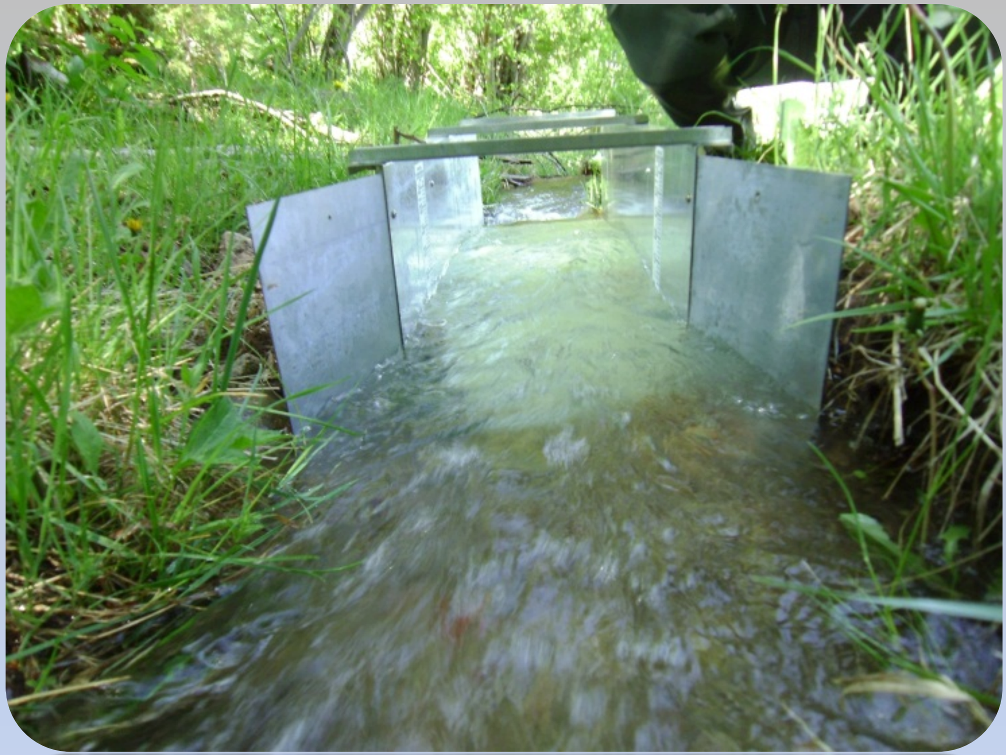


Agricultural Water Conservation in Different Hydrologic Regions of New Mexico

Sam Fernald, New Mexico Water Resources Research Institute

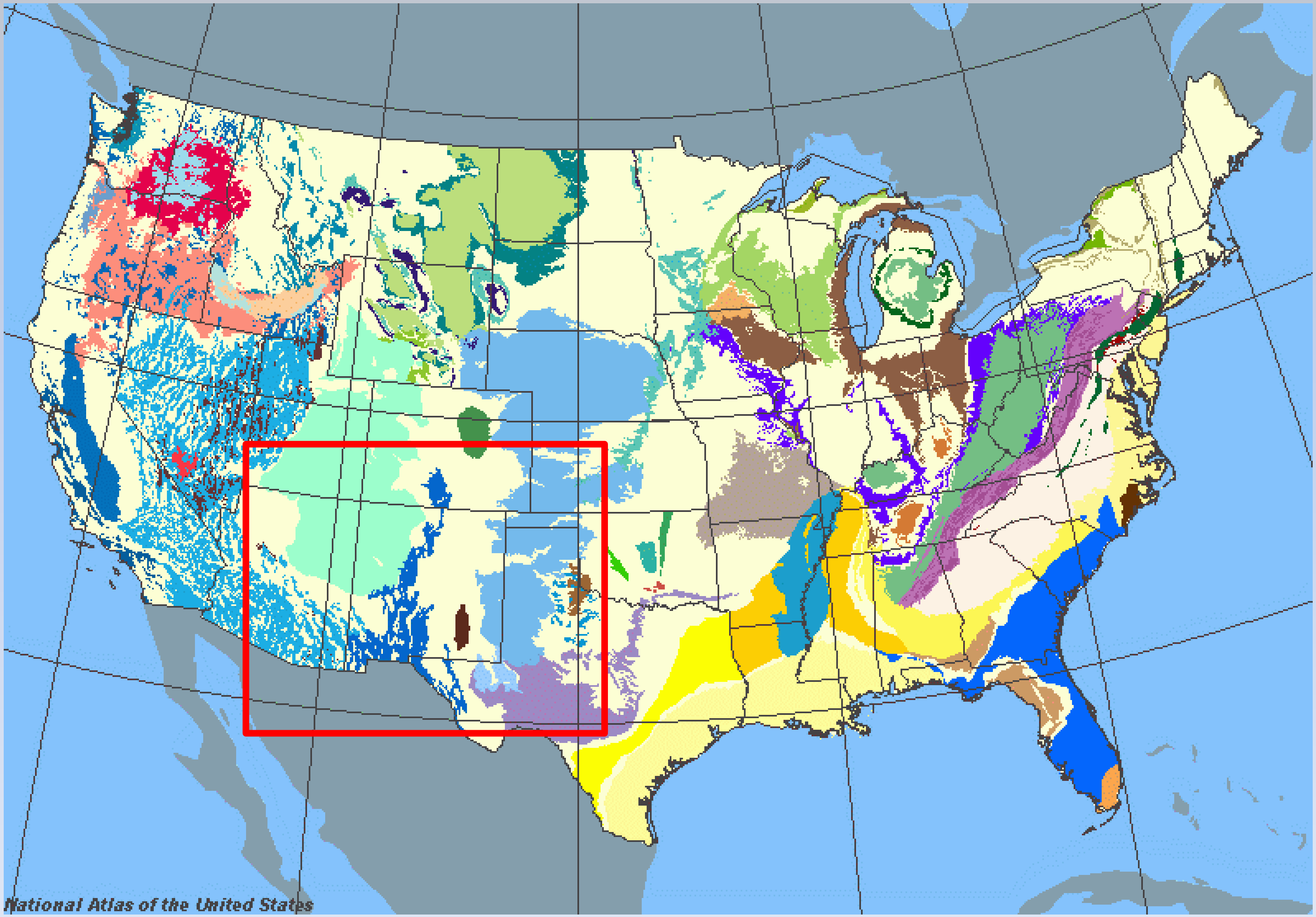
14 October June 2013

Legislative Drought Subcommittee

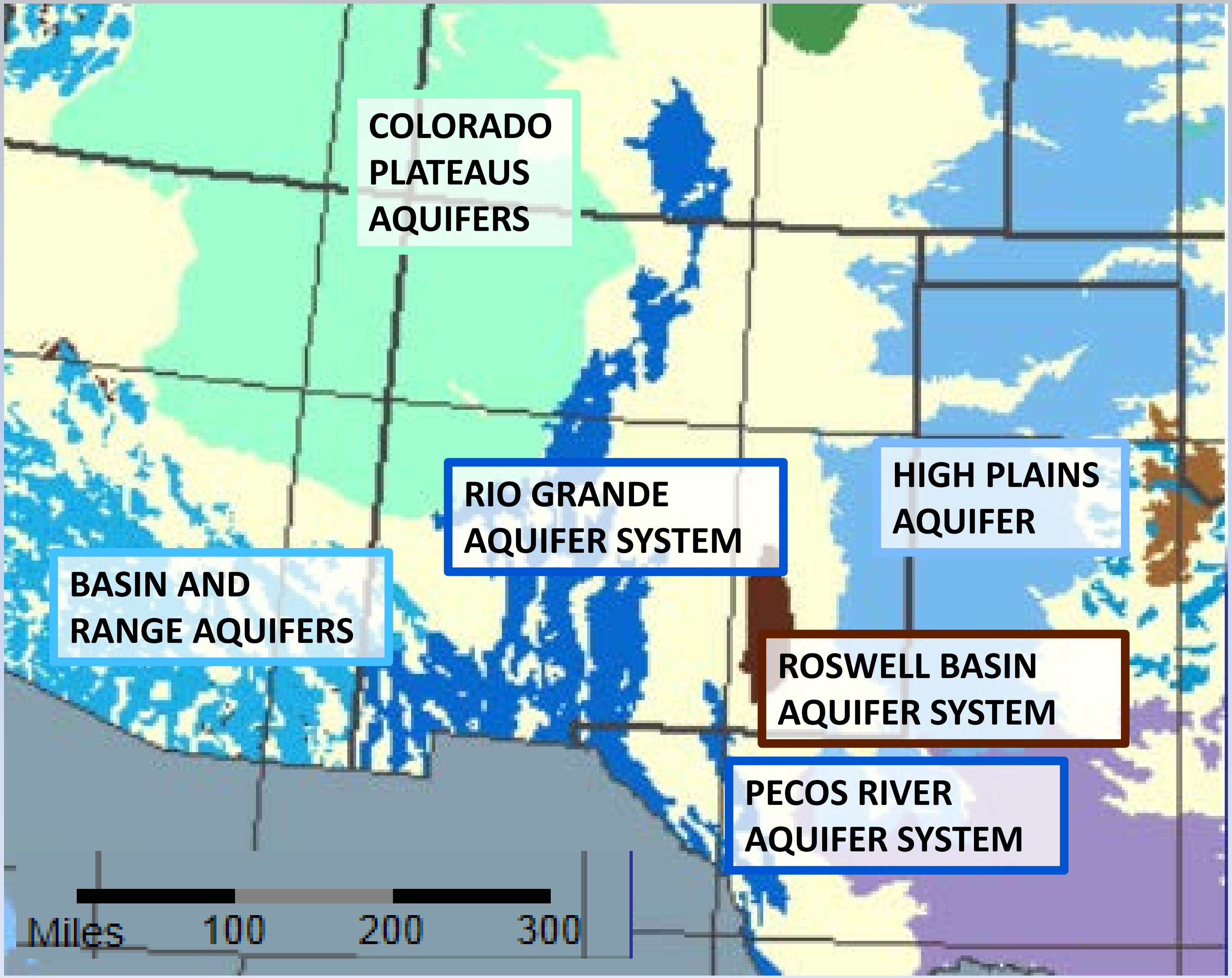
OUTLINE

- Water conservation by NM hydrologic region related to withdrawals vs depletions
  - High Plains Aquifer
    - Relict groundwater aquifers
    - Efficiency
  - Upper Rio Grande – Acequias
    - Runoff producing and receiving regions
    - Surface water-connected aquifers
    - Gaining and losing surface water groundwater interactions
    - Return flows
  - Lower Rio Grande - Efficiency and total water use (Ward)
    - Efficiency leads to pressure on depletions
- Solutions vary by region
  - Need solutions appropriate for hydrologic region
  - Need statewide water budget to integrate regional solutions

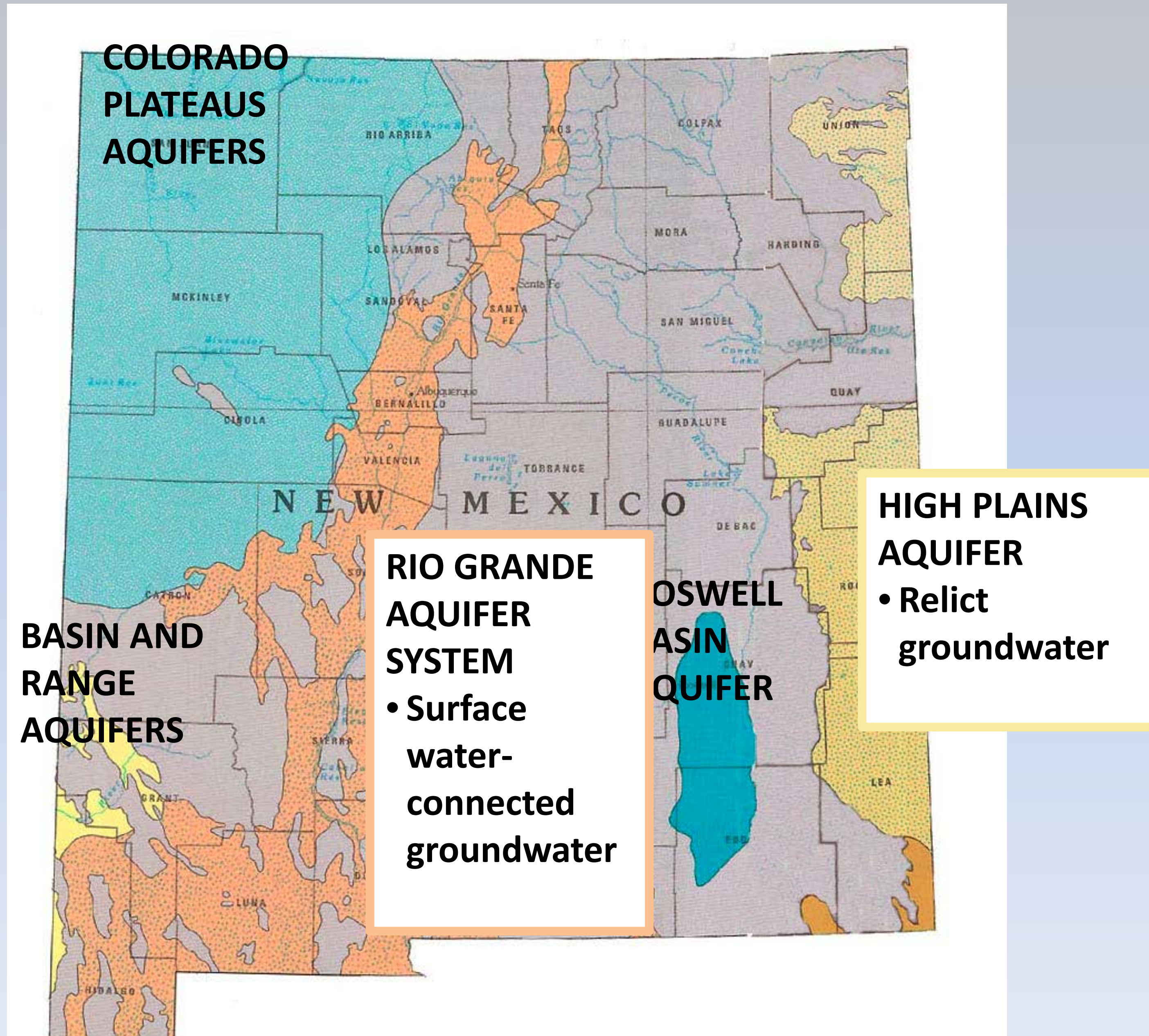
AQUIFERS OF THE LOWER 48 – Hydrologic diversity



Aquifers of New Mexico – Hydrologic Diversity



Conservation in regions of relict groundwater compared to surface water-connected groundwater



GROUNDWATER DEPLETION = Recharge - Abstraction

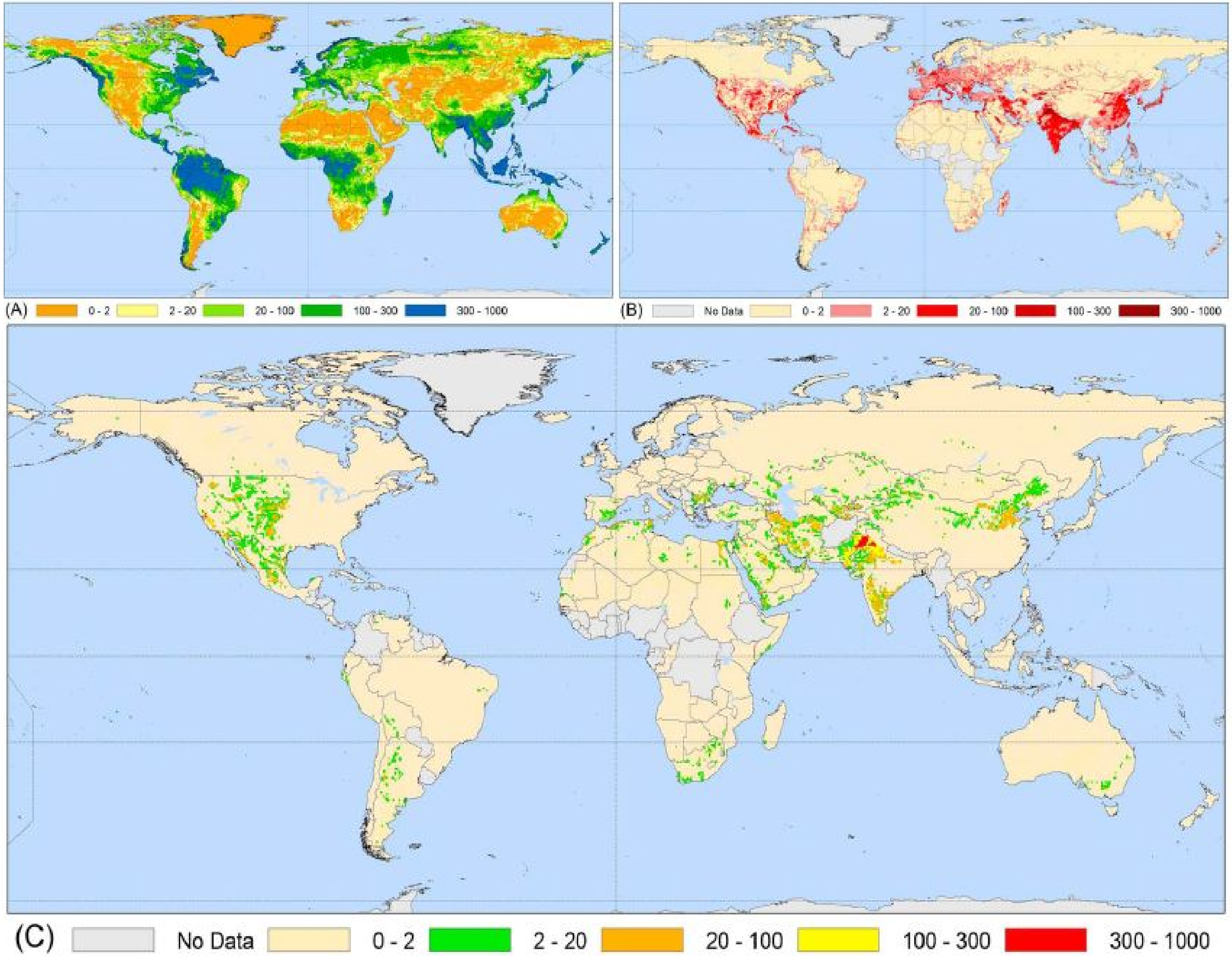
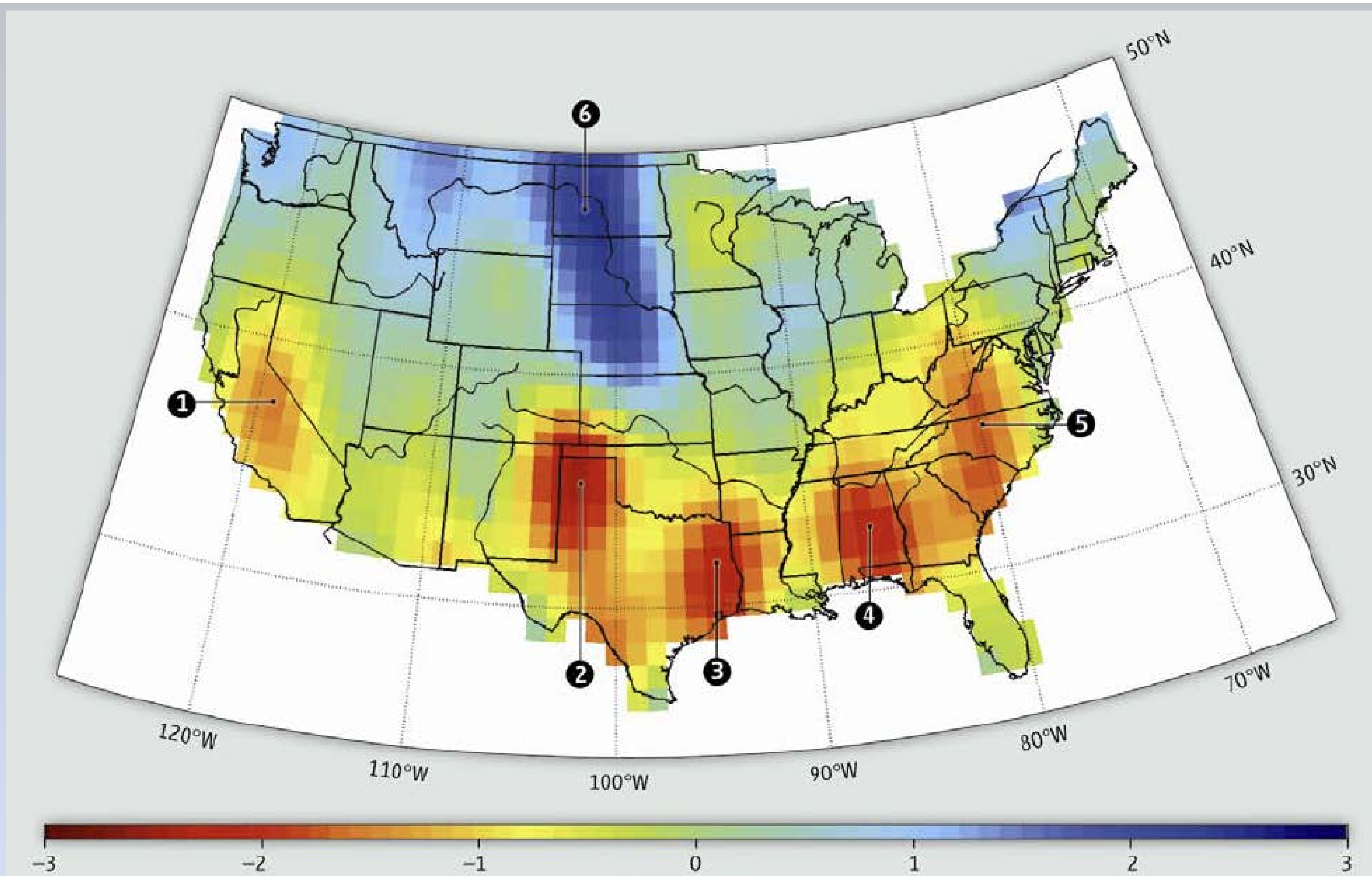


Figure 1. (a) Simulated average groundwater recharge by PCR-GLOBWB, (b) total groundwater abstraction for the year 2000 and (c) groundwater depletion for the year 2000 (all in mm a^{-1}). (Wada et al., 2010)

Gravity-based groundwater change assessment
High Plains Aquifer – depletion in south, recharge in north



ENVIRONMENTAL SCIENCE

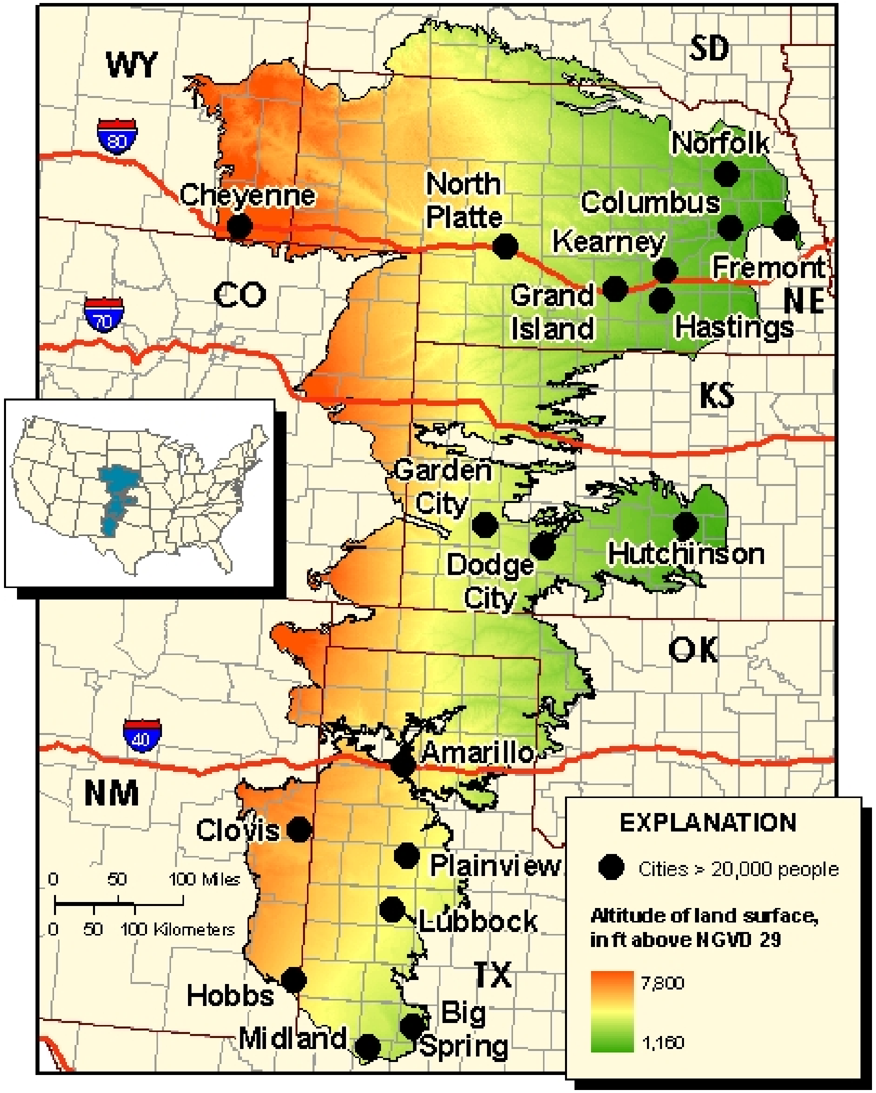
Water in the Balance

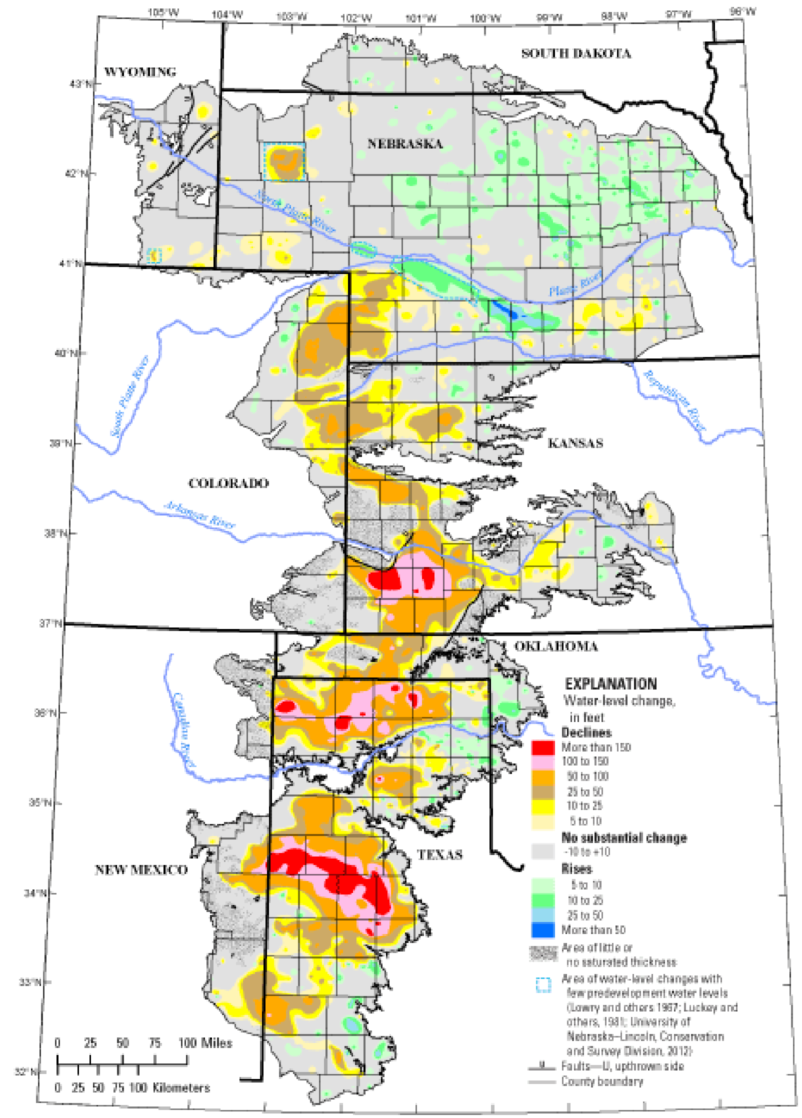
14 JUNE 2013 VOL 340 **SCIENCE** www.sciencemag.org
Published by AAAS

James S. Famiglietti[1,2,3] and Matthew Rodell[4]

Satellite data may enable improved management of regional groundwater reserves.

USGS HIGH PLAINS AQUIFER STUDY – Water levels drop in mined groundwater





Base from U.S. Geological Survey digital data, 2001, 1:2,000,000
Albers Equal-Area Conic projection
Standard parallels 29° 30' and 45° 30', central meridan -101°
North American Datum of 1983 (NAD 83)

Aquifer boundary from Qi (2010); areas of little or no saturated thickness and faults from Gutentag and others (1984) and Cederstrand and Becker (1999a, 1999b)

McGuire, V.L., 2013, Water-level and storage changes in the High Plains aquifer, predevelopment to 2011 and 2009–11: U.S. Geological Survey Scientific Investigations Report 2012–5291, 15 p.

Agricultural water conservation in the high plains aquifer region

•By the time recharge reaches aquifer depth, there won't be an aquifer – John Shomaker

•Maximize agricultural yield

Low water use plants

Targeted water delivery (drip, etc…)

Irrigation efficiency

Rio Grande Aquifer System

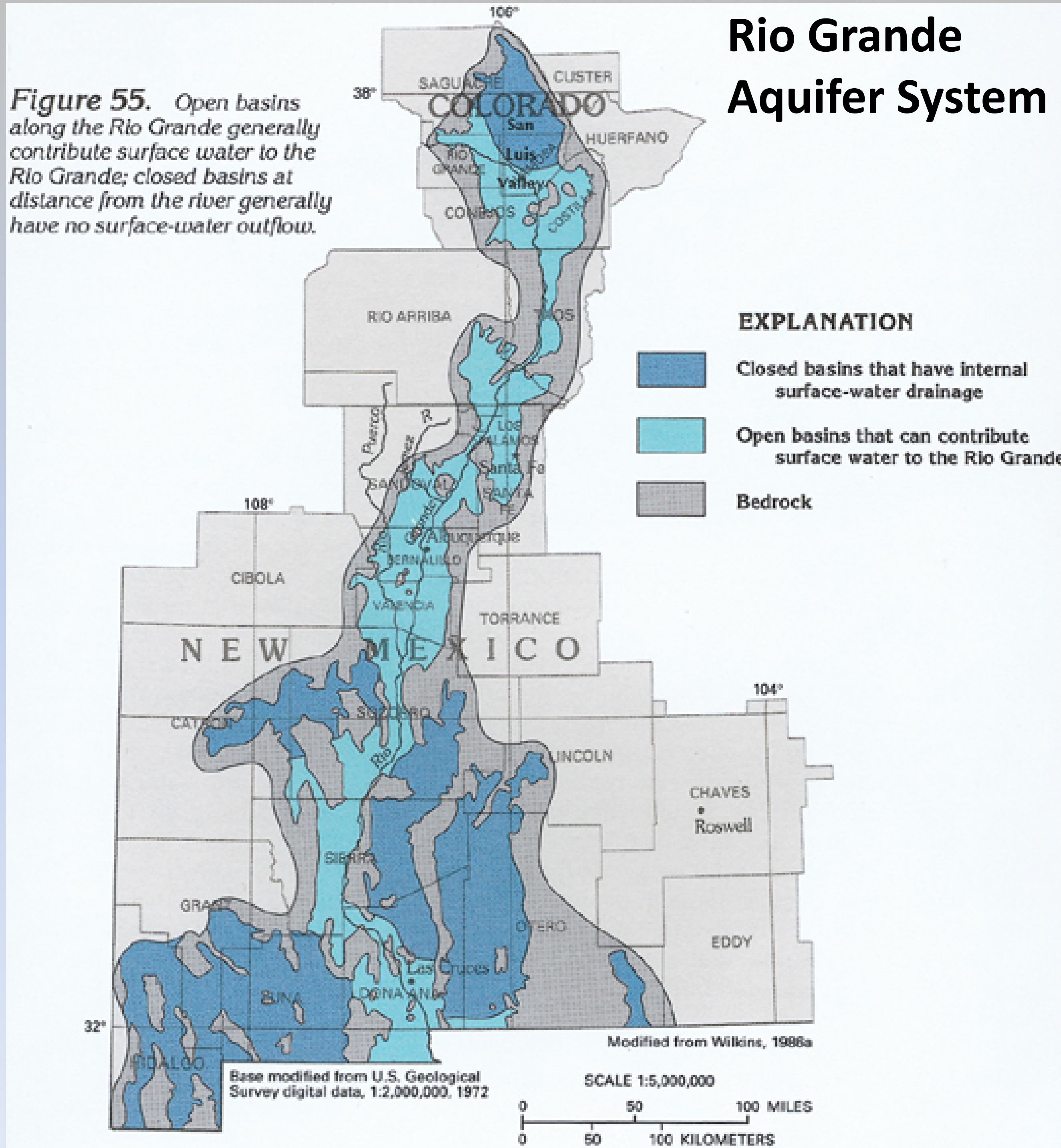


Figure 55. Open basins along the Rio Grande generally contribute surface water to the Rio Grande; closed basins at distance from the river generally have no surface-water outflow.

GROUND WATER ATLAS of the UNITED STATES
Arizona, Colorado, New Mexico, Utah
HA 730-C

RUNOFF PRODUCTION

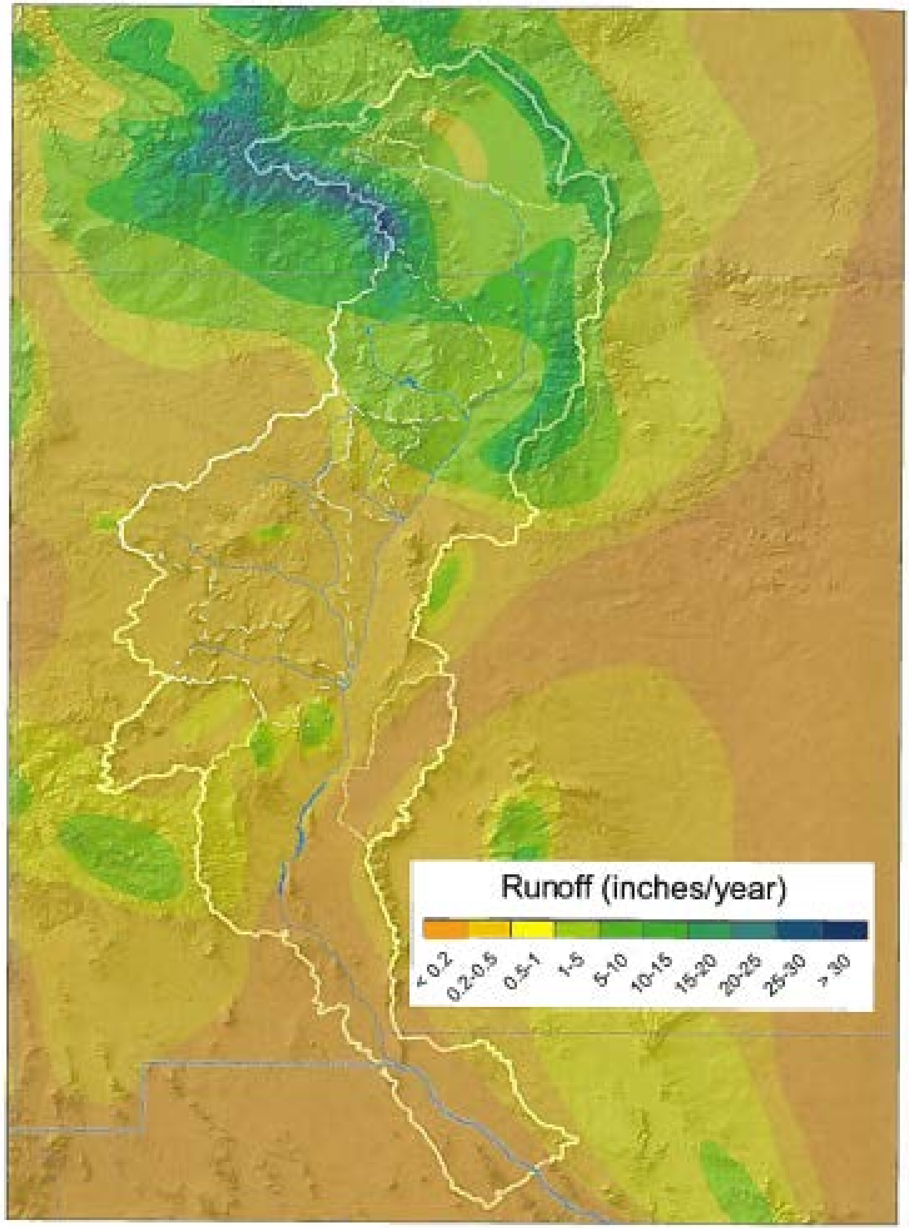
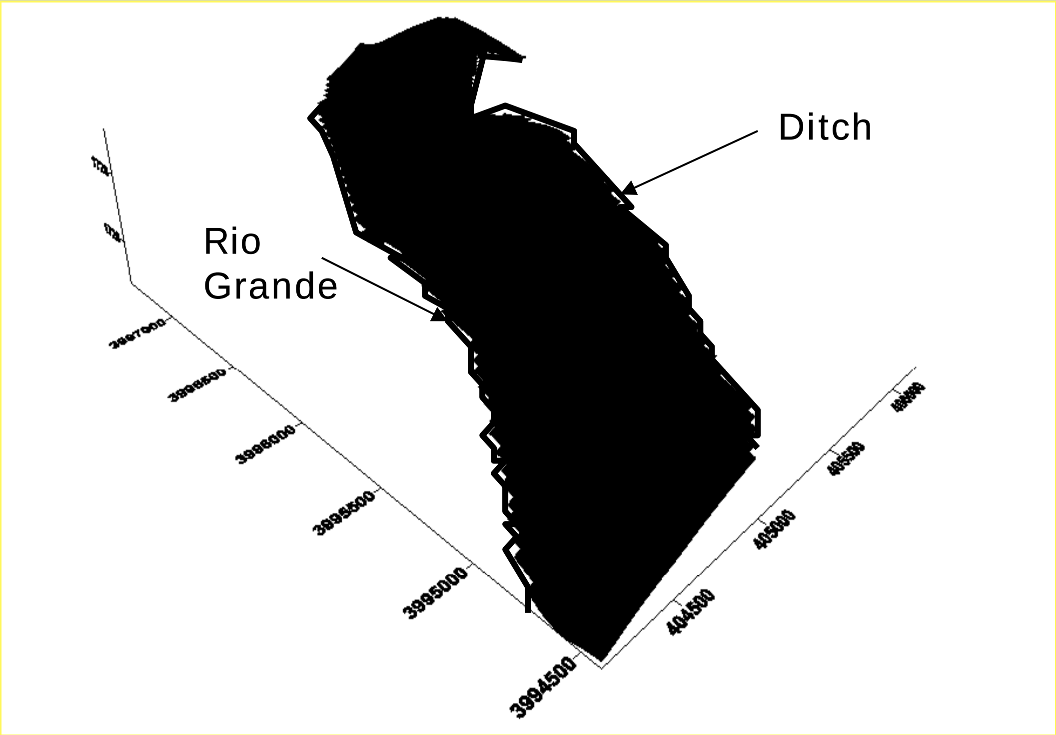


Plate 13
Runoff produced by precipitation over the Rio Grande basin. The units (in/yr) show the amount of precipitation that must run off to supply the flow in the streams draining each portion of the basin. Nearly all of the areas that produce large amounts of runoff are found at the highest elevations, and the monster canal diversions in the San Luis Valley cut off the areas producing the most flow from the rest of the drainage basin. Image courtesy of Matej Durcik and Fred M. Phillips.

Phillips et al., 2011

GAINING RIVER

- River below floodplain water table, gains water from groundwater



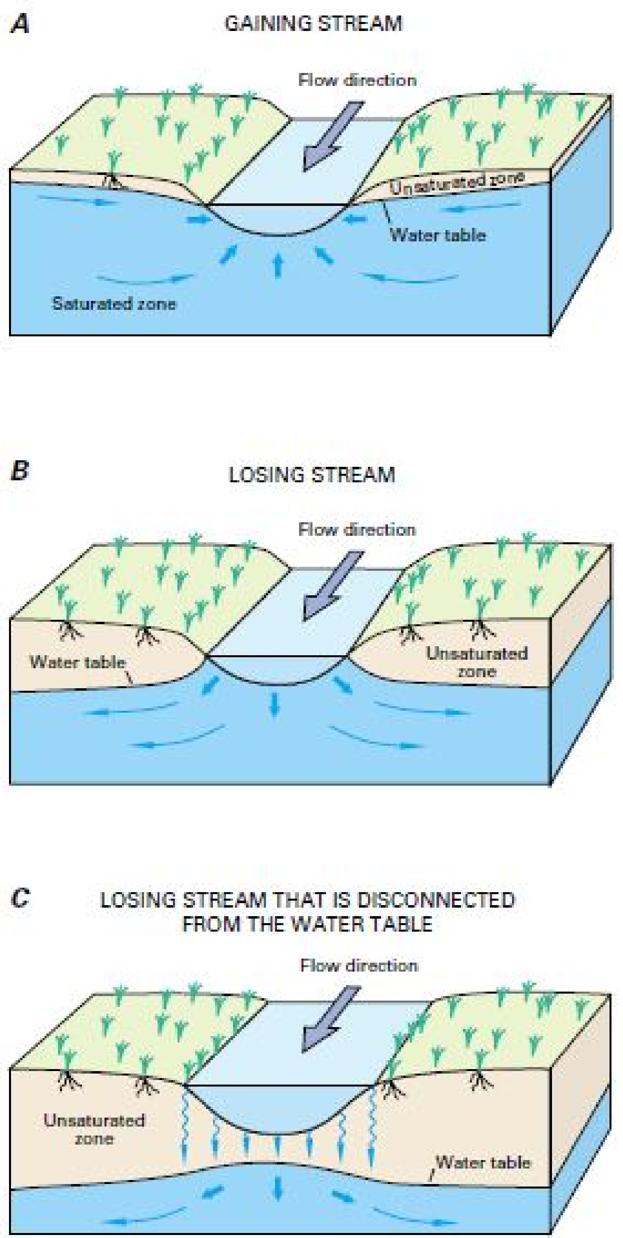
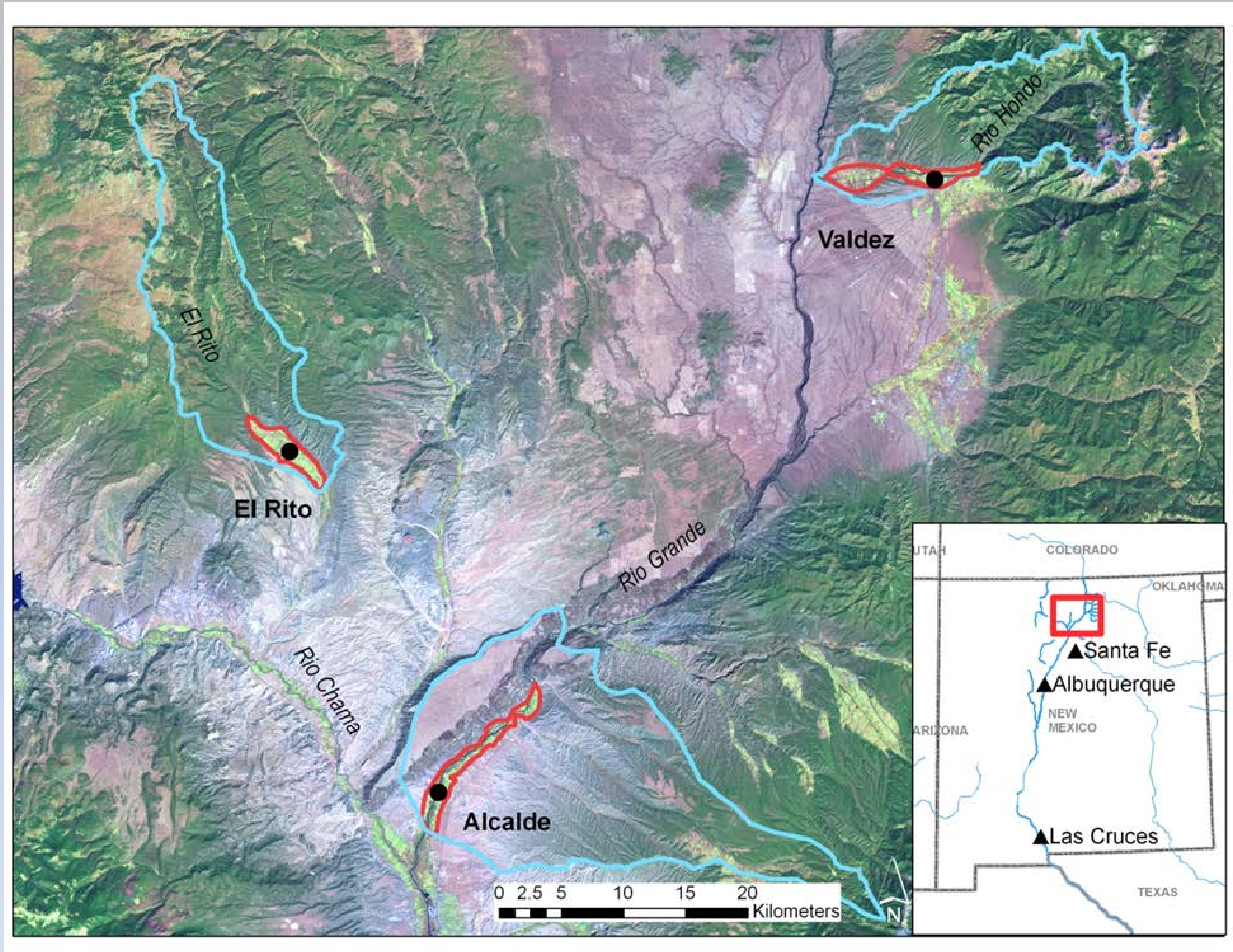
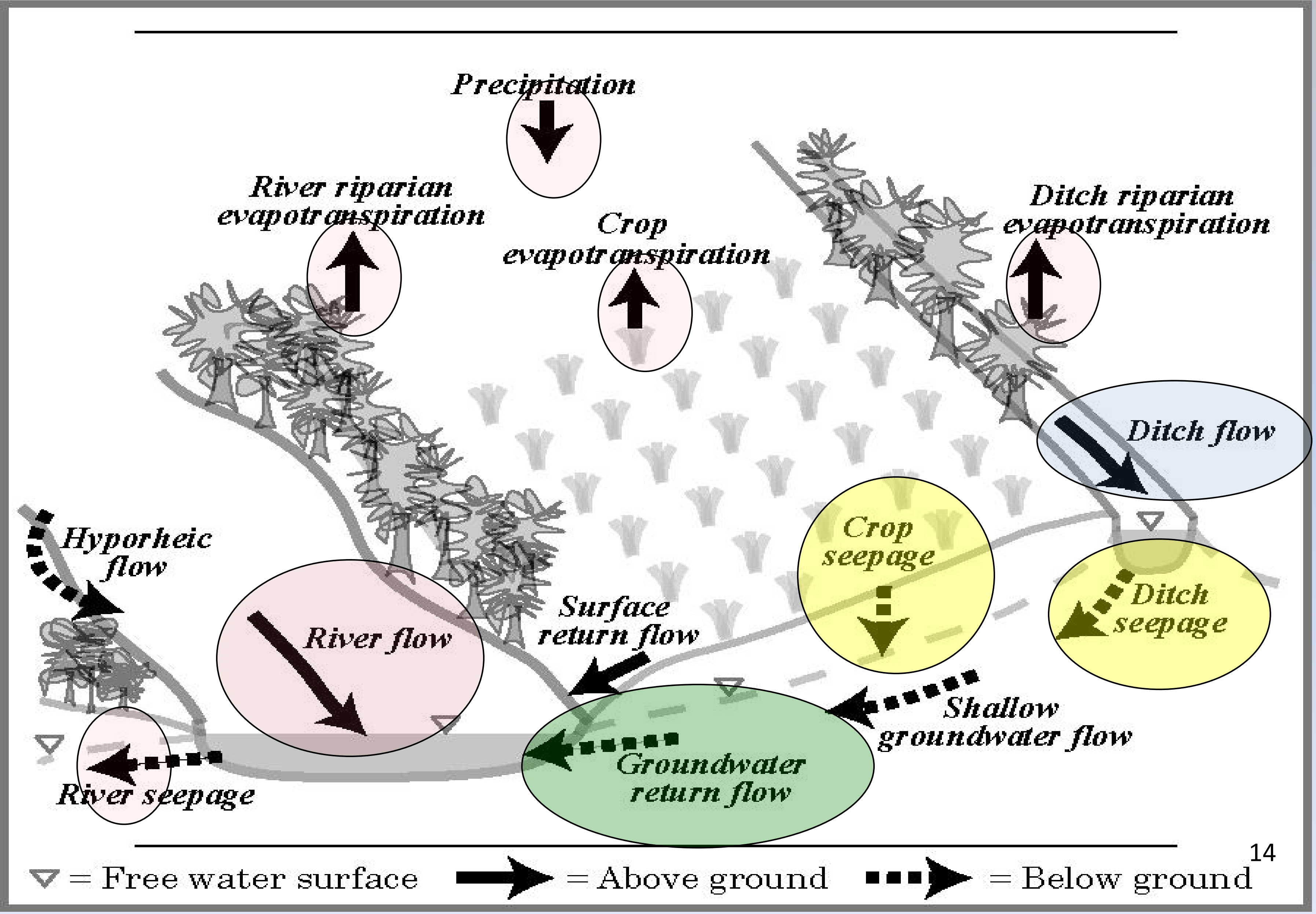


Figure 12. *Interaction of streams and ground water. (Modified from Winter and others, 1998.)*



Northern NM acequia study communities (black circles), their associated irrigated valleys (red lines) and contributing watersheds (blue lines).

Irrigation – Groundwater – River Connections




River Diversion
Acequia
Acequia Diversion
Irrigated Field

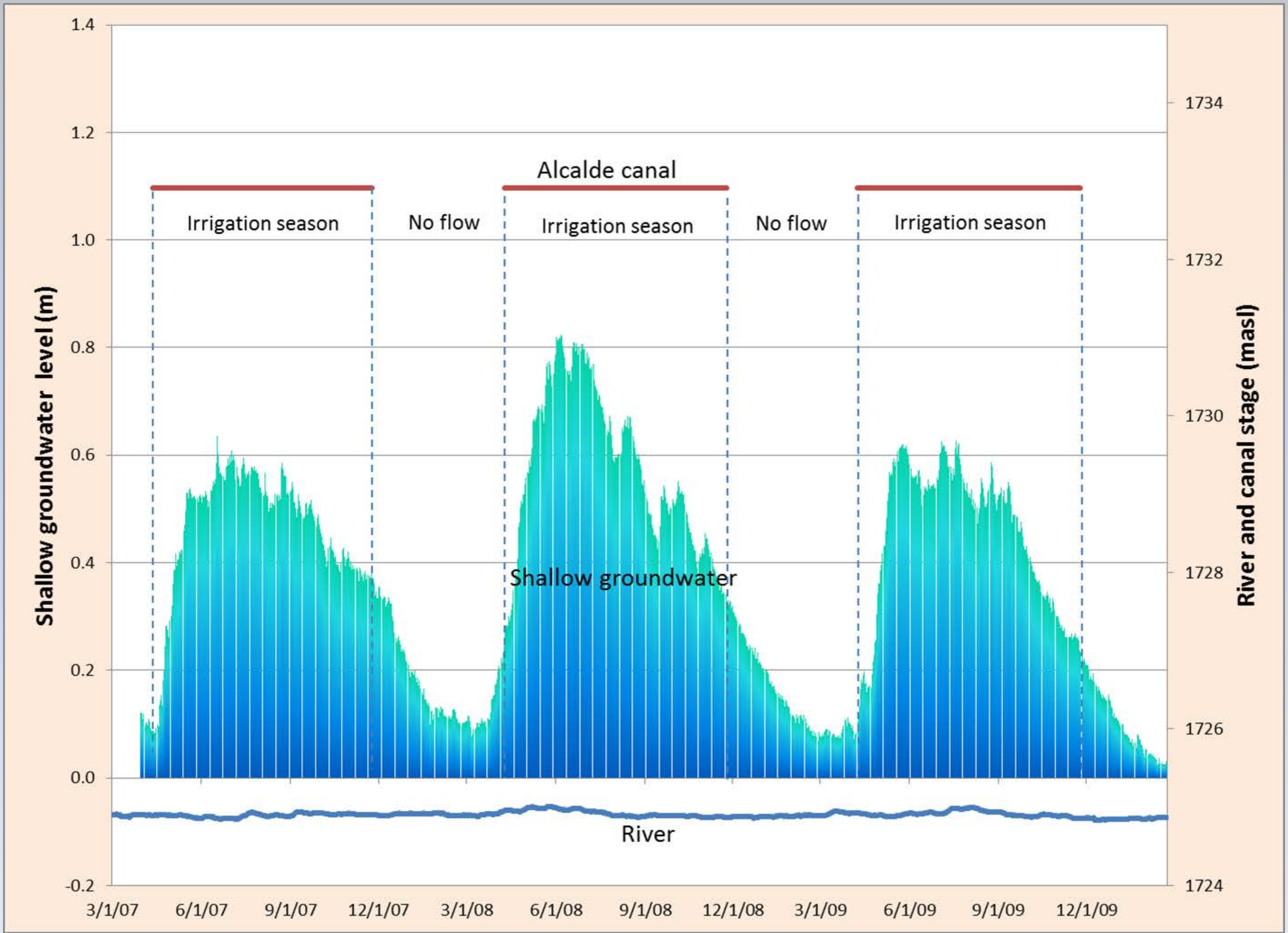
Water budget

Alcalde Acequia three year (2005-2007) averaged water balance.

Component		Amount from canal diversion (%)	Range (%)
Surface water return flow	Turnouts	9.5	0 to 14
	Crop field tailwater	8.9	0 to 19
	Canal outflow	40.9	28 to 67
Ground water return flow	Ditch seepage	12.1	5 to 17
	Deep percolation	21.2	9 to 32
Evapotranspiration		7.4	1 to 15
	Total	100.0	

Rio Grande above Rio Chama - Water table fully recharged every year

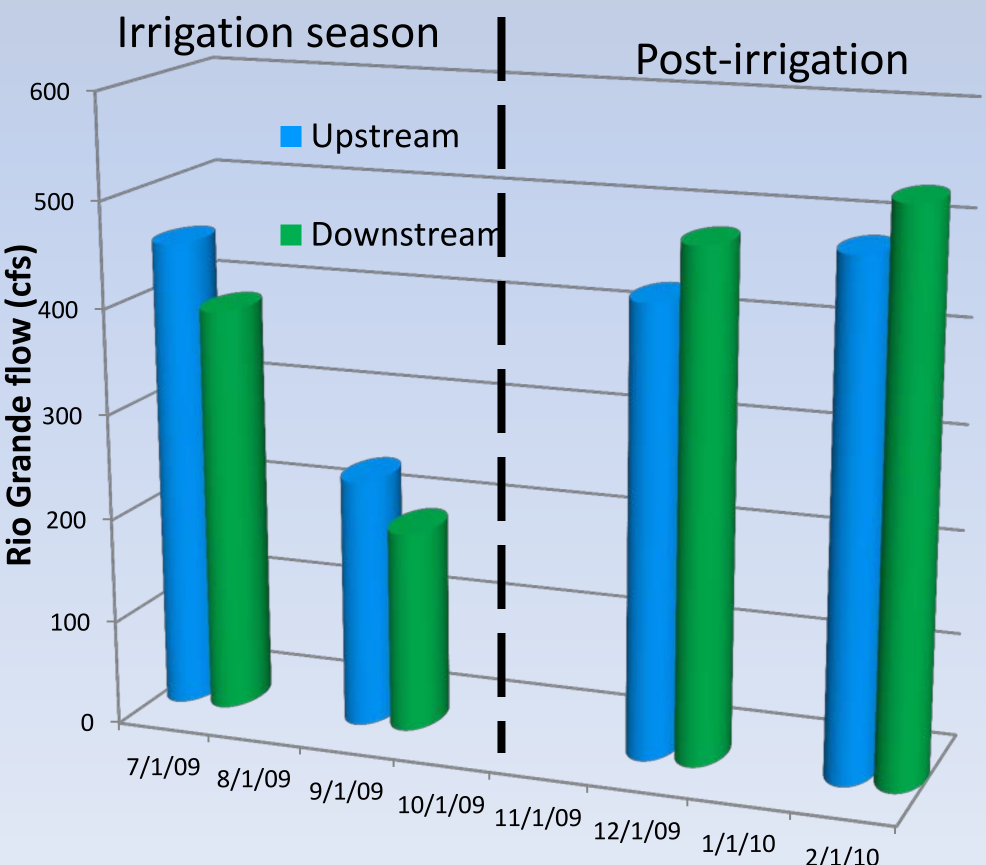
- **Recharge exceeds abstractions**

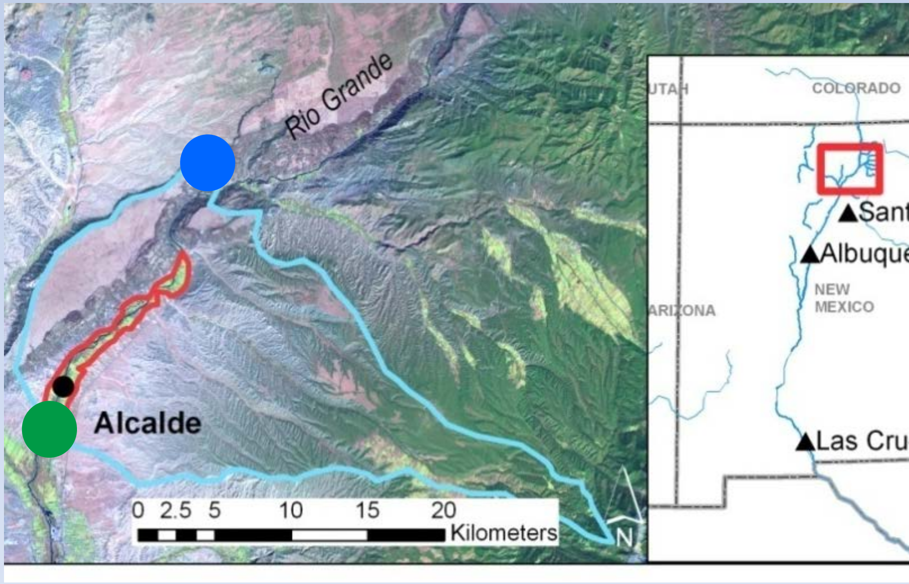


River flow and delayed return flow

• Higher flow in downstream river in response to delayed groundwater return flow at the end of the irrigation season.

•The irrigation systems collectively take spring and summer runoff from the river and retransmits the flow to later in the year through seepage and groundwater return flow



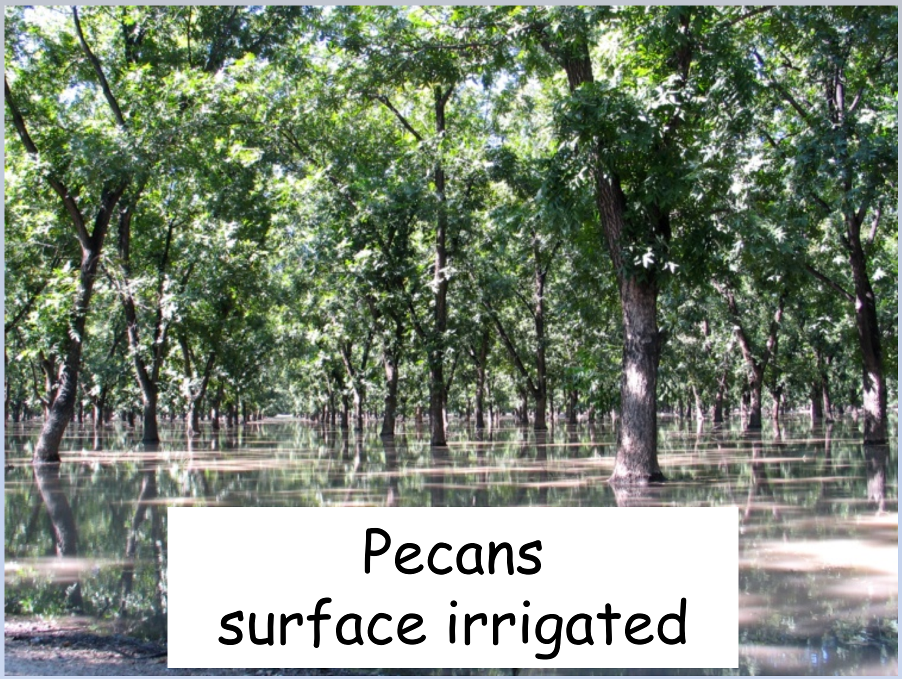


Agricultural water conservation in the gaining Rio Grande river reaches of northern NM

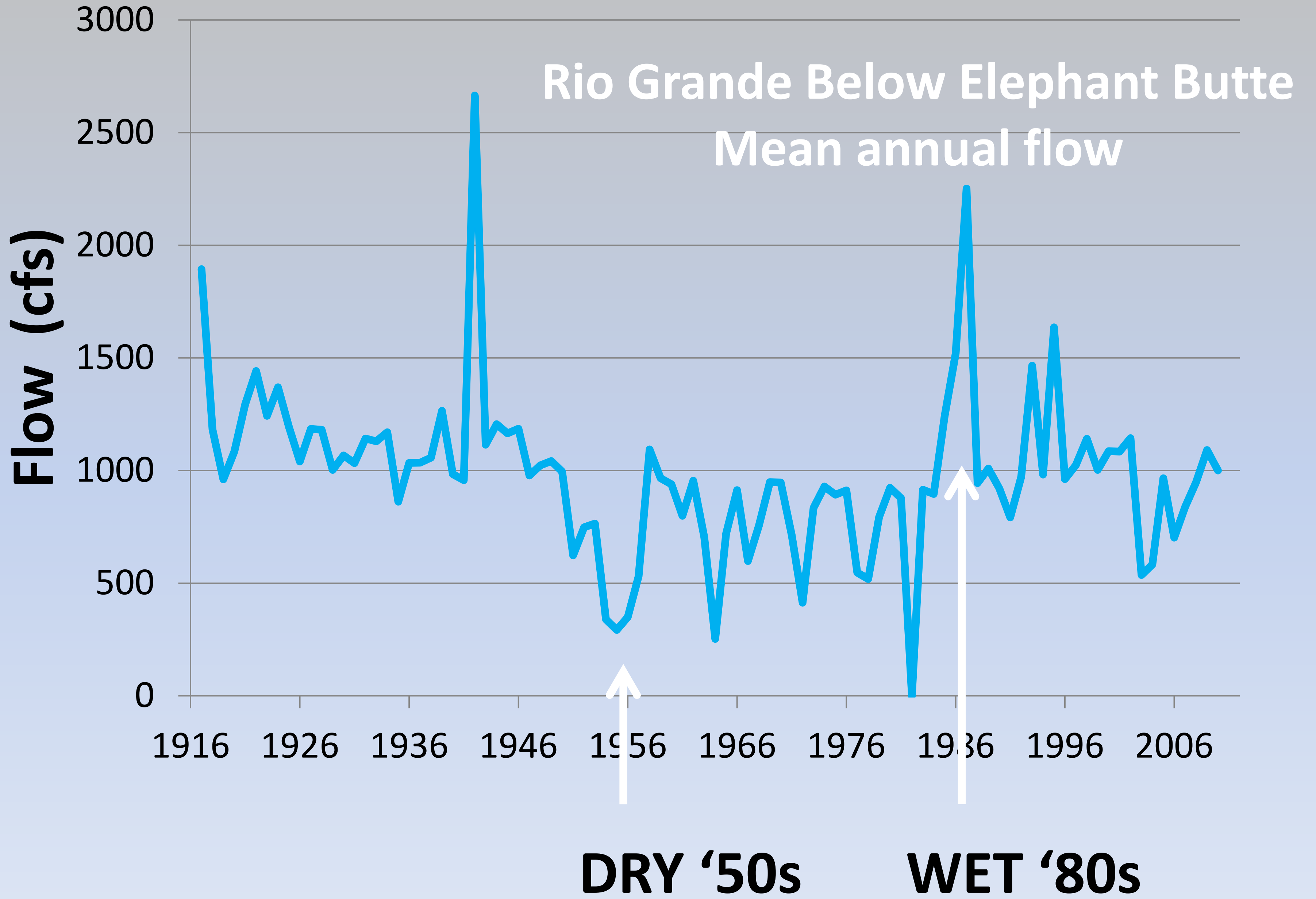
- **Water is not lost when in percolates past root zone - Deep percolation recharges groundwater and returns to river**

- **Conservation at local to regional scale for optimized hydrologic functions**
  - **Crop production**
  - **Hydrologic benefits of percolation**
    - **– riparian**
    - **– water quality**
    - **– aquifer recharge**
  - **Shallow groundwater return flow to river and downstream users**

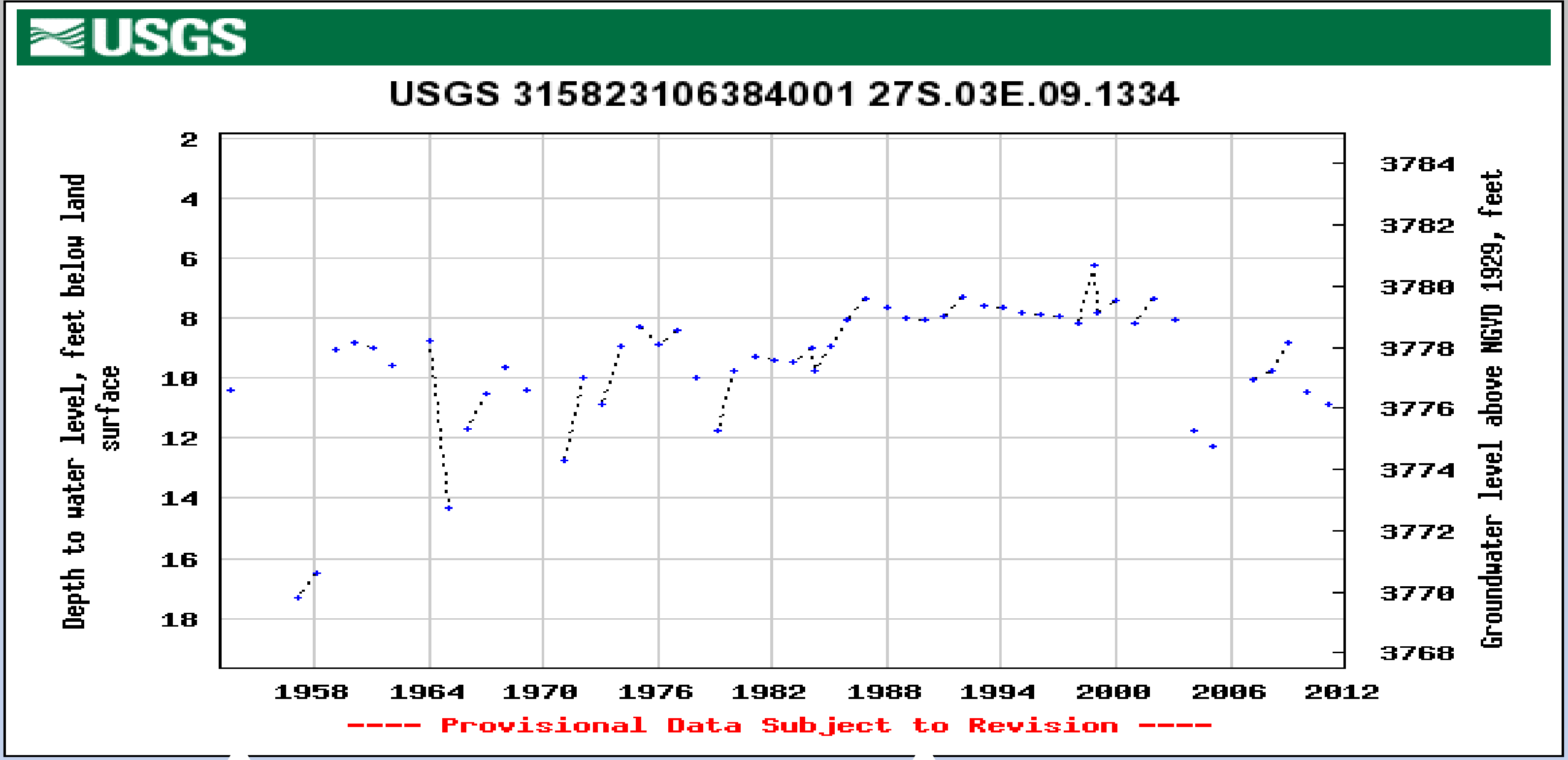
Lower Rio Grande analysis of irrigation efficiency


Pecans
surface irrigated

Pecans
drip irrigated



Rio Grande Below Elephant Butte
Mean annual flow
Flow (cfs)
3000
2500
2000
1500
1000
500
0
1916
1926
1936
1946
1956
1966
1976
1986
1996
2006
DRY '50s
WET '80s

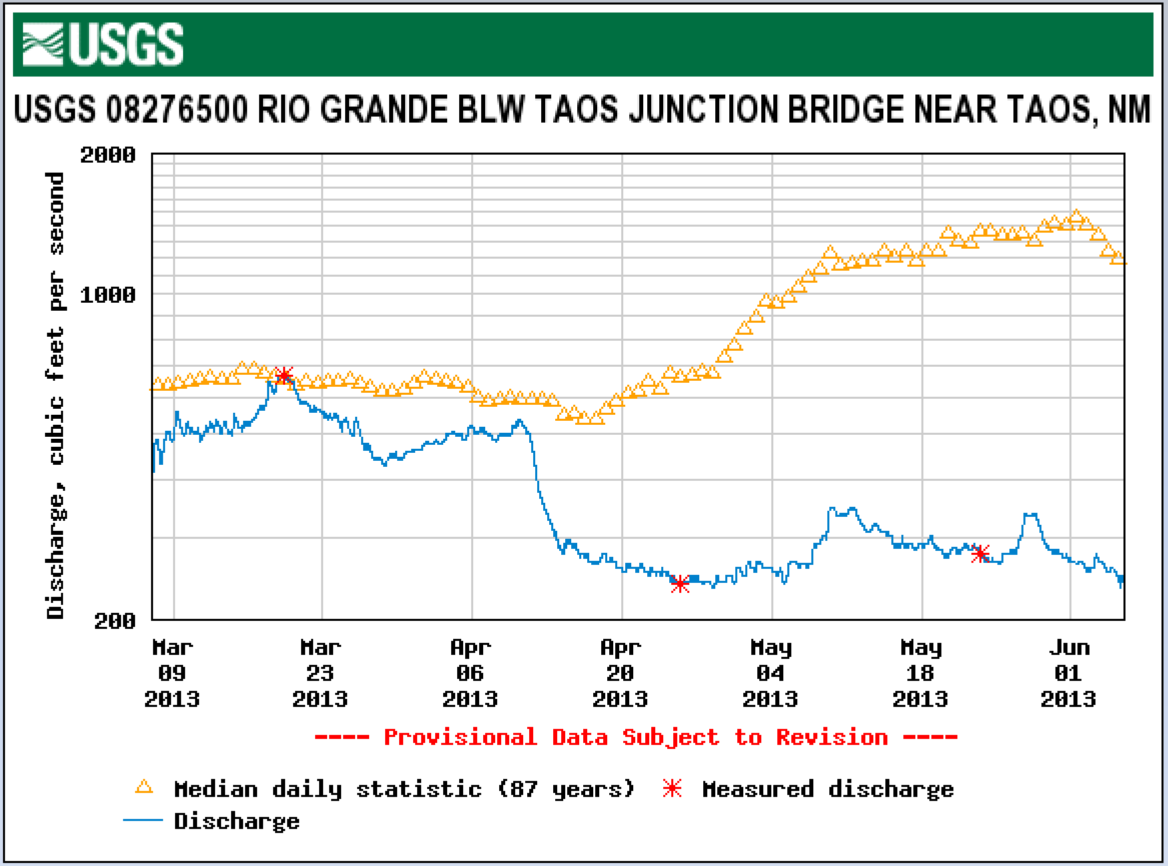


DRY '50s

WET '80s

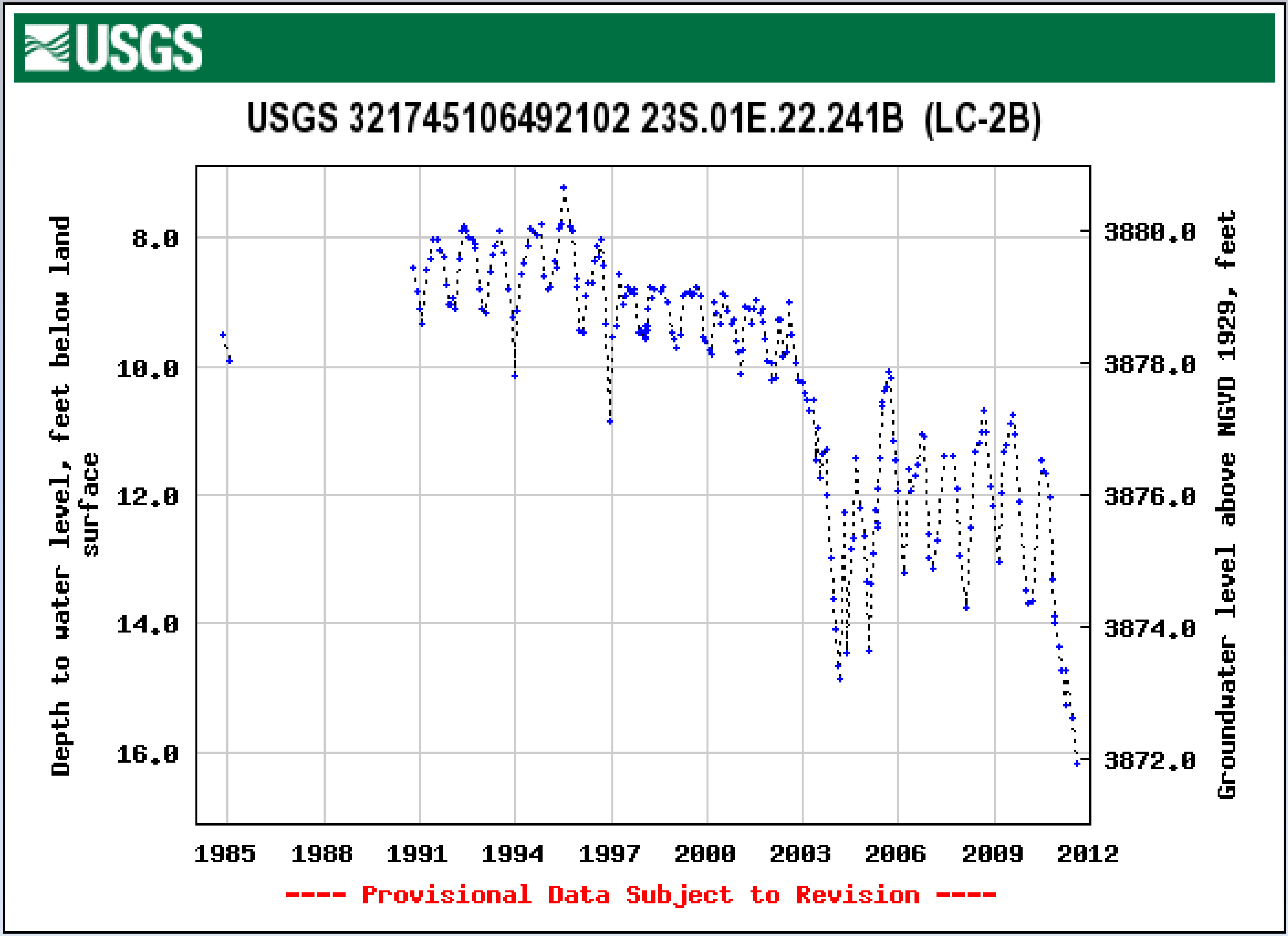
Shallow groundwater drops in dry years and recovers in wet periods

LESS WATER AVAILABLE FOR RECHARGE IN DRY YEARS



Mesilla Valley Shallow Groundwater

- Recharged each year by seepage
- Drops in drought years



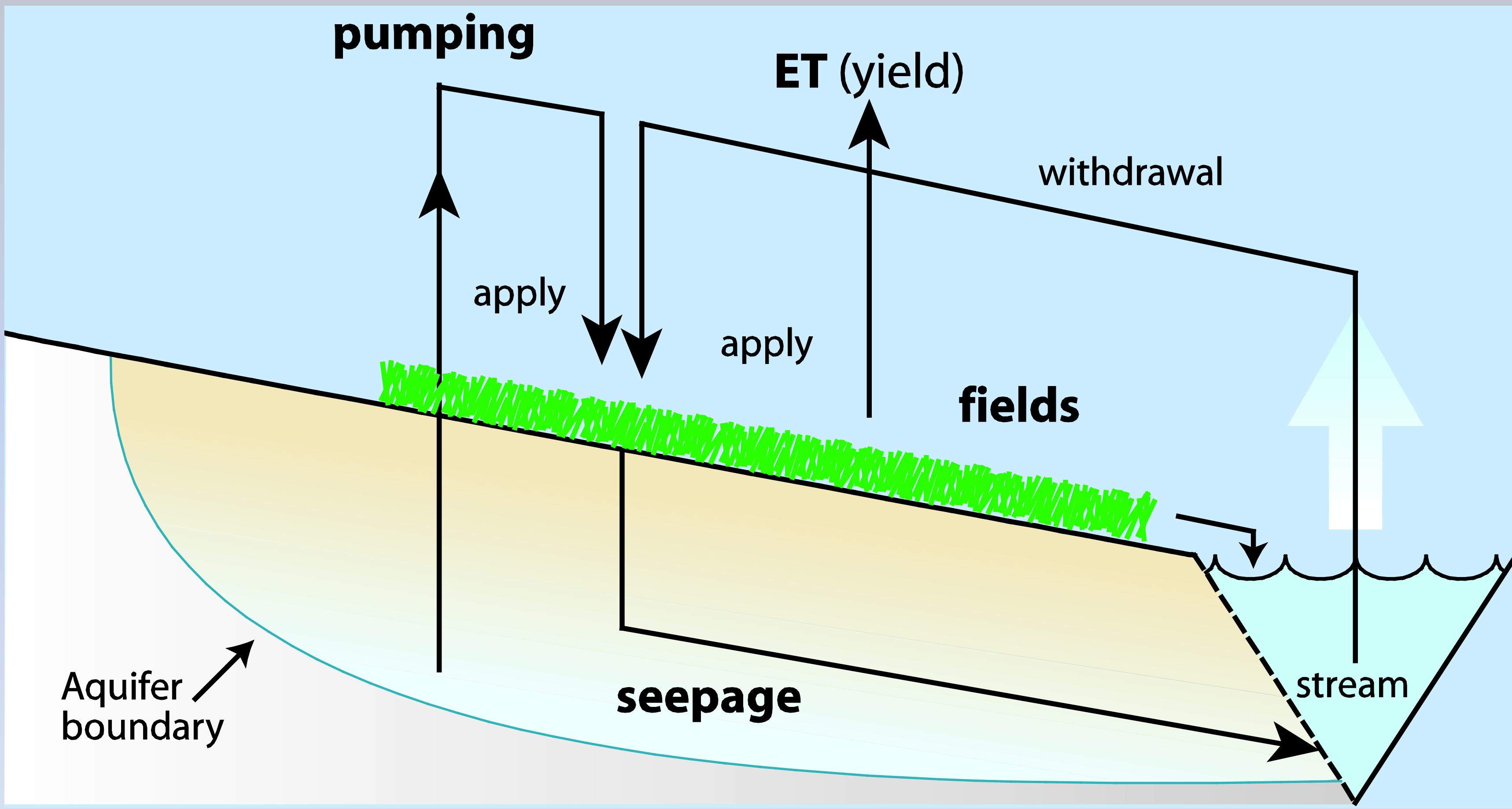
Basin Hydrology: Water Rights Administration – Frank Ward

- Requires water depletions in the basin to be no larger with water conservation subsidies than without them

- For both surface and drip, distinguish
  - water application
  - water depletion

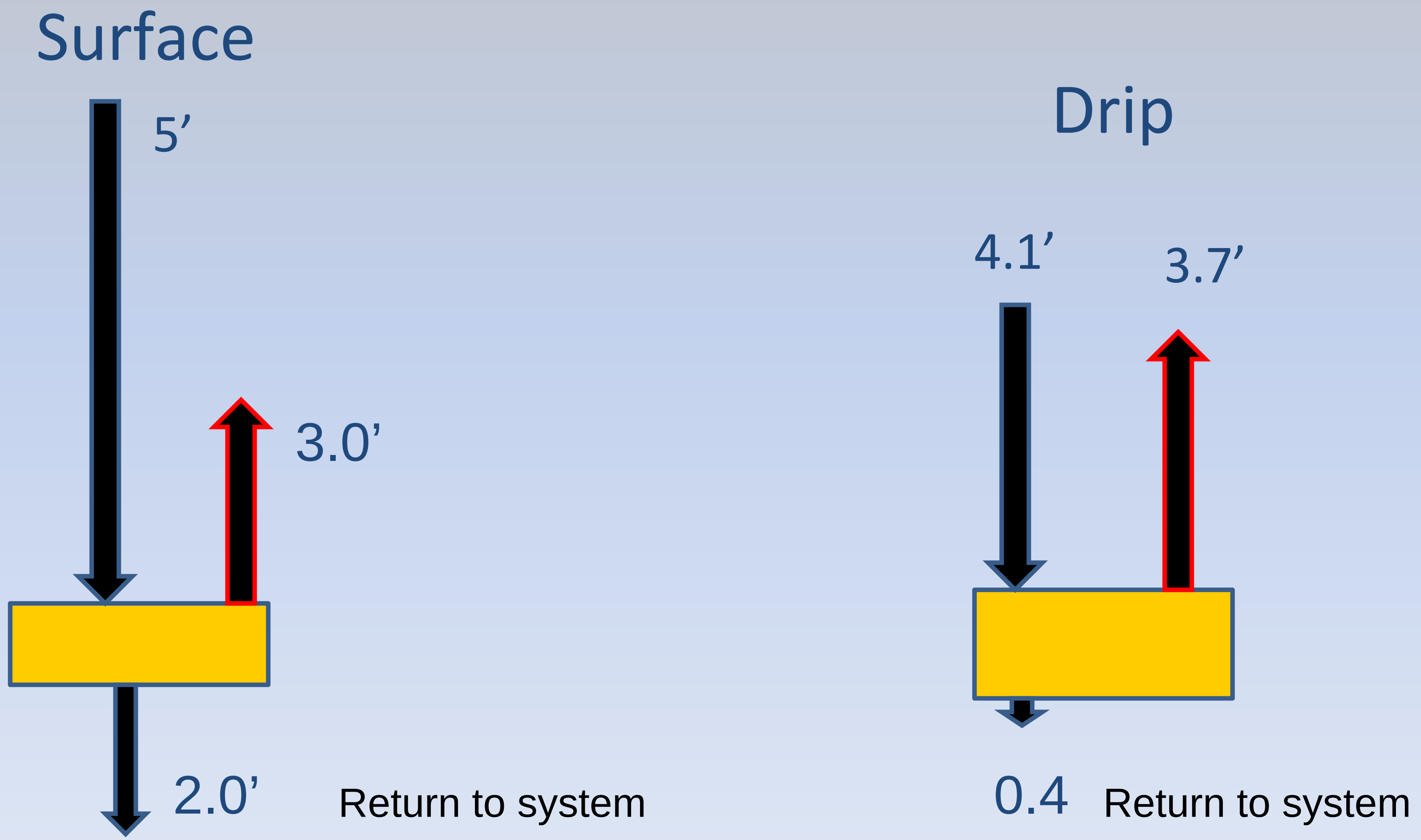
- Note: depletion/application = Ir. Eff.

Ag Water Balance



NM Pecans: Water Balance

Total ET: higher with drip



Reminder

Evaporation v Transpiration
Irrigation / Ac

Weighted Ave over Crops (EBID)

Technology	Apply	ET	E?	T?	I. Eff
Surface	4.27	2.74			0.64
Drip	3.45	3.16			0.90

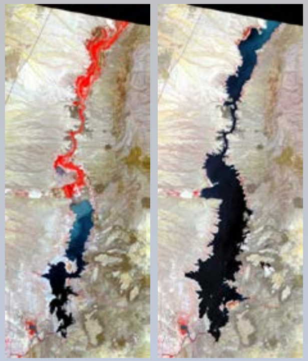
Lessons Learned: water- conserving technology

- Irrigators invest in water-saving technologies when faced with lower costs for converting from surface to drip.
- Drip irrigation subsidies ⇑ farm income, ⇑ crop yields, ⇑ value of food production, and ⇓ crop water applications.
- **By raising crop yields and raising crop water ET, drip irrigation subsidies put upward pressure on water depletions.**
- Where water rights exist, authorities need to guard against ⇑ depletions with growing subsidies that reduce water applications.

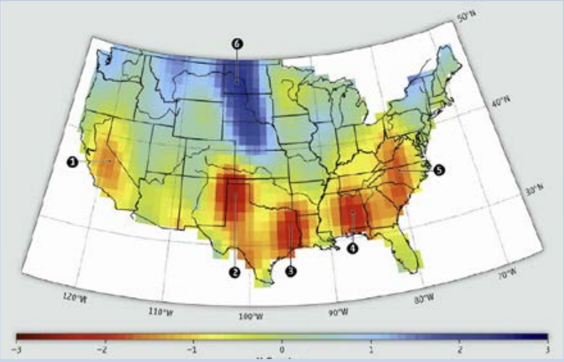
What promotes real water conservation in irrigation? - Ward

- Better water measurement
  - Gauges
  - Tracking use by crop (application, ET)
- Better water accounting
  - Current use patterns
  - Potential use patterns
- Adjudications
  - Who has the senior/junior rights in the face of future supply variability. Important as drought/climate intensifies.
  - Can promote trading water for $

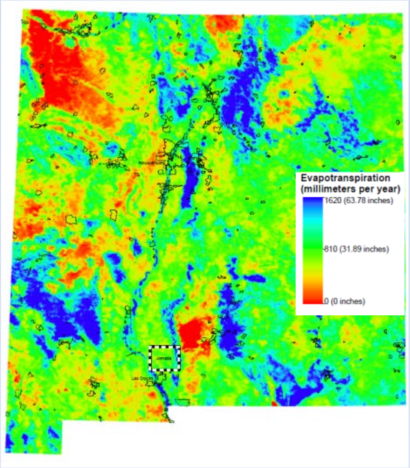
Statewide water budget



Need statewide hydrologic water budget to integrate regional conservation solutions



- Dynamic – every one or two years
- Comprehensive – includes water inputs and outputs
- Science based – utilizing cutting edge information
- Integrative – connects diverse regions



Thank you!