50-Year Water Plan.

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PIVOTING FROM HISTORICAL TRENDS TO FUTURE RESILIENCE

- Using findings from NM DSWB Community Conversations to drive further participant contributions
- Breakout sessions from the perspectives of different water users and sources to identify challenges faced, constraints, and suggestions/opportunities for meeting future needs
- A resilience game session to test strategies for different water disturbance events
- Pre-conference surveys and live polling questions will gain additional insight across many participants

GROUNDWATER CONSERVATION PROJECT

GOAL

- Improve water sustainability of New Mexico river valley agricultural operations and associated communities

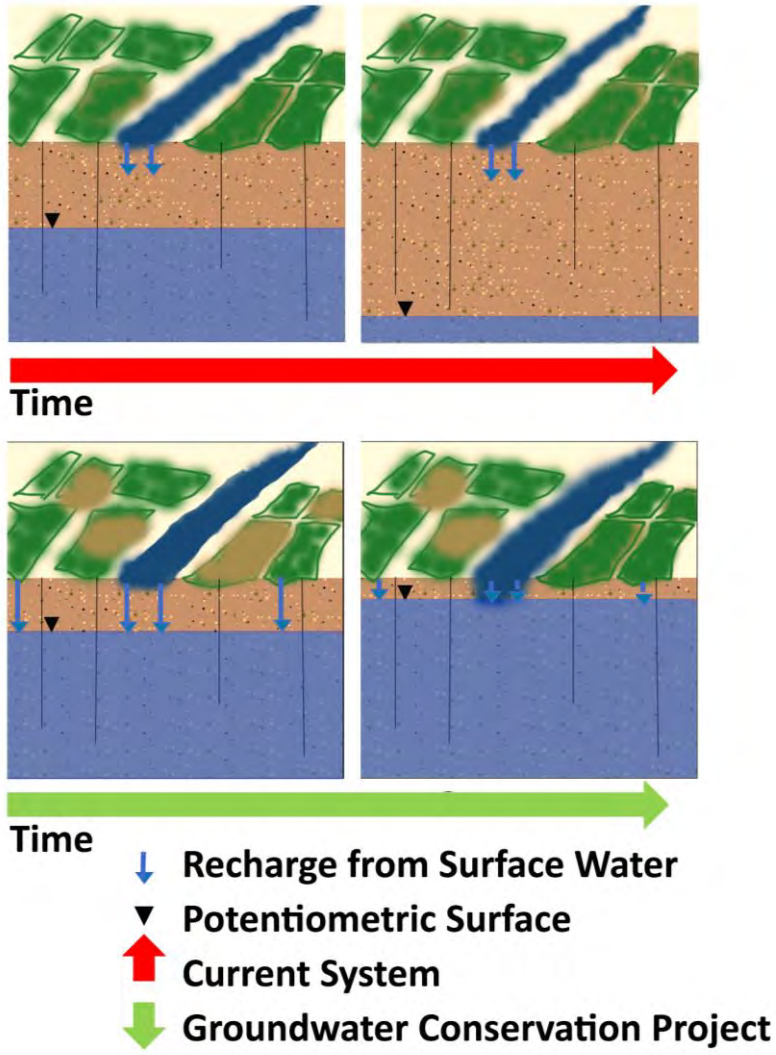
APPROACH

- Work with stakeholders to identify desirable fallowing and water demand reduction strategies
- Assess the impacts of these strategies on water budgets and agricultural economies

IMPACTS

- Save water through reduced groundwater pumping
- Improve environmental quality and reduce dust storms
- Support farmer livelihoods
- Plan for water resilience with NMDSWB and 50-yr water plan

$100K Legislative request for recurring RPSP funding:
Request moving through NMSU approval process



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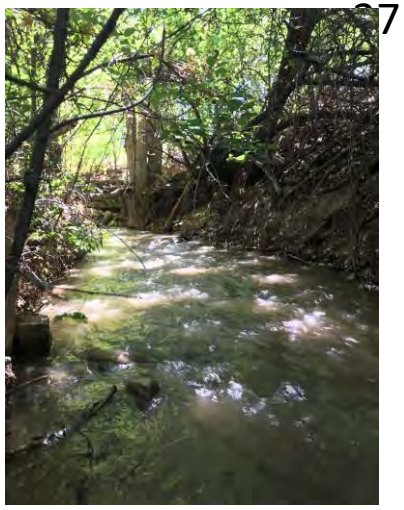
THANK YOU!



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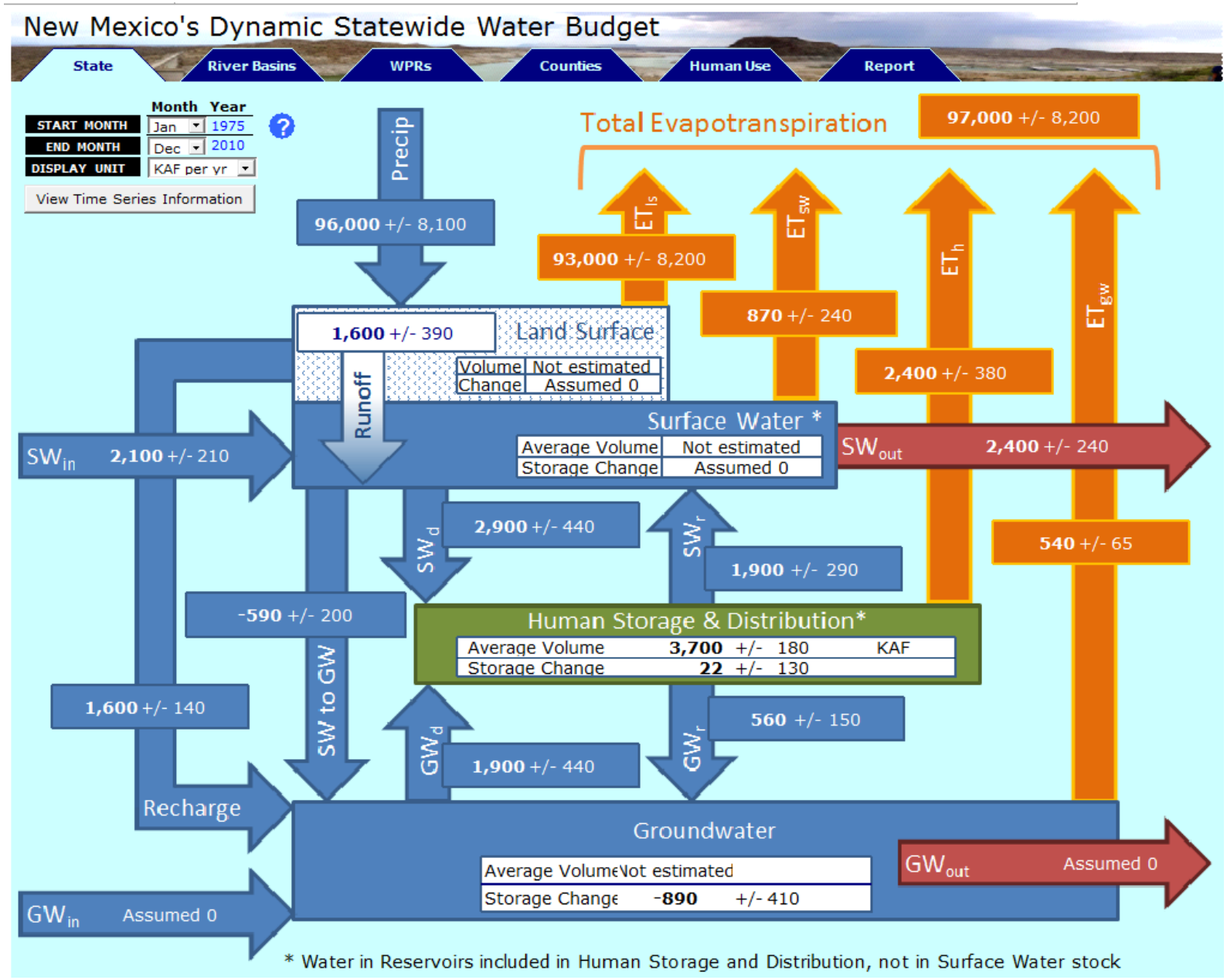
ADDITIONAL SLIDES


New Mexico's Dynamic Statewide Water Budget
State
River Basins
WPRs
Counties
Human Use
Report
START MONTH Jan 1975
END MONTH Dec 2010
DISPLAY UNIT KAF per yr
Month Year
View Time Series Information
Precip
96,000 +/- 8,100
Total Evapotranspiration
97,000 +/- 8,200
ET_ls
93,000 +/- 8,200
ET_sw
870 +/- 240
ET_h
2,400 +/- 380
ET_gw
540 +/- 65
1,600 +/- 390
Land Surface
Volume Not estimated
Change Assumed 0
Runoff
Surface Water *
Average Volume Not estimated
Storage Change Assumed 0
SW_in 2,100 +/- 210
SW_out 2,400 +/- 240
SW_d 2,900 +/- 440
SW_r 1,900 +/- 290
-590 +/- 200
SW to GW
Human Storage & Distribution*
Average Volume 3,700 +/- 180 KAF
Storage Change 22 +/- 130
1,600 +/- 140
GW_d 1,900 +/- 440
GW_r 560 +/- 150
Recharge
Groundwater
Average Volume Not estimated
Storage Change -890 +/- 410
GW_out Assumed 0
GW_in Assumed 0
* Water in Reservoirs included in Human Storage and Distribution, not in Surface Water stock

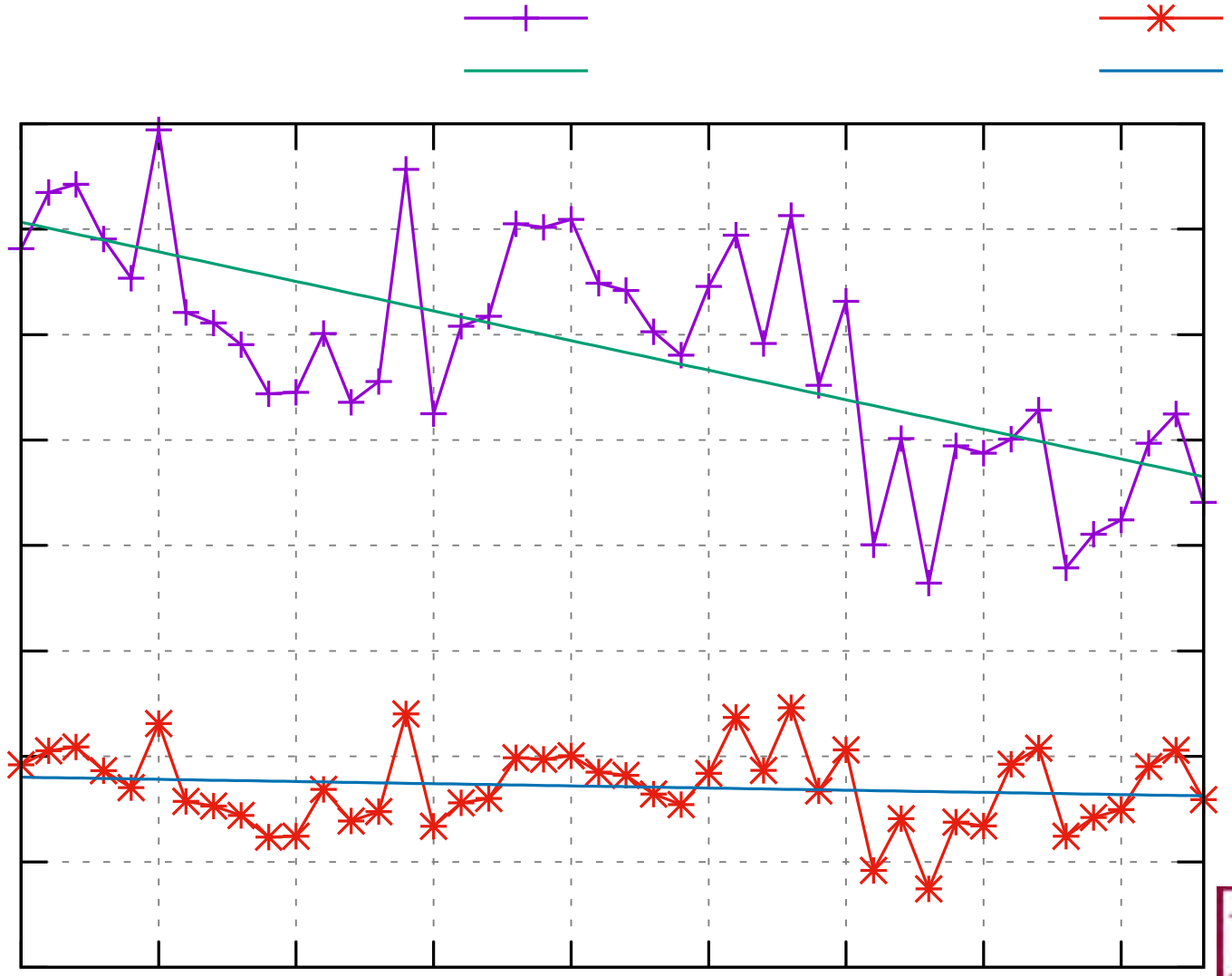
ELEPHANT BUTTE RESERVOIR

Google Earth image of Elephant Butte in 1998.

Google Earth image of Elephant Butte in 2021.

IRRIGATED AGRICULTURE TOTAL (SW + GW) WITHDRAWAL AND DEPLETION IN DONA ANA

- If we consider withdrawals only, the general trend of total water use for irrigated agriculture has been declining in Dona Ana since 1975.
- However, the consumptive use (depletion) has had a steady long-term trend. In other words, the lower withdrawals did not translate into less consumption.
- These trends may be explained by relatively higher temperatures, higher ET, and less recharge along with changing irrigation technology.



Analyzing Groundwater Recharge in New Mexico

In arid regions like New Mexico in the US, groundwater recharge (RE) is critical

Thus, it is important to understand the major hydrological contributors to RE

Data for five counties with various geographical features from 1975-2015 evaluated

Taos
Eddy
Torrance
Lea
Doña Ana

→ New Mexico Dynamic Statewide Water Budget Model →

Hydrological contributions of precipitation (P), surface water (SW), and evapotranspitation (ET) to RE varied based on regional geography

Statistically significant abrupt change in RE (change-point) for all counties in the 1990s

Decline in RE after the change-point in all counties

P and SW played dominant roles in impacting RE in northern NM; ET had the highest and increasingly continuous influence in central and southern NM

Strong connection between decreasing snowpack, agriculture, and industries with RE, although more studies needed

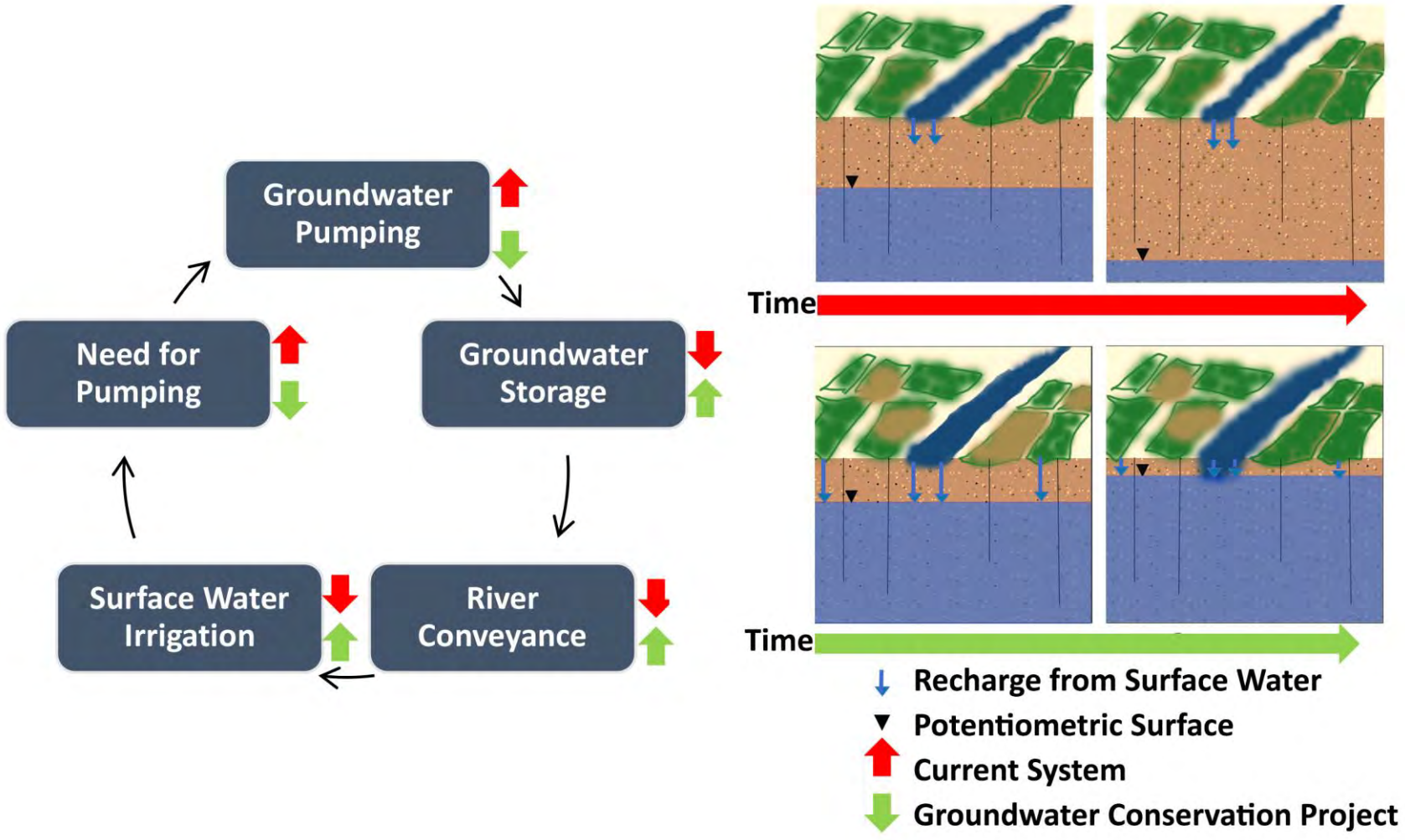
Planning water budgets need to account for regional variations in groundwater recharge to maintain the water table

JAWRA
JOURNAL OF THE AMERICAN WATER RESOURCES ASSOCIATION

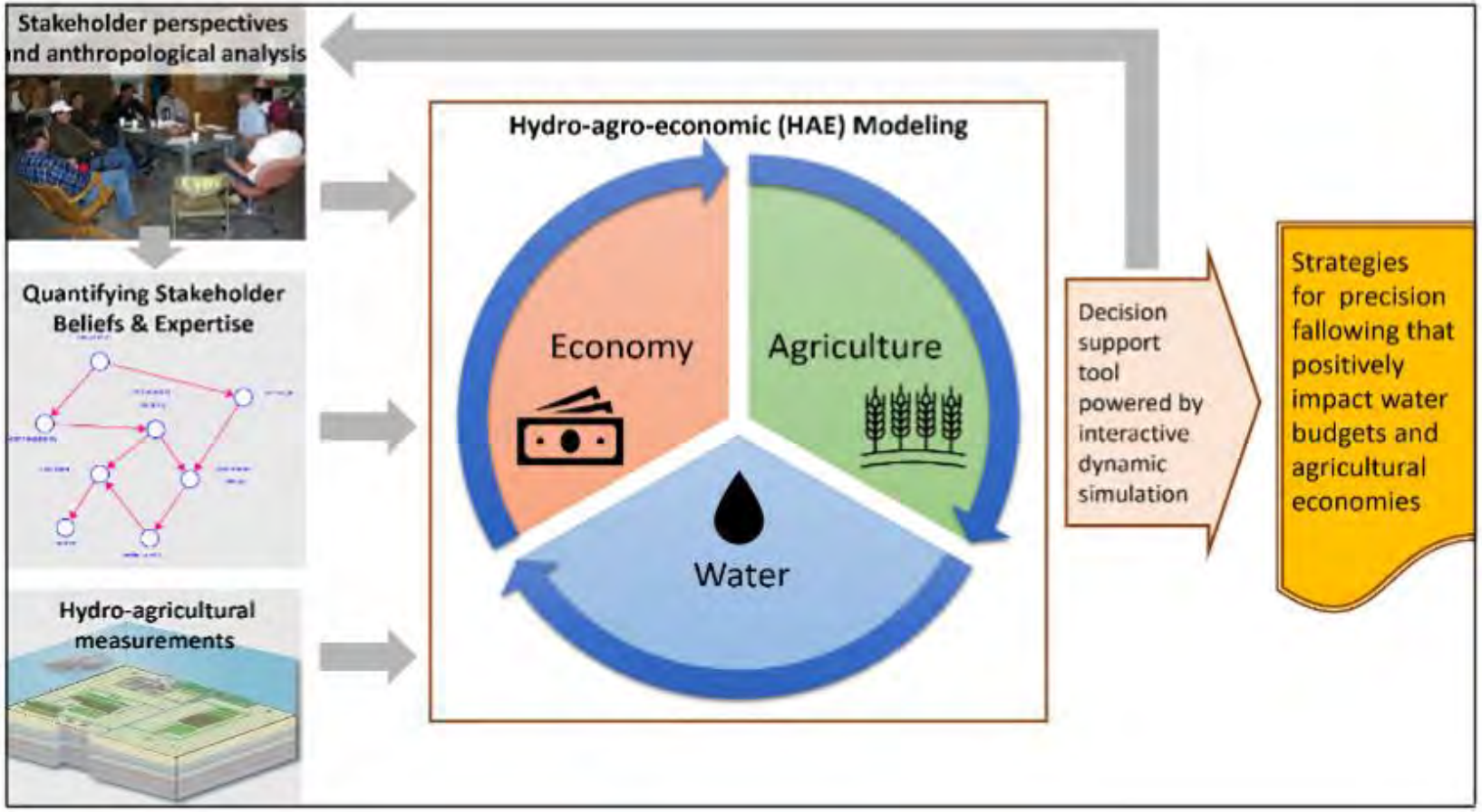
Assessing Long Term Changes in Regional Groundwater Recharge Using a Water Balance Model for New Mexico

Li *et al.* (2021) | Journal of the American Water Resources Association

PROPOSED COMMUNITY RESEARCH PROJECT: GROUNDWATER CONSERVATION THROUGH WATER DEMAND REDUCTION



DECISION TOOL PROCESS: GROUNDWATER CONSERVATION THROUGH PRECISION FALLOWING AND LAND MANGEMENT



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