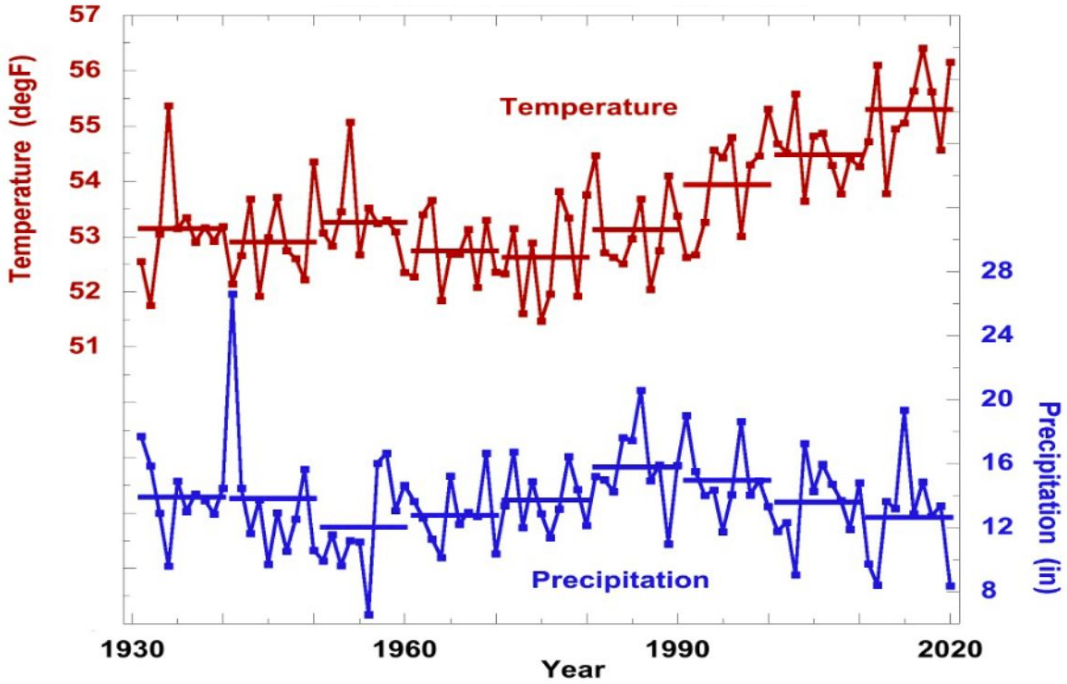
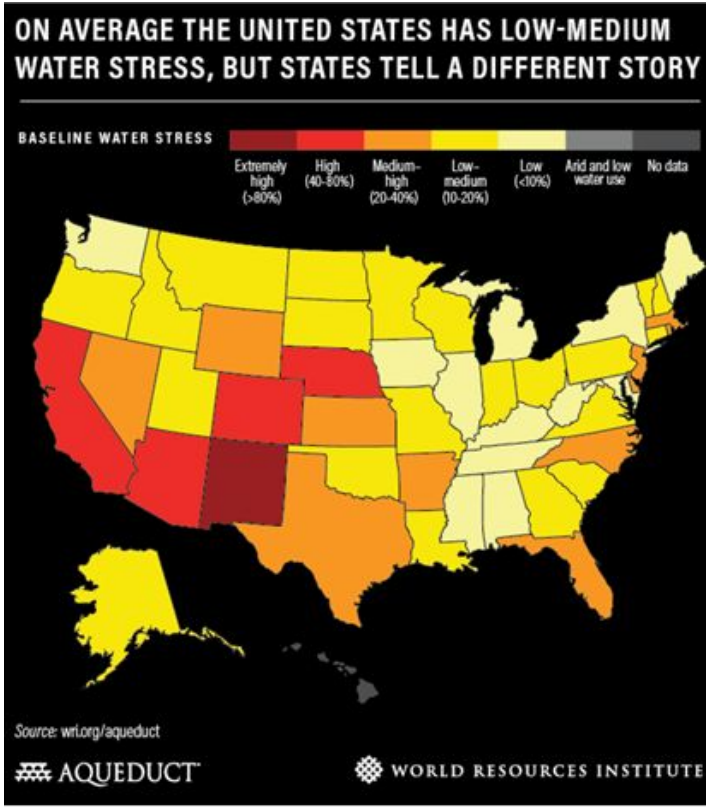
Water Challenges — Resilience to an Increasingly Arid and Variable Climate

Marcy Litvak
Jennifer Rudgers
Dept of Biology

Climate Change in NM

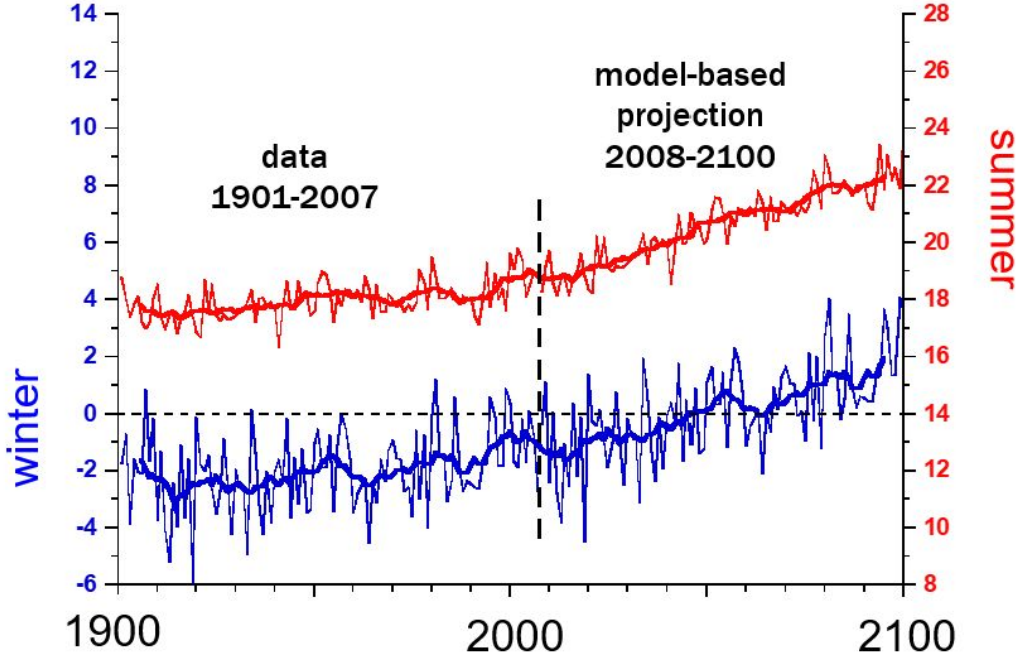
Temperature and Precipitation 1931-2020





https://geoinfo.nmt.edu/ClimatePanel/report/home.html

Climate Projections for NM

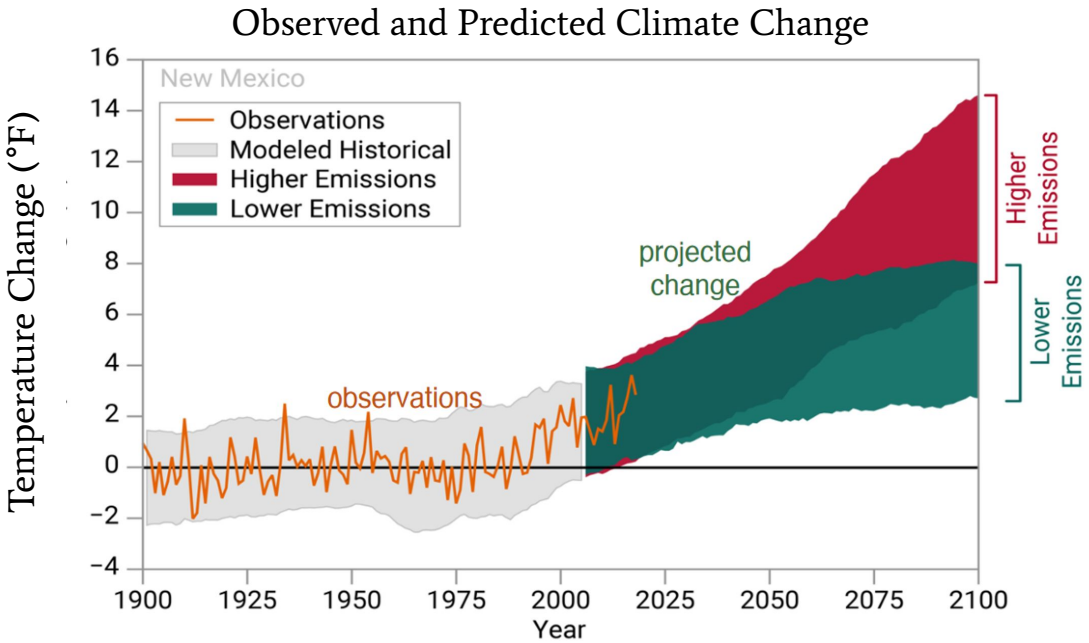


The Next 50 years in NM

- 5-7°F warmer
- 15-25 % less recharge to aquifers
- 25 % less flow in the Rio Grande
- 50 % less forest

... intensified competition for scarce surface and groundwater

Climate Projections for NM



By 2100...

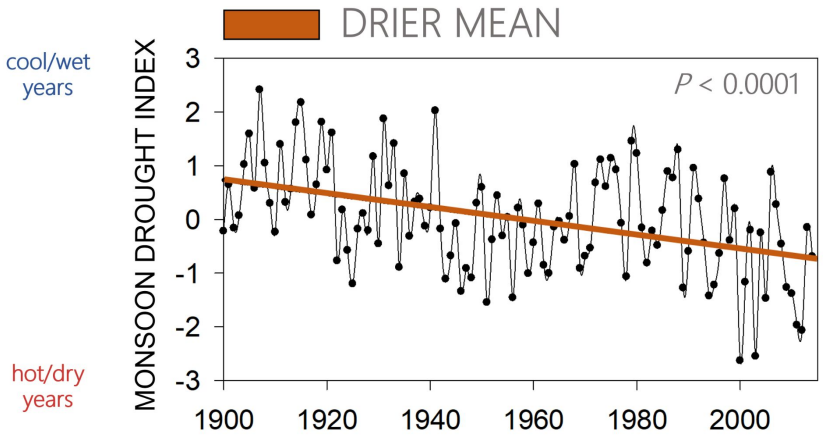
Albuquerque → El Paso

Taos → Española

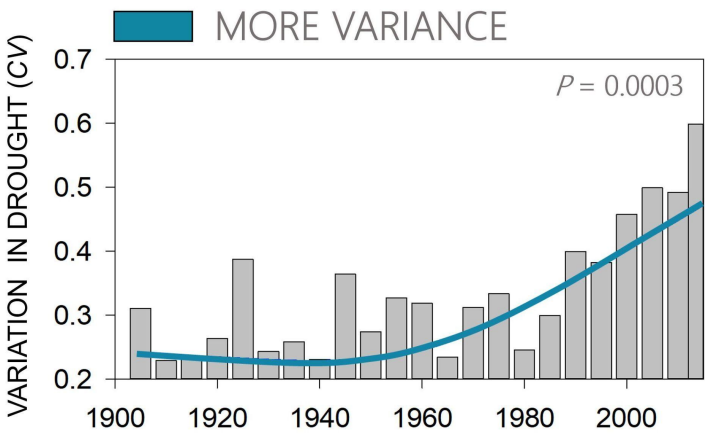
A1B Projections
Gutzler and Robbins (2011)
Climate Dynamics

Climate Change in NM

Summers are more arid



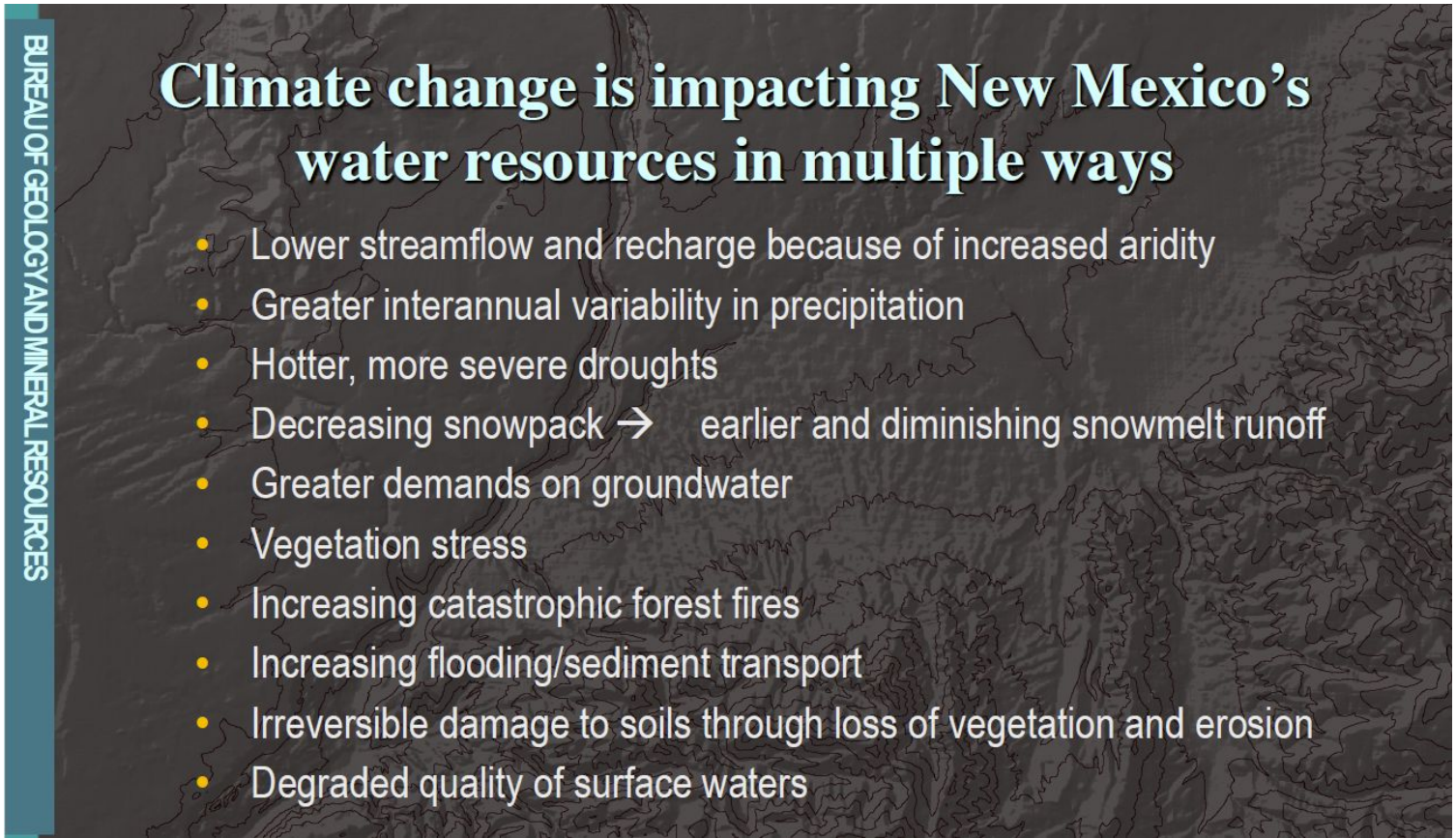
and more variable (less predictable)



Socorro, NM
Rudgers al. (2018)
Ecology

Recent report:

Climate Change in New Mexico Over the Next 50 Years: Impacts on Water Resources



SPECIAL SECTION: OUR CLIMATE FUTURE

Time to act *NOW*

SPECIAL SECTION: OUR CLIMATE FUTURE | REVIEW

Harnessing the potential of nature-based solutions for mitigating and adapting to climate change

SPECIAL SECTION: OUR CLIMATE FUTURE | REVIEW

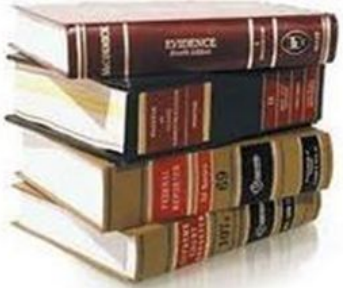
Getting ahead of climate change for ecological adaptation and resilience

Resilience

the capacity of a system to withstand threats without losing fundamental structure or function

UNM is tackling these research needs in a number of ways …

1) Grand Challenge for Sustainable Water
2) Existing Research Programs
    a) Center for Water and the Environment
    b) New Mexico Elevation Gradient
    c) Long Term Ecological Research - Sevilleta
    d) Bosque Environmental Monitoring Program
    e) METALS Superfund Center
3) Collaborative Efforts (EPSCoR, RIE)
4) Formation of New Institute - ARIE

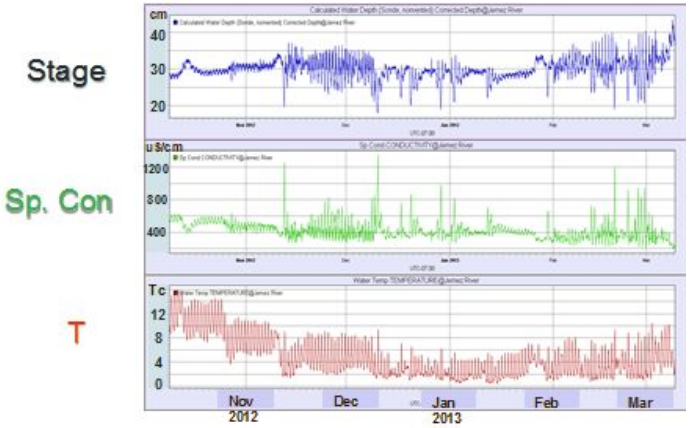


Goals

- Conduct research to help decision makers, communities, and individuals make better choices about how they use water.
- Become a repository of expertise that the state needs to responsibly manage water.
- Train the next generation of water managers and leaders

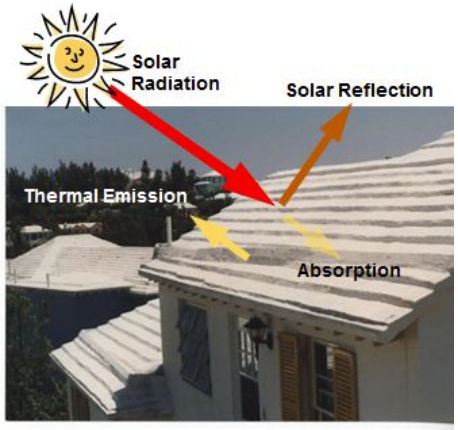
Sustainable Water Research Questions

1 What is the quantity and quality of our water and how is it changing?



2 How much water does the natural environment need and what happens if there is not enough?

3 What technologies will let us use less water and improve the quality of what's left?



Sustainable Water Research Questions

4

Can we use other sources of water, like wastewater and brackish groundwater?

How should water be shared among everyone who wants to use it, while maintaining economic vitality?

5

6

What is the best way to communicate with and educate our community about water?

Sustainable Water Grand Challenge Activities

Building UNM's water community

- Workshops
- Networking events
- Interdisciplinary seed grants
- Reaching out to stakeholders
- Start-ups for 2 new faculty

Promoting the visibility of UNM's water research

- Website
- News stories
- Publication highlights
- Seminar series
- Undergraduate research communication scholarship
- Partnering with Water Resources Program

Increased funding opportunities

- Seed grants led to $8.6 M (6 awards)
- Writing workshop led to $15 M NSF Transformation Network
- New faculty $300 K
- 9 new grants funded >$10 M

Metrics to quantify success

Dr. Alex Webster
Dept Biology

UNM PARTNERSHIPS

Community and Regional Planning, NanoScience & Microsystems Engineering, Landscape Architecture, Latin American Iberian Institute, Natural Heritage New Mexico, Biology Dept & Sevilleta LTER, Civil Construction & Environmental Engineering, Resilience Institute, Center for Stable Isotopes, Bosque Ecosystem Monitoring Program, Economics Dept, Utton Transboundary Resources Center, School of Law, Earth & Planetary Sciences Dept, Center for Water and the Environment, Political Science Dept, Geography Dept & Environmental Studies, Water Resources Program

The Intermountain West Transformation Network (imwTN)

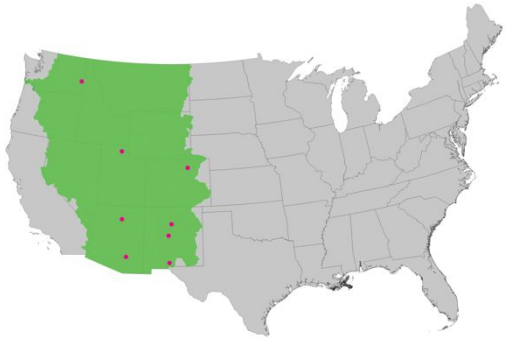
Mark Stone

5 Y $15 M grant from *National Science Foundation*

8 universities (led by UNM) and 50+ non-academic partnerships

Research and training programs to transform coupled urban-rural systems for sustainability

- Regional Food-Energy-Water Systems (Tribal Emphasis)
- Resilient Headwater Systems (Climate Change and Wildfires)
- Place Based Systems (Upper/Middle Rio Grande, Four Corners, Colorado Front Range, Yakima River Basin)



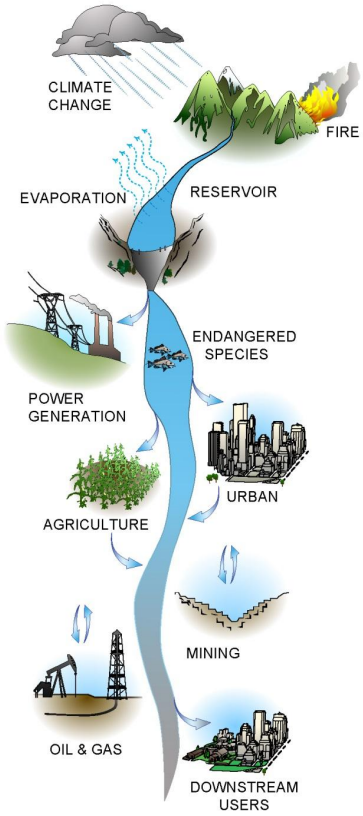
Center for Water and the Environment

- Since 2014 - currently $10 M from the National Science Foundation for Center for Research Excellence in Science and Technology (CREST)
- Cutting edge research on water and the environment: **watersheds, treatment technologies**, and the nexus of **energy development, water availability** and **contamination**
- Increased participation **of underrepresented minorities** in STEM, significant outreach to K-12 and local communities
- Supports **Southwest Environmental Finance Center** – training and assistance to water utilities throughout the country, with major funding from the EPA


Kerry Howe


Andrew Schuler

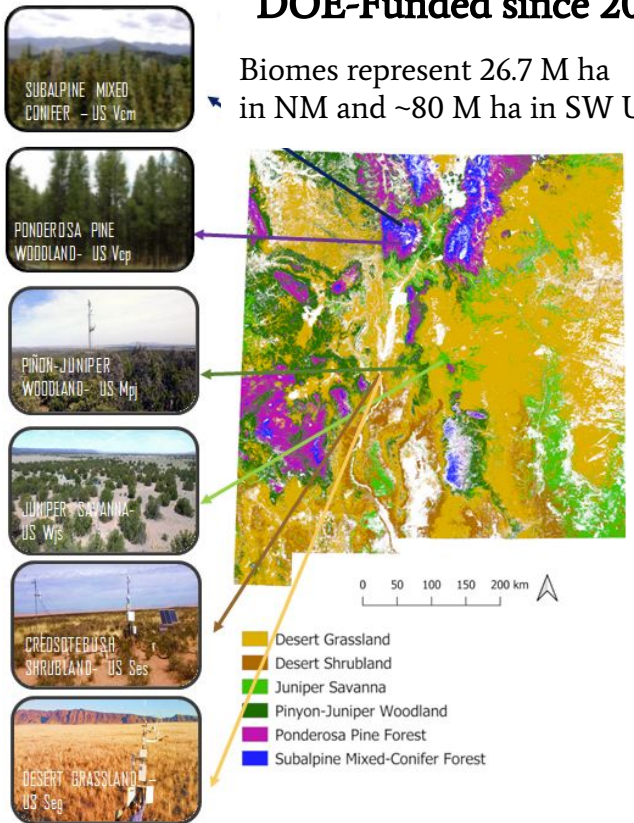
SOUTHWEST ENVIRONMENTAL FINANCE CENTER



New Mexico Elevation Gradient

DOE-Funded since 2007

Biomes represent 26.7 M ha in NM and ~80 M ha in SW US



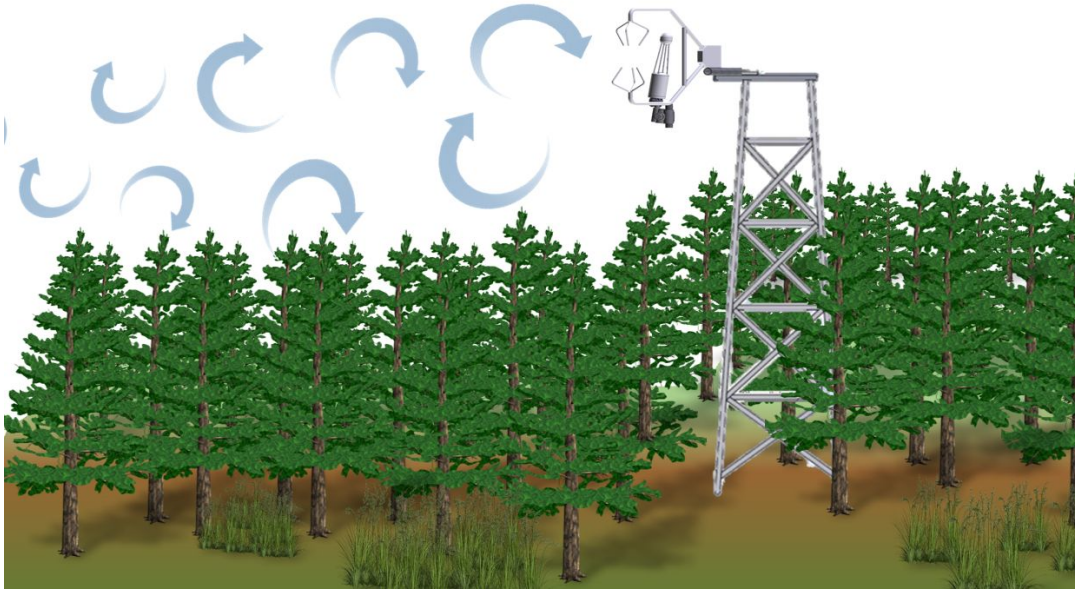
Vital roles of our NM ecosystems

1. Aesthetics/Recreation/Tourism
2. Erosion control
3. Biodiversity and habitat
4. Contribute to groundwater recharge
5. Sequester carbon (natural climate solution)
6. Release water to the atmosphere
   a. Carries heat away from the surface
   b. Increases cloud cover
7. Turbulent transfer of heat from the surface
8. Regulate sunlight reflection back to space

New Mexico Elevation Gradient

9 biomes

Continuous measurements of greenhouse gas, water vapor and energy fluxes at the ecosystem scale



- Site-level ecosystem process knowledge
- Long-term trends, inter-annual variability
- Time-based information for inventory needs
- Hot moments (drought, fire, insect outbreaks)
- Support management decision making
- Validate global climate modeling
- Ground-truth remote sensing (satellite) products

Sevilleta Long-Term Ecological Research Program

- NSF-funded since 1989
- $75 M in total/leveraged
- 910 pubs, 65,000 citations
- 73 Research scientists
- 50 Graduate students
- Undergraduate research REU

SEV-LTER: Mean - Variance Experiment

First experiment in the world to combine drier & more variable

Speeds up climate change to improve forecasts for common SW US ecosystems

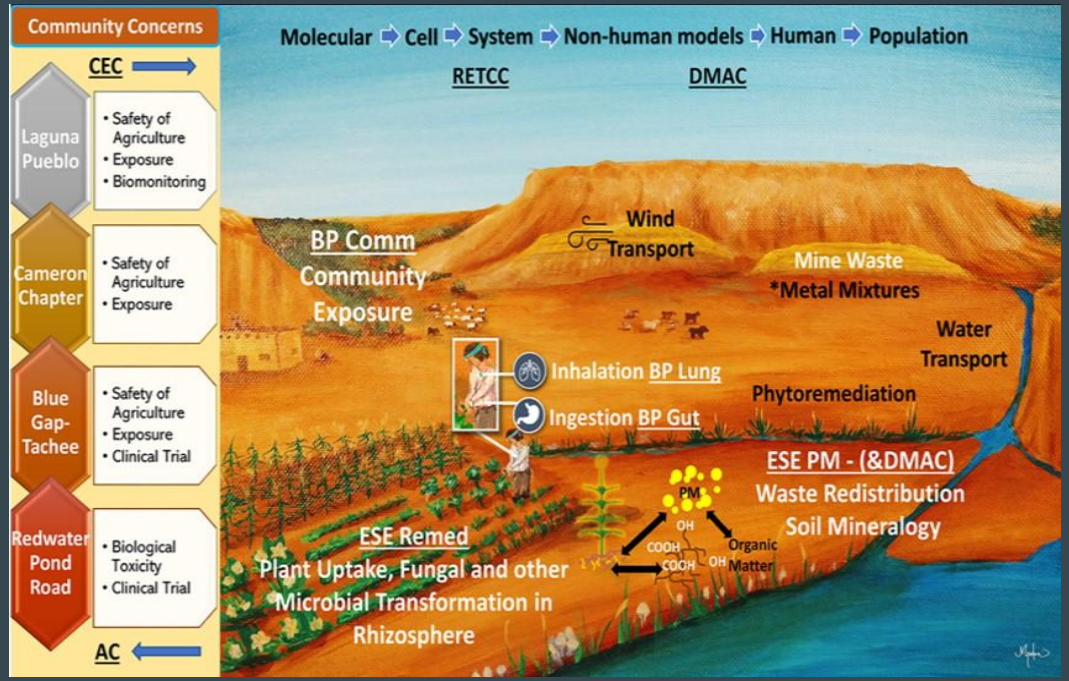
Bosque Ecosystem Monitoring Program

Equitable and inclusive hands-on student research to improve management of the Rio Grande ecosystem.

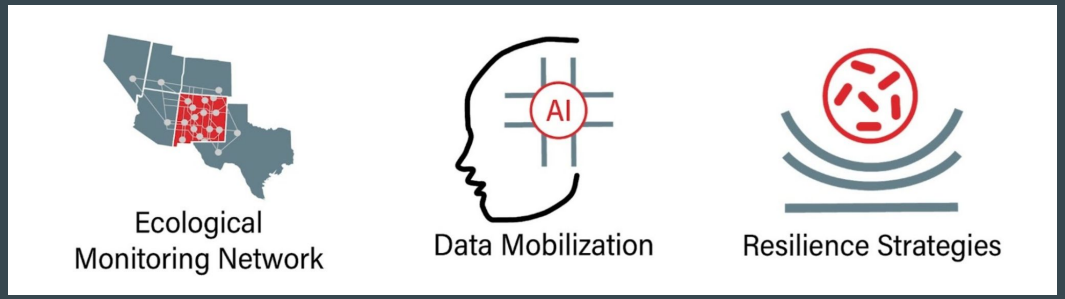
- 20-50 schools, focus on Title I
- ~9,000 participants / year
- 33 Rio Grande sites
- Groundwater data
- Federal & state agencies and Pueblos use data

METALS Superfund Center (NIH)

- Environmental and health impacts of mine waste
- Transdisciplinary: Toxicologists, immunologists, engineers, biologists, mineralogists, geographers, indigenous scientists
- Co-trainings that blend Western and Indigenous science and cultures for innovative transdisciplinary solutions
- Predict redistribution with drought and wind, find equitable solutions that increase resilience to climate



CENTER for DRYLAND RESILIENCE



Mission Statement

Transform understanding and management of natural capital under environmental change, a critical challenge at the interface of science and society.

EPSCoR Track 1 - *not funded*

R. Berrens
R. Bixby
M. Devetsikiotis
M. Fricke
R. González-Pinzón
D. Hanson
C. Hushman
M. Litvak
M. Martinez-Ramon
A. Menicucci
J. Rudgers
A. Schuler
X. Sun
C. Takacs-Vesbach
J. Wang
A. Webster

D. Bailey
H. Cao
S. Fuentes-Soriano
H. Geli
N. Hanan
S. Muhammad Hamdi
B. Hurd
T. Le
E. Lehnhoff
S. Misra
P. Nagarkar
N. Pietrasiak
E. Pontelli
L. Prihodko
J. Song
S. Tran

D. Cadol
L. DeVeaux
B. Duval
D. Jones
M. Khandelwal
T. Kieft
M. Schaefer
J. Sharbrough
H. Wang

J. Yan

K. Eichhorst

J. Garcia
E. Griffin

B. Hovde

E. Stricker

D. Dye

V. Tidwell

NSF Regional Innovation Engine

10 Y $160 M

RALI-WEST

Regional Advancement Leveraging Innovations for Water and Energy Security Transformation

Clean Water and Clean Energy

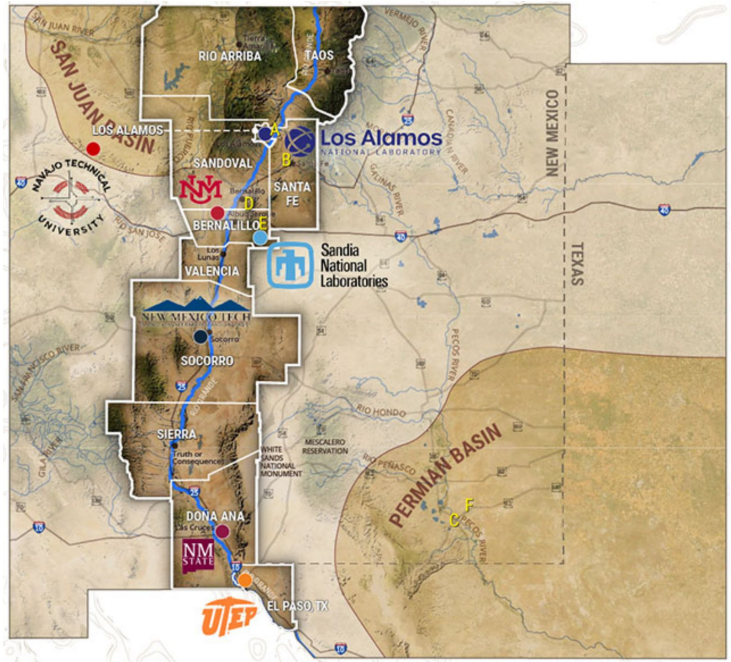
Use-inspired research and development

Translation of innovation results to society

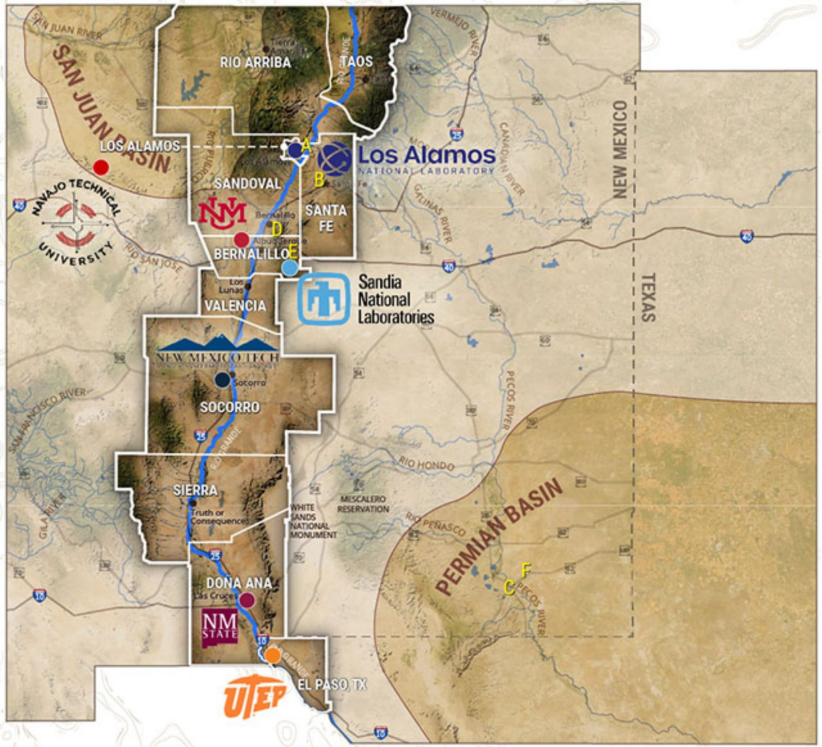
Workforce development to grow and sustain regional innovation

UNM Rainforest Innovations
Supporting Technology Transfer and Catalyzing Economic Development at the University of New Mexico

Northern Rio Grande Corridor Collaborative



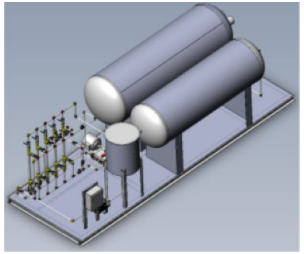
RALI-WEST Regional Innovation Engine



Agrivoltaics

Algal turf scrubber

Bioreactors
hollow-fiber nanofiltration



ARIE

Aridland Resilience Innovation Engine

maximize resilience to climate change

... while growing the regional economy

ARIE Vision

co-create resilience solutions that bring clean water to every tap, decarbonized power to every door, and natural climate solutions for sustainable prosperity in our region

- Inclusive training to solve STEM workforce needs and reduce unemployment
- Support for the NM Climate Strategy with education, job training, big data, model forecasts, and innovative resilience solutions
- Pioneer resilience strategies for land managers, ranchers, farmers, and urban centers
- Sustain and grow a diverse, inclusive and vibrant economy in clean water and energy