Water Supply Vulnerabilities Study

Presented by NM Universities Working Group
to Interim Committee on Water and Natural Resources
December 2, 2014

Janie Chermak, David Gutzler, Peggy Johnson, J. Phillip King, Lee Reynis

- Drought, 1950s vs today: Climate, hydrology, agriculture and NM's economy (focusing on Lower Rio Grande)
- We are unsustainably out of hydrologic balance
- We will identify principal social and economic vulnerabilities to water shortages in the Lower Rio Grande
- We will initiate development of short-term and long-term strategies for improved resilience to water shortages

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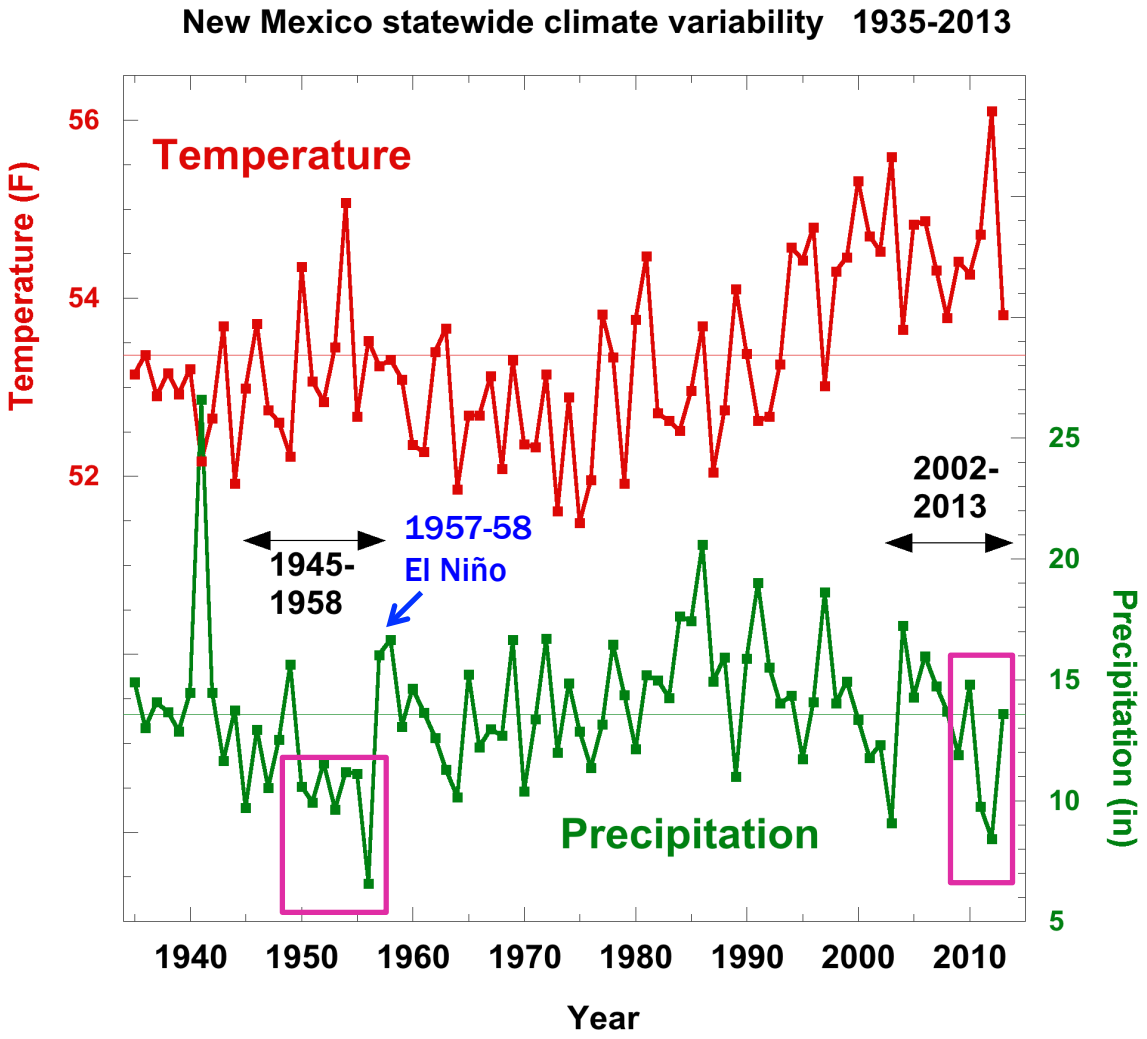
SCIENCE • ENGINEERING • RESEARCH UNIVERSITY

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

NM STATE UNIVERSITY

Two Droughts, 50 Years Apart

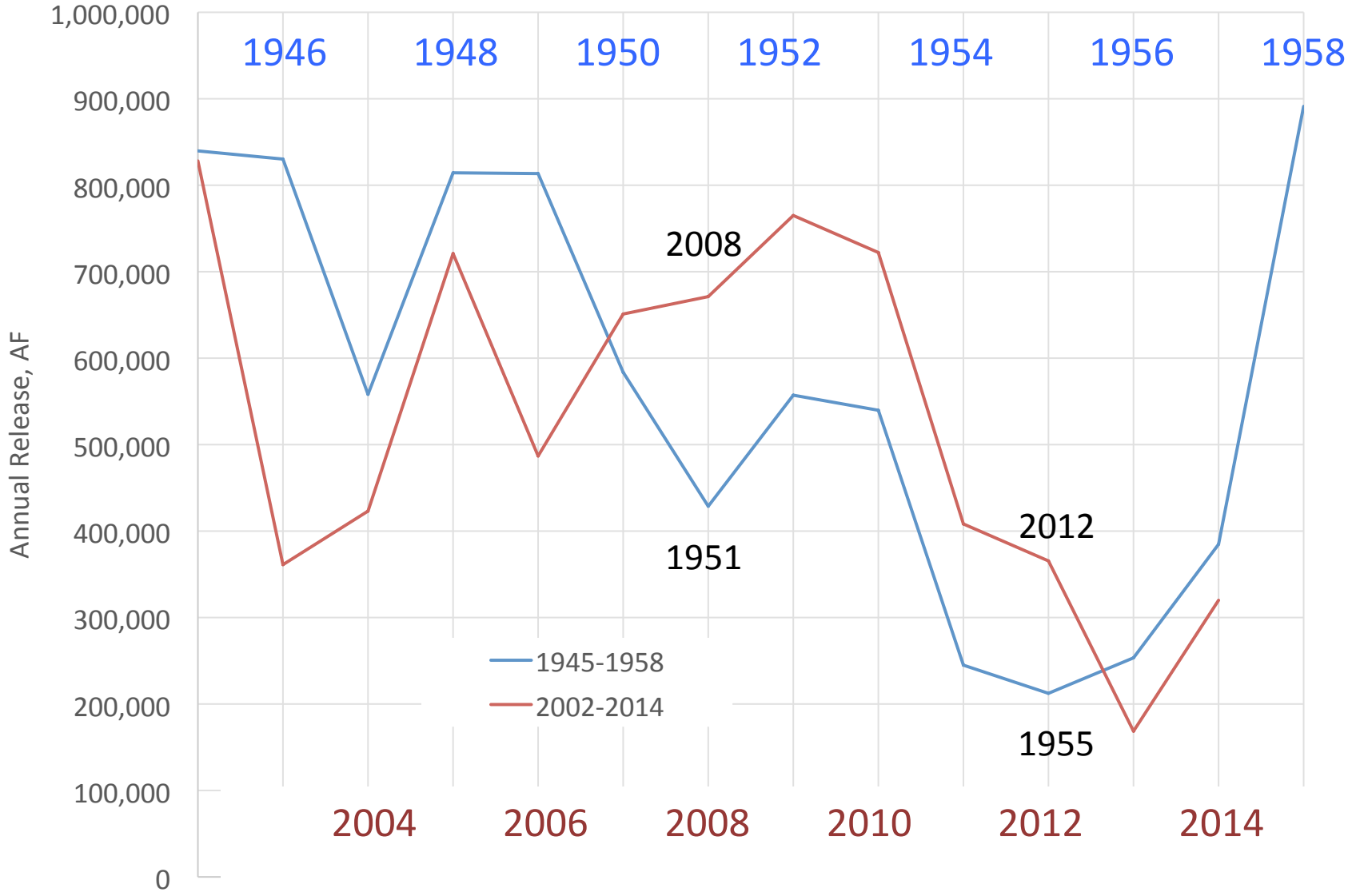


Temperature is now much warmer than in the 1950s

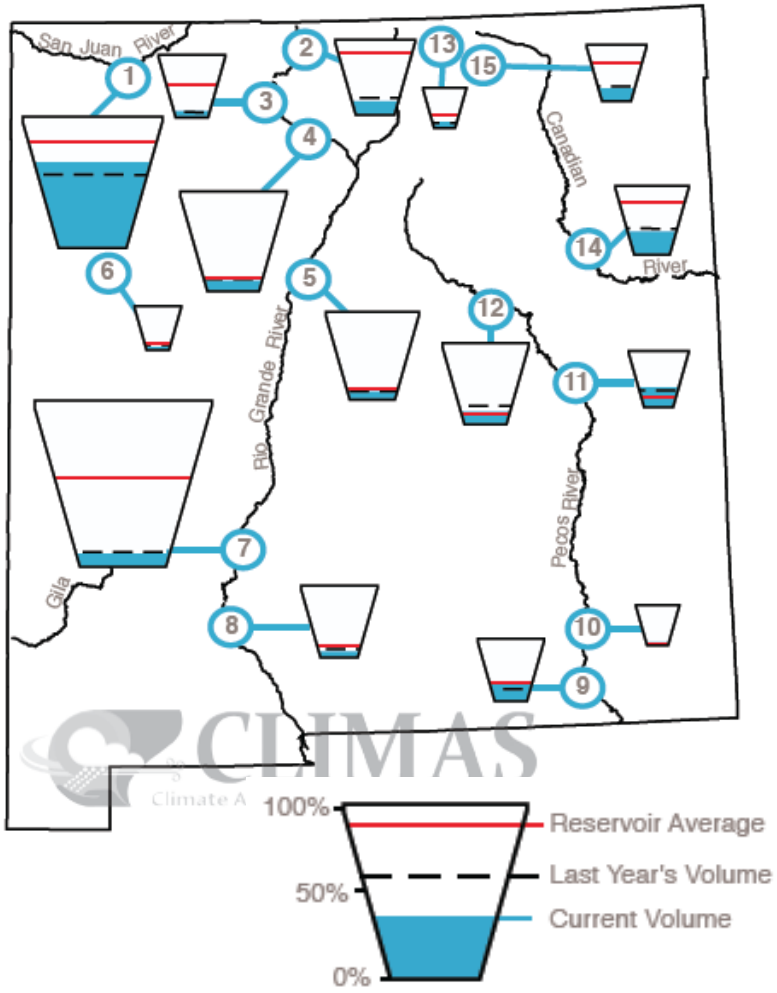
1950-56
7 straight years of below-average precip

2008-13
3 out of 6 years of below-average precip
(but snowpack has been worse)

Comparing Droughts: Caballo Reservoir Outflow

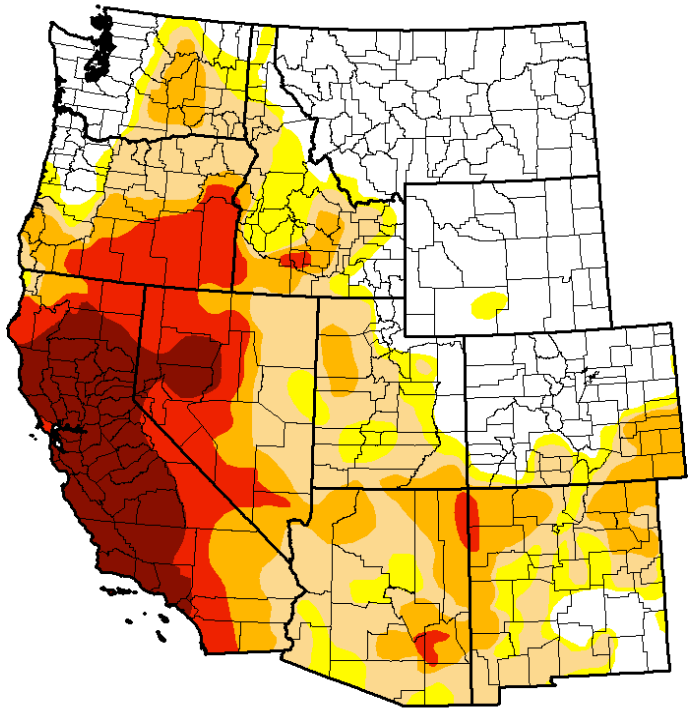


New Mexico Reservoir Storage
31 Oct 2014



CLIMAS (U Arizona) Southwest Climate Outlook
November 2014

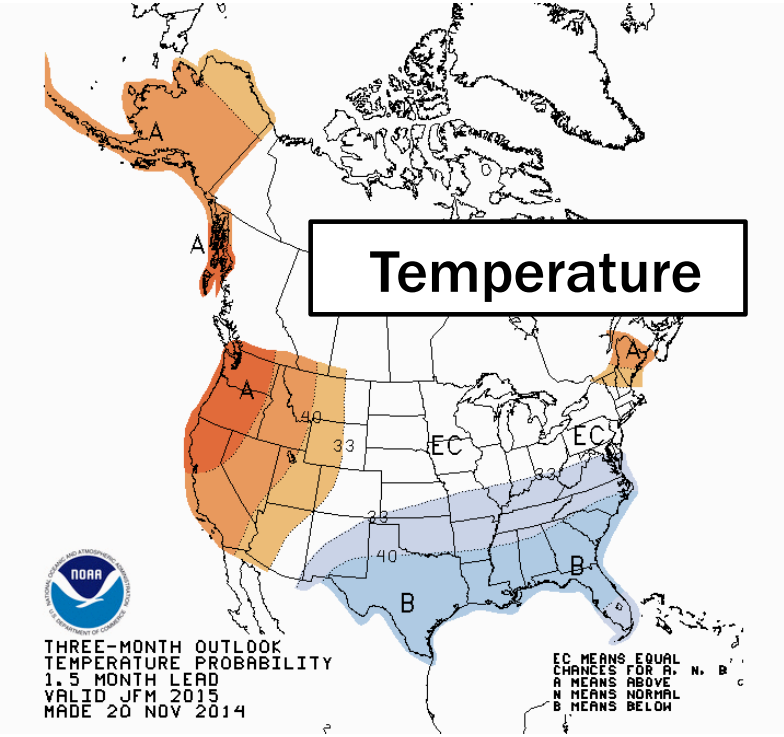
US Drought Monitor
25 Nov 2014

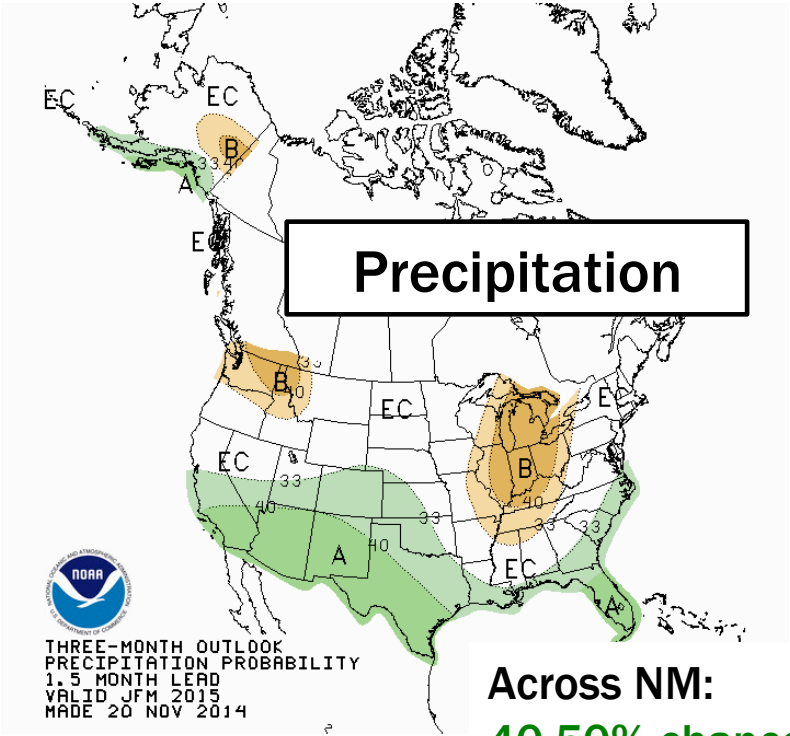


Despite abundant summer rains, most reservoirs contain below-average storage at the end of Oct
→ most notably, Elephant Butte

Winter 2015 Climate Outlook

issued 20 Nov 2014

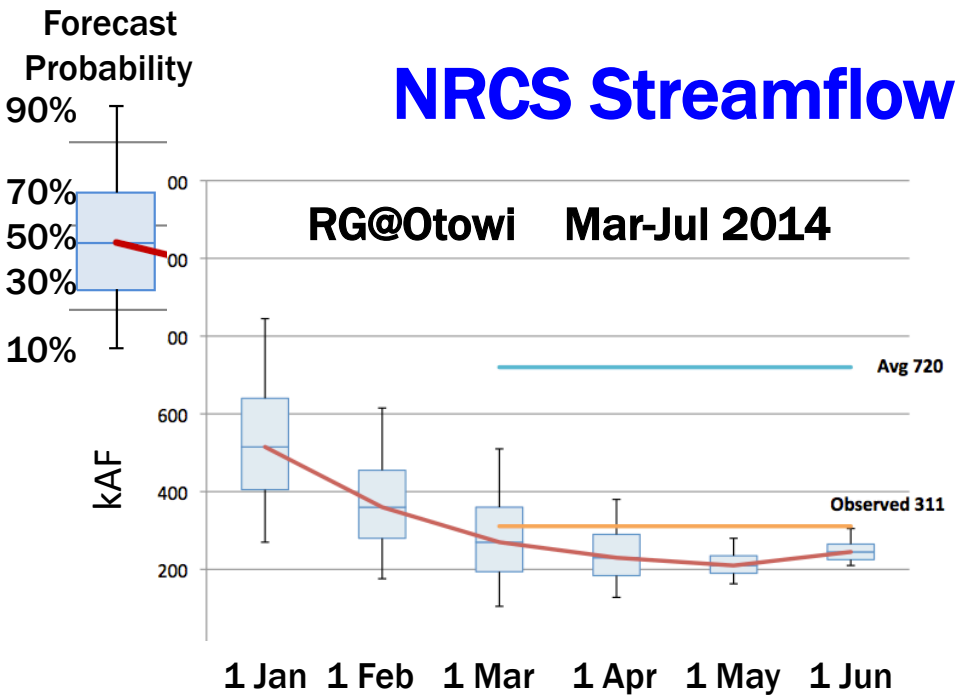




Across NM:
40-50% chance of Above-avg precipitation

El Niño to the rescue this winter? Maybe …
Equatorial Pacific Ocean anomalies have been strengthening for the past month

NRCS Streamflow Forecast Analysis

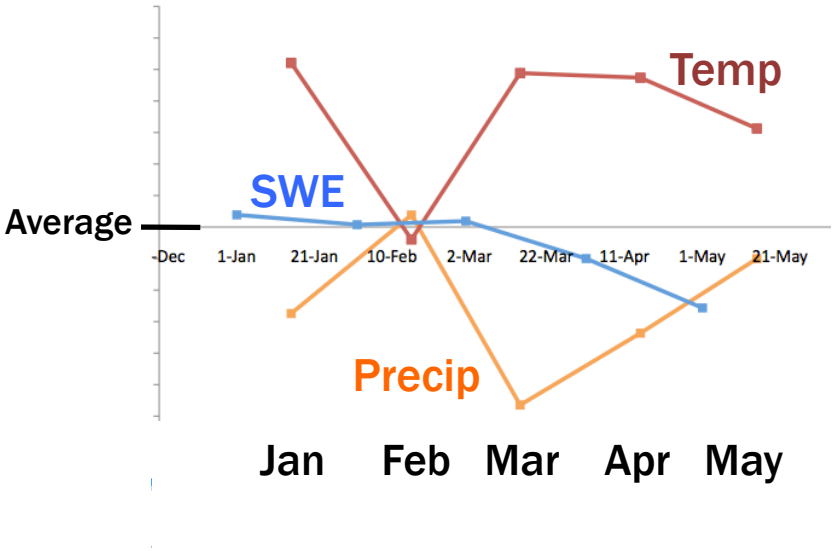


Flow Forecast Evolution:
Rio Grande @ Otowi (naturalized)
for Mar-Jul 2014

1 Jan forecast was a severe overestimate

Forecast reduced thereafter as temp and precip anomalies persisted through the Spring months

Observed flow far below average, but above late spring forecast, due to recovery in summer (spring flows were very low)



Climate Data (Anomalies)

Very warm & dry from March - May
Snowpack drops below avg 1 Feb onward

Shaleene Chavarria, UNM
Angus Goodbody, NRCS

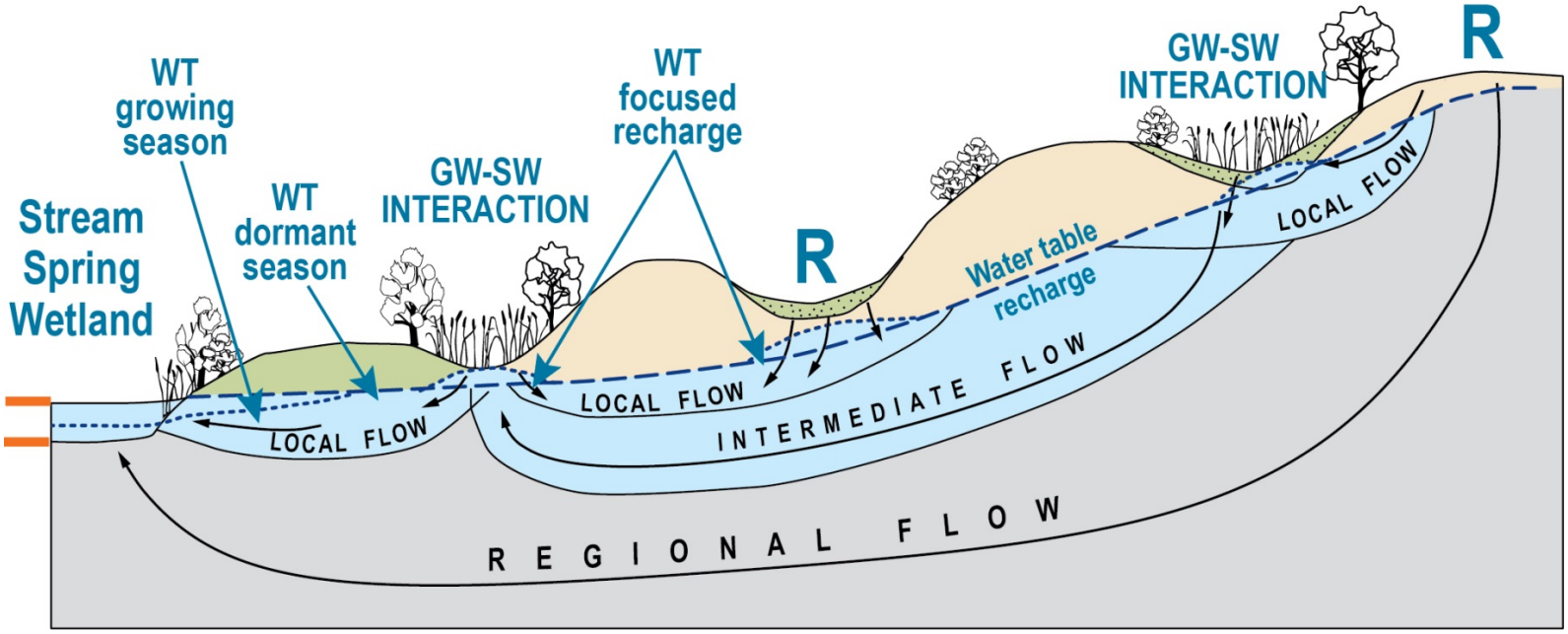
Groundwater Vulnerability During Drought

Peggy Johnson
Principal Hydrogeologist
New Mexico Bureau of Geology
A Division of New Mexico Tech
December 2, 2014

Groundwater Systems

A hydrologic balance between recharge, discharge and changes in aquifer storage

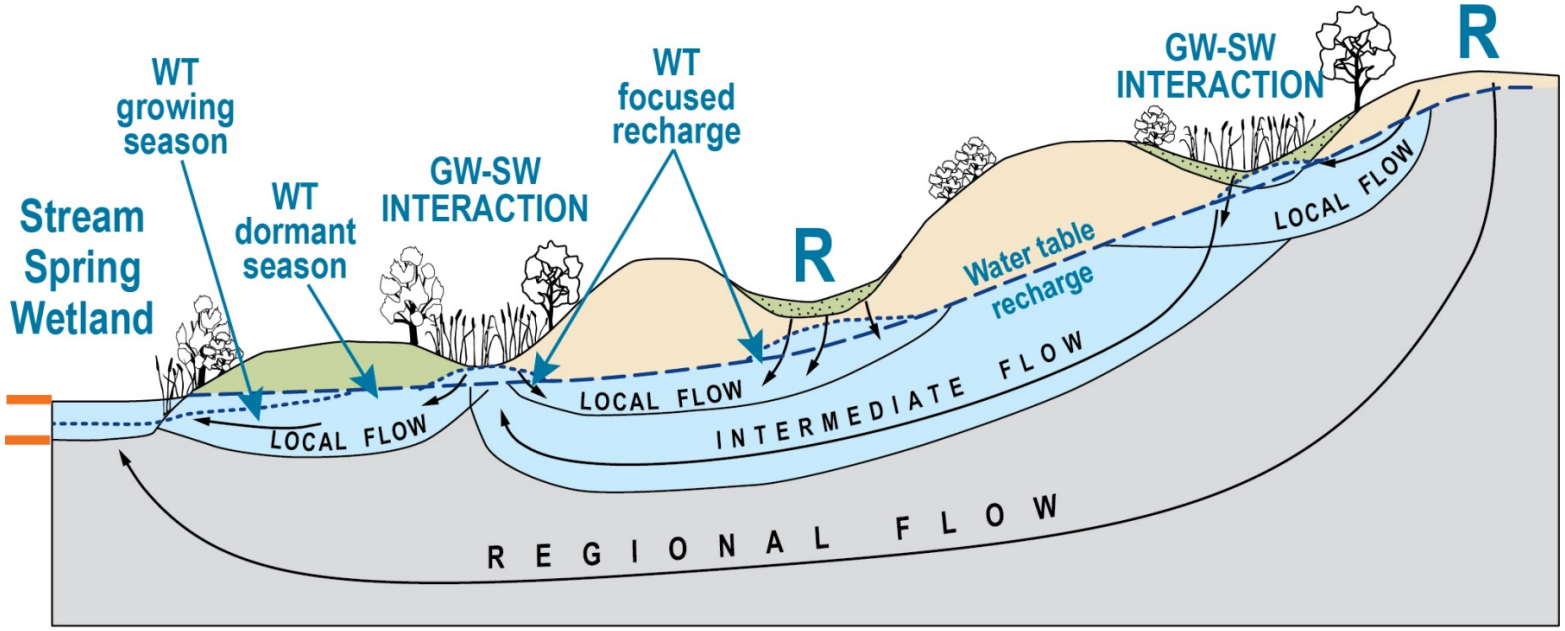
- Recharge – occurs when Precipitation >> Evaporation
- Groundwater has provided a stable water reserve during short-term droughts — recharges during wet cycles or with seasonal streamflow
- Warming climate will impact the P-ET balance and change the distribution of groundwater recharge and availability



Groundwater Systems Under Warming Climate

Increased temperature, regardless of rainfall, produces a cascade of negative impacts on groundwater

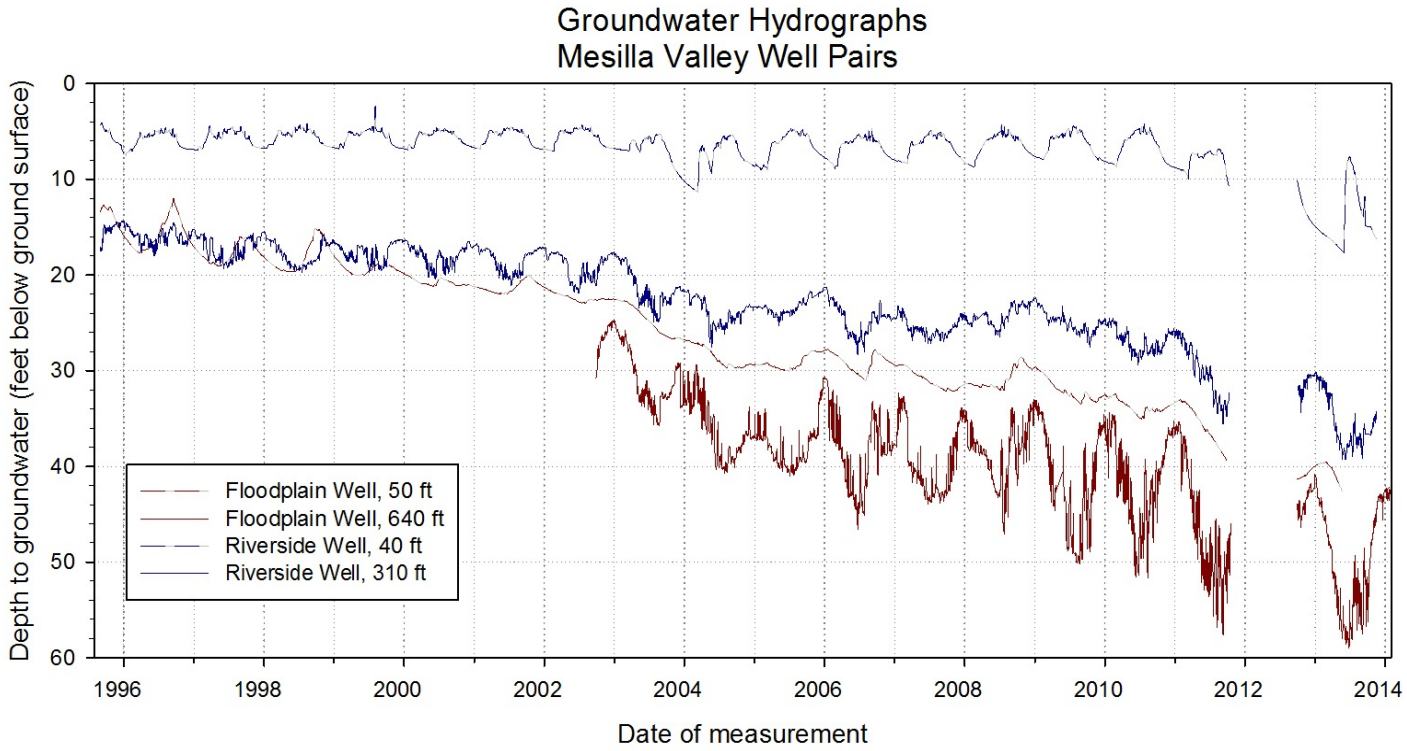
- Large increase in the evaporative demand (higher T, greater ET)
- Decrease in soil-water content
- Decrease in water infiltration below the root zone
- Reduced groundwater recharge
- Increased evaporative losses from shallow GW, streams, lakes
- Increased groundwater pumping to compensate for surface shortages



Groundwater Depletion

"Rates of withdrawal exceed long-run average recharge" = **Groundwater Mining**
Increases groundwater vulnerability during drought

- High-frequency hydrographs in Mesilla Valley
- Shallow wells — summer water-level high (recharge)
- Deep wells — winter water-level high (wells are resting)
- Superposition of seasonal fluctuations and depletion is visible since 2011
- Deep aquifers isolated from direct effects of climate change – but vulnerable to rapid depletion from drought-related pumping



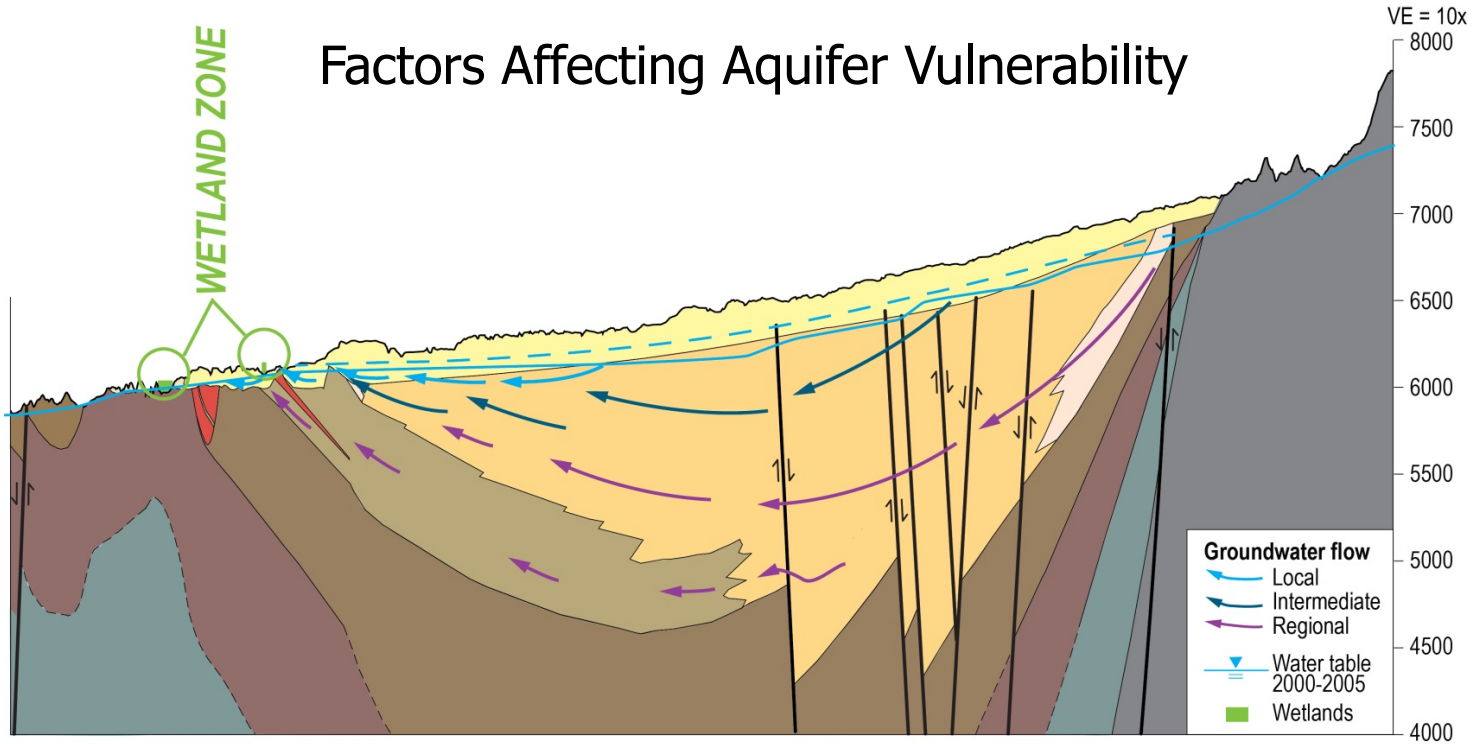
Groundwater Depletion in Western River Basins

- Colorado River Basin — "long-term reliance on GW combined with 14-year drought drove rapid depletion"
- Groundwater depletion increases seepage and reduces streamflow

	Sacramento and San Joaquin River Basins	Colorado River Basin	New Mexico	Rio Grande Basin
Subsurface water loss* or groundwater depletion** (Acre-Feet)	16.5 Million AF*	41 Million AF*	14.5 Million AF**	4.7 Million AF**
Time span	Oct 2003–Mar 2010	Dec 2004–Nov 2013	Jan 2000–Dec 2010	Jan 2000–Dec 2010
Basin area	59,460 mi^2	246,000 mi^2	121,700 mi^2	75,700 mi^2
Population served	6,247,900	~40,000,000	2,059,179 (2010)	1,500,696 (2010)
Annual per capita depletion (AF approx.)	~0.40 AF	~0.11 AF	~0.64 AF	~0.28 AF
Water use	Drinking & irrigation	Drinking & irrigation	Drinking & irrigation	Drinking & irrigation

* – GRACE-based estimate (NASA's Gravity Recovery and Climate Experiment)
** – Groundwater depletion estimated from NMOSE Water-Use Reports (2000, 2005, 2010)
AF – acre-feet

Factors Affecting Aquifer Vulnerability



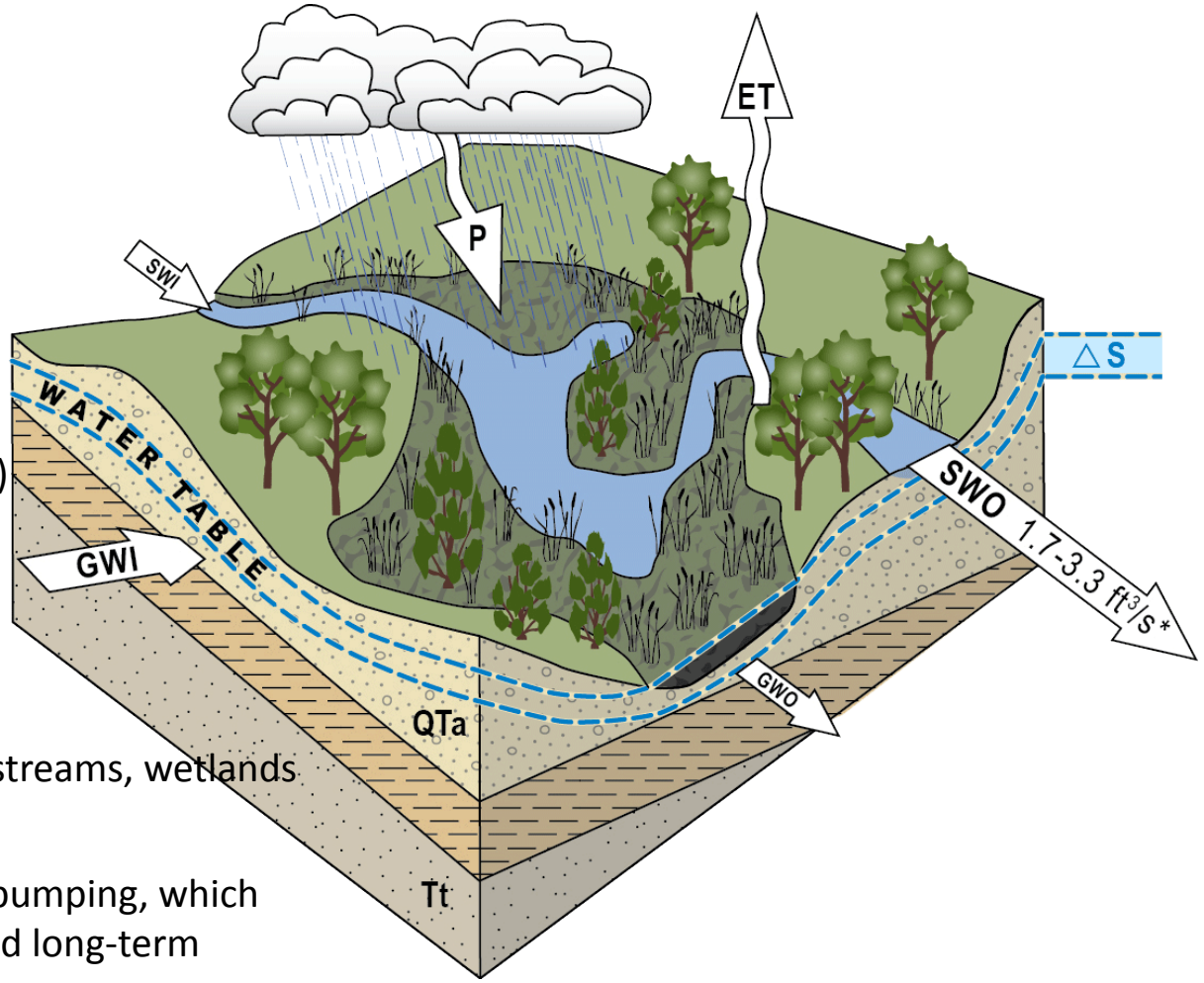
Hydrogeologic setting determines how vulnerable or resilient ground water is to combined pressures of warming climate, drought and depletion

- **Aquifer type** – mountain bedrock vs. alluvial basin
- **Aquifer storage** – large alluvial basin vs. thin or fractured aquifer vs. isolated compartment
- **Aquifer recharge** – aquifer depth: 100 ft (local), 300-500 ft (intermediate), >500 ft

Water Budgets During Drought

Dynamic balance between inflow and outflow

- Increasing evaporation
  Decreasing recharge
  Significantly increased pumping
- Outflows increase
- Inflows decrease
- Aquifer storage loss (irreversible?)



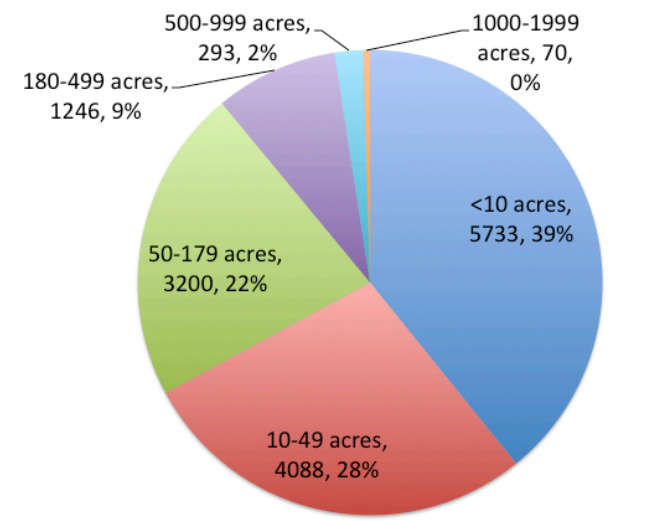
Groundwater Vulnerabilities

- Shallow GW — when levels drop, streams, wetlands and springs are impacted
- Deep GW — subject to increased pumping, which compounds water-level decline and long-term depletion
- Long-term depletion can lead to land subsidence and permanent loss of fresh-water storage

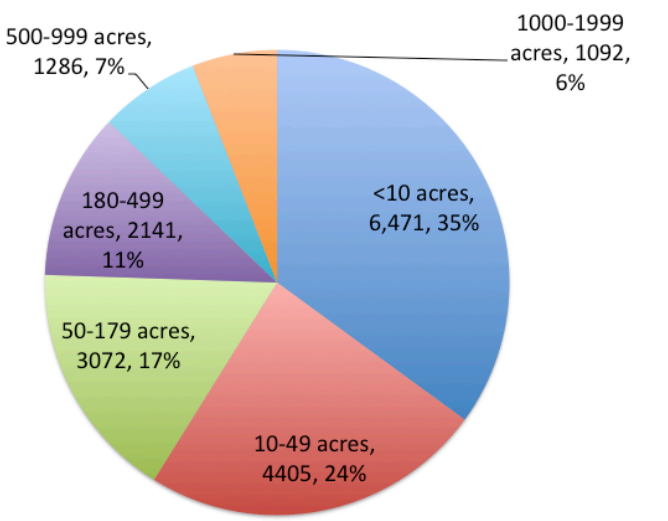
Changes in NM Agriculture
1950s Drought vs Today

FARM SIZE

1954

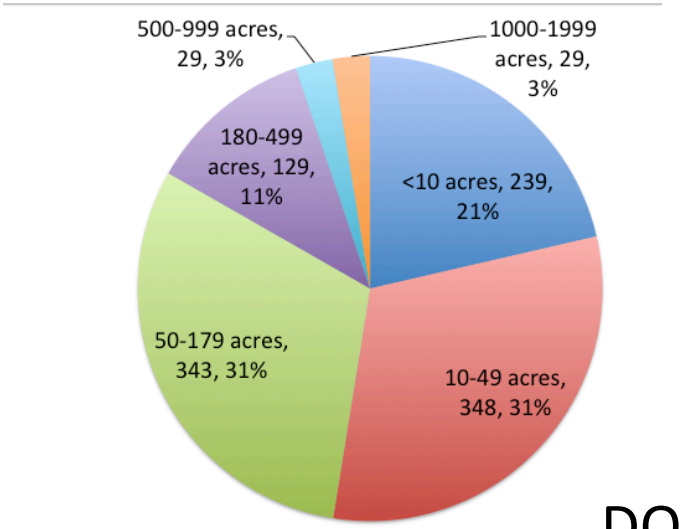


2007

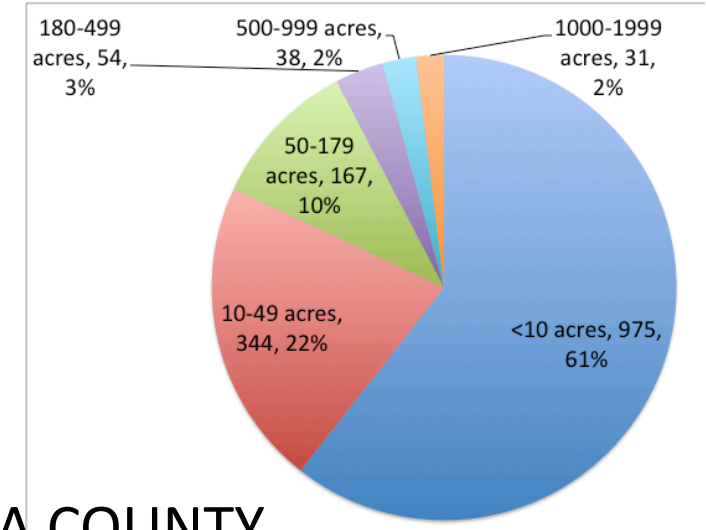


STATE

1954



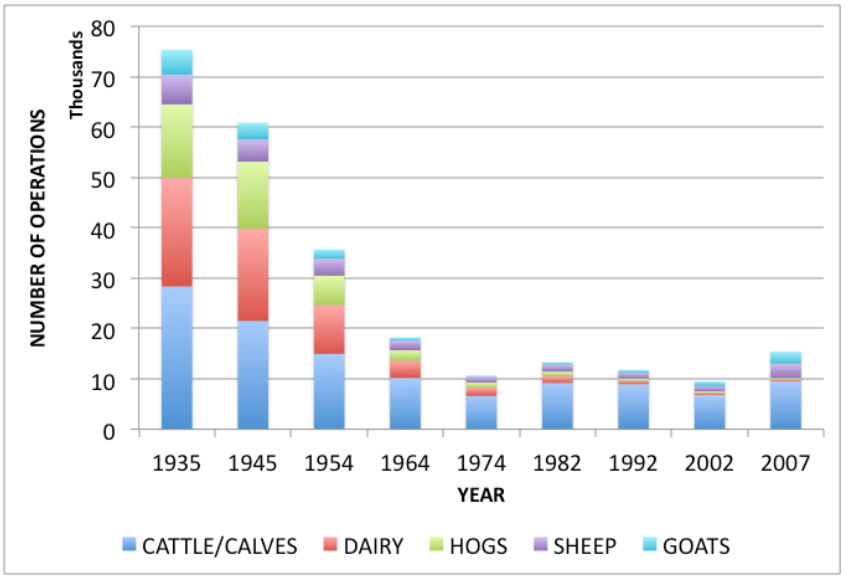
2007



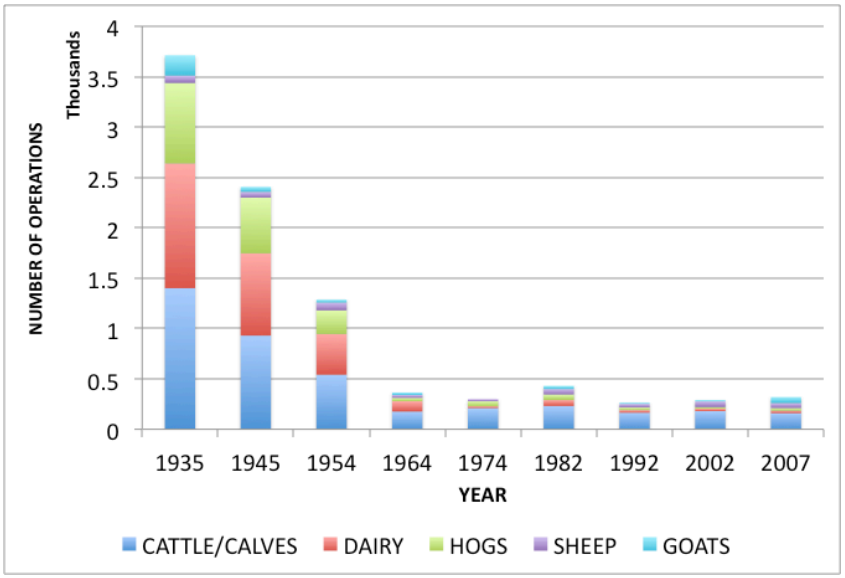
DONA ANA COUNTY

OPERATIONS WITH LIVESTOCK

STATE: NUMBER OF OPERATIONS WITH ANIMALS

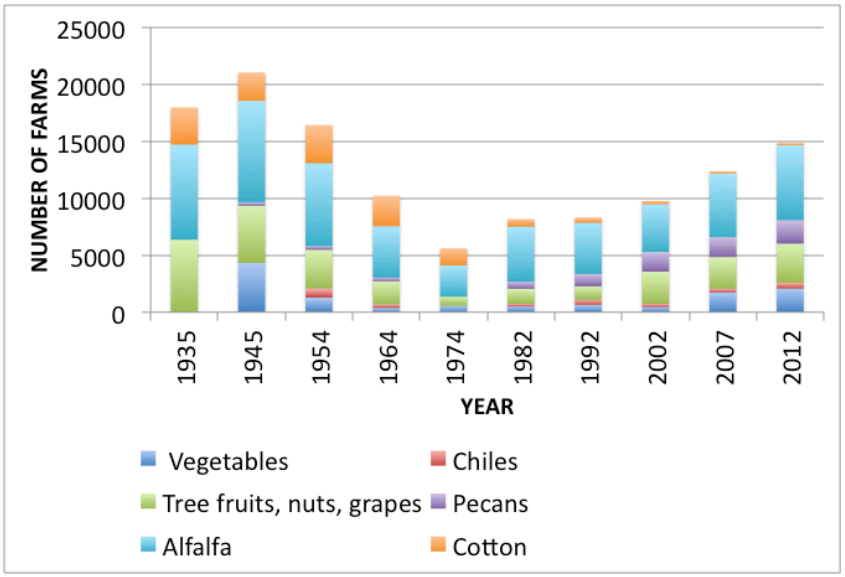


DONA ANA: NUMBER OF OPERATIONS WITH ANIMALS

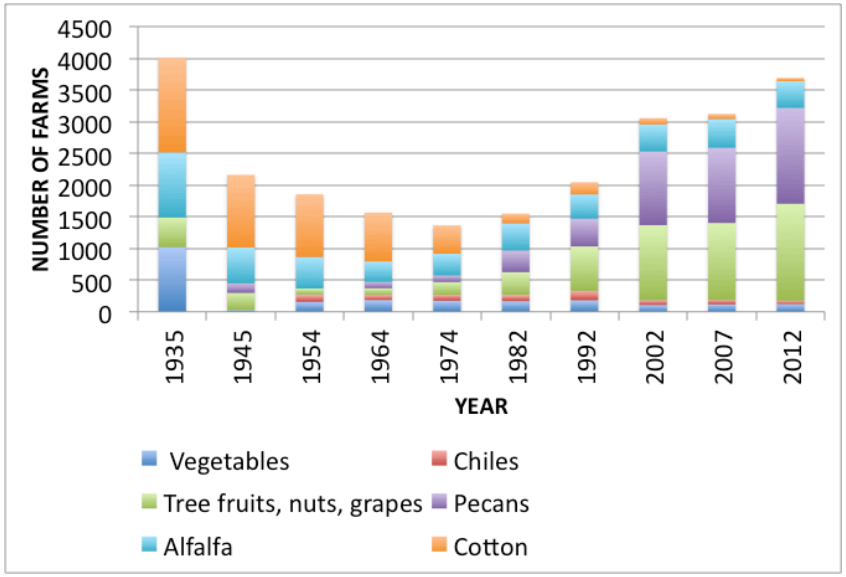


NUMBER OF FARMS BY CROP TYPE

STATE:
NUMBER OF FARMS BY CROP



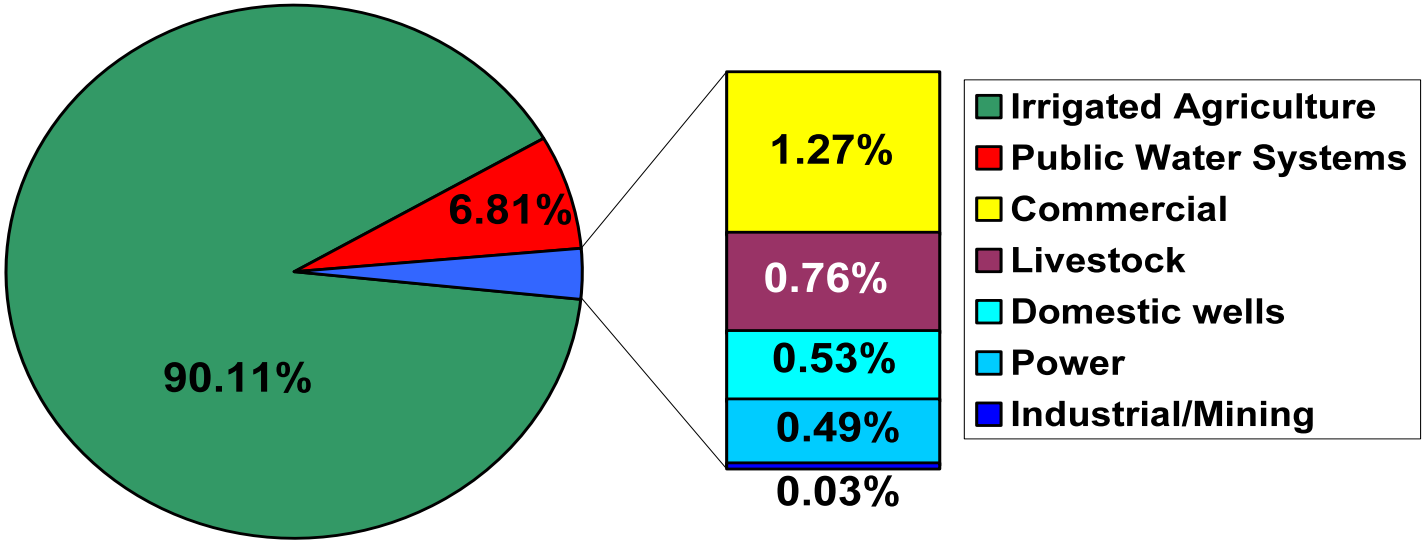
DONA ANA:
NUMBER OF FARMS BY CROP



NEW MEXICO AGRICULTURE

- Agriculture today significantly different from the 1950's
- Crop changes may constrain management choices
- Farm sizes can impact management choices
- Any management strategy results in tradeoffs

Water Demand in New Mexico's Lower Rio Grande



- Irrigated agriculture by far the largest, all of Rio Grande Project surface water diversion in New Mexico
- No M&I use of surface water (yet)

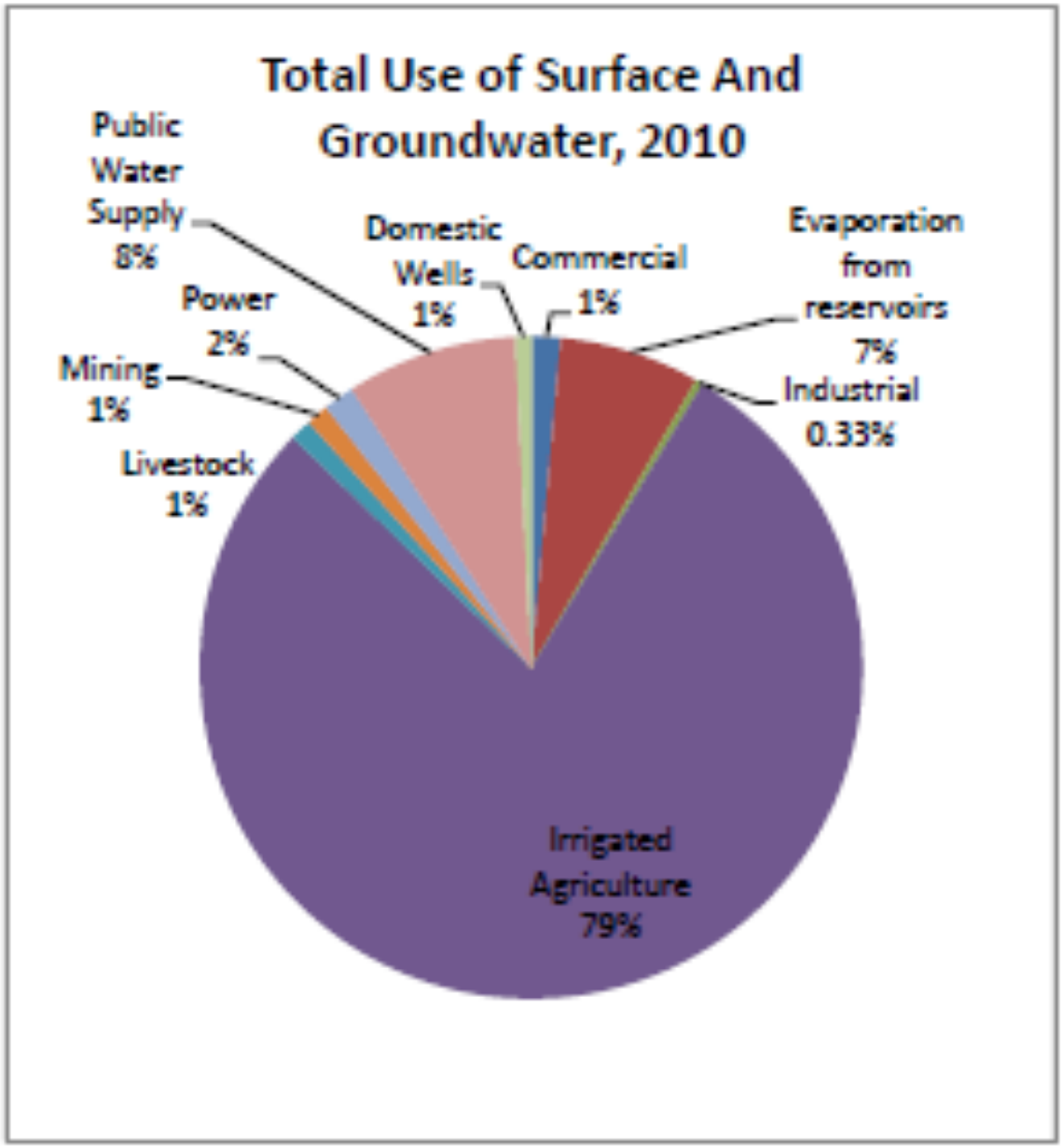
2004 LRG Regional Water Plan

The Economy and Drought, the 1950s and Today, NM and Las Cruces

Preliminary Results and Research under State Appropriation

Dr. Lee A. Reynis

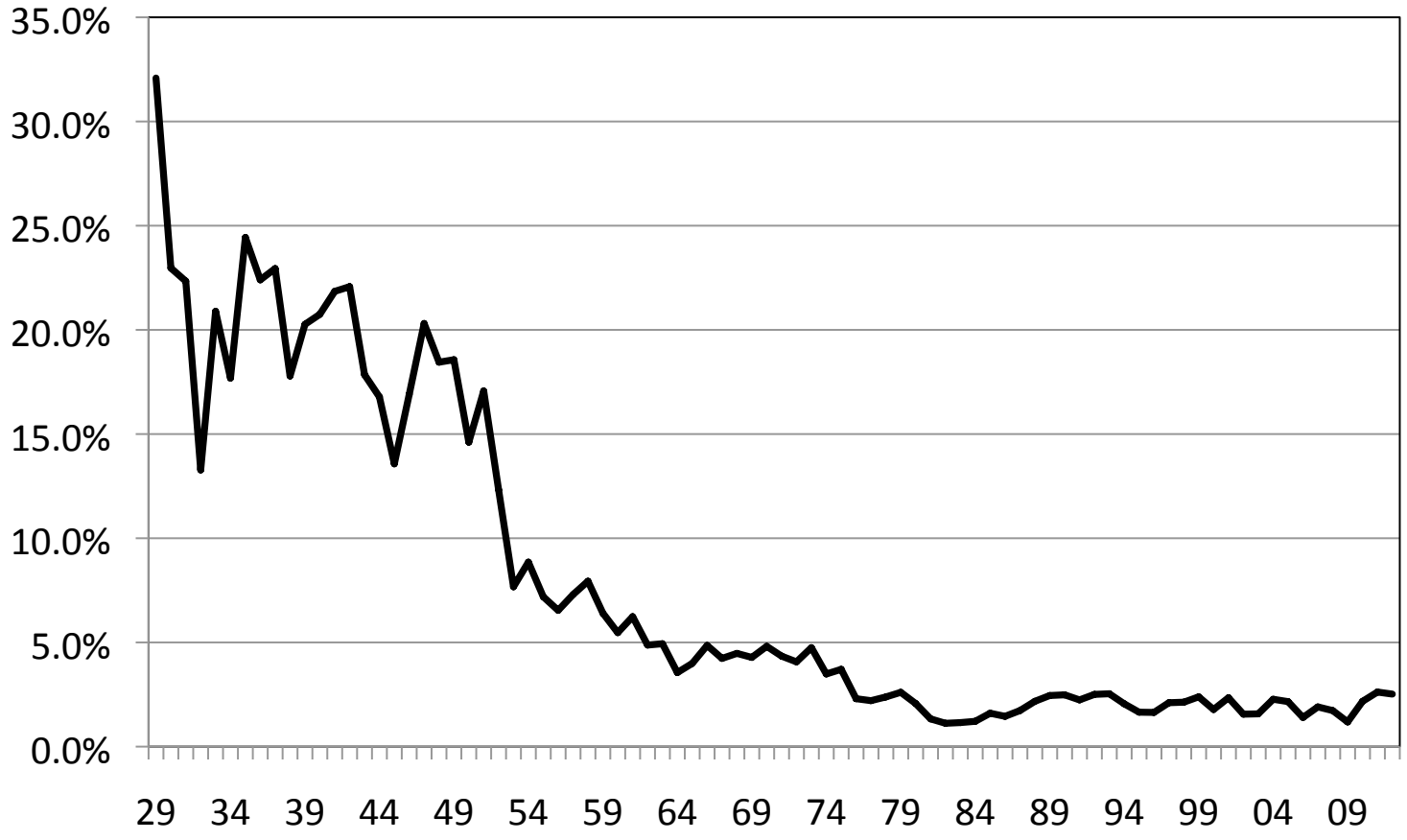
UNM Burueau of Business and Economic Research



2014 Water Town Hall

New Mexico Farm Sector

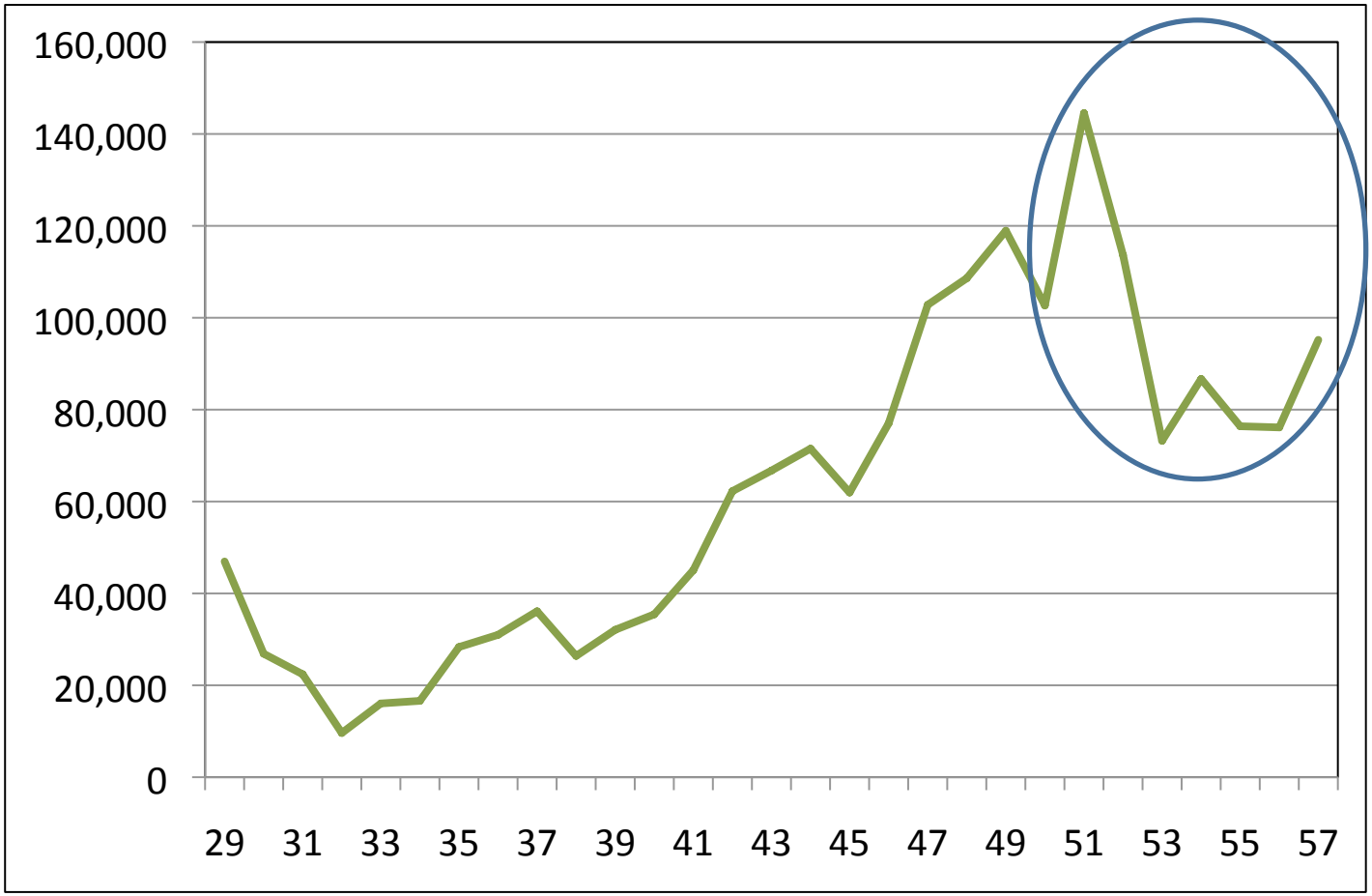
New Mexico Farm Income as a % of Total Income



Source of Data: US Bureau of Economic Analysis

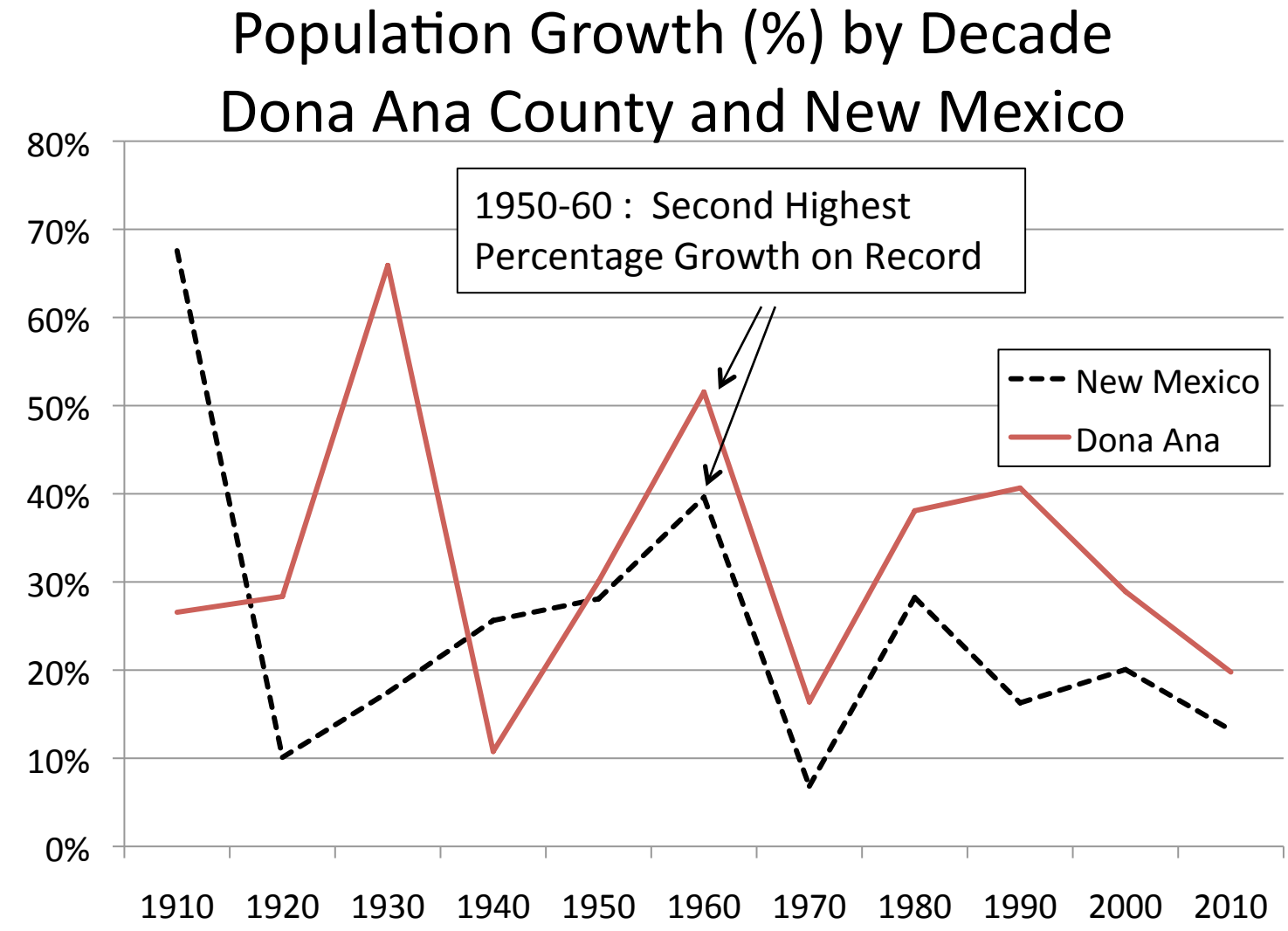
The 1950's Drought and the Economy

New Mexico Farm Income ($000s)



Source of Data: US Bureau of Economic Analysis

The 1950's Drought and the Economy



Source: US Bureau of the Census, Decennial Census, 1910 - 2010

The 1950's Drought and the Economy

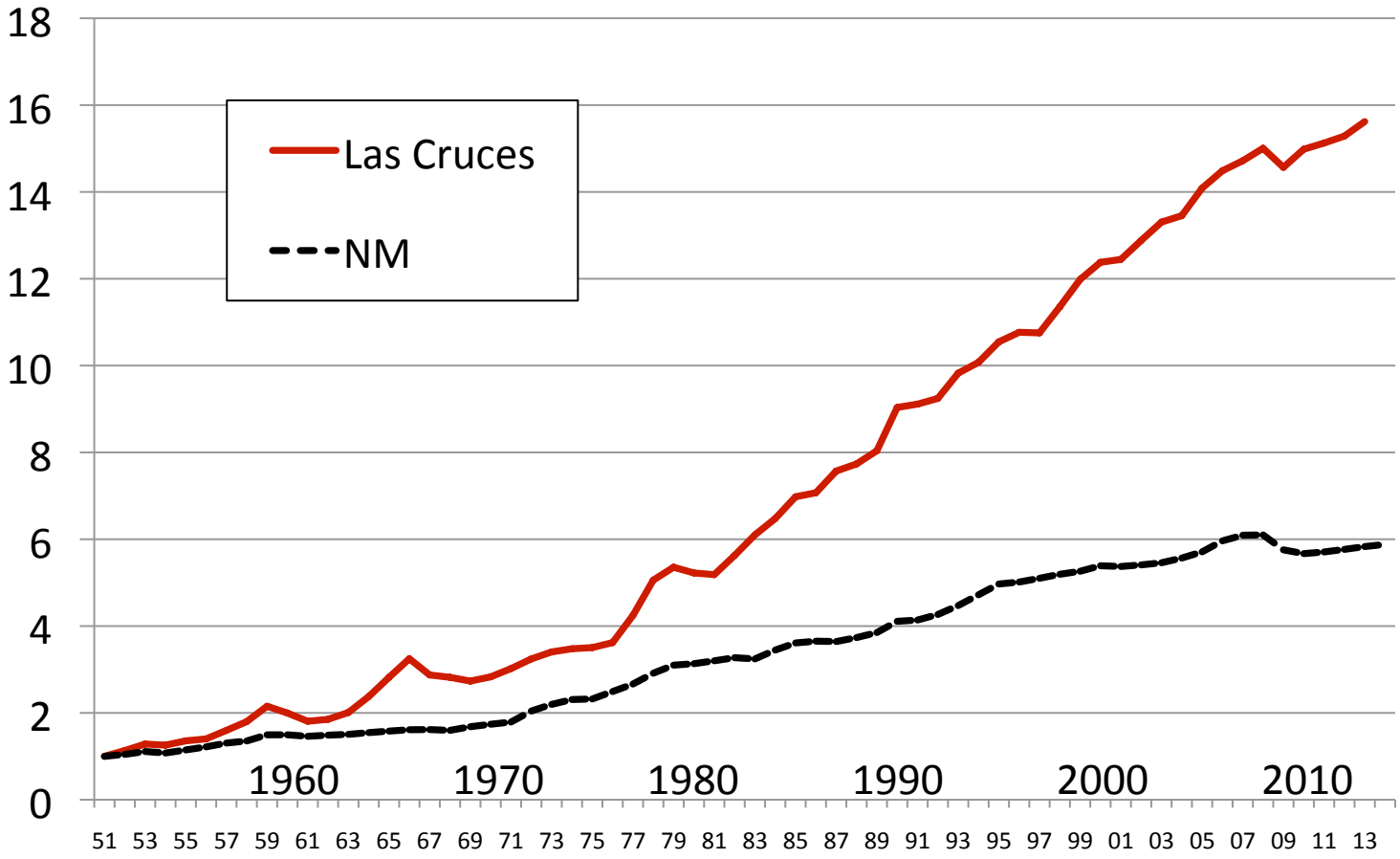
Agricultural Workforce Shrinks , Rest of the Economy Takes Off

	1950	1960	Change	
New Mexico				
Agricultural Labor Force	39,488	22,568	(16,920)	-43%
Employed in Agriculture	37,895	20,514	(17,381)	-46%
Non Ag Labor Force	178,595	282,148	103,553	58%
Total Non-Ag Employed	168,569	267,390	98,821	59%

Source: Decennal Census 1960

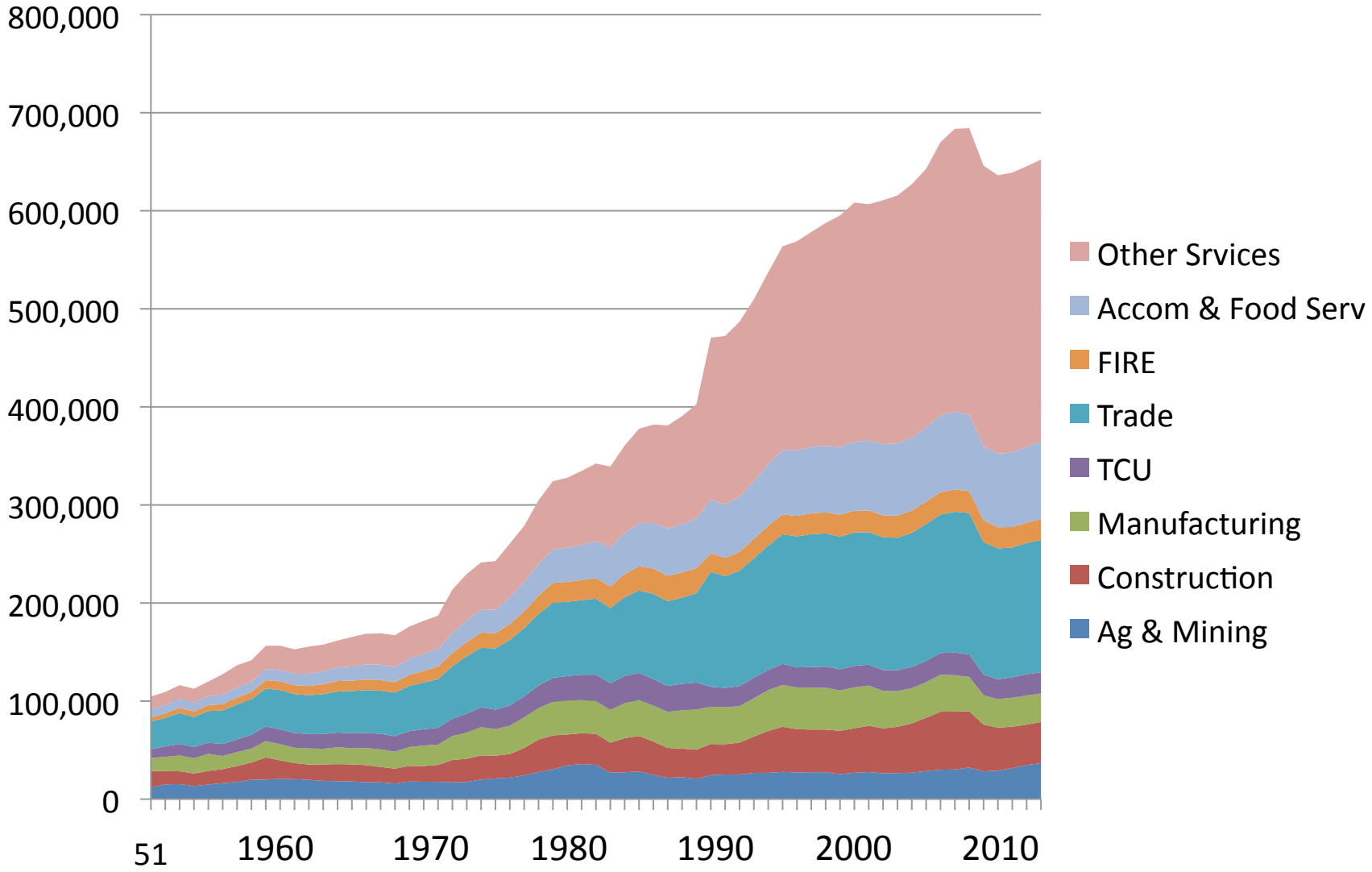
The Economy Since the 1950's

Total Private Sector Employment Indexed to 1951
Las Cruces MSA and New Mexico



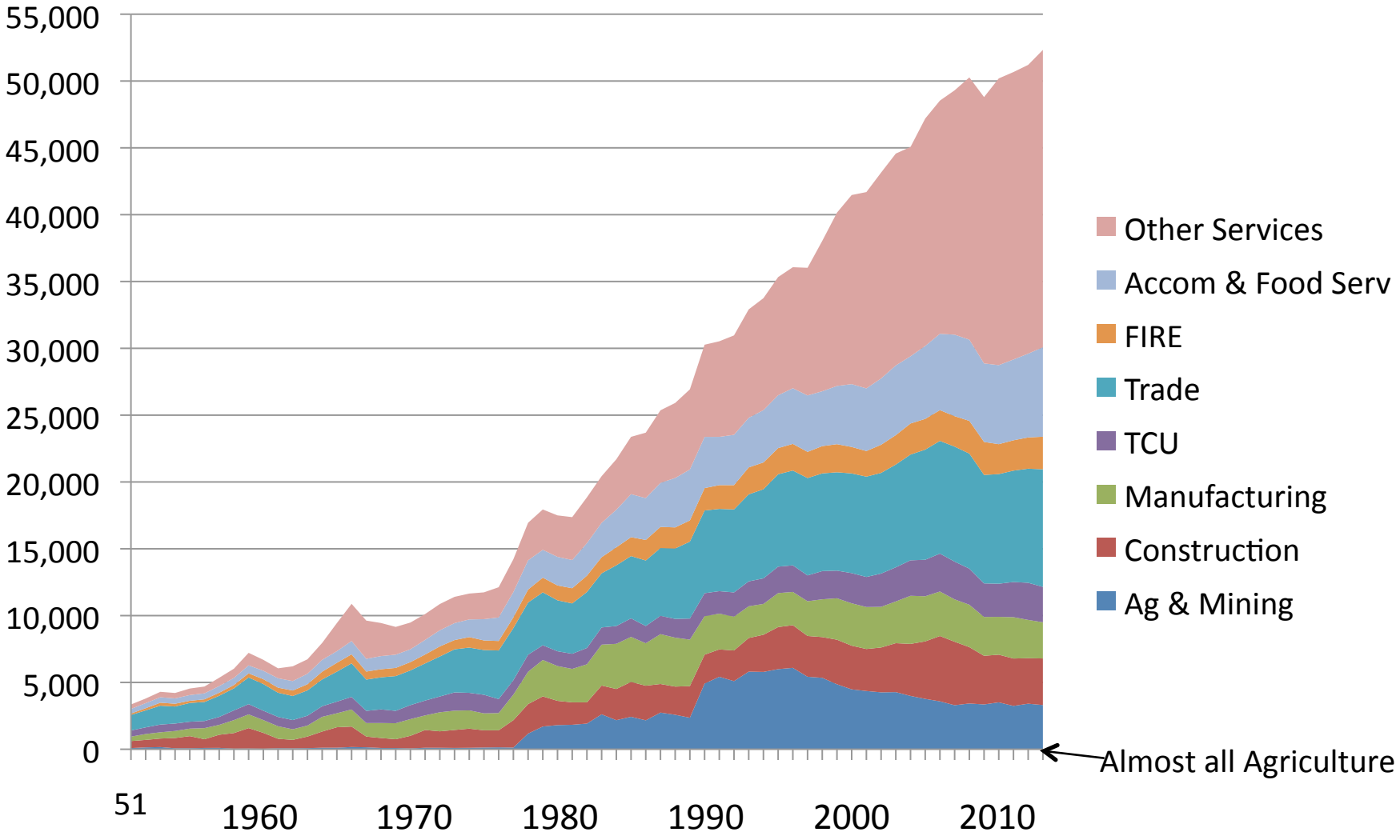
Source: Quarterly Census of Employment and Wages

New Mexico, Composition of Private Sector Wage and Salary Employment 1951 to 2013



Source: Quarterly Census of Employment and Wages

Las Cruces MSA, Composition of Private Sector Wage and Salary Employment, 1951 to 2013

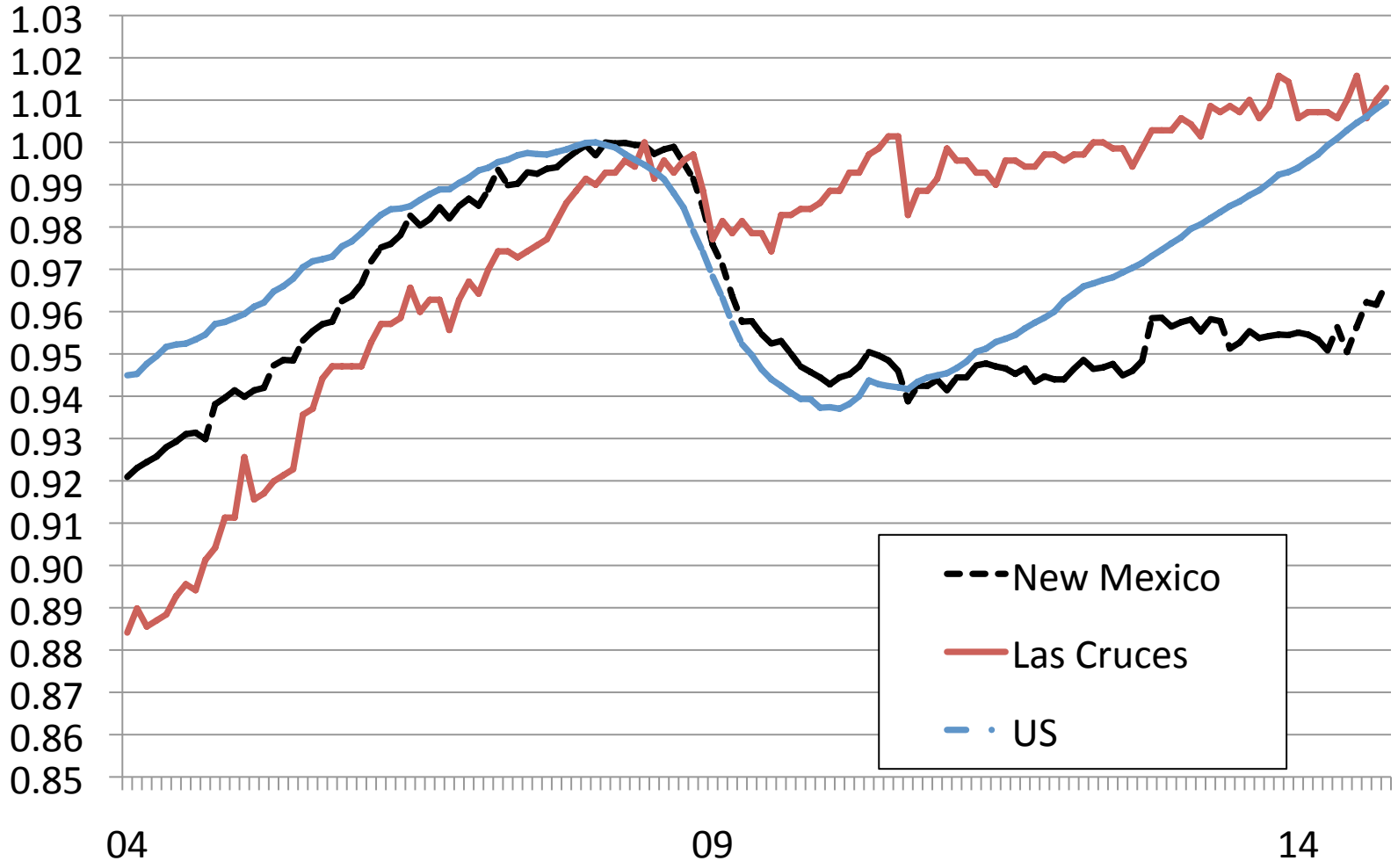


Source: Quarterly Census of Employment and Wages

Recent Climate Variability/Drought and the Economy

New Mexico, Las Cruces MSA and US Employment

Monthly, Seasonally Adjusted, Each Indexed to 2008 Peak



Source: US BLS CES