New Mexico Universities Working Group on Water Supply Vulnerabilities

Briefing for the Interim Committee on Water and Natural Resources, 27 July 2015

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This Working Group was funded by the State Legislature to: assess the current status of water supply and demand after years of severe drought in New Mexico; put the current drought into long-term context with a more arid climate, reduced surface water, groundwater depletions, and economic activity; and develop a list of vulnerabilities and promote policy strategies to mitigate these vulnerabilities. This assessment focuses on the Lower Rio Grande, a major population and economic center whose water supply issues are particularly critical.

Key Findings:

- While monsoonal rains and the development of El Niño in 2015 have brought a sense of optimism to the Lower Rio Grande (LRG), the past decade has been one of scarcity in terms of surface water supply, particularly for the past four years. While the drought of the 1950s was worse than the current drought (so far) in terms of precipitation deficit, higher temperatures in the current climate and increases in water consumption have led to more severe impacts on the surface water supply and groundwater system in the LRG. Much longer and more severe droughts in terms of precipitation deficits have occurred in the past 500 years, but if exacerbated by the warmer climate we are now in, such a megadrought could be devastating.
- Drought-induced surface water shortage has a compound effect on groundwater supplies. First, surface water is by far the largest source of recharge for the groundwater system, through river and irrigation canal seepage, and deep percolation from on-farm irrigation. Less surface water in the system means less recharge. The groundwater is further effected by the response to reduced surface water, which is increased groundwater pumping for irrigation to make up the deficit. Drought impacts can be masked for years through groundwater depletions, including those induced by municipal and industrial pumping which will affect future years' surface water supply. The aquifer response to the current extended drought suggests that current depletions in the LRG exceed the likely future capacity of the aquifer system to provide a reliable supplemental water supply.
- Irrigated agriculture is the only user of surface water in the LRG, and the largest user of groundwater, and hence is the sector most immediately affected by drought. While agriculture was a larger component of the LRG's economy in the drought of the 1950s, it remains a key producer of revenue and jobs. The cropping mix in the LRG has also changed since the 1950s, and now has a much higher percentage of permanent crops, particularly pecans, which are valuable but allow less flexibility in year to year water use. Future economic development in the border region will require water, to support both municipal and industrial growth. The groundwater supply is likely already beyond its long term carrying capacity even for current uses.

Principal Vulnerabilities:

- Extended drought, transitioning quite possibly into a permanently warmer and more arid climate, likely means a long-term decrease in mean available surface water supply for the LRG. The deficits in surface water will propagate through the groundwater system, and the conjunctive system will not be able to support current, much less expanded use of water in the long term in the LRG.

- Agriculture in the area is highly productive, but increasingly inflexible in its response to water shortage. Improvements in irrigation technology have distinct benefits, but are expensive, and may increase depletions.
- Growth and economic development that do not consider the interactions and tradeoffs between human activity and the physical realities of water supply (and variability of supply) may result in increasingly severe constraints in times of drought that cannot easily be mitigated.

Recommendations:

- Initiate development of possible strategies for strengthening long-term resiliency when facing persistent water shortages by bringing supply and demand closer to balance. Specifically, develop strategies that allow flexibility in times of shortages and that consider the physical and the economic impact of the choices.
- Consider better integrating the management of groundwater and surface water resources, for example by optimizing the use of groundwater during severe drought to minimize impacts to surface water and shallow aquifers.
- Investigate feasible means of reducing groundwater pumping and artificially enhancing groundwater recharge in order to mitigate the depletion of groundwater storage. Research and assessment of additional water sources should begin immediately. Due to stress imparted upon the region's water supplies by the ongoing drought, it is unlikely that additional freshwaters will be available. Given the availability of brackish water, a desalination plant is an option that should be given serious consideration, and particularly given the development occurring on the border at Santa Teresa..
- Support improvements in irrigation water management and conservation, including technology improvements, flexible transfer mechanisms for groundwater among irrigators, and intersectoral transfer mechanisms and incentives.

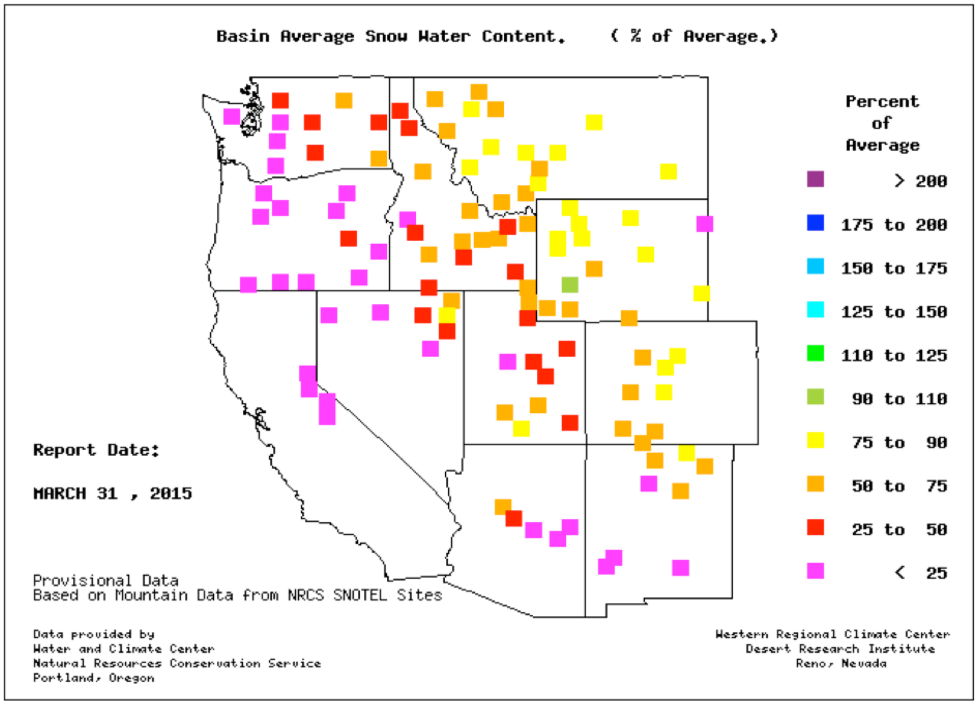


Figure 1. Percentage of long-term average snowpack in high elevation basins across the western U.S. on March 31, 2015, near the peak of the annual snowpack accumulation season. Basins that supply runoff to rivers in New Mexico all reported less than 75% of the long-term average snowpack. [Data from Western Regional Climate Center, Reno NV http://www.wrcc.dri.edu/snotelanom/basinswe.html]

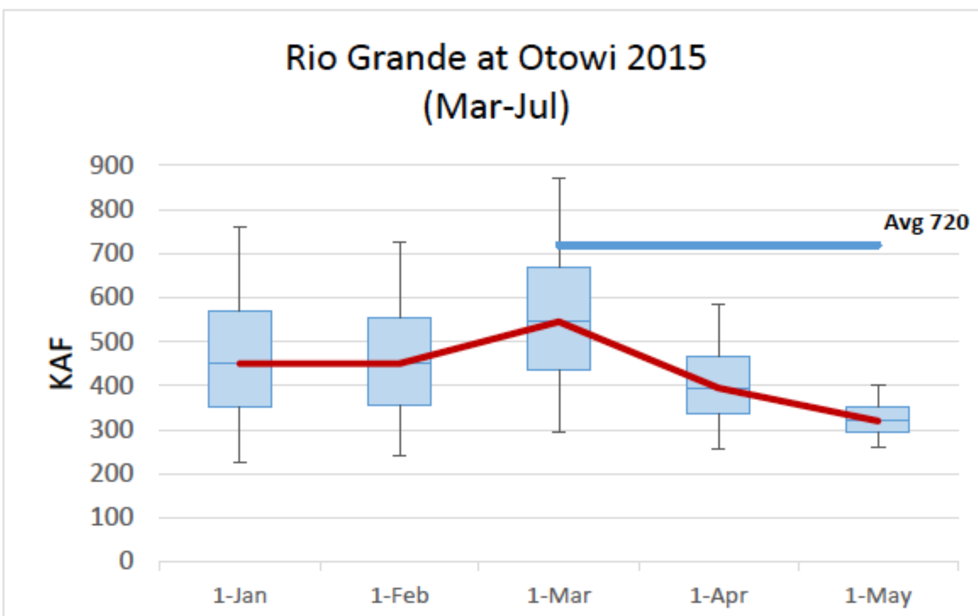


Figure 2. Evolution of Spring-Summer streamflow forecasts for Rio Grande flow at Otowi between March and July 2015, issued by NRCS between 1 January and 1 May 2015. The long-term average (naturalized) flow at Otowi, 720 Kaf, is shown by the horizontal blue line. On the first of each month, starting on 1 January, NRCS forecasts Mar-Jul flow; each of these forecasts is shown here as a box-and-whiskers plot. The most probable flow, the median estimate, is the center of each box (connected by the red line). Uncertainty in each forecast is indicated by the width of the box and whisker about each median estimate. [Source of data: U.S. Natural Resources Conservation Service]

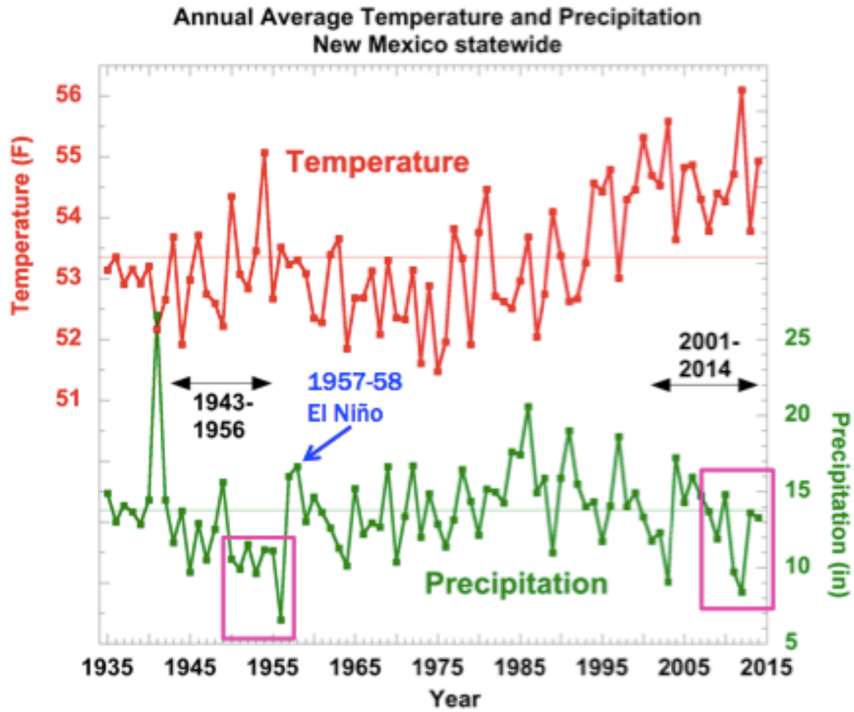


Figure 3. Time series of annual average temperature (red curve, top) and precipitation (green curve, bottom) averaged over the state of New Mexico for the period 1935-2014. Boxes on the precipitation plot show the major multiyear periods of drought in the 1950s, and in recent years. [Source of data: U.S. National Oceanic and Atmospheric Administration, obtained from the Western Regional Climate Center, Reno NV]

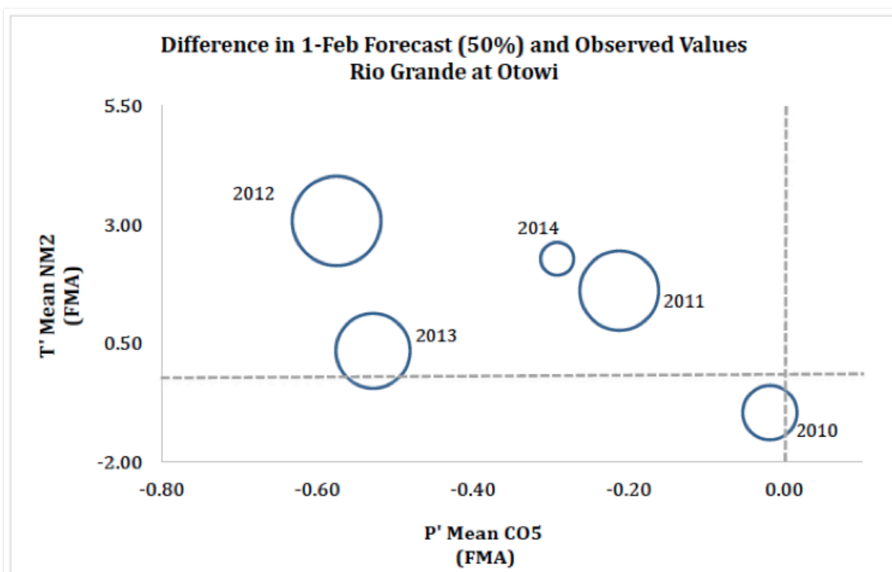
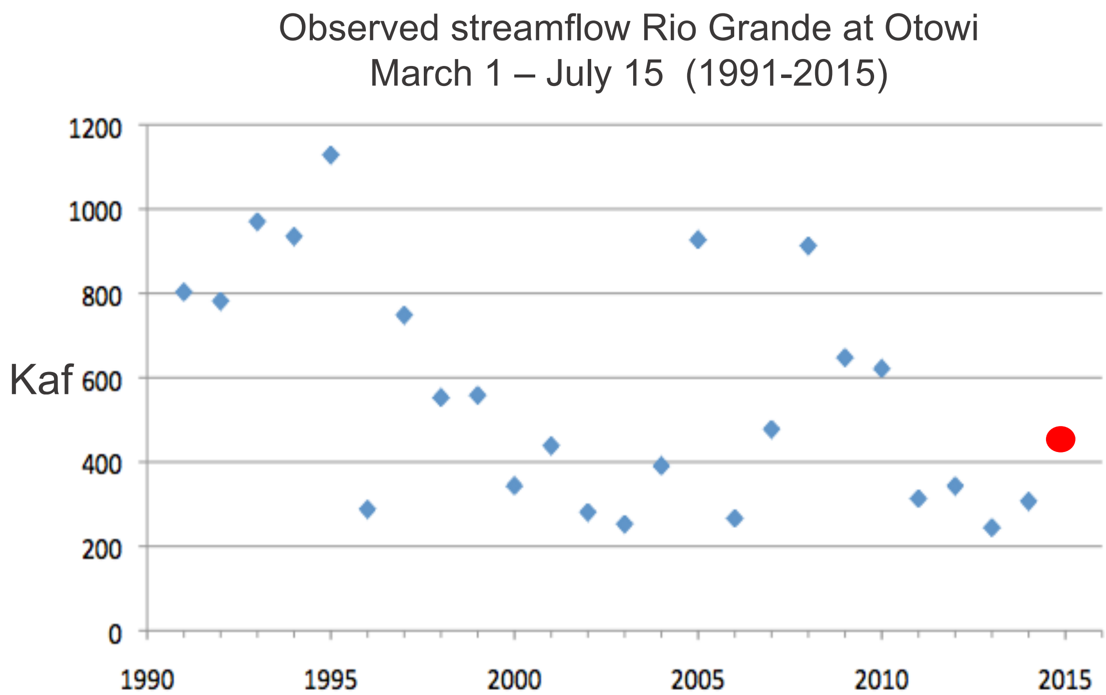


Figure 4. Assessment of the five most recent Spring-Summer streamflow forecasts for Rio Grande flow at Otowi (naturalized), issued by NRCS on 1 February for year 2010-2014. The size of each circle represents the magnitude of the forecast error relative to what was subsequently observed. Open circles represent over-estimated flows; solid circles (there are none of these) would represent underestimated flows. Each forecast error circle is plotted on an x-y plot where the x-axis represents the observed precipitation anomaly for February-April, and the y-axis represents the observed temperature anomaly for February-April. [Streamflow forecast data from the U.S. Natural Resources Conservation Service; temperature and precipitation climate divisional data from the U.S. National Oceanic and Atmospheric Administration, obtained from the Western Regional Climate Center, Reno NV]



So how much has the heavy rain this Spring helped boost streamflow?

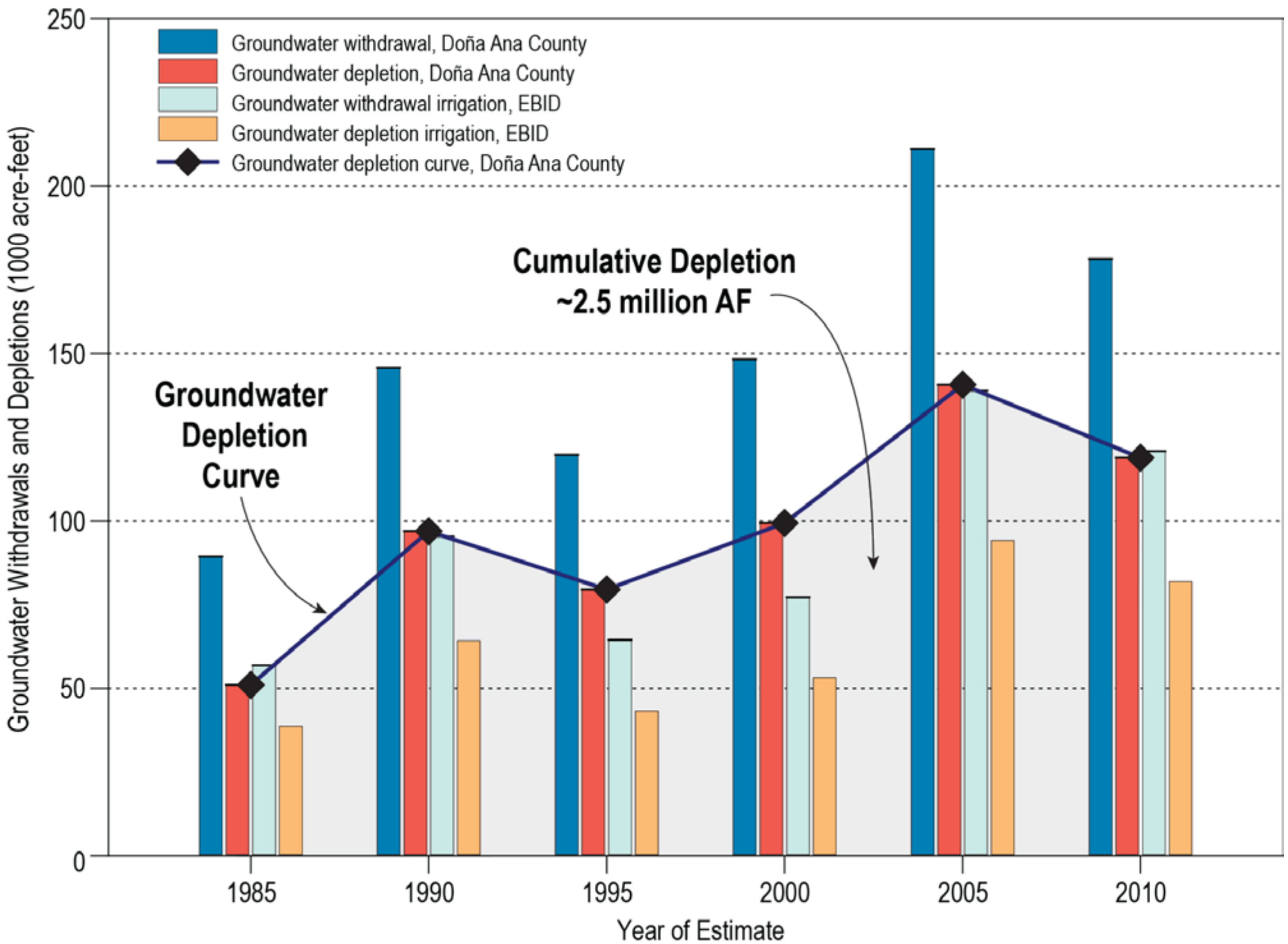
These are observed flows at Otowi for the past 25 years; the red dot shows the current year. This year's Mar-Jul flow is still somewhat below average for the past 25 years, despite very heavy Spring and early Summer rainfall. For sure, this is better than the previous four years, and better than the snowmelt-based forecast from earlier this year, but we need to remember that most of the Spring-Summer flow in the Rio Grande is still snowmelt-derived.

Groundwater Vulnerability During Drought

GROUNDWATER PROVIDES A VITAL, SUPPLEMENTAL WATER SOURCE DURING DROUGHT THAT COMPENSATES FOR LOST SURFACE SUPPLIES

- Water use and groundwater depletion
- Groundwater occurrence
- Declining groundwater levels with drought and pumping

Water Use and Groundwater Depletion



Depletion: "the part of a withdrawal or diversion that is evaporated, transpired, taken by crops or products, consumed by man or livestock, or otherwise removed from the aquifer"

How much groundwater is used?

Two major uses of surface water and groundwater:

- Irrigated Agriculture (⅔)
- Public Water Supply (⅓)

Groundwater provides 100% of drinking water

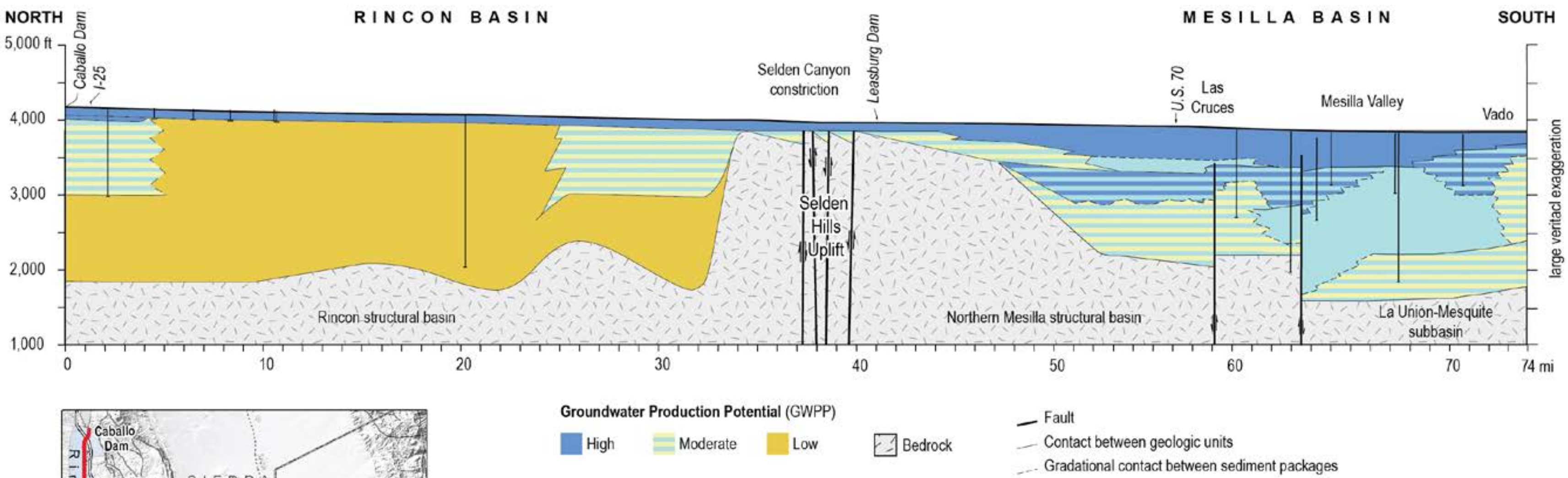
How much groundwater is depleted?

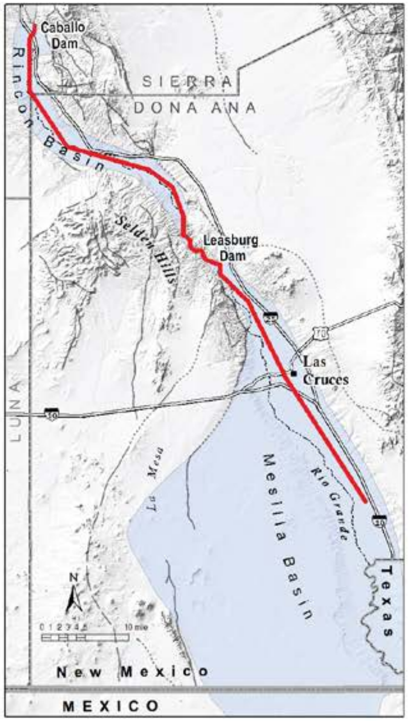
67-68% of pumped groundwater is depleted

32-33% is recycled to the river and aquifer

Estimated cumulative groundwater depletion is ~2.5 million acre-feet, comparable to the capacity of Elephant Butte Reservoir

Groundwater in the Rio Grande Valley — Caballo Dam to Mesilla





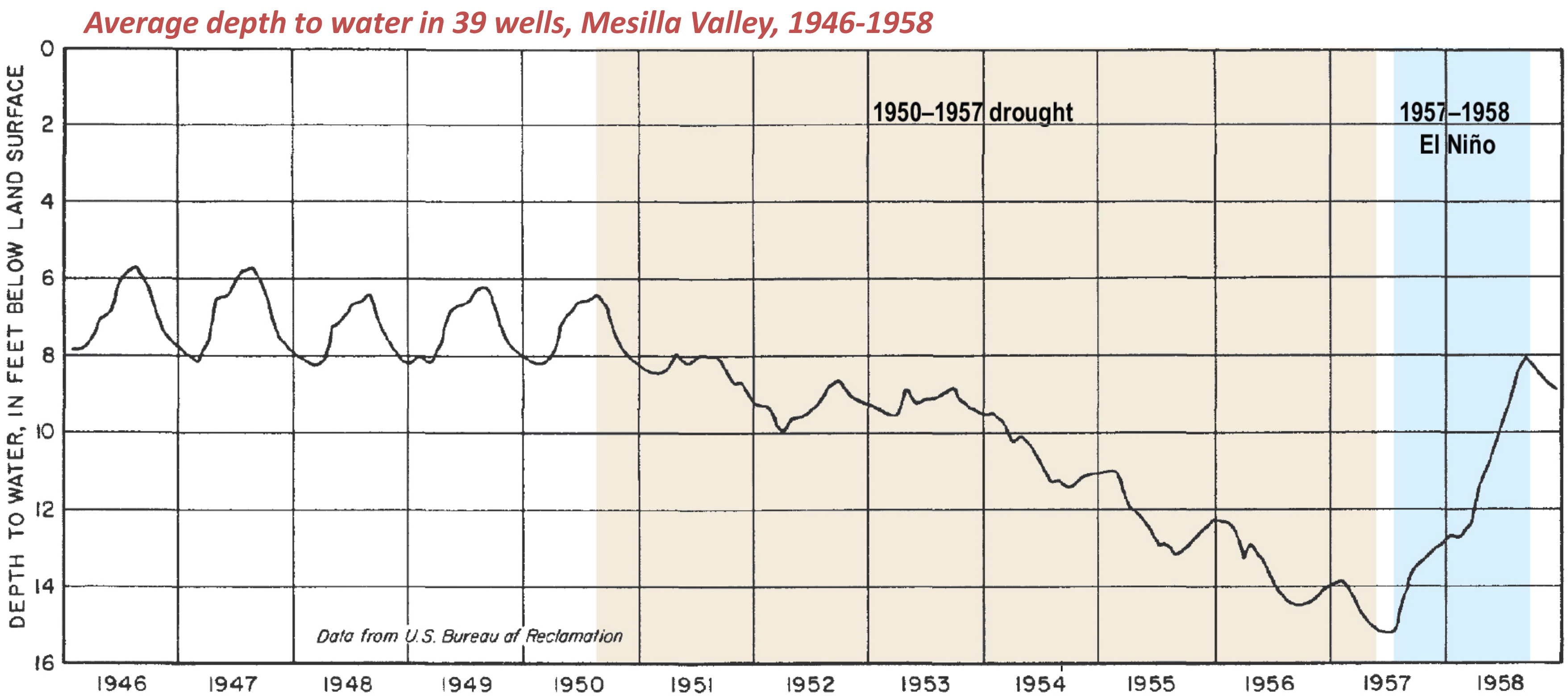
Where is the water?

Mesilla Valley near Las Cruces – contains a major sand aquifer up to 2,000 feet thick that thins to 500 feet or less at the Texas state line

Rincon Valley, Caballo to past Leasburg – the thick productive aquifer is absent; a thin aquifer extends just 60-80 feet beneath the river channel to bedrock

Productive aquifers are well-integrated with surface water system – effects of groundwater pumping, both deep and shallow, are readily transmitted to the interconnected river channel, canals and drains

Effects of the 1950s Drought on Groundwater in the Mesilla Valley



Prior to 1951 — summer water-table rise in the irrigation season and a winter drop → **recharge pattern**.

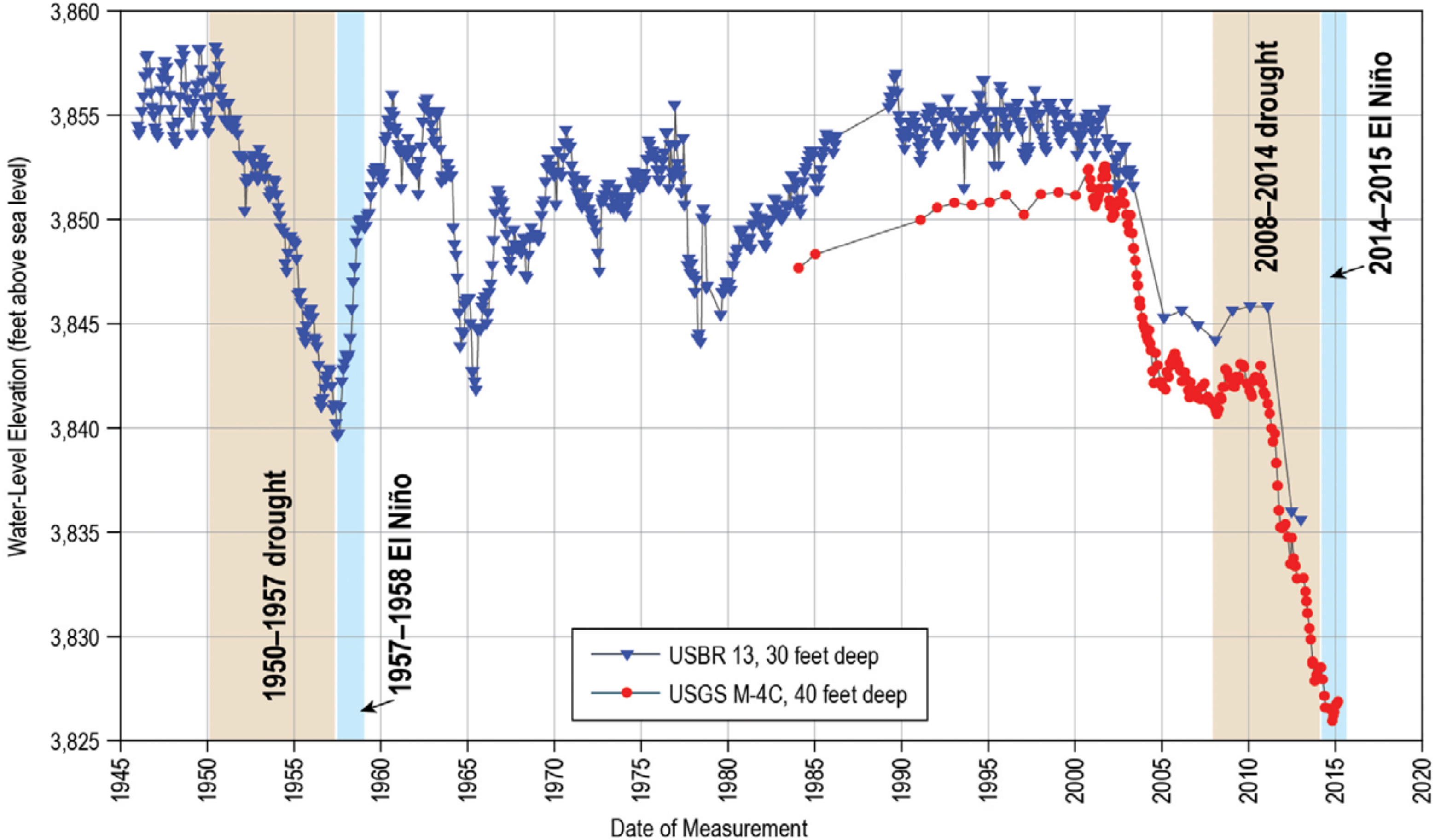
Dramatic rise in irrigation wells — 11 in 1946, 50 in 1947, and more than 1,600 by 1955.

1951–1953 — the natural recharge pattern is lost, but there is no appreciable water-level drop.

1954 to mid-1957 —wells were the main source of supply and water levels declined each year. At the end of 1956, the water level was 6 feet lower than pre-1951.

1957-1958 El Niño — water levels recovered rapidly to within 2 feet of pre-drought levels.

Effects of Drought and Pumping on Groundwater — 2 Shallow Wells 1946-2015

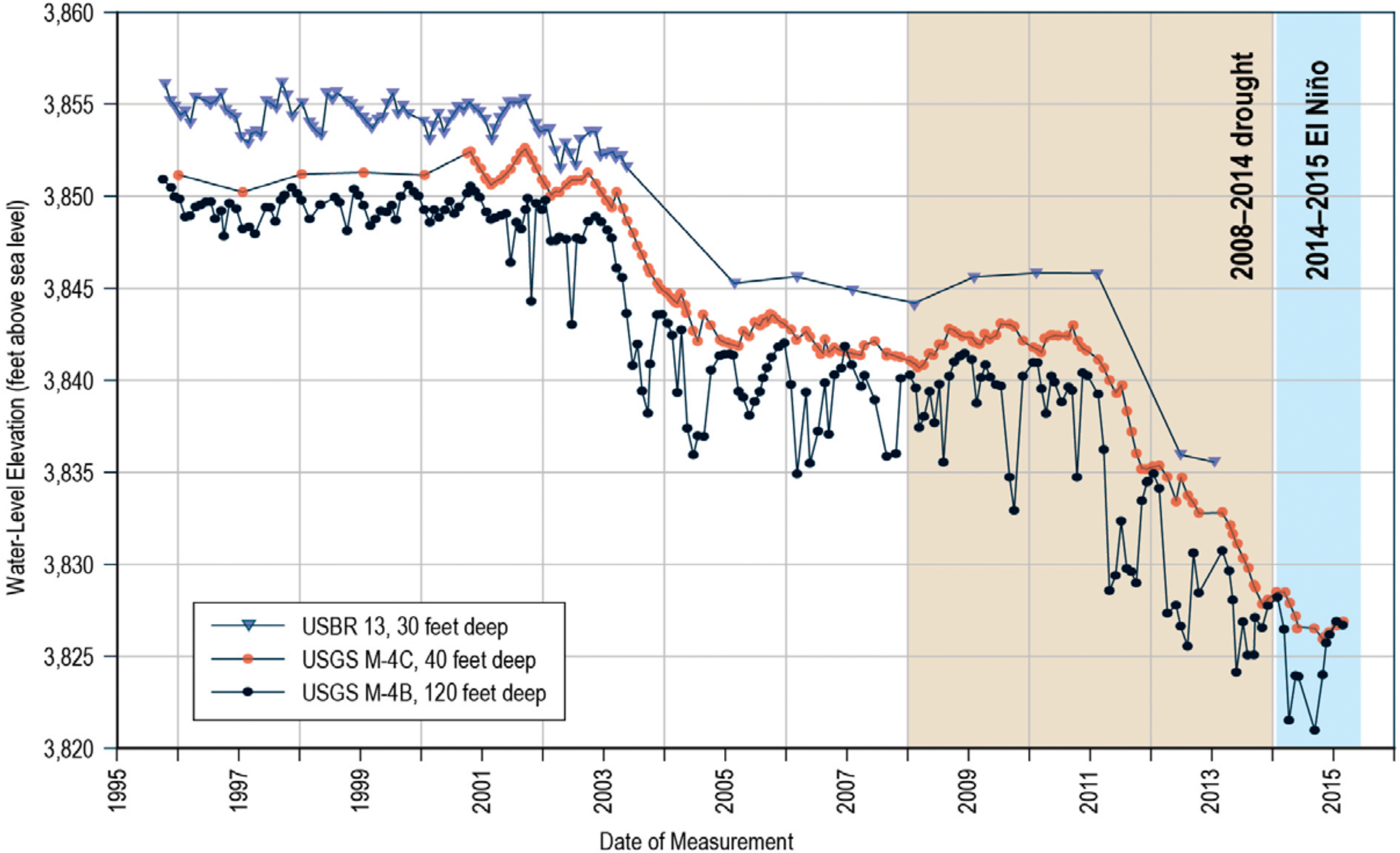


The 1950s groundwater levels in well USBR13 replicate the pattern in the average hydrograph, with a 16-ft drop.

The pre-1951 recharge pattern (summer high/winter low) was disrupted in the 1960s and 1970s, but returned during the wet years of the 1990s.

The 1990s water-level highs were 2-3 feet lower than pre-1951 levels. Was the assumption that the aquifer fully recovered following the 1950s drought and pumping correct?

Effects of Groundwater Pumping and Drought — 1995-2015

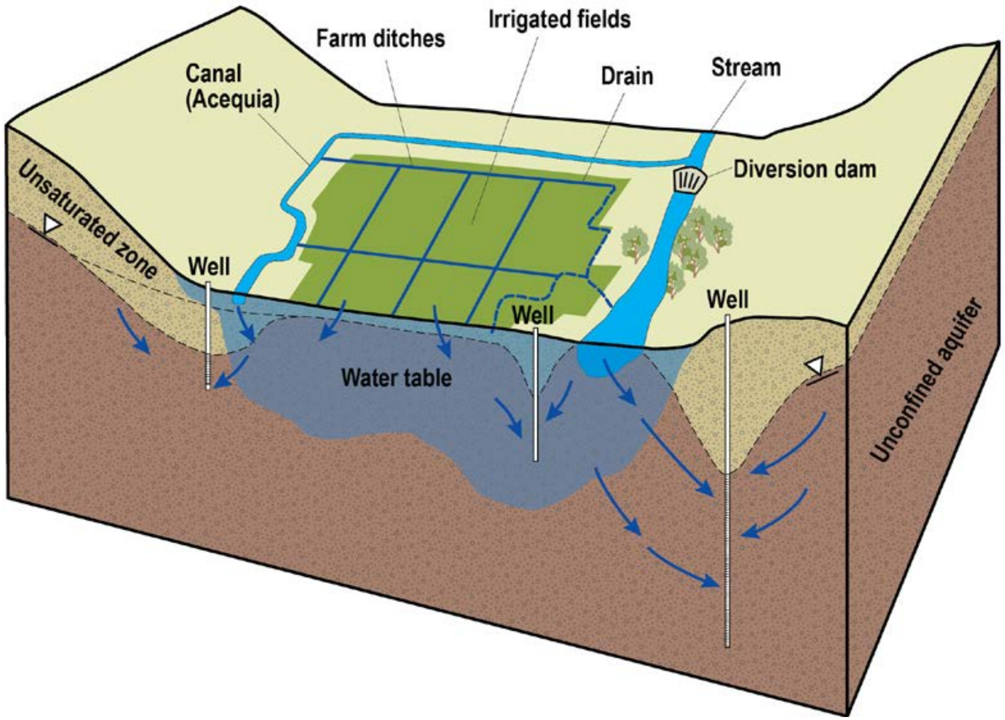


In 2003, 5years prior to onset of drought, the summer recharge pattern of the 1990s shifts to a summer pumping pattern. Water levels drop 7.5 feet. →→ Early groundwater storage loss is due to pumping

April 2011 to June 2015, 18.5 foot water-level drop in well M-4C (red) →→ Late groundwater storage loss due to drought-impaired recharge and intensive pumping.

Total water-level decline 2002–2015 June is 26 feet. No sign of recovery despite shift to wet El Niño conditions.

The Surface-Water Groundwater System – How it can fail



Groundwater Vulnerabilities During Drought

1. The availability and distribution of groundwater recharge is reduced
2. Surface shortages trigger intensive groundwater pumping , which drives groundwater declines and compounds storage losses and depletion
3. The groundwater system may decouple from surface sources, which drives excessive seepage and conveyance losses.

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Implications of Economic Development and Population Growth

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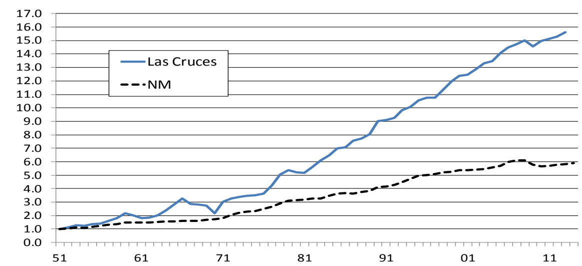
OVERVIEW

The Las Cruces Metropolitan Statistical Area (MSA) is coincident with Doña Ana County. Compared with NM as a whole, the Las Cruces MSA private economy has been a fairly consistent performer since the 1950s, as illustrated by employment changes since the 1950's. The composition of the economy has changed – becoming more diverse. Today, agriculture and non-agricultural activity are both important in the area and, as in the 1950s the economic activity is providing dynamic opportunities. But these opportunities are constrained due to limited availability of both surface water and groundwater.



Employment increases indexed to 1951 (BLS)

CONSIDERATIONS

Santa Teresa

- Port of Entry - Transportation and Industrial Hub - 250,000 shipping container capacity
- Two industrial parks (Verde Santa Teresa Intermodal Park and Verde Bi-National Industrial Park)
- 63% population growth between 2000 and 2010
- 93% increase in NM exports to Mexico (2014)
- Groundwater reliance

Population Growth

- Dona Ana County 50% forecast growth (2010-20150)
- 2007 NM LRG Water Plan: Forecast Water Diversions
  - Agriculture, livestock, environment: constant
  - Commercial, industrial, mining: 67% increase
  - Public/private supply: 60% to 300% increase

Agriculture

- 100% surface water and 77% groundwater withdrawals
- Perennial versus annual crops
- Pecans: NM one of top US producers (20% to 25% of US total)
- Conservation, improved efficiency, relationship to reducing vulnerabilities

SUMMARY

- Economic development choices constrain alternatives in times of drought
- Short-term management solutions
- Longer-term planning solutions