



— BUREAU OF —
RECLAMATION

“Current and Future Conditions of the MRG”

- current management objectives for the river,
- climate change predictions and challenges, and
- likely future scenarios in which to manage.

Presented at: *Management of Vegetated Islands and Bank-Attached Bars Workshop for the Middle Rio Grande*

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Current management objectives for the river

Diversions for irrigation, municipal, and tribal uses



Conveyance to Elephant Butte Reservoir for delivery under the Rio Grande Compact.



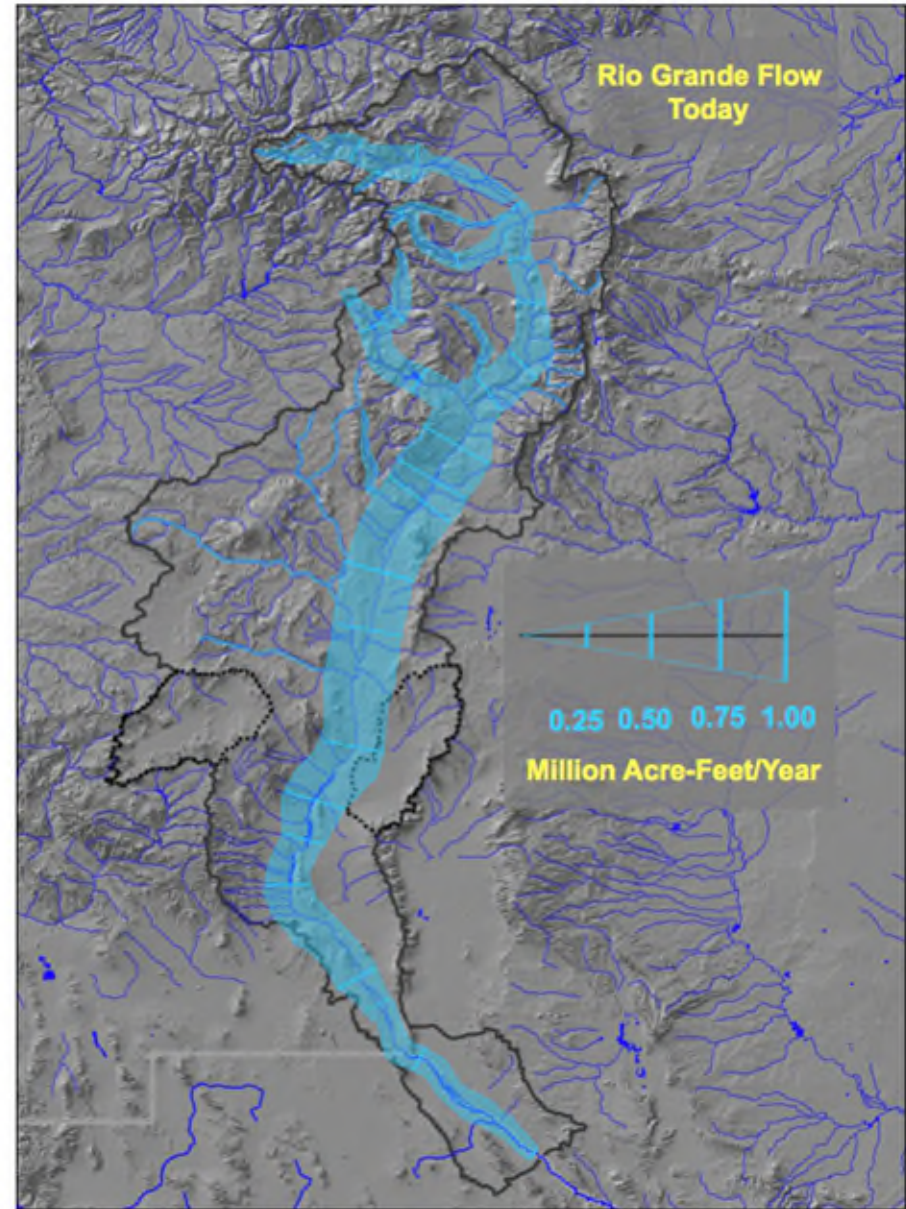
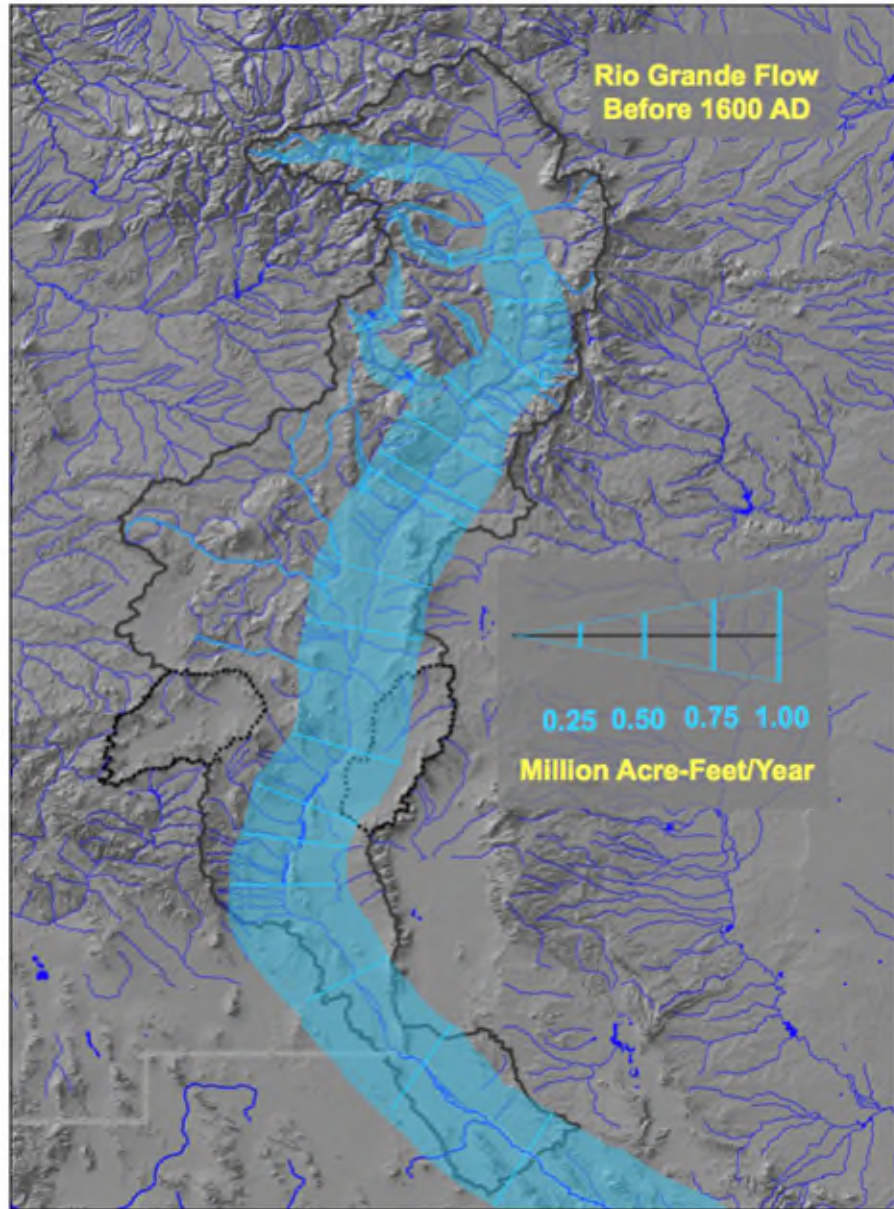
Endangered species and other environmental compliance

- Habitat restoration projects by multiple agency parties
- Supplemental water acquired and managed by Reclamation (with dwindling supplies)

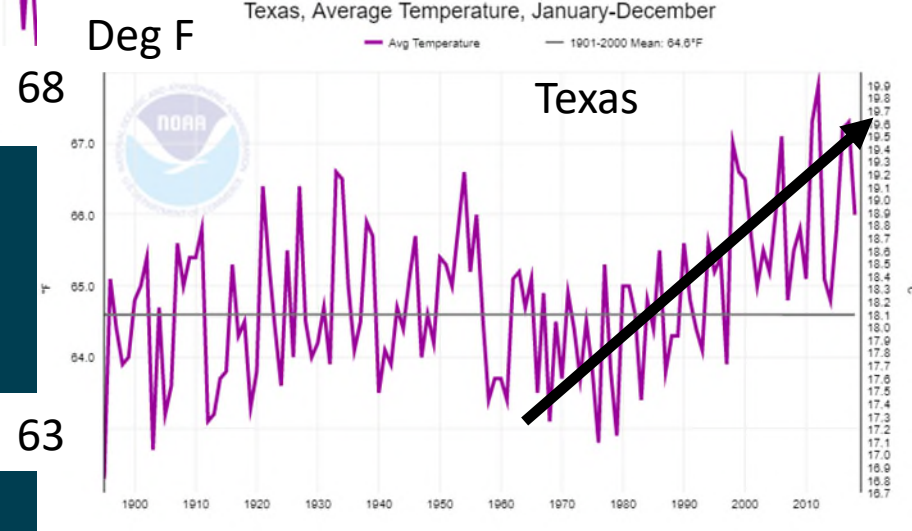
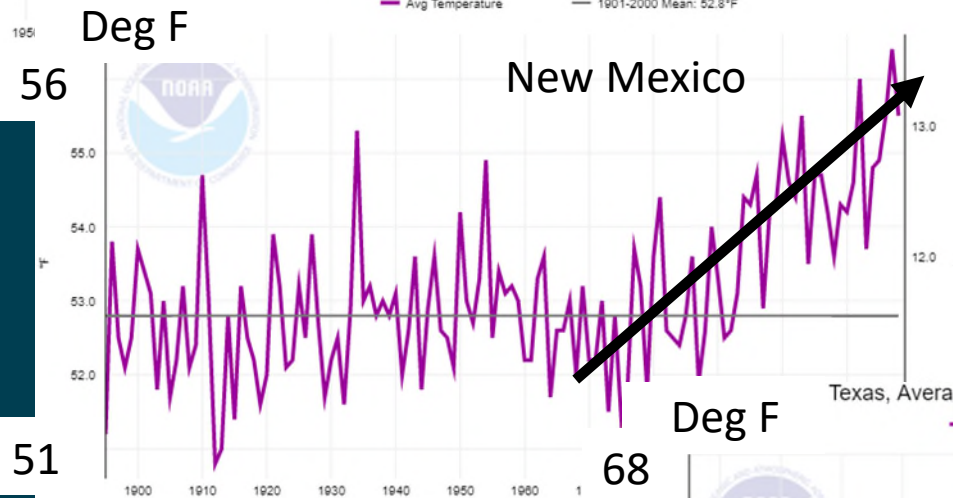
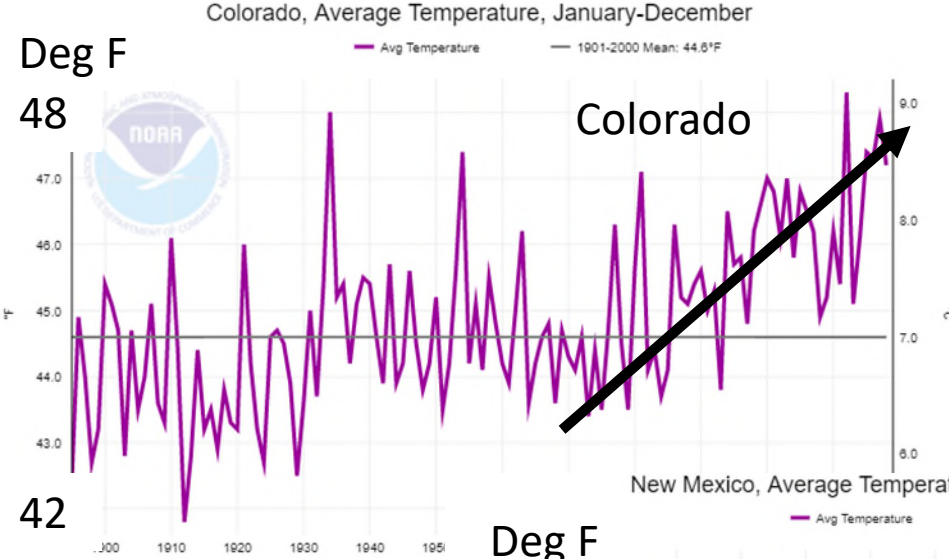


Altered Rio Grande Flow Regime

Source: Fred Phillips, "Reining In the Rio Grande"



Climate-change predictions and challenges



Plots of the changing annual average temperatures in the three Rio Grande basin states, degree Fahrenheit, 1895 to 2019.

Source: NOAA "Climate at a Glance"

<https://www.ncdc.noaa.gov/cag/statewide/time-series/>

The Rio Grande is threatened by aridification associated with climate change

Recent literature on the impacts of climate change on western water

Western water and climate change

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Abstract. The western United States is a region long defined by water challenges. Climate change adds to those historical challenges, but does not, for the most part, introduce entirely new challenges. Rather climate change is likely to stress water supplies and resources already in many ways, for or beyond, natural limits. Projections are for continued and, likely, increased aridity in the region, with a near certainty of continuing changes in seasonality of precipitation and a strong potential for attendant increases in evaporative demand. While the southernmost West sees declines. However, climate models project precipitation increases in the northern West. Precipitation uncertainties can be projected to challenge water supplies, even where annual precipitation is high, and water-quality challenges are likely to be exacerbated.

"The Rio Grande Offers the best example of how climate-change induced flow decline might sink a major system into permanent drought"

If climate change continues, the Rio Grande may sink into permanent drought.
—Paul Dickinson, *Los Angeles Times*

INTRODUCTION

The western United States has always been a region of great opportunity and great challenge for the Nation. The region is notable for burgeoning human settlements

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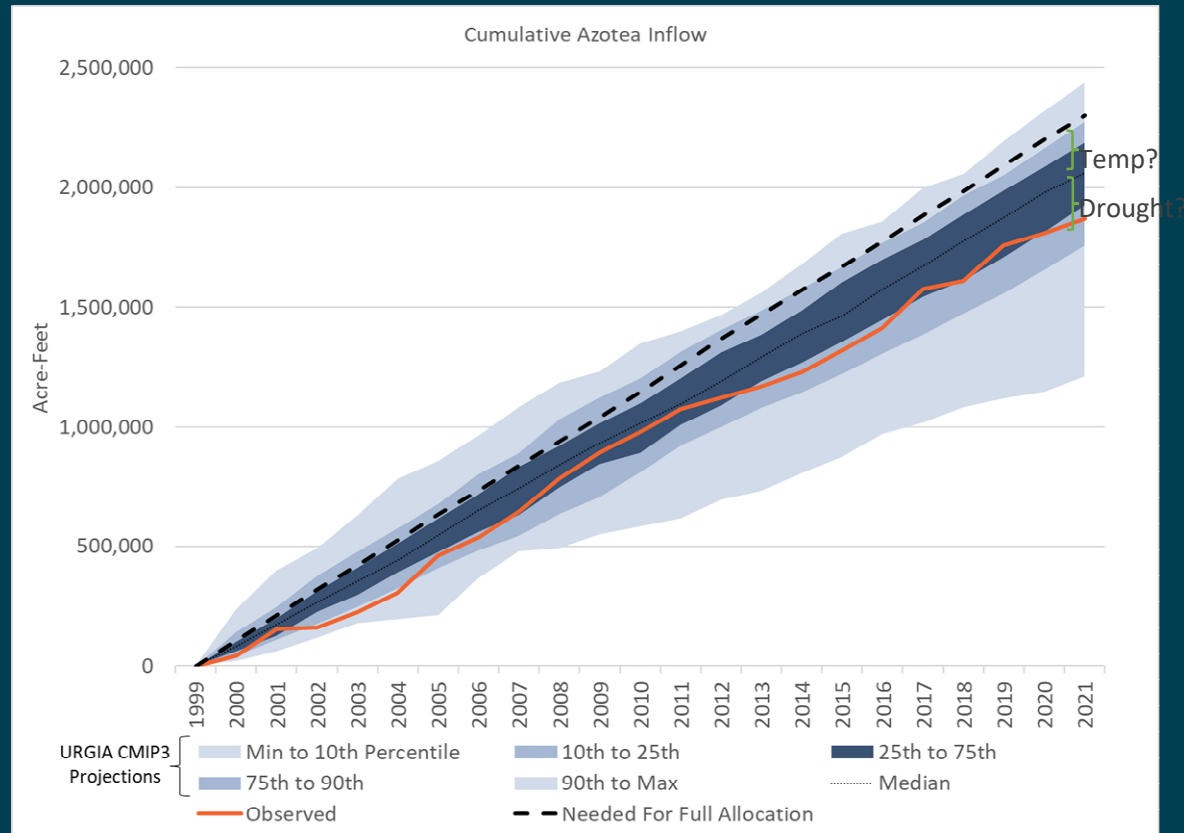
Editors' Note: This paper was commissioned by the journal editors to commemorate the ESA Centennial celebration. A virtual Table of Contents with links to all the Centennial Papers will be available on the journals web site (esajournals.org) in late 2015.

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large human populations and survival of the region. Now, like so much of the natural conditions in the western U.S., the region is changing rapidly due to a variety of influences. The region's long history of recurrent and severe droughts, increasing water-quality contamination, environmental degradation and endangered species, strong competition for the often limited water supplies that exist among a diverse set of

What to Expect in the Future: San Juan-Chama Project

- Drought and climate change are both affecting inflows
- Future depends on relative effect of drought vs climate change (temperature)
- Udall and Overpeck estimated 1/3* of flow reduction is due to temperature alone
 - *Range of 1/6 to 1/2

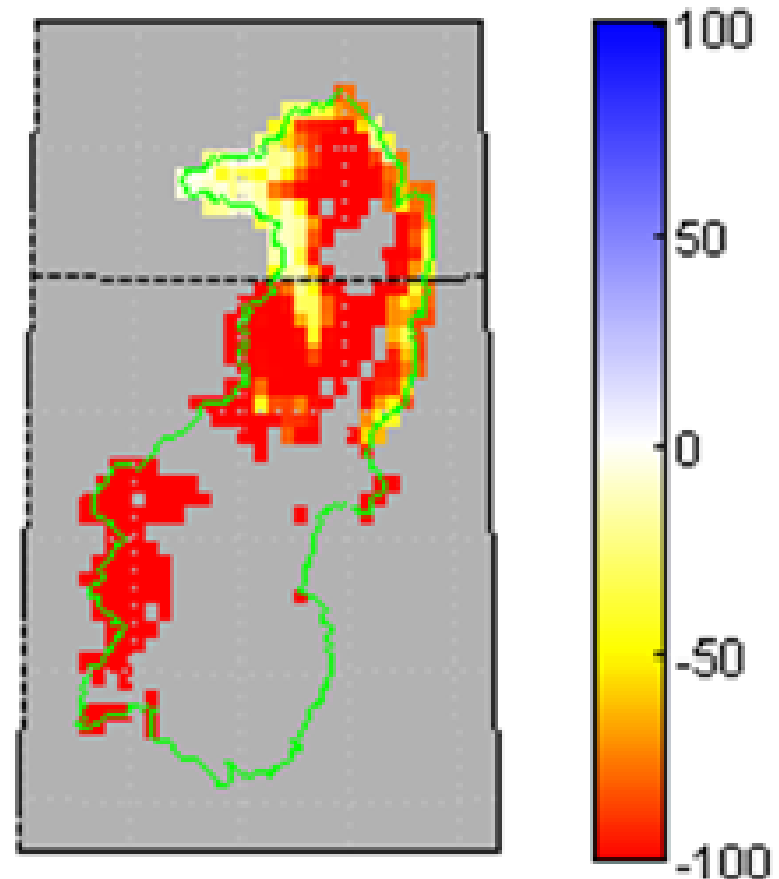


Implications for Snowpack

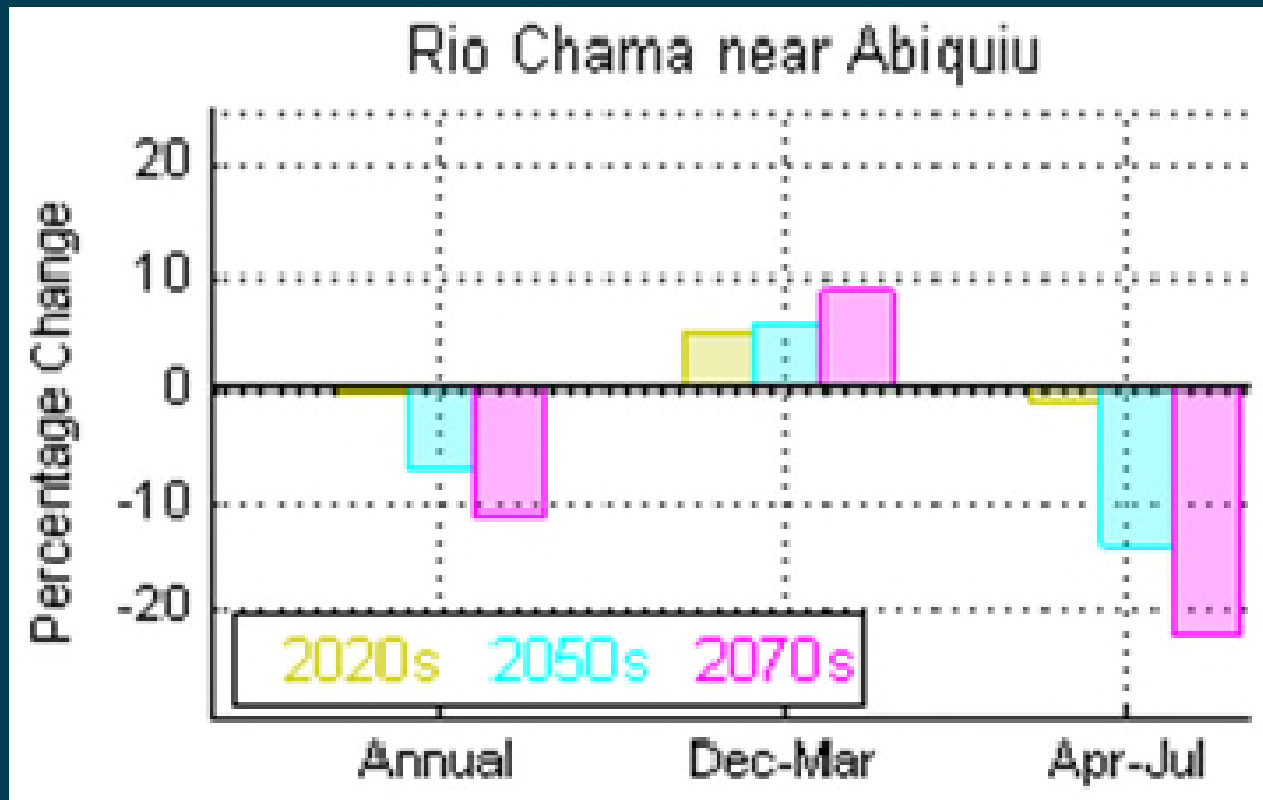
Warmer
temperatures
mean more
precipitation falls
as rain rather than
snow, and the
snow we do get
melts off faster

Upper Rio Grande Basin-Distributed Snow
(2070s relative to the 1990s):

Change in Mean April 1st SWE (%)
2070s-1990s, Ensemble-Median



...Leading to changes in flow timing

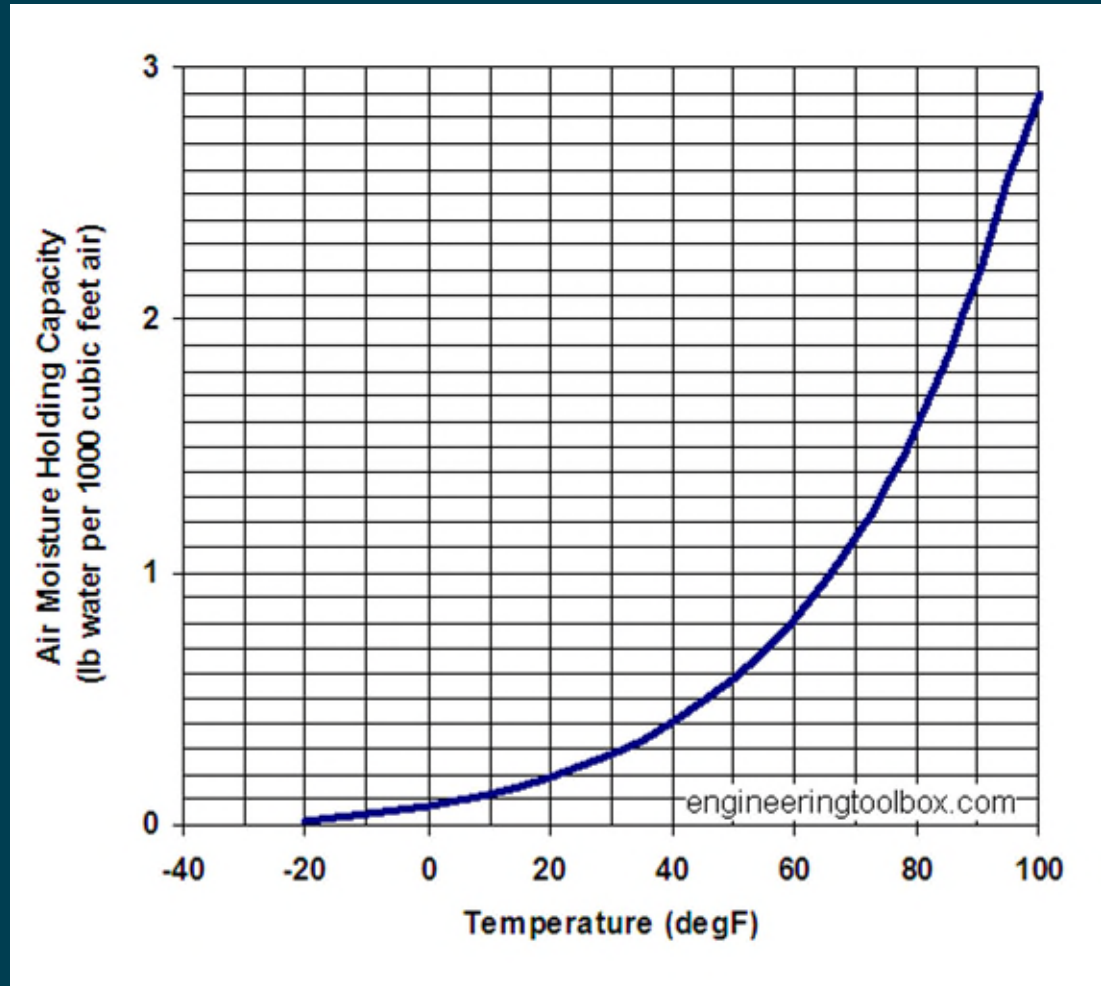


- Decreased annual runoff throughout basin
- Some regions have increased cool season runoff and reduced warm season runoff



Exponential relationship between air temperature and water-holding capacity

At higher temperatures, small change can lead to significant increases in water demand.



Increasing aridity and wind, along with overgrazing, make our snow dirty, which makes it melt faster



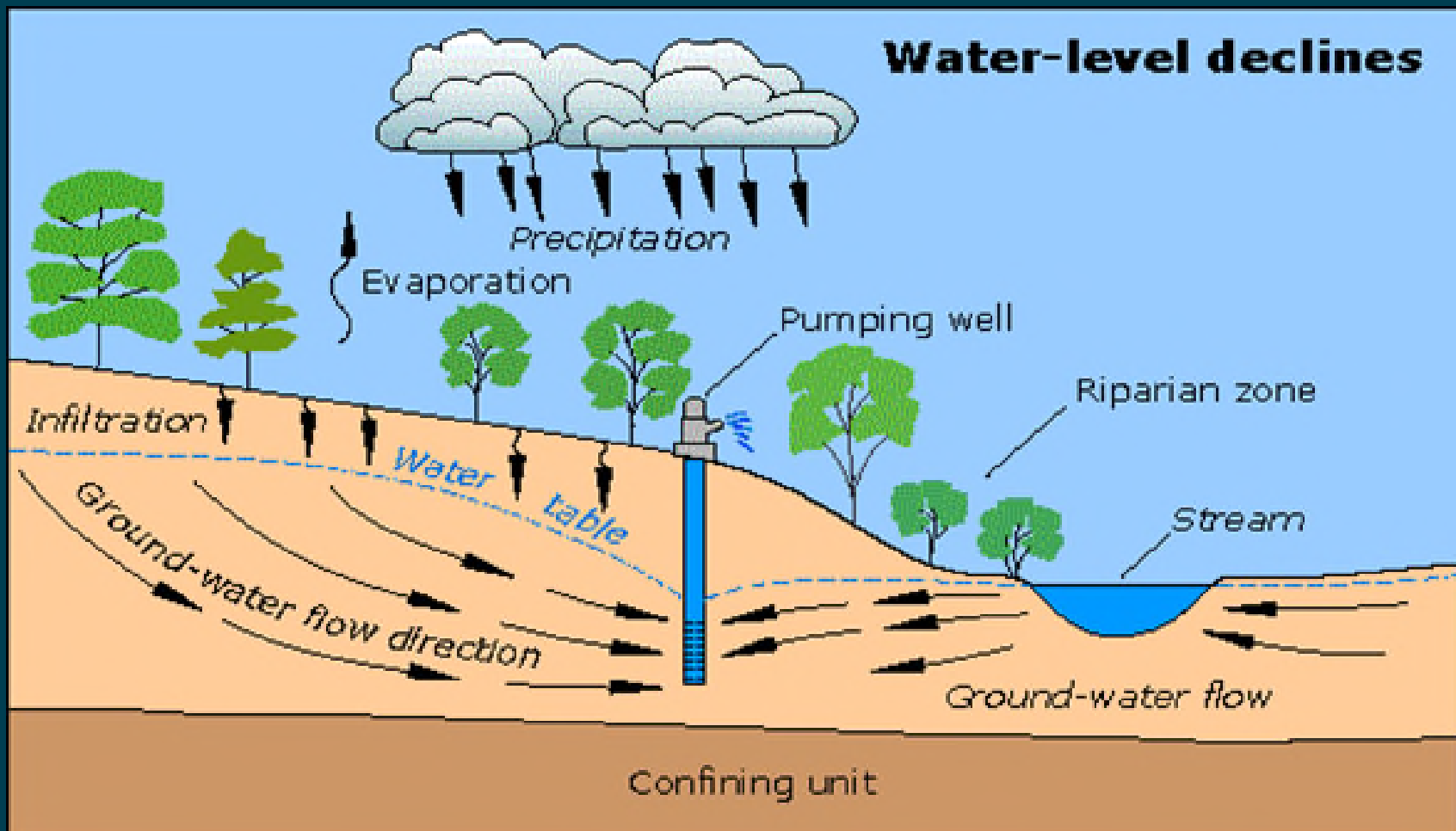
Groundwater

- Cascade of primary impacts on groundwater*
 - Large increase in evaporation losses from shallow groundwater
 - Increases in water use by plants (transpiration)
 - Decrease in soil-water content
 - Decrease in water infiltration below the root zone
 - Reduced groundwater recharge
- Secondary impacts – increased groundwater pumping when surface-water supplies are low.

**Peggy Johnson, Utton Center Conference,
Oct. 9 2014*



Depletion due to Pumping / Groundwater Interaction



We are losing our snow...and also our forests



Dying piñon pine, Jemez Mts.

October 2002

Through beetle kill.....

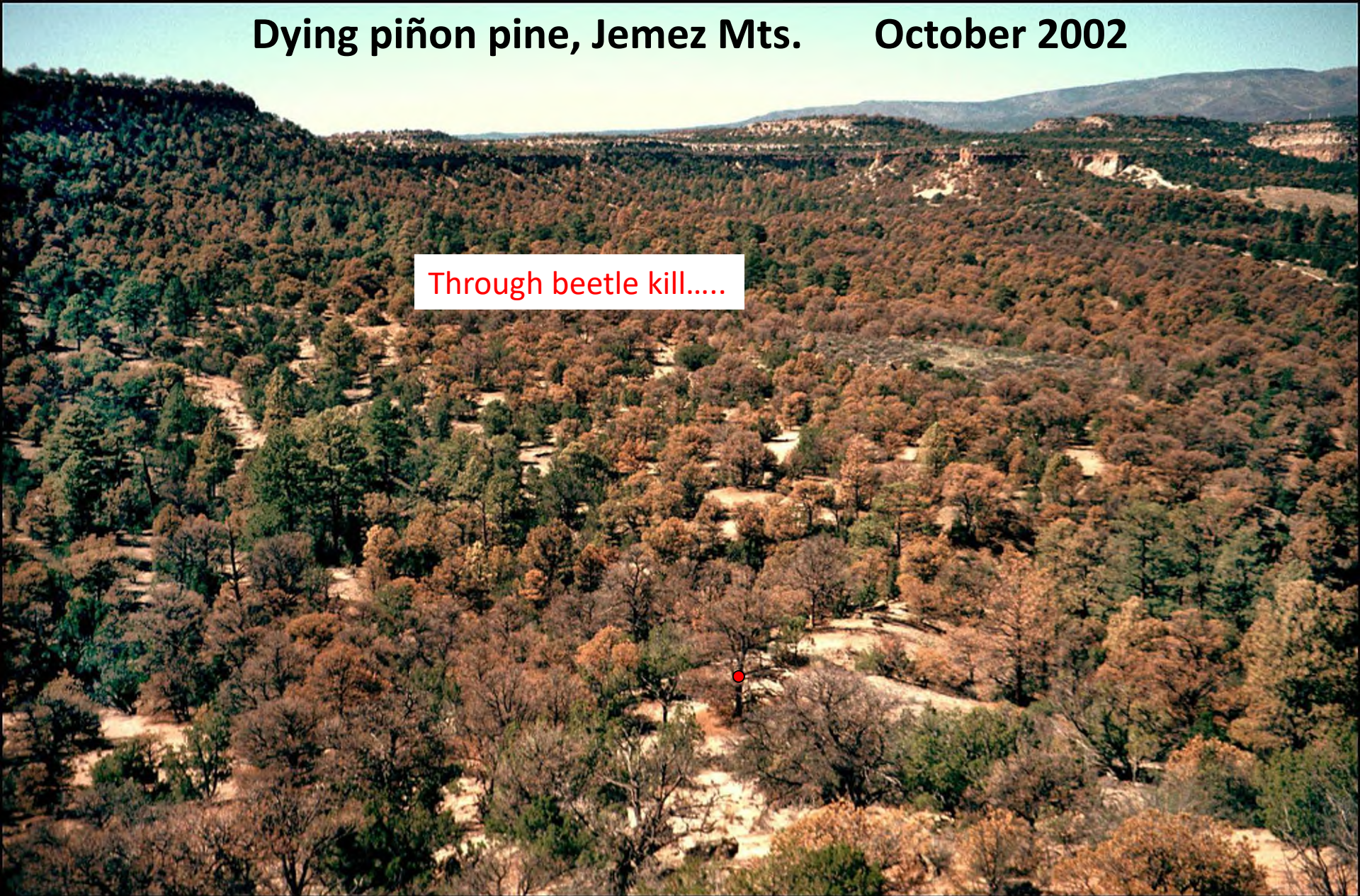


Photo: Craig D Allen

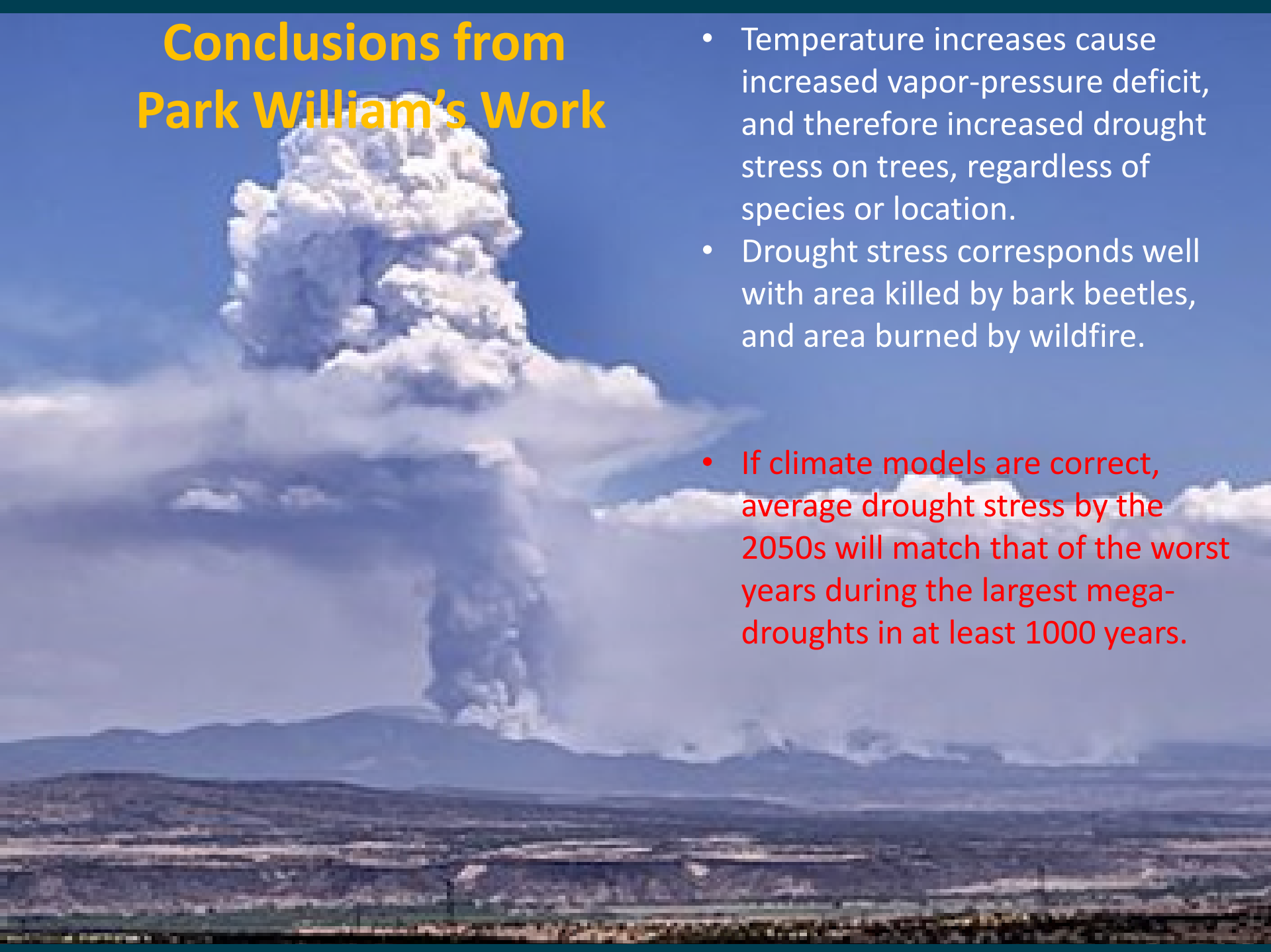


And through wildfire...

Photo: Craig D. Allen

Conclusions from Park William's Work

- Temperature increases cause increased vapor-pressure deficit, and therefore increased drought stress on trees, regardless of species or location.
- Drought stress corresponds well with area killed by bark beetles, and area burned by wildfire.
- If climate models are correct, average drought stress by the 2050s will match that of the worst years during the largest mega-droughts in at least 1000 years.



Impacts to Upland Forests Cascade into Other Systems



**Las
Conchas
and its
aftermath**



Summer Monsoons...?

Some evidence suggests that the summer monsoons on the Rio Grande may intensify under warmer conditions.



Peralta Canyon Confluence
Post-Fire
9/2013

Debris fan



Likely future scenarios in which to manage.

- Decreasing average annual flows, primarily due to increasing temperatures.
- More flow variability (on top of the Rio Grande's already high flow variability) – deeper droughts and larger floods; less flow predictability.
- Changes in flow timing – Higher winter flows, earlier and shorter snowmelt runoff, more summer river drying.
- Increasing size and intensity of wildfire; loss of upland forests to wildfire and insect infestations. Increasing sediment supply to the river, including debris flows.
- Decreasing groundwater levels, as groundwater is used when surface-water is in short supply; increasing loss of river flow to the aquifer below; increasing water conveyance challenges.
- Increasing challenges in meeting the needs of listed endangered species.



Key Takeaways for the river and riparian corridor

- The future Middle Rio Grande will likely have **lower flows** most of the time, and lose more water to the aquifer below. These lower flows will be laden with **more sediment**. These conditions will likely lead to **riverbed aggradation**.
- Lower average flows will lead to a **decrease in channel width**, primarily through **vegetation encroachment** by both native and non-native species. **The existing cottonwood gallery will die away.**
- Extreme precipitation events will increase in magnitude, which will create **occasional high flows** in a river that would convey them **less efficiently**.
- **Wildfires** pose a risk of **debris flows**, which could block the river, and accelerate watershed erosion, which greatly increases river sedimentation.



Cautionary Tale: Fields of non-native vegetation in the riverbed, the “forgotten reach”





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