BUREAU OF GEOLOGY AND MINERAL RESOURCES

The Increasing Water Scarcity Challenge: Climate Change In New Mexico Over the Next 50 Years

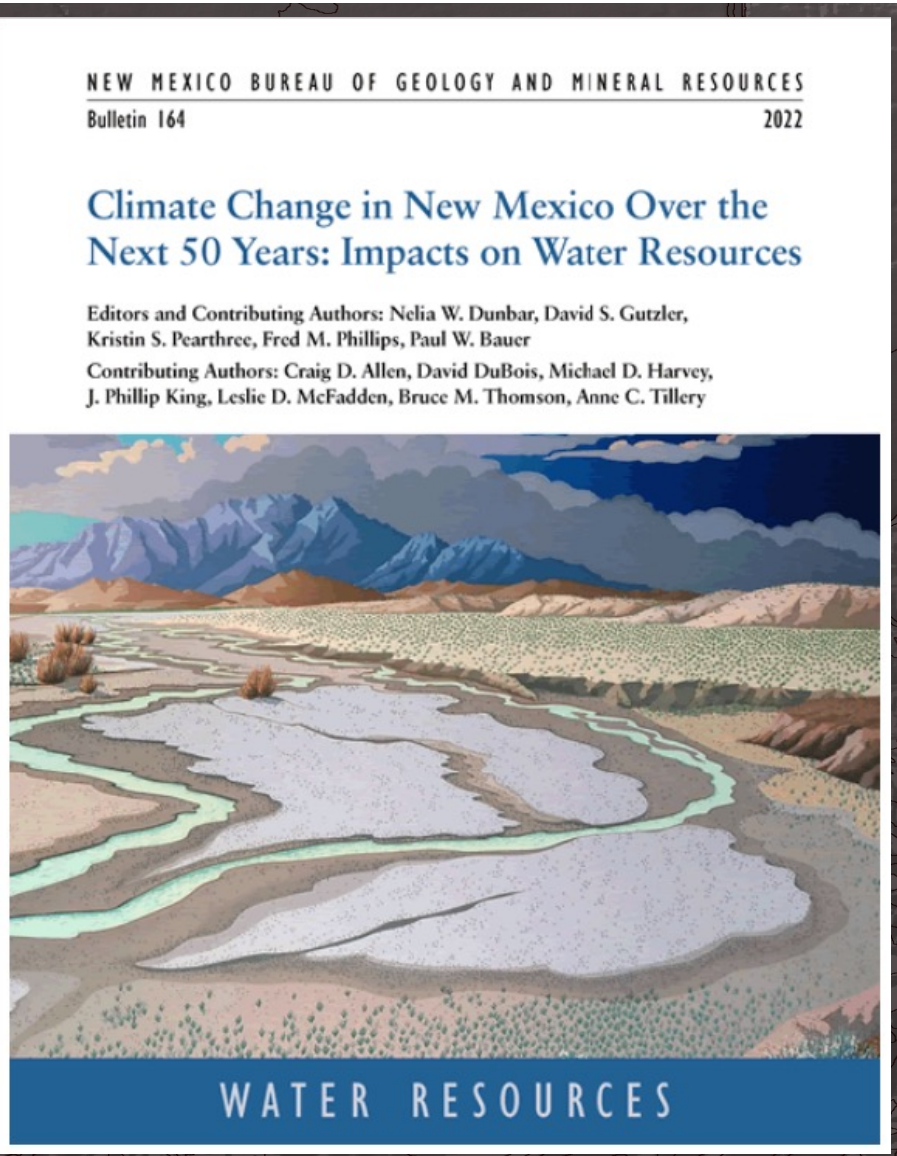
Nelia W. Dunbar
Emerita Director and State Geologist
New Mexico Bureau of Geology and Mineral Resources

New Mexico Bureau of Geology and Mineral Resources
New Mexico Tech
Earth Science for the 21st Century

Presentation for the New Mexico Water Dialog
29th Annual Statewide Meeting

Office of the State Engineer
nm
Interstate Stream Commission

BUREAU OF GEOLOGY AND MINERAL RESOURCES



- Collaboration with the NMISC
- Experienced team of scientists
  - Fred Phillips, Dave Gutzler, Craig Allen, Dave DuBois, Mike Harvey, Phil King, Les McFadden, Bruce Thomson, and Anne Tillery
- Compilation and integration of existing data
- Many Zoom meetings and writing
- Peer-reviewed and opened for public comment

- GSA Frye Award Winner 2023!

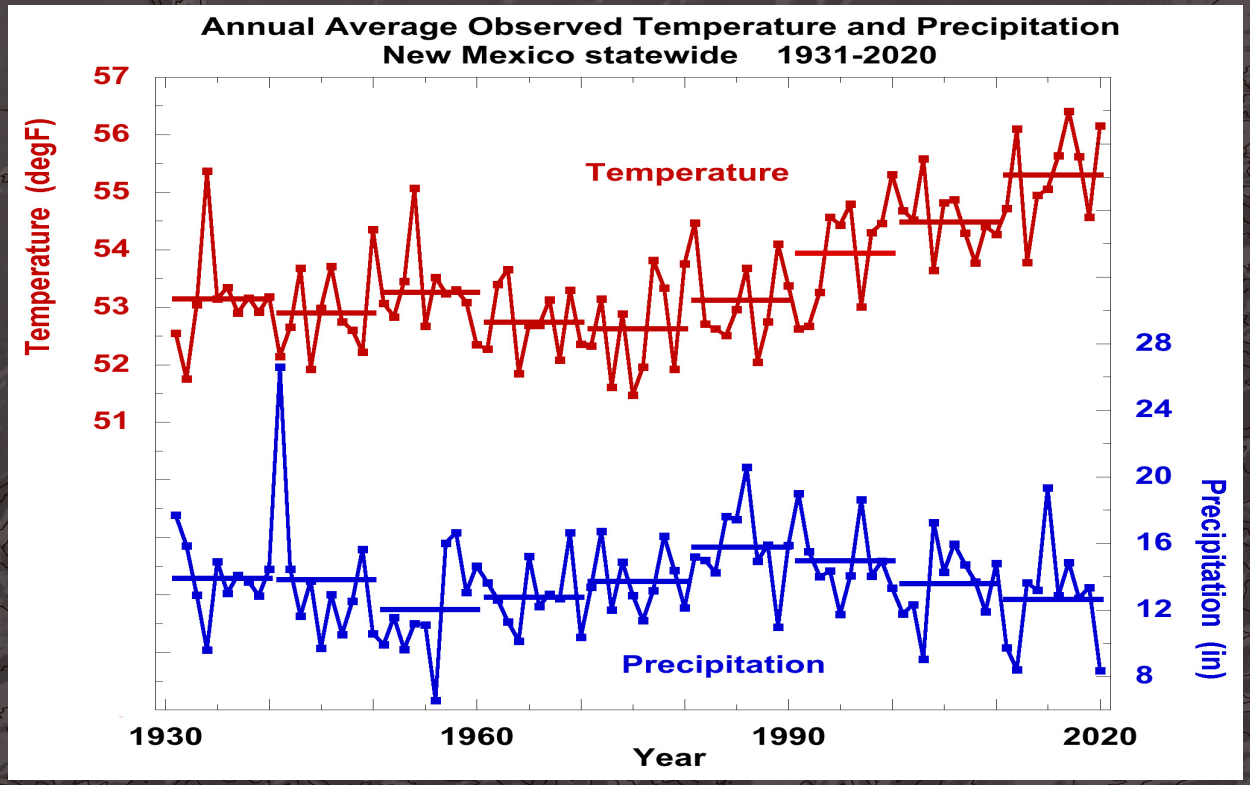
New Mexico Bureau of Geology and Mineral Resources Bulletin 164
Or… Search for: Bureau of Geology climate report

BUREAU OF GEOLOGY AND MINERAL RESOURCES

Why do we need this?

New Mexico's climate is warming

A new 50-year water plan for the state must account for ongoing and future changes to our climate and water resource reliability

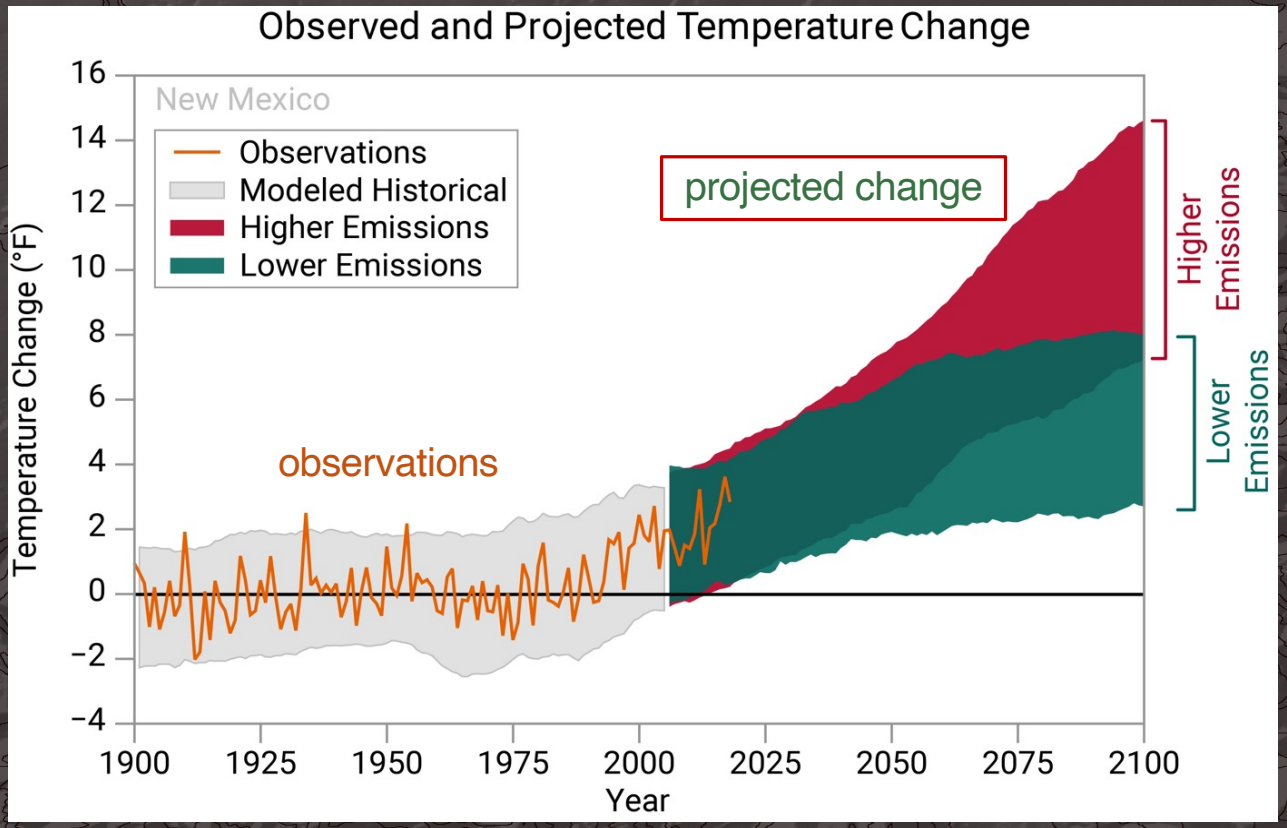


Decade-average temperatures have been climbing steadily for the past 50 years

Precipitation has no clear trend but is hugely variable, annually and decadally
4 of the 5 driest years since 1930 have occurred in the past two decades

BUREAU OF GEOLOGY AND MINERAL RESOURCES

New Mexico's climate will continue to warm in response to increasing concentrations of atmospheric greenhouse gases



Red and **green** bands represent future temperature increases in NM projected by an ensemble of climate models, in response to **higher** or **lower** rates of future greenhouse gas emissions

BUREAU OF GEOLOGY AND MINERAL RESOURCES

Ground rules of the study

→ Assess and synthesize recent scientific literature on climate, hydrology, and impacts of these changes

- Future climate projections
- Changes to the surface water budget
- Ecological dynamics
- Impact on soils
- Landscape change/fires/erosion
- Surface water and groundwater
- Sedimentation in rivers
- Extreme precipitation and flooding
- Water quality

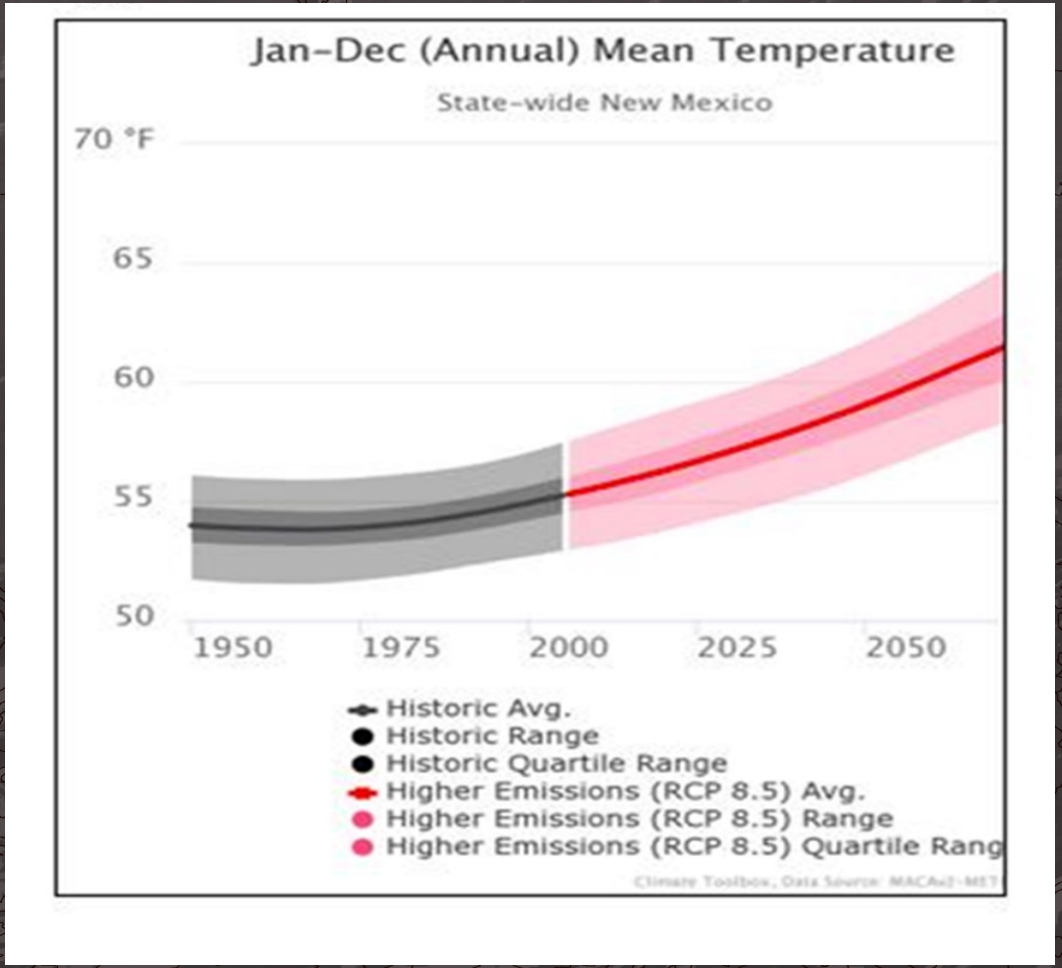
BUREAU OF GEOLOGY AND MINERAL RESOURCES

Climate change is impacting New Mexico's water resources in multiple ways

- Lower streamflow and recharge because of increased aridity
- Greater interannual variability in precipitation
- More extreme precipitation events
- Hotter, more severe droughts
- Decreasing snowpack → earlier and diminishing snowmelt runoff
- Greater demands on groundwater
- Vegetation stress
- Increasing catastrophic forest fires
- Increasing flooding and sedimentation in rivers
- Irreversible damage to soils through loss of vegetation and erosion
- Degraded quality of surface waters

BUREAU OF GEOLOGY AND MINERAL RESOURCES

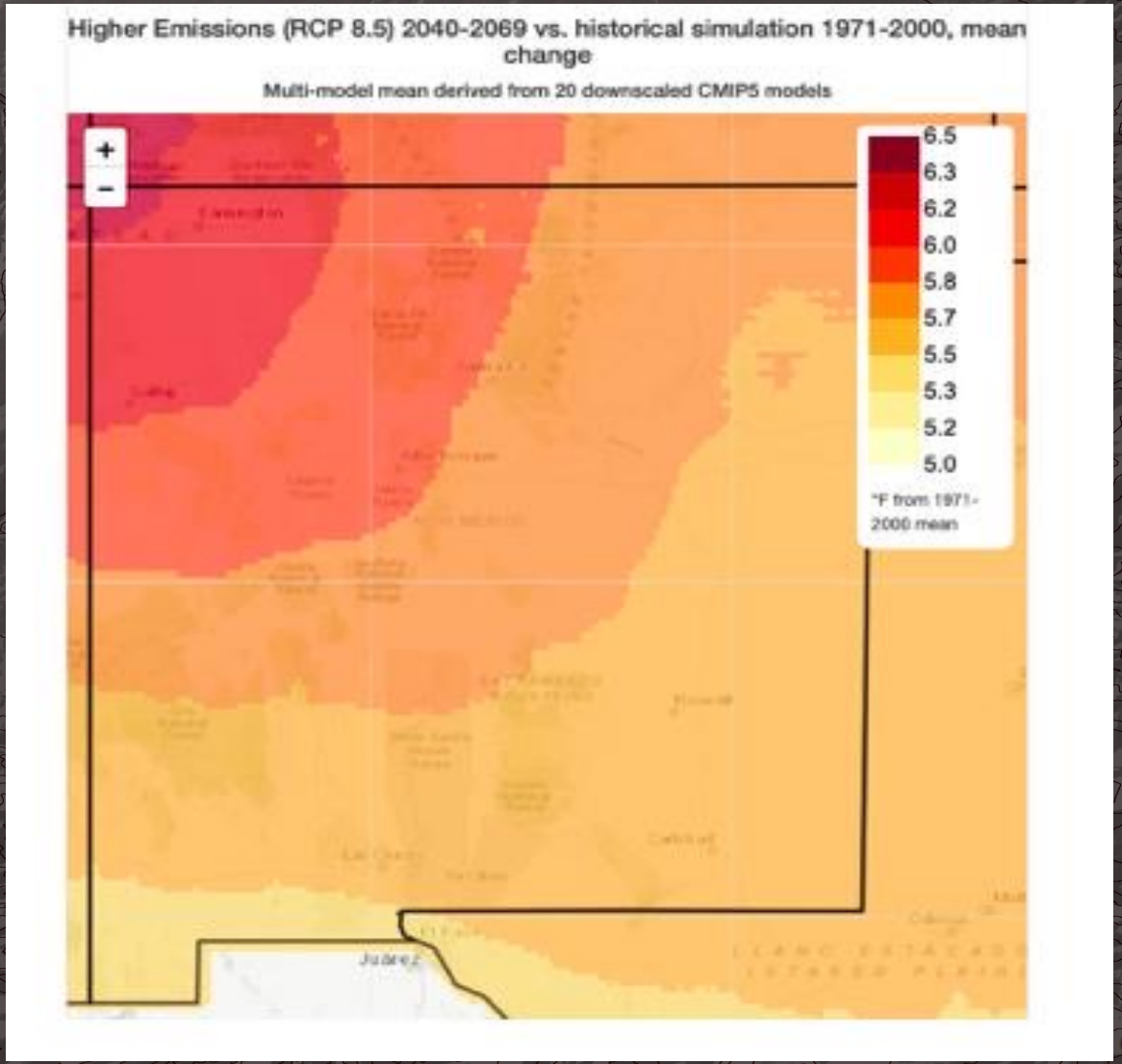
Future Climate Projections



BUREAU OF GEOLOGY AND MINERAL RESOURCES

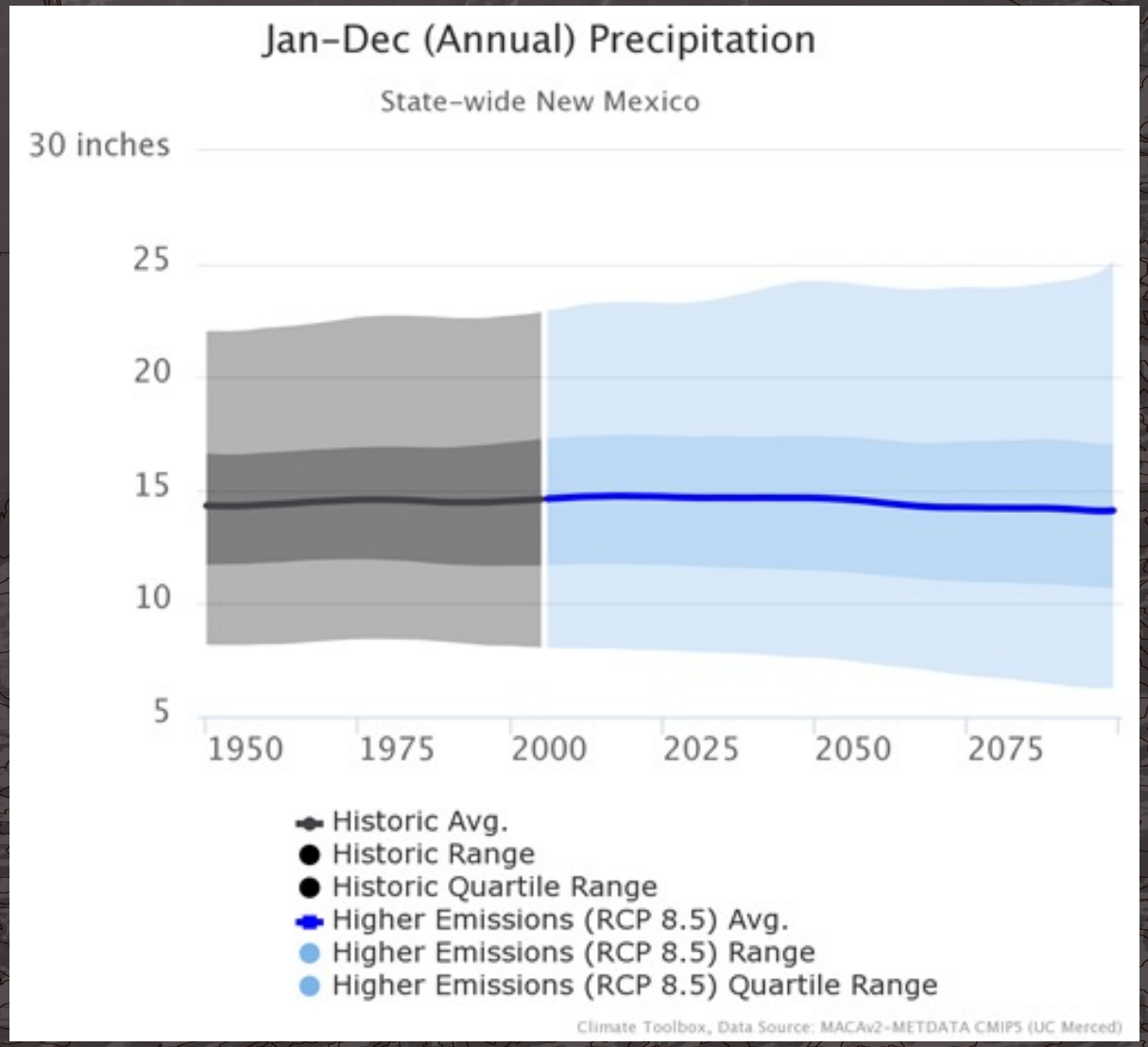
Warming everywhere. Temperature rise non-uniform across the state of New Mexico

Bootheel is around a decade behind the NW corner



BUREAU OF GEOLOGY AND MINERAL RESOURCES

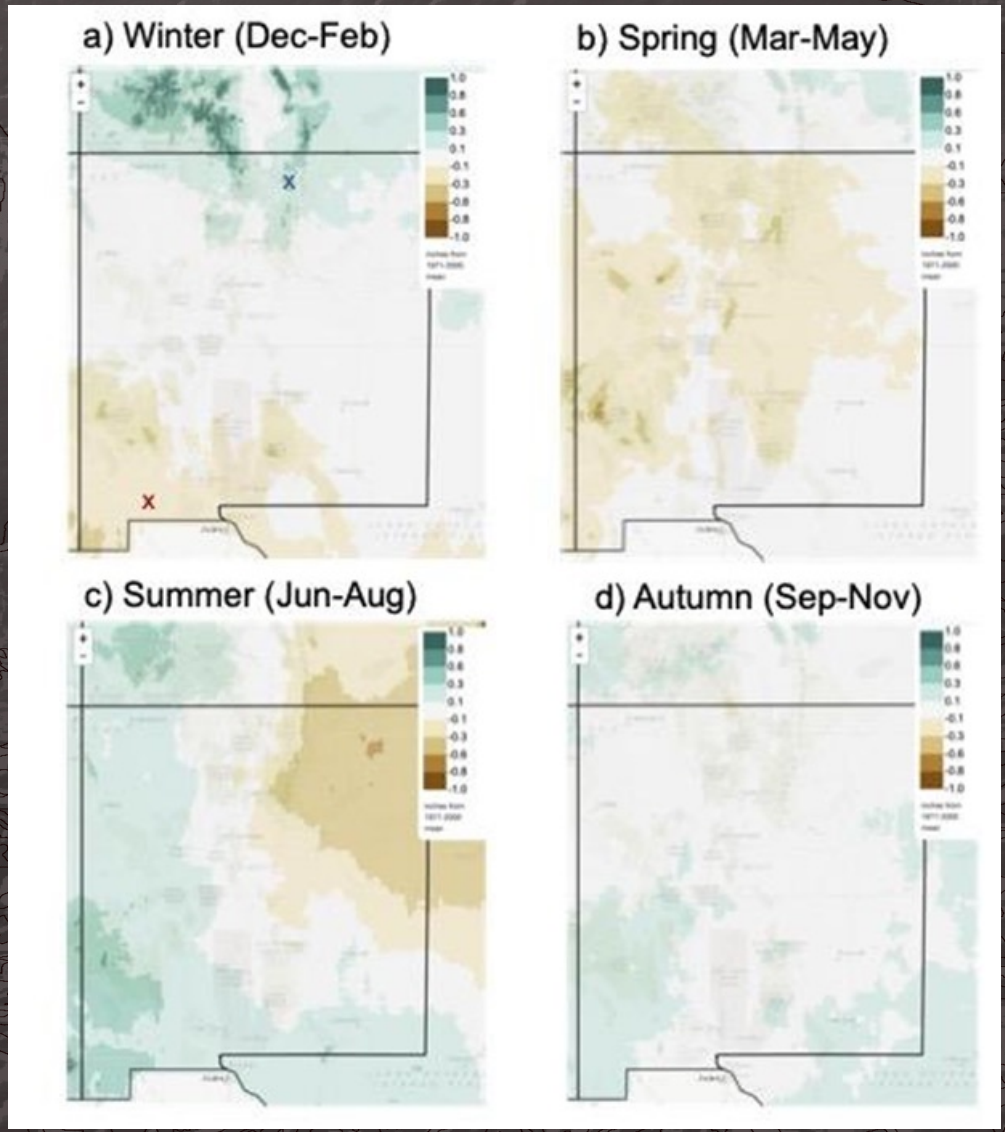
Average Precipitation



BUREAU OF GEOLOGY AND MINERAL RESOURCES

Season/Geographical Distribution of Precipitation

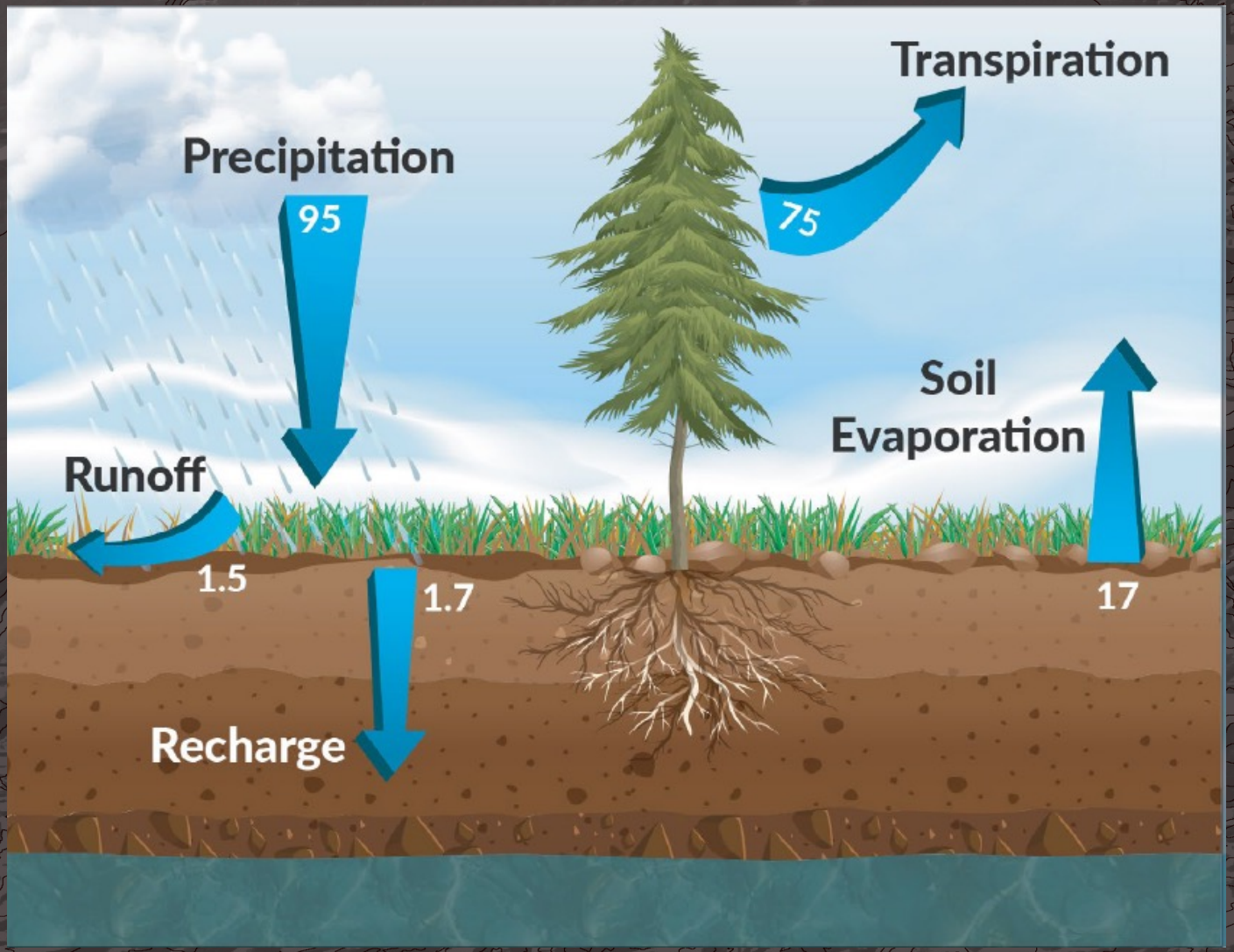
Green=More
Brown=Less



BUREAU OF GEOLOGY AND MINERAL RESOURCES

Land-surface water budget in New Mexico's arid climate

Numbers represent millions of acre-feet per year



BUREAU OF GEOLOGY AND MINERAL RESOURCES

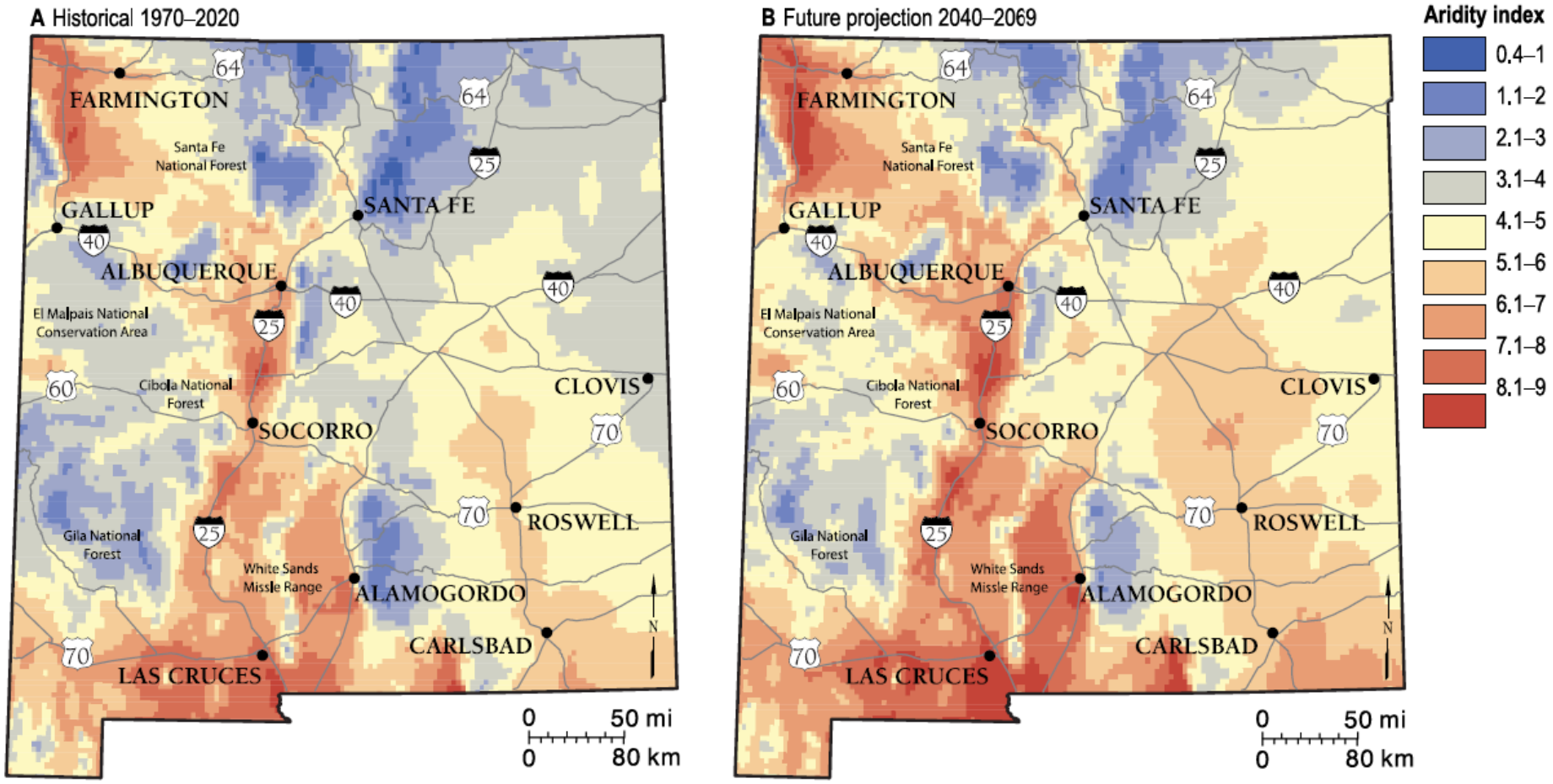
Even with no trend in precipitation, New Mexico will become more arid because of increasing air temperature

- The amount of water that air can "hold" goes up as the air temperature rises (a ~2°F increase in temperature allows air to hold 7% more water vapor).
- Liquid water will be lost more rapidly from leaves and soil.
- Dry soil absorbs more precipitation than wet soil, causing less runoff and recharge.

Aridity Increases → More Severe Droughts

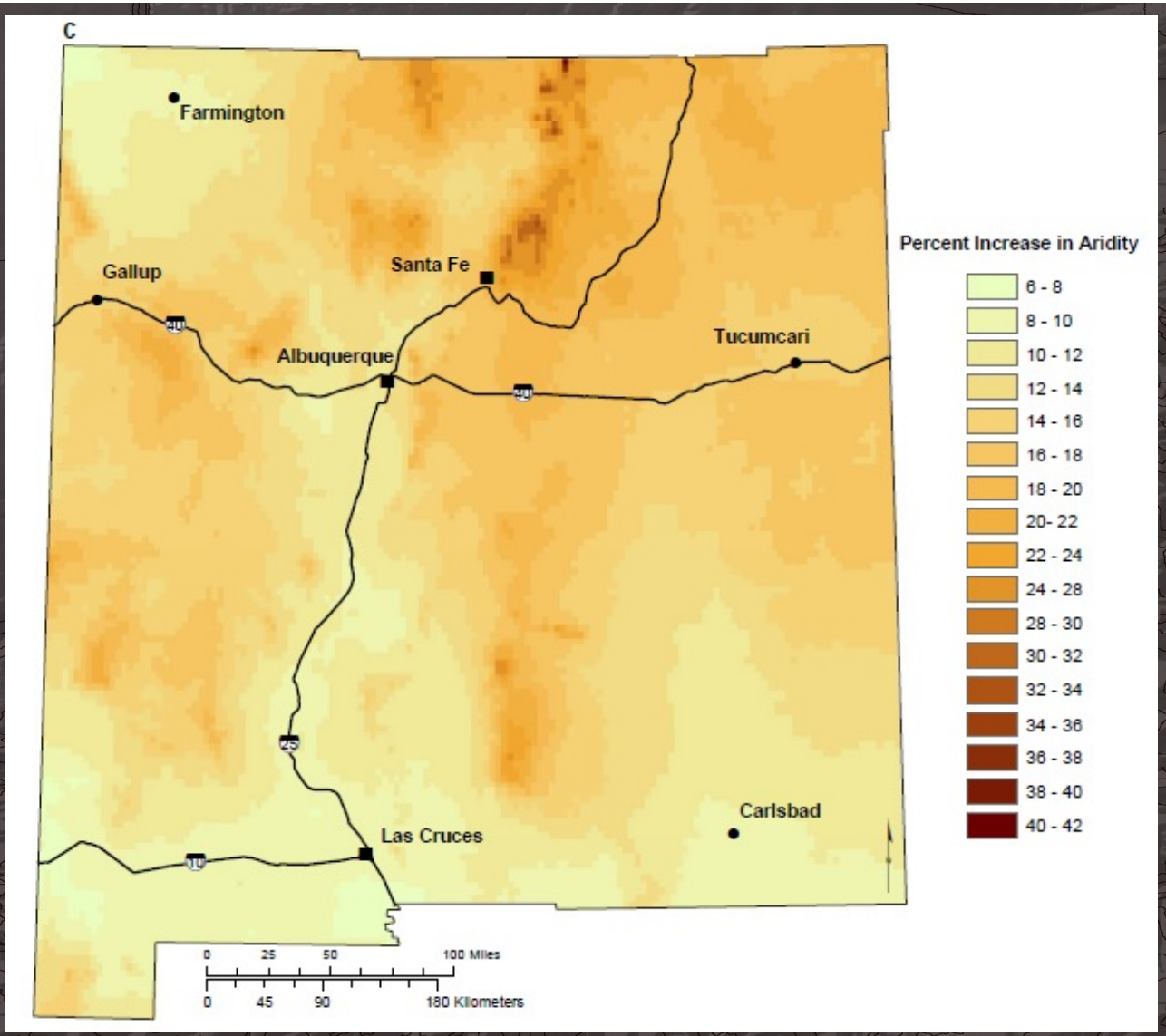
BUREAU OF GEOLOGY AND MINERAL RESOURCES

Aridity Index = Average Potential Evapotranspiration/Average Precipitation



BUREAU OF GEOLOGY AND MINERAL RESOURCES

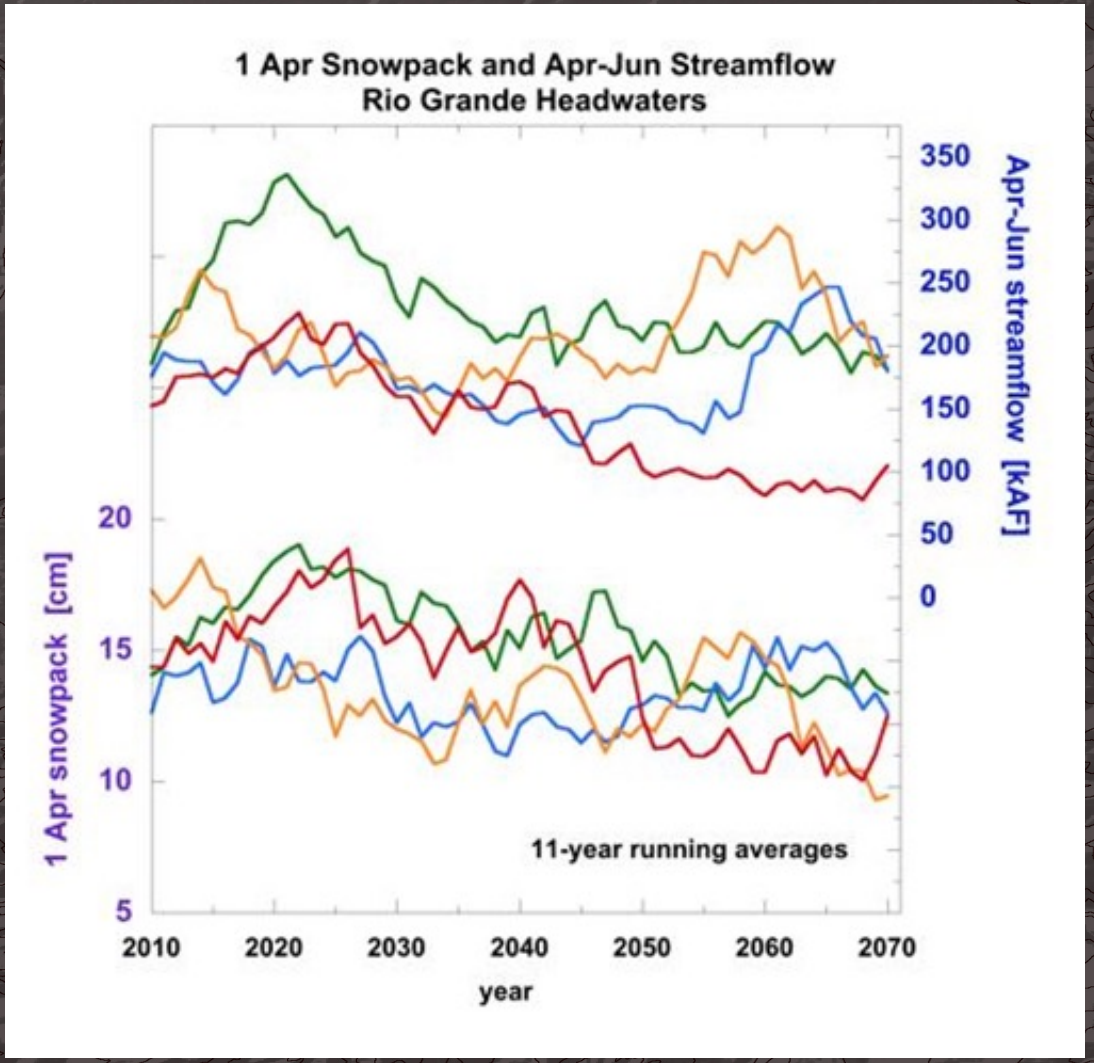
Percent increase in aridity index between 2040-2069 and 1970-2000



BUREAU OF GEOLOGY AND MINERAL RESOURCES

Snowpack and spring streamflow will decline

Different colored lines represent 4 individual simulations that show range of future projections



BUREAU OF GEOLOGY AND MINERAL RESOURCES

Impacts of drought on forest health

BUREAU OF GEOLOGY AND MINERAL RESOURCES

Post-fire erosion

BUREAU OF GEOLOGY AND MINERAL RESOURCES

Extreme post-fire sedimentation

BUREAU OF GEOLOGY AND MINERAL RESOURCES

Extreme Precipitation

- Based on increased atmospheric moisture and temperature, more extreme precipitation events would be expected.
- Although NM record over past 20 years is notably variable, integrated data from SW US indicate increasing extreme precipitation events

Photo by Dana Ulmer-Scholle

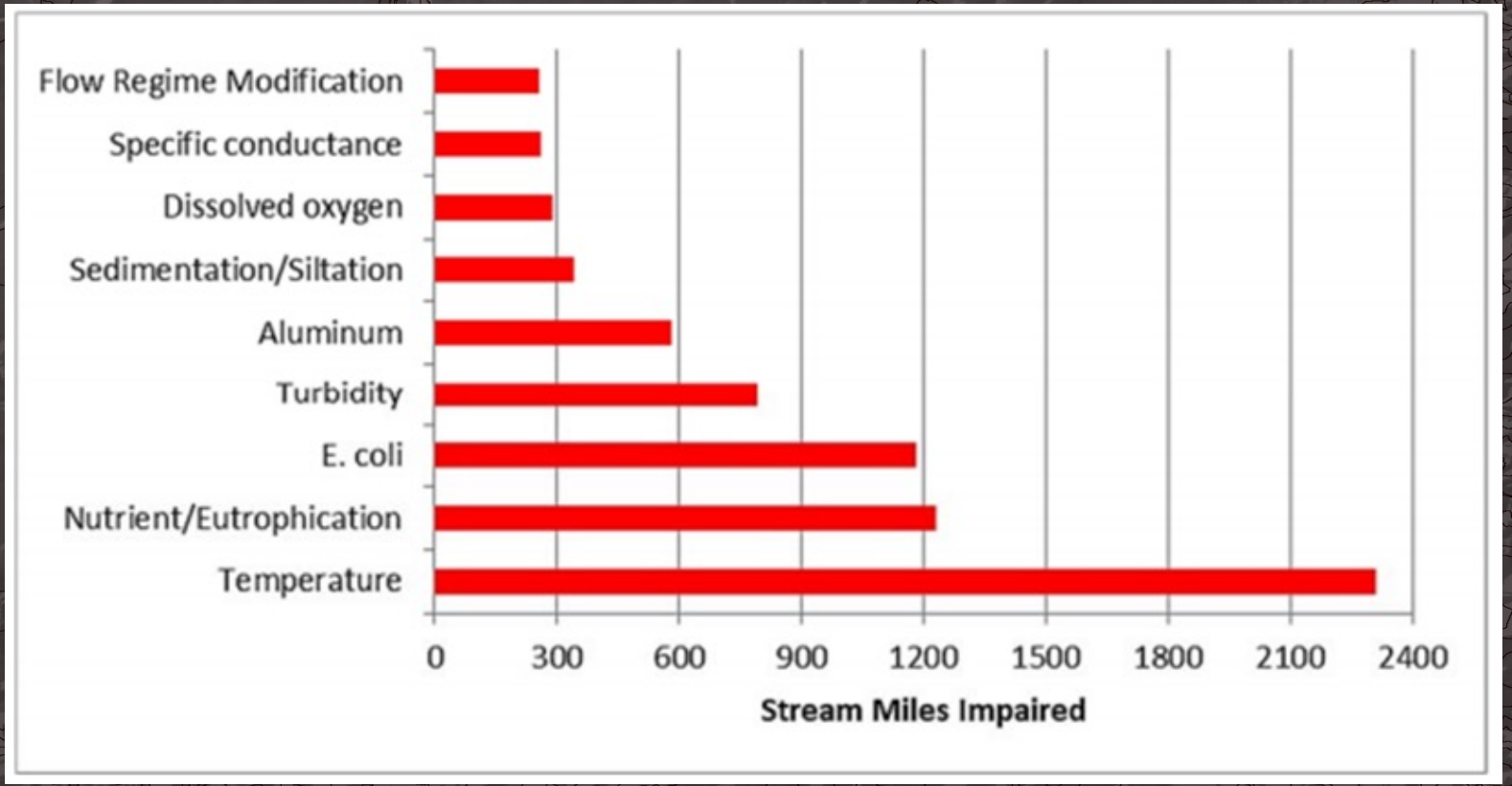
BUREAU OF GEOLOGY AND MINERAL RESOURCES

Impact on New Mexico Rivers

- Over next 50 years, flow will decline by 16-28%
- Due to extreme precipitation and fire-drive disruption of watersheds, the amount of sediment delivered to rivers will double
- Beds of undammed rivers will be built up
- Reservoir capacity will be reduced
- Channels will narrow

Water Quality

The dominant impact on water quality will be an increase in temperature



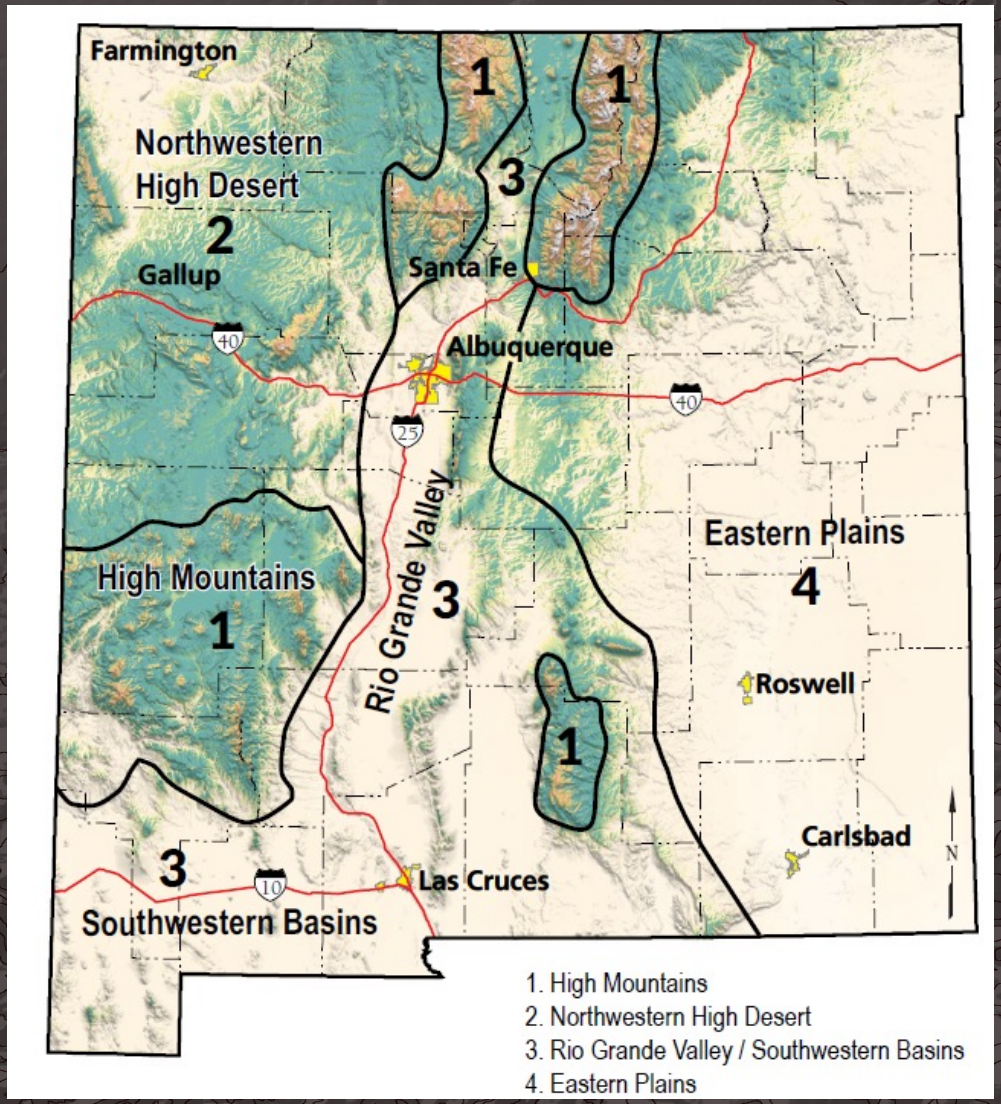
NMED, 2021

BUREAU OF GEOLOGY AND MINERAL RESOURCES

Statewide and Regional Impacts

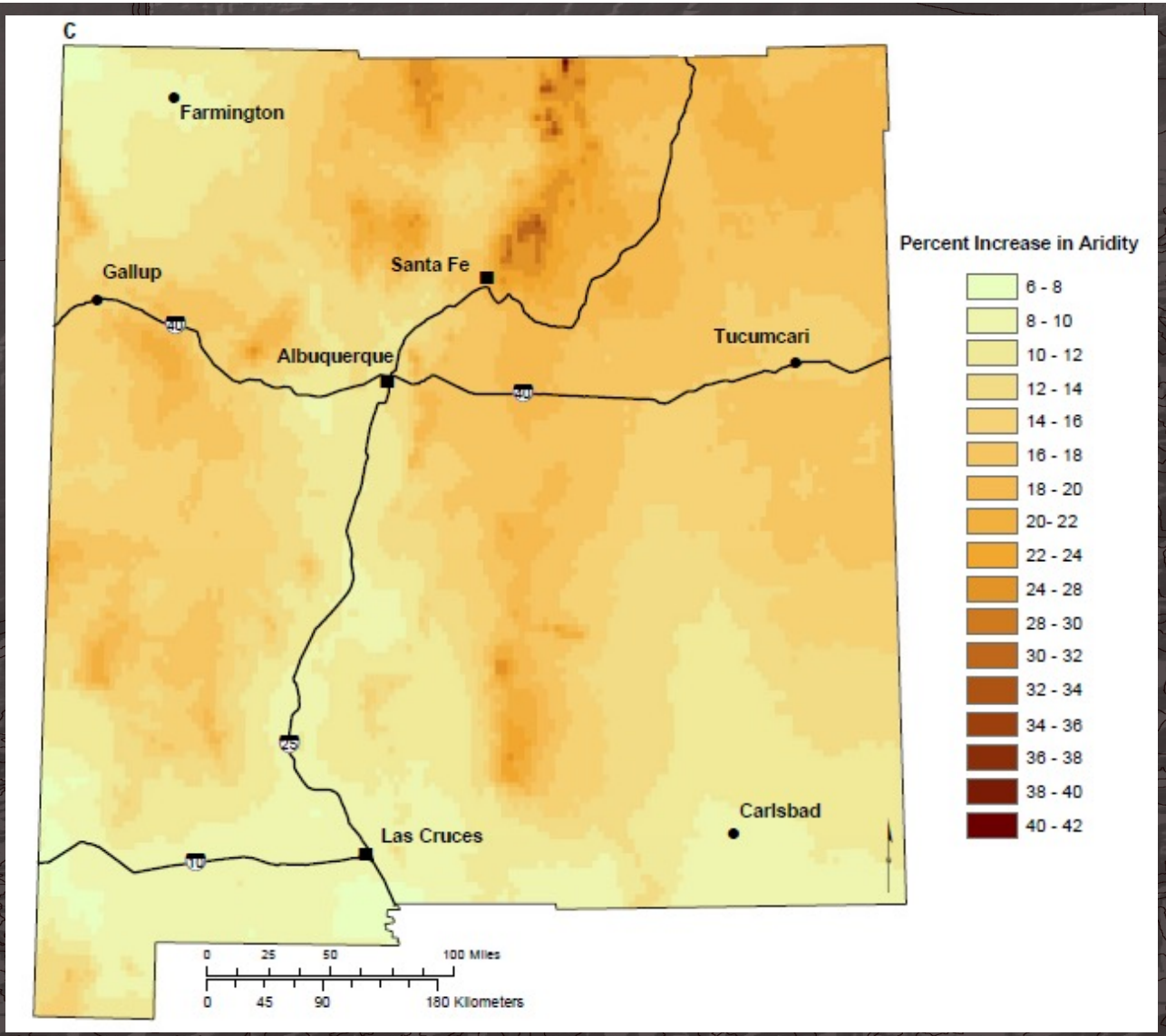
New Mexico is a state characterized by varied landscape. Increasing temperature will have different impacts on different parts of the state. We identified 4 regions which may experience similar impacts.

1. High Mountains
2. Northwestern High Desert
3. Rio Grande Valley/SE Basins
4. Eastern Plains



BUREAU OF GEOLOGY AND MINERAL RESOURCES

Percent increase in aridity index between 2040-2069 and 1970-2000



BUREAU OF GEOLOGY AND MINERAL RESOURCES

Dominant Impacts by Region

- High Mountains
  - Will be most impacted by climate change, and impacts will be felt throughout the state. Less snowmelt and higher evapotranspiration
  - Changes to plant communities and increased wildfire will be felt not only in the mountains, but also in "downstream" areas
- Northwestern High Desert
  - Loss of soil
  - Increased dustiness
  - Increased arroyo incision
  - Possible transition from grasses to shrubs

BUREAU OF GEOLOGY AND MINERAL RESOURCES

Dominant Impacts by Region

- Southwest Basins/Rio Grande Valley
  - Lower river flows (25% lower flow in Rio Grande in 50 years), changes in timing of runoff, trending earlier
  - Greater loss of water from reservoirs (with a 5 degree temperature increase, Elephant Butte will lose 2 additional feet of water per year
- Eastern Plains
  - Extreme precipitation events
  - Loss of soil, increased desertification
  - Increased dustiness

Chapter XII. Data Gaps and Research Directions

PRECIPITATION

- Further assessment of extreme precipitation and seasonality of precipitation
- Better understanding of snowmelt runoff

MODELS

- Fine-tuning local climate models, allowing determination of the most probable climate outcomes, as well as better understanding of clouds in GCMs
- Calibrated hydrological model for recharge and runoff specifically for NM
- Simpler vegetation dynamics models that incorporate disturbance processes

BUREAU OF GEOLOGY AND MINERAL RESOURCES

OBSERVATIONAL DATA GAPS

- Quantitative and geographically distributed measurements of NM aquifer water levels and public accessibility of such data
- Soil moisture
- Impact of climate change of water quality
- Hydrological response to watershed vegetation changes
- Timing of landscape readjustment to climate disturbance
- Studies of soil, plant communities, and landscape characteristics in high elevation mountain ranges where recharge and runoff occur
- Long-term ecological monitoring and research to understand response of NM ecosystems to climate change, and associated ecohydrological reponses

BUREAU OF GEOLOGY AND MINERAL RESOURCES

Questions?

nelia.dunbar@nmt.edu

https://geoinfo.nmt.edu/climatepanel

Photo by Matthew Zimmerer