Upper Watershed Health Effects on Downstream Users

Water and Natural Resources Committee 9/7/2021

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The New Mexico Water Resource Research Institute (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).

Watershed dynamics in New Mexico

New Mexico has a diversity of ecological conditions, today, I will address several major dynamics of watersheds and the management to improve water quality and quantity

Forested regions

near Tijeras, New Mexico

Northern NM, Acequia regions

Peggy Boney - farm in Mora County

Southern Desert regions

Rincon Arroyo Watershed, Doña Ana County

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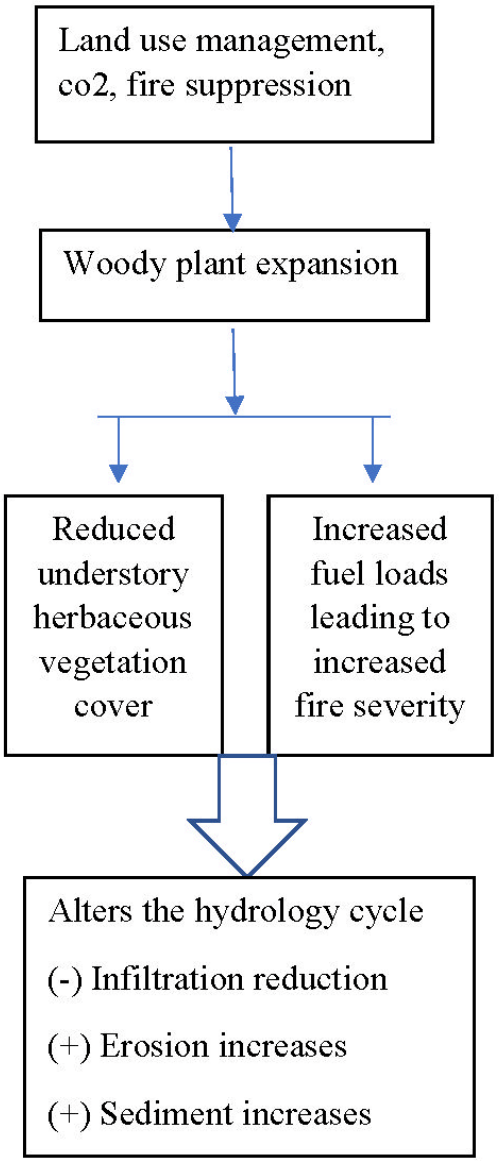
Watershed Dynamics in Forested Regions



Issue: Woody plant encroachment into grasslands and savannas

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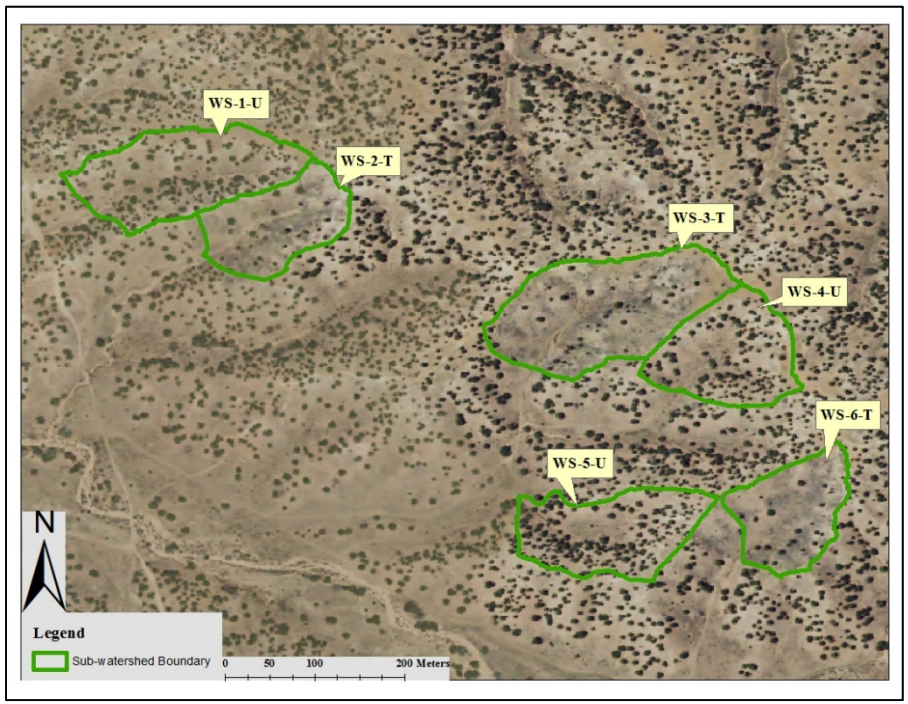
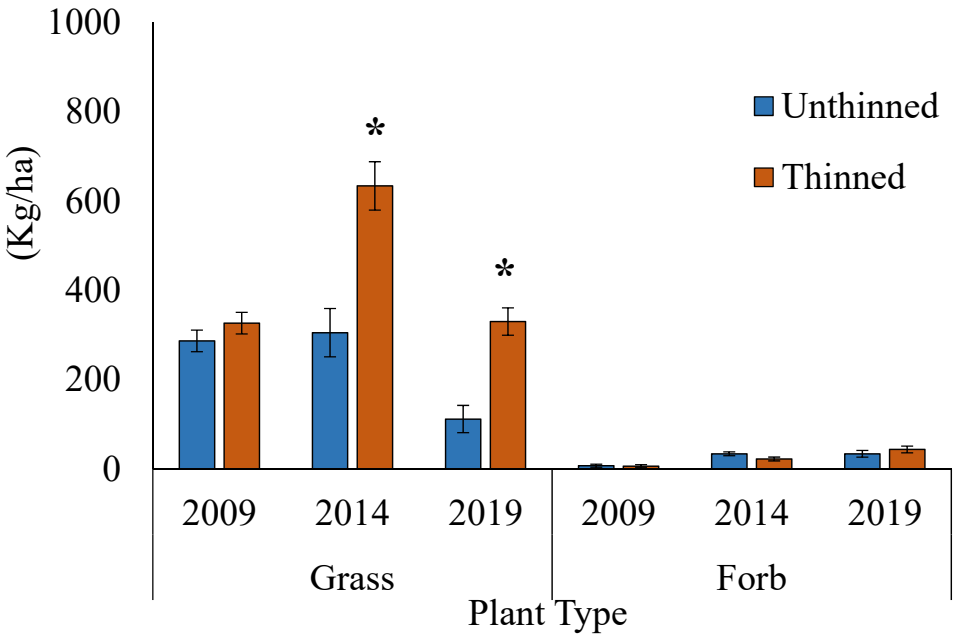
Understory vegetation and runoff response to thinning of a pinon-juniper woodland: Santa Fe Ranch

Study on 3 watersheds paired with 3 control watersheds (untreated)



The average of herbage production from unthinned and thinned pinon-juniper woodland in 5 and 10 years post-treatment



Results: I) Thinning increased grass cover, II) In this area with low precipitation levels, did not have significant effect on annual runoff[1,2].

1. Ochoa, C., Fernald, A., Tidwell, V., 2008. Rainfall , Soil Moisture , and Runoff Dynamics in New Mexico Piñón-Juniper Woodland Watersheds. USDA Forest Service Proceeding RMRS-P-51. 67–74.

2. Almalki, Y., Fernald, A., Cibils, A., Cram, D., Ochoa, C.G., Steiner, R.L., 2015. Understory vegetation and soil moisture response to thinning piñón-juniper woodlands. New Mexico State University.

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Santa Fe Ranch and similar study results for stakeholder goals to increase downstream water yield

- In order to detect increase in water yield, a high amount of precipitation is needed. No water yield increases below 18" annual precipitation. The precipitation is too low to increase water yield by clearing trees[3,4].

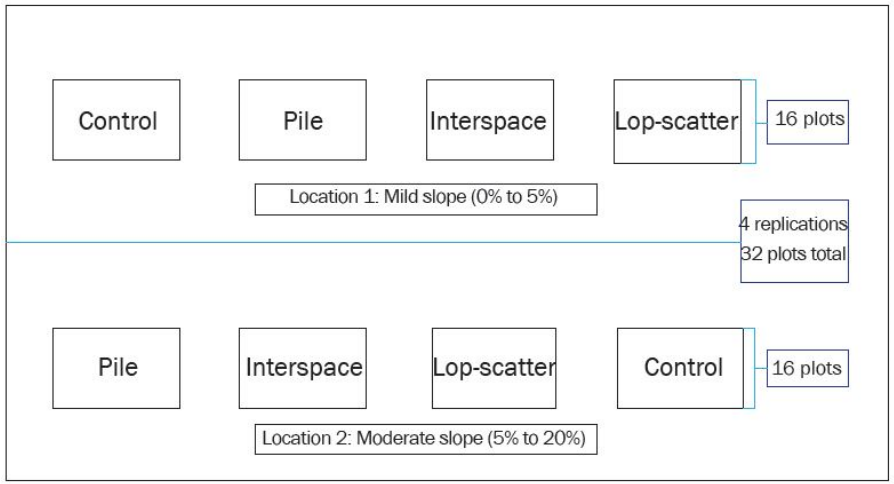
- Managing ponderosa forests for water yield and water quality: Water yield increase occurs in spring (when least needed); Usually need to remove more than 50% of basal area to increase water yield; Even with 100% tree removal, water yield will temporarily increase by 25% maximum or much less[3,4].

- In general, forest clearing has many benefits, but studies are not supporting the strategy an easy source of lots of water for New Mexico[4].

3. MacDonald, L.H., Stednick, J.D., 2003. Forests and Water: A State-of-the-Art Review for Colorado. Chapter2. PPT 7-9. CWRRI Complet. Rep. 65.
4. Fernald, A.. Watershed Management Presentation RGSC 318/518. New Mexico State University.

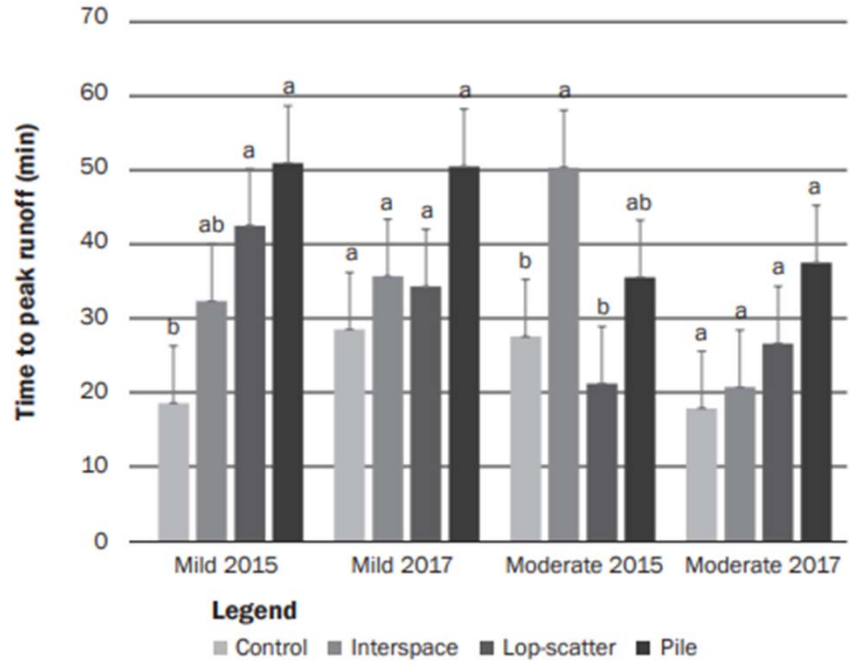
Runoff and sediment yield in areas subjected to four different forest thinning operations in a northern New Mexico mixed-conifer forest near Mora

Study: Effect of four different forest thinning operations on hydrological function



Results: Significantly longer time to peak flow, indicating lower flow energy, and lower sediment yield, indicating less erosion

Time to peak runoff means during wet runs from treatments by location by year interaction effect in a New Mexico forest near Mora, New Mexico. Lowercase letters represent the comparison among treatments within each location by year combinations. Means followed by same letters were not significantly different at 0.05 level.



Dry run sediment yield (kg ha⁻¹) estimates and inferences.

Treatment × location		Sediment yield (kg ha⁻¹) Control	Interspace	Lop-scatter	Pile	*P*-value
Location	Mild	6.07a	5.33a	6.23a	6.11a	0.9443
	Moderate	5.45c	8.32bc	10.93ab	12.39a	0.0015

Atalar, F., O. Beyazoglu, A. Fernald, O. Burney, D. VanLeeuwen, and D. Cram. 2021. A case study of runoff and sediment yield in areas subjected to different forest thinning operations in a northern New Mexico forest. Journal of Soil and Water Conservation.

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Simulated browsing and soil-plant water dynamics in relation to sapling size and density: Corona — Savanna ecosystem

	Treatment			
	Herbecide in year 1	Single clipping in year 1	Single clipping in years 1 and 2	Control
Size	Small Sapling	Small Sapling	Small Sapling	Small Sapling
	Large Sapling	Large Sapling	Large Sapling	Large Sapling
Patches	Sparse Sapling	Sparse Sapling	Sparse Sapling	Sparse Sapling
	Dense Sapling	Dense Sapling	Dense Sapling	Dense Sapling

Study to determine how different types of thinning effect soil moisture and understory. Study is still running, with initial results indicating:

1) Simulated browsing (sapling defoliation) frees up (retains) detectable amounts of soil moisture, which results in increased runoff, increased understory growth, and new seedling establishment.
2) The effects of defoliation are contingent on sapling size and stand density.

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COLLEGE OF AGRICULTURAL, CONSUMER AND ENVIRONMENTAL SCIENCES

Assessment of Postfire Debris-flow Hazards, La Jara Watershed, North-central New Mexico

Douglas S. Cram, Robert Sabie, Jr., Samuel T. Smallidge, and Nicholas K. Ashcroft[1]

Agricultural Experiment Station • Cooperative Extension Service • RITF-86

https://aces.nmsu.edu/pubs/_ritf/RITF86/welcome.html

Research on the potential hazards of a wildfire

The community of La Jara, New Mexico, relies on perennial surface water from the La Jara Watershed for drinking and irrigation. The community's drinking water treatment infrastructure is located just one half-mile from the base of this watershed in the direct path of a potential debris flow.

Results found that if there ever were a wildfire a high probability of a debris flow even with a common rain event due to the current fuel load. Reduction treatments, such as thinning followed by prescribed fire and so-called "fire use for resource benefit," have been shown to reduce subsequent fire severity, thereby reducing the potential for damaging postfire debris flows.

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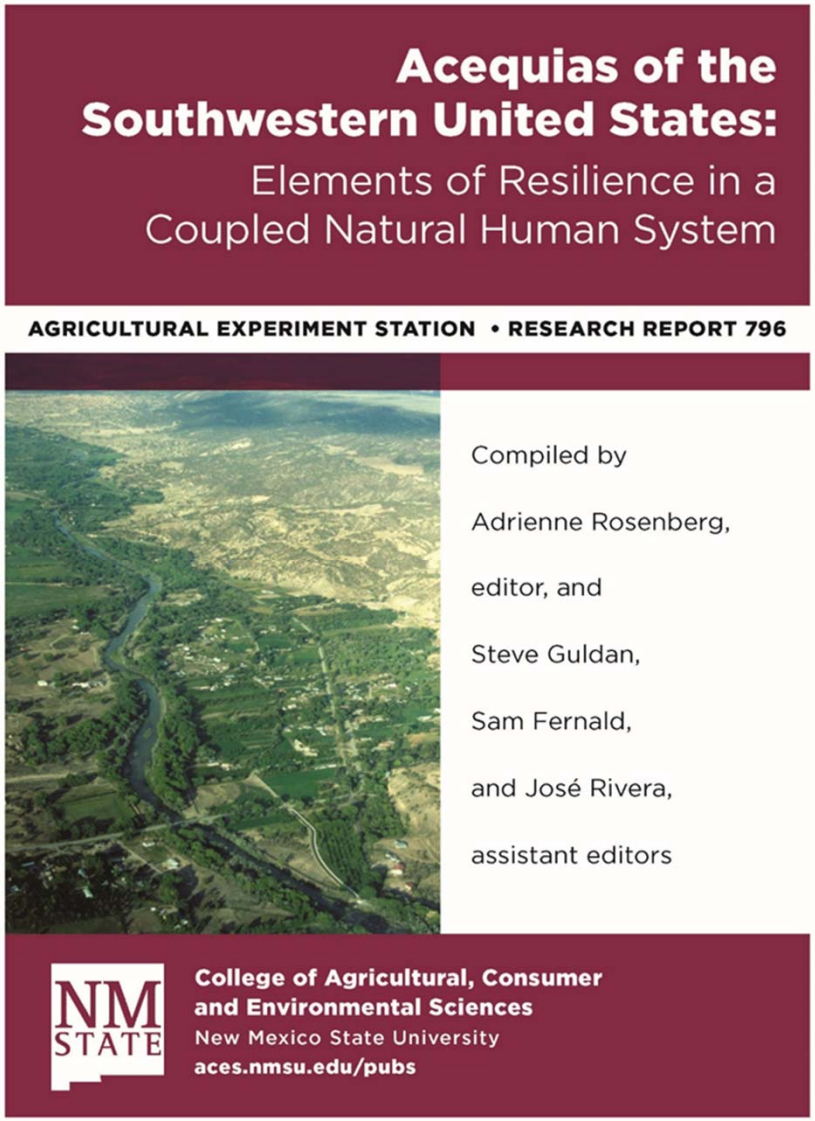

Acequia irrigation system clues to water resilience

Dr. Fernald presented results of NM WRRI research on Acequias at the August 12th WNRC meeting

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

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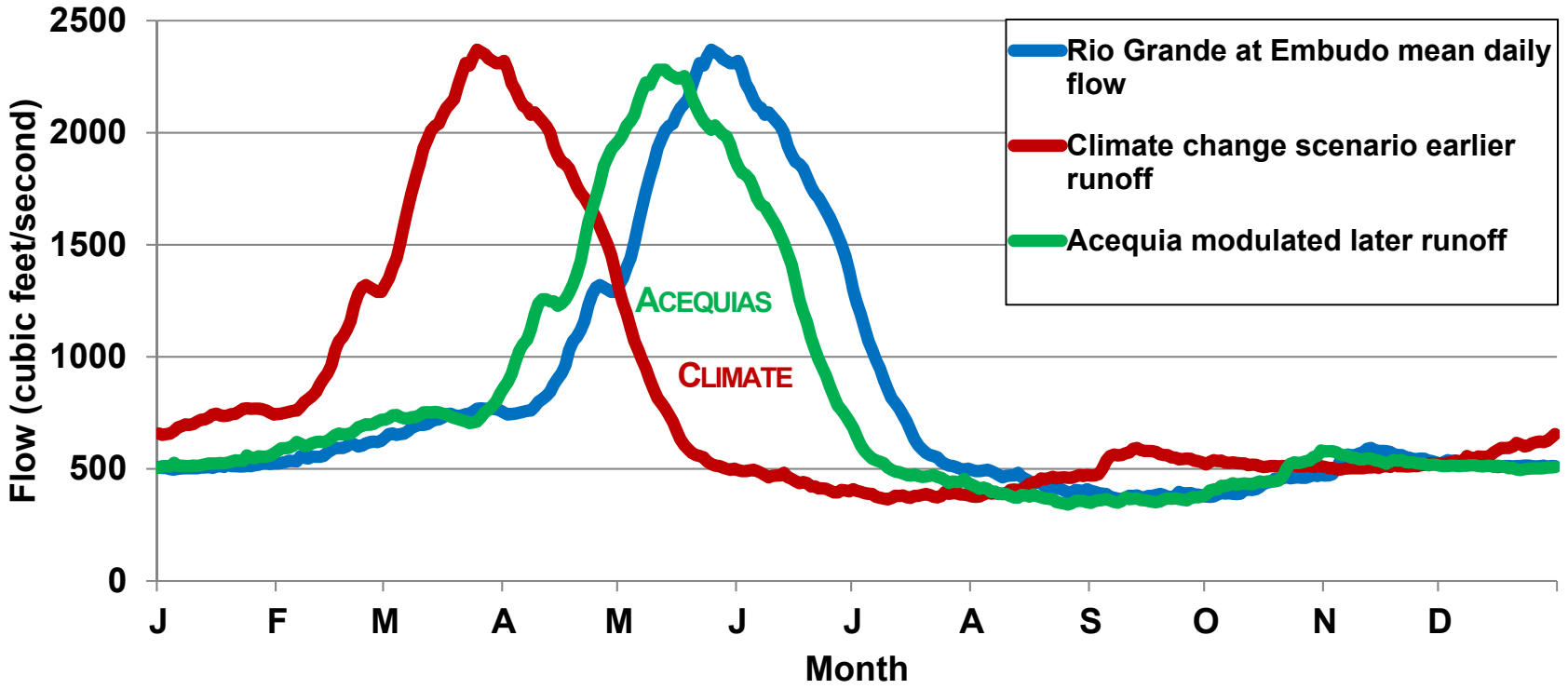
Acequias perform the function of floodplains, storing and conveying water slowly

The farmers spread flow across the floodplain fields, where it infiltrates into the soil, is stored and released slowly to the river, as well as recharges groundwater, which also contributes to surface flow

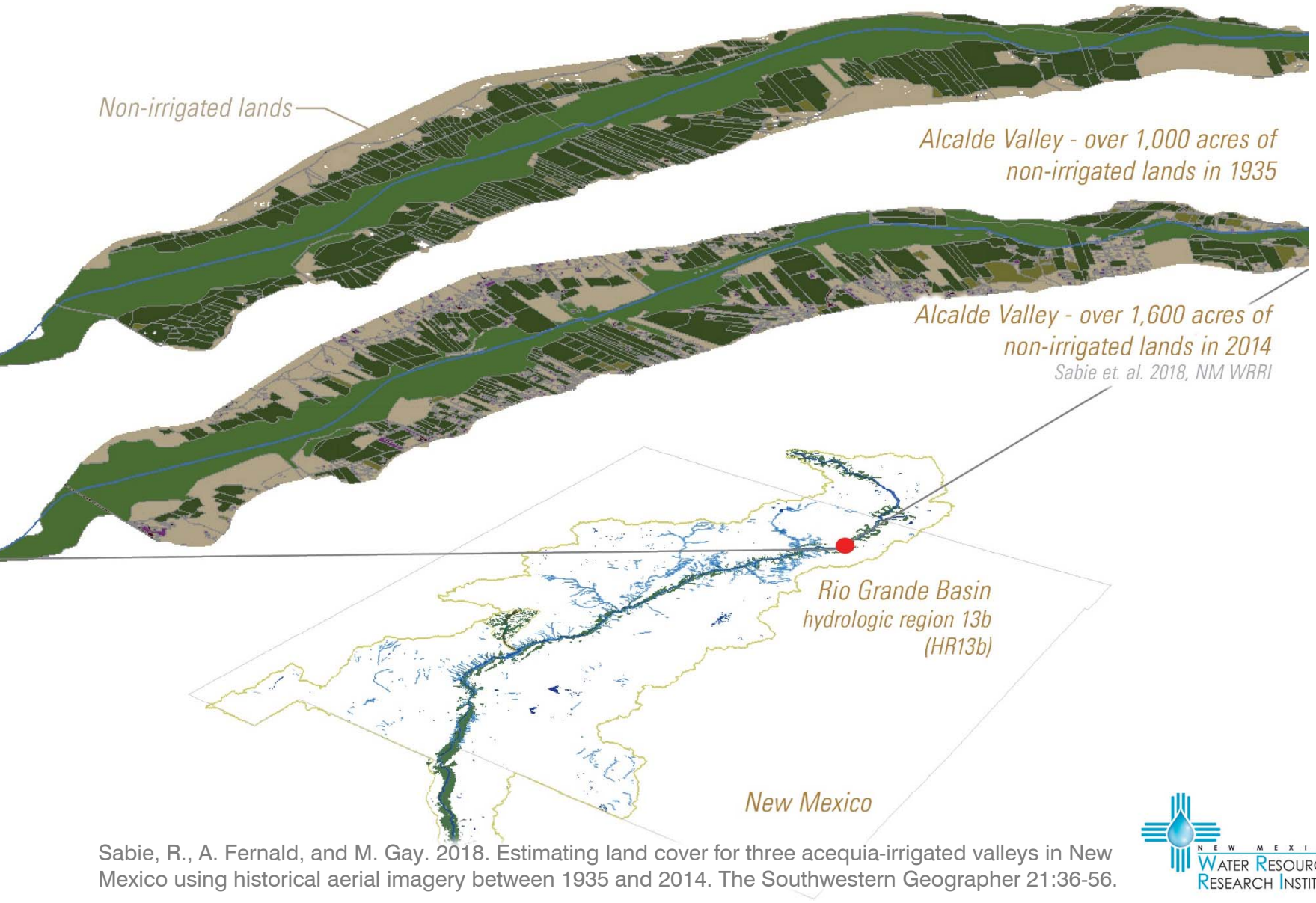
Acequias delay spring runoff that is projected to be earlier in the year

Acequias mimic snowpacks, they perform the same delay function by storing water and releasing it slowly

That delay can help offset some of the effects of climate change, which result in snowpack melting earlier



One result of protecting *Acequias* is the protection of surface water flows for downstream users



~60% increase in non-irrigated (fallowed) lands over 79 years

Sabie, R., A. Fernald, and M. Gay. 2018. Estimating land cover for three acequia-irrigated valleys in New Mexico using historical aerial imagery between 1935 and 2014. The Southwestern Geographer 21:36-56.

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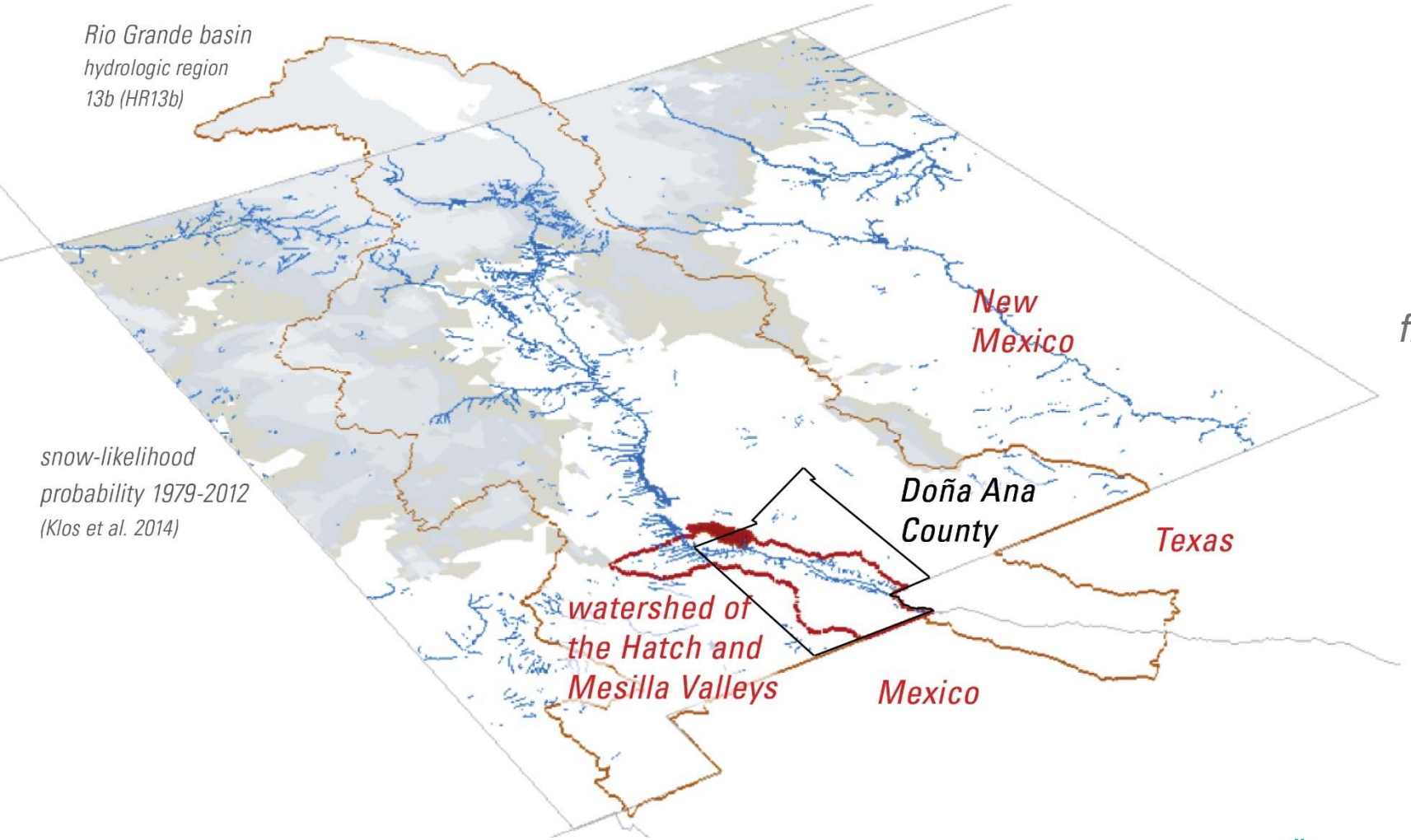
Watershed Dynamics in Southern Desert Regions



Valleys depend on surface water from the North, and the uplands on local climate conditions

Hatch and Mesilla Valley Watershed Planning Process

Preliminary identified issues by stakeholders:

1) Increasing erosion and flooding from degraded upper watersheds
2) Water scarcity and aquifer depletion
3) Urban development in arroyo flow zones
4) Increase coordination to achieve goals and reduce conflict
5) Coordinated watershed planning efforts in the National Monument

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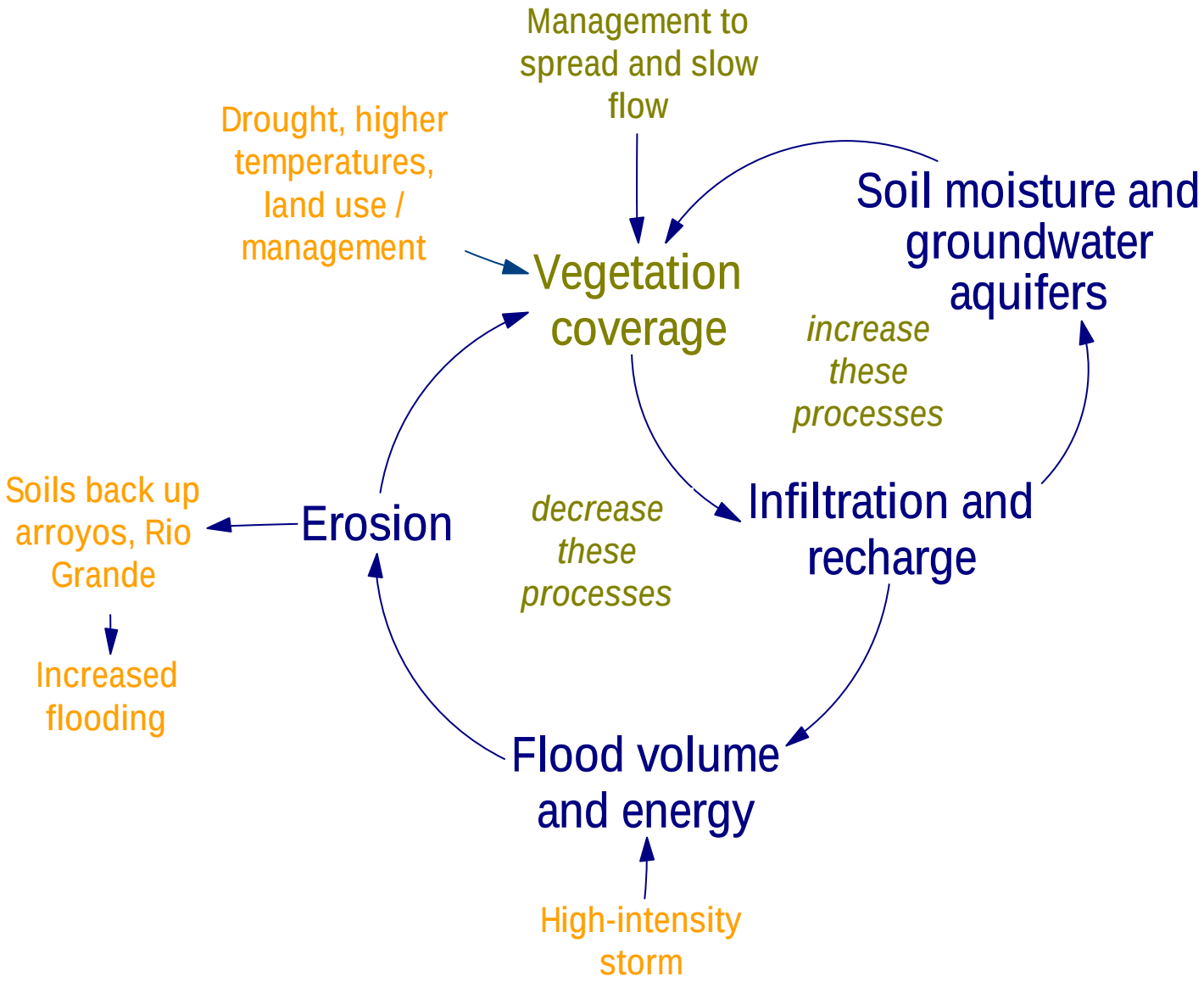
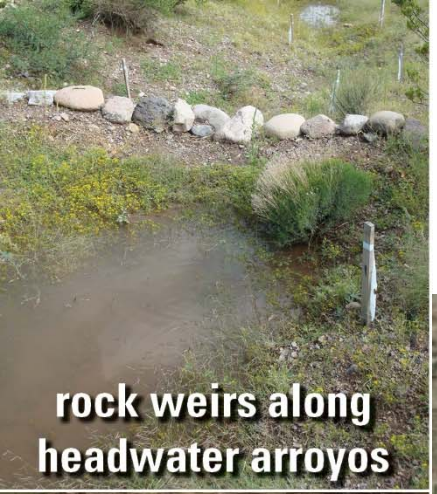


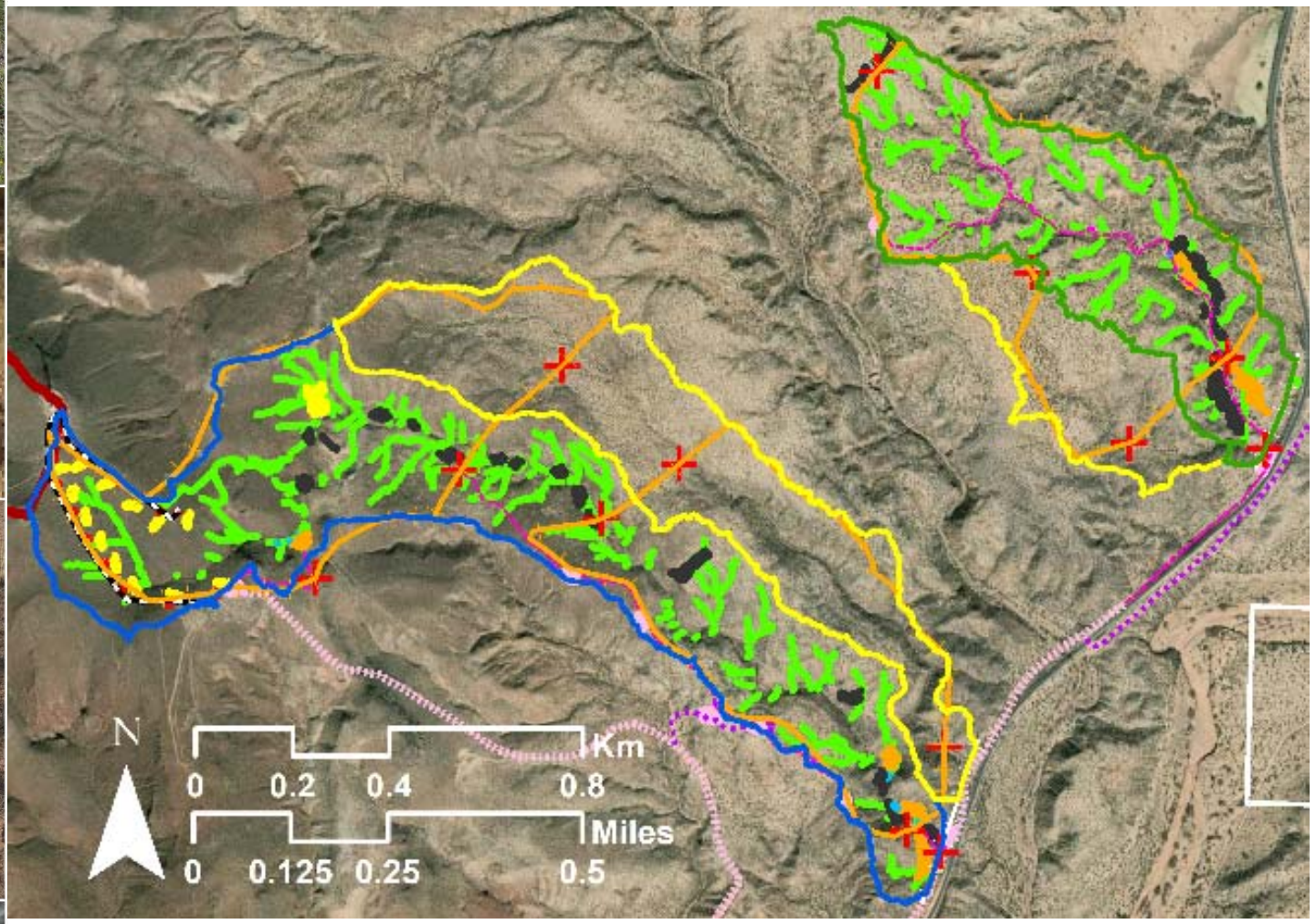
Understand and manage the natural dynamics

Manage flow to increase vegetation to kick start restoration processes

- *Maxwell, C. M., A. G. Fernald, D. Cadol, A. M. Faist, and J. P. King. 2021. Managing flood flow connectivity to landscapes to build buffering capacity to disturbances: An ecohydrologic modeling framework for drylands. Journal of Environmental Management 278:111486.*
- *Opperman, J. J., R. Luster, B. A. McKenney, M. Roberts, and A. W. Meadows. 2010. Ecologically functional floodplains: connectivity, flow regime, and scale. JAWRA Journal of the American Water Resources Association 46:211-226.*

On scale of restoration practices - pilot project to quantify effects





Restore dynamics upstream from erosion:
Quantify effects on runoff, soil moisture, vegetation coverage, and *E. coli* transport

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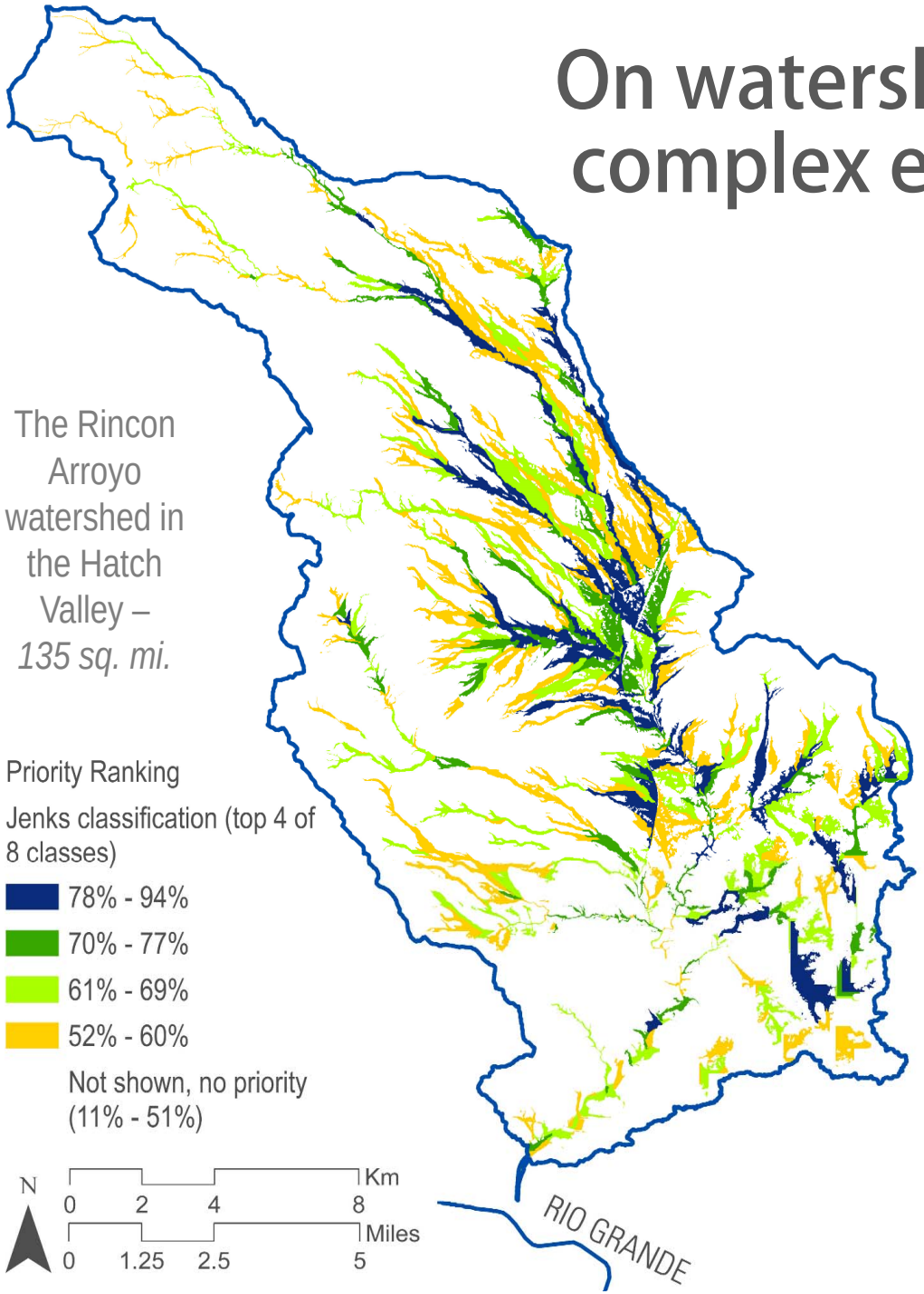
On watershed scales, we synthesize complex ecosystem characteristics



Tool developed to identify best locations for spreading flow and how much restoration is needed to achieve goals

Topographic indicators

- Upstream from erosion
- Widest floodplains
- Channel depth < 3.5’
- Low slope areas with flow

Soil indicators

- High infiltration capacity
- Soil available water storage capacity (AWS) that supports vegetation

Flow indicators

- Volume
- Frequency

Maxwell, C. M., A. G. Fernald, D. Cadol, A. M. Faist, and J. P. King. 2021 draft. Managing the buffering capacity of dryland watersheds using vegetation pattern indicators: An ecohydrologic modeling framework to predict the effects of connecting flood flow to the landscape. Target journal: Journal of Environmental Management.

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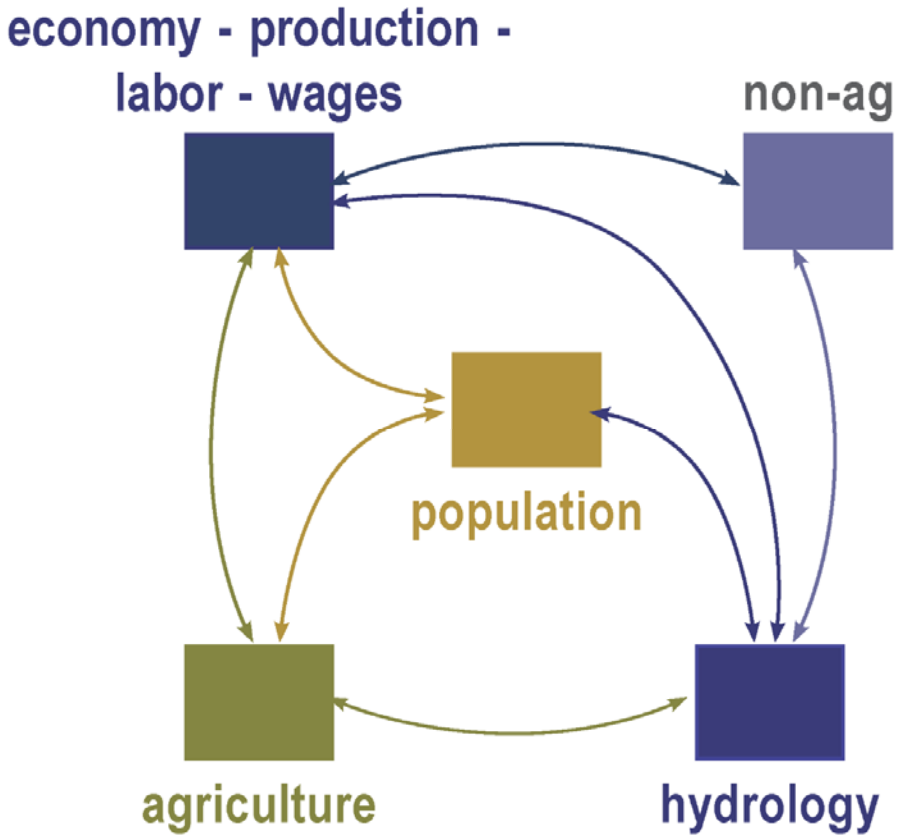
On regional scales, we collaboratively develop critical understandings and evidence to inform management of the watershed



We work collaboratively with land and water managers and the larger community to understand their visions and challenges.

We test the ability of strategies to achieve these visions using customized models that integrate the best science and data:

- Dynamic Statewide Water Budget Model results
- Regional unique dynamics
- Socio-economic factors

Initial modeling has estimated strategies of flow management that can reduce upland flow energy and maintain enough flows for valley aquifer recharge.

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Thank you!

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