



Climate Impacts and Water Sources in the Riparian Zone

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- Riparian Water Sources
 - Basin groundwater
 - Flood driven bank storage and riparian aquifer recharge
 - Human related sources – agricultural returns and WWTP
- Climate Change and Variability
 - Seasonality of flooding – winter vs summer vs managed
- Controls on Flood Recharge
 - Geology – scale of river / scale of basin aquifer system
 - Hydrologic status – gaining vs losing
- Contrasting Examples
 - San Pedro
 - Rio Grande
- Management Implications

Funding



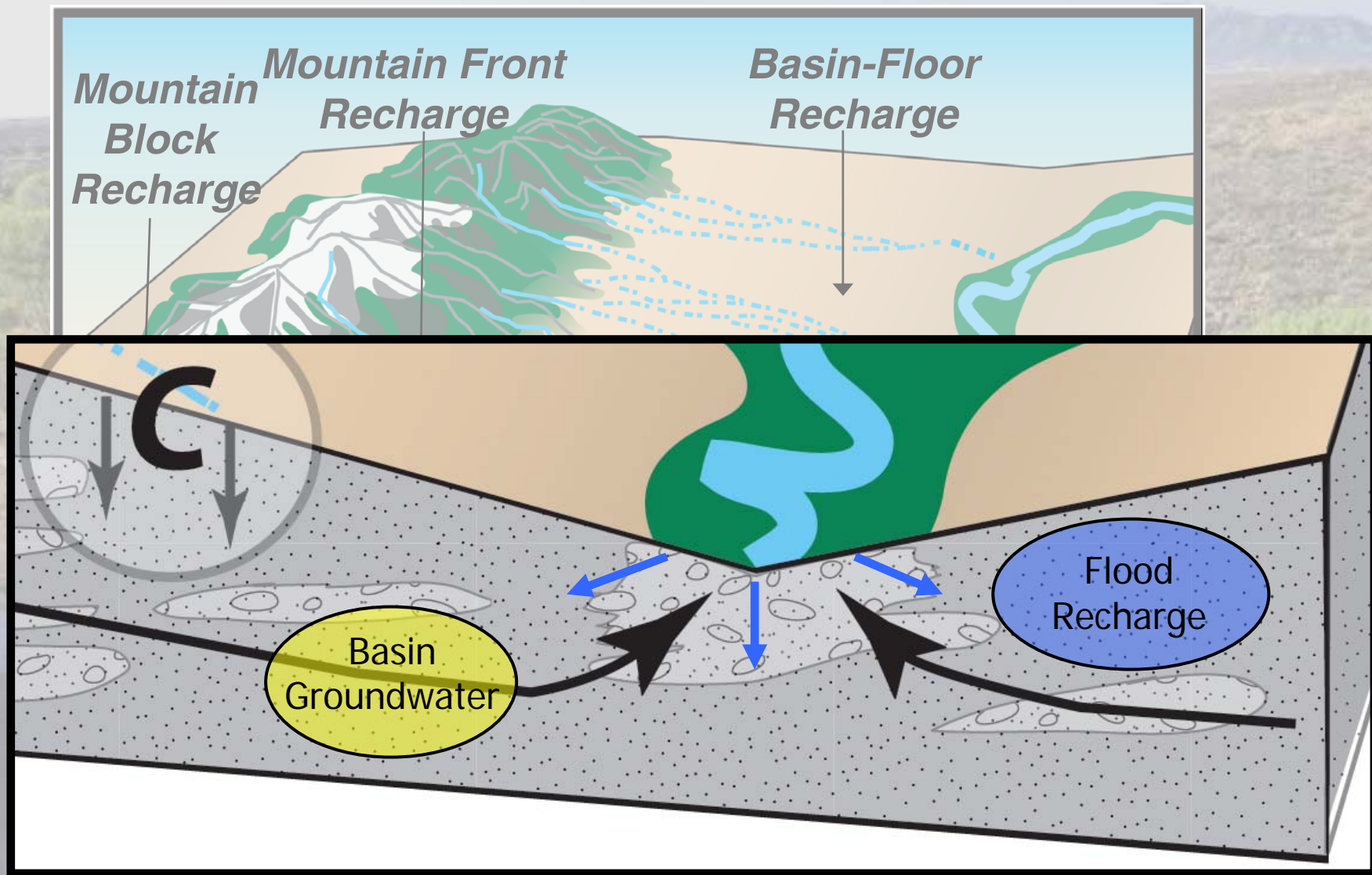
Research Partnerships



CEA-CREST

Stakeholders/ Additional Support





Fundamental control

Ratio of basin groundwater flux : flood runoff volume

Controls on this ratio

Seasonality of flooding – winter vs summer

Runoff volumes – upstream area/flood generation

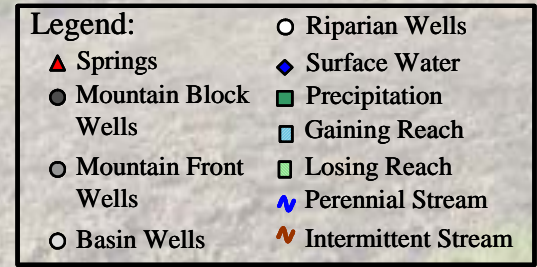
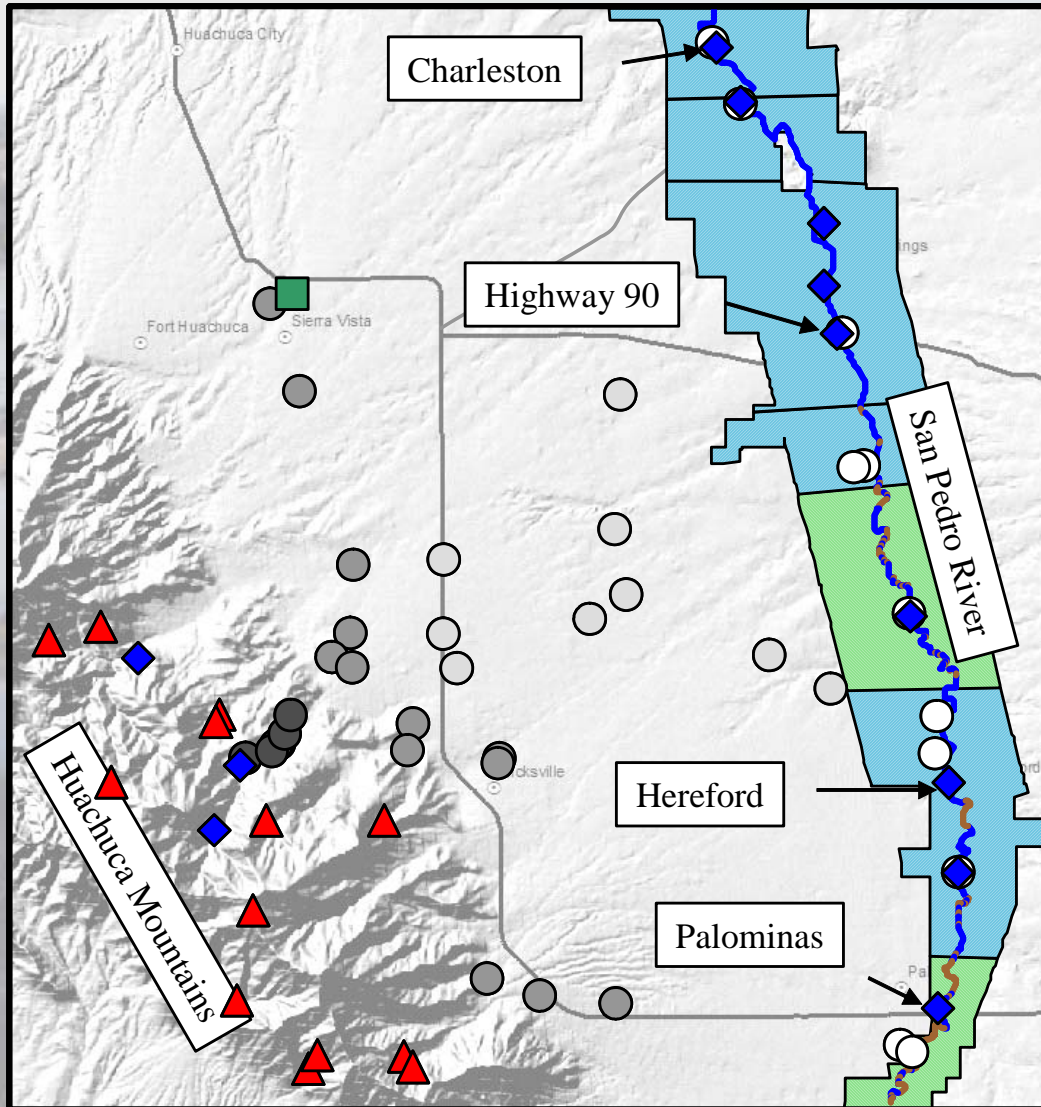
Basin recharge – size of basin / aquifer character

Human alteration – GW pumping / WWTP discharge
changes in runoff

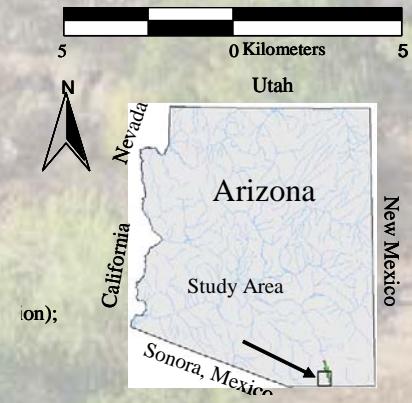
Two contrasting examples

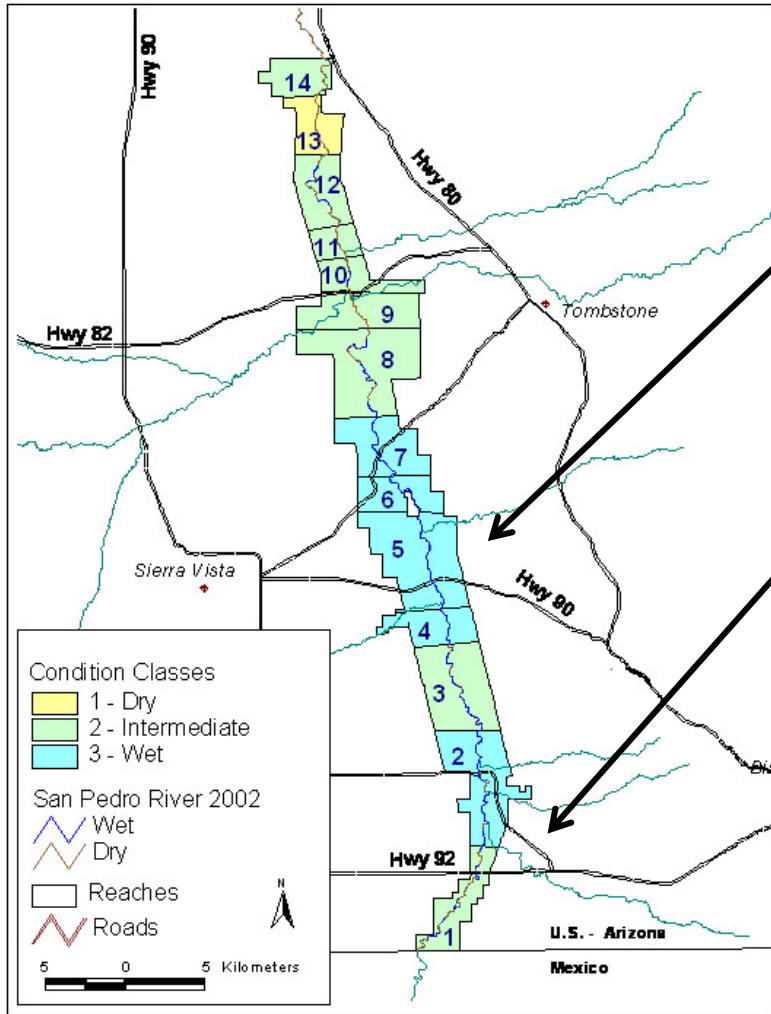
San Pedro – small basin, monsoon flood recharge,
moderate basin recharge, “natural”

Hueco Bolson/Rio Grande – very large basin, snowmelt
dominated, very little basin recharge, “managed” 5

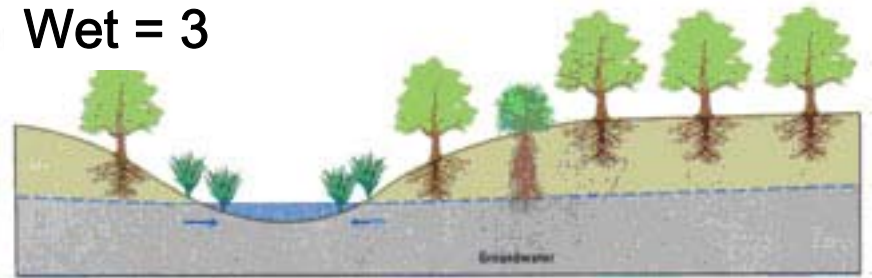


Losing/Gaining reach data from Stromberg et al. (in preparation)
 flow permanence data from the Nature Conservancy

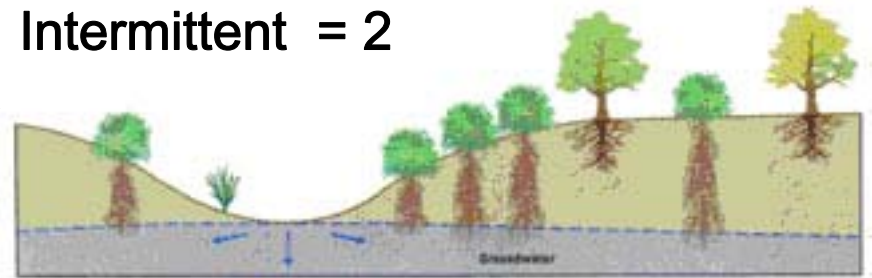




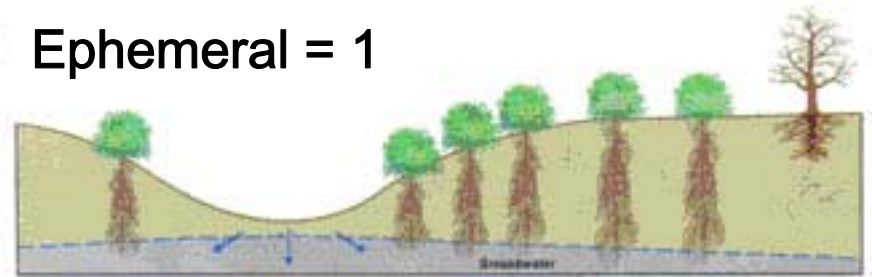
Wet = 3

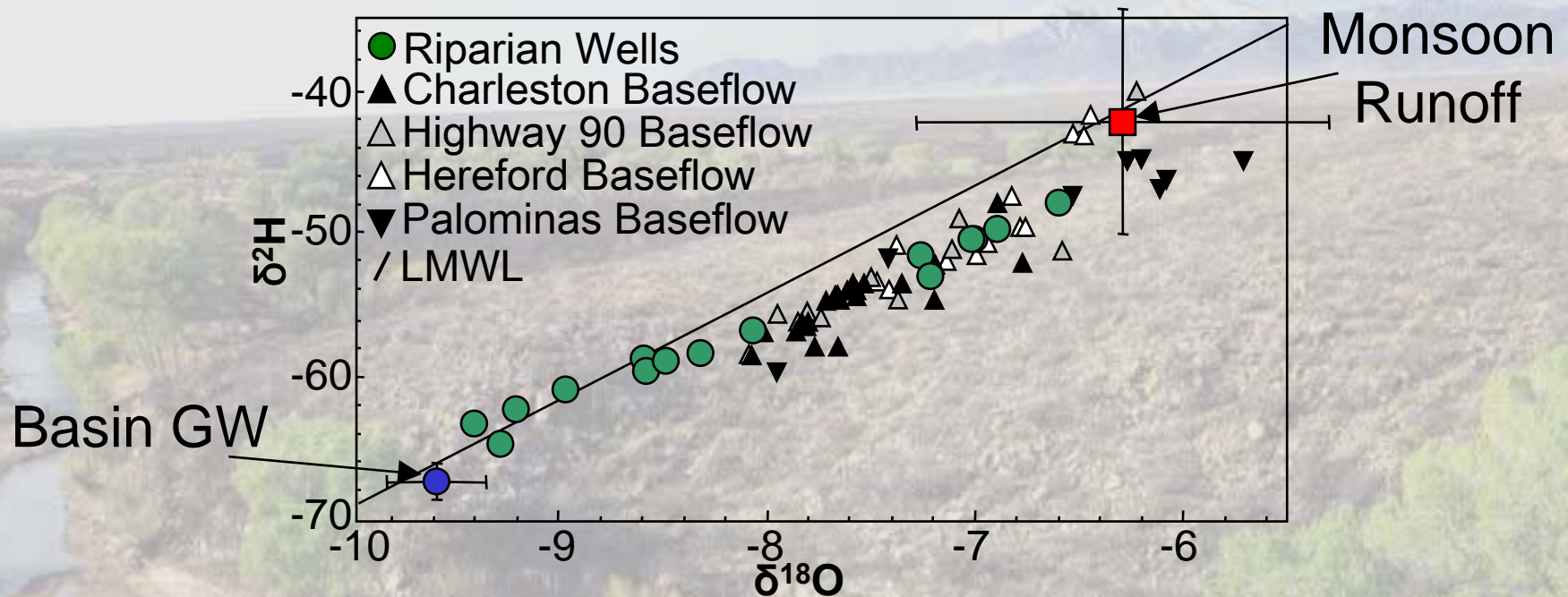


Intermittent = 2

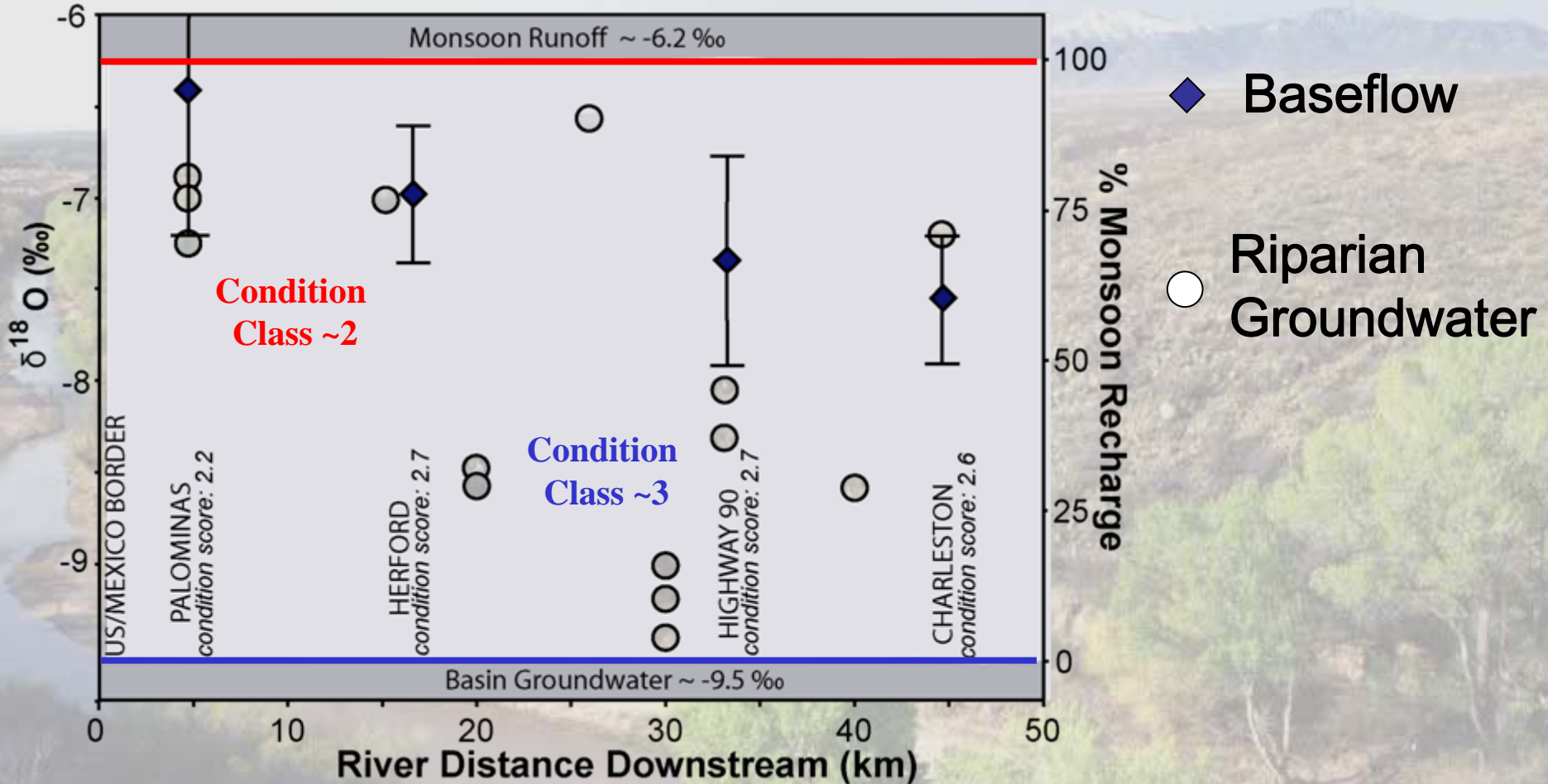


Ephemeral = 1



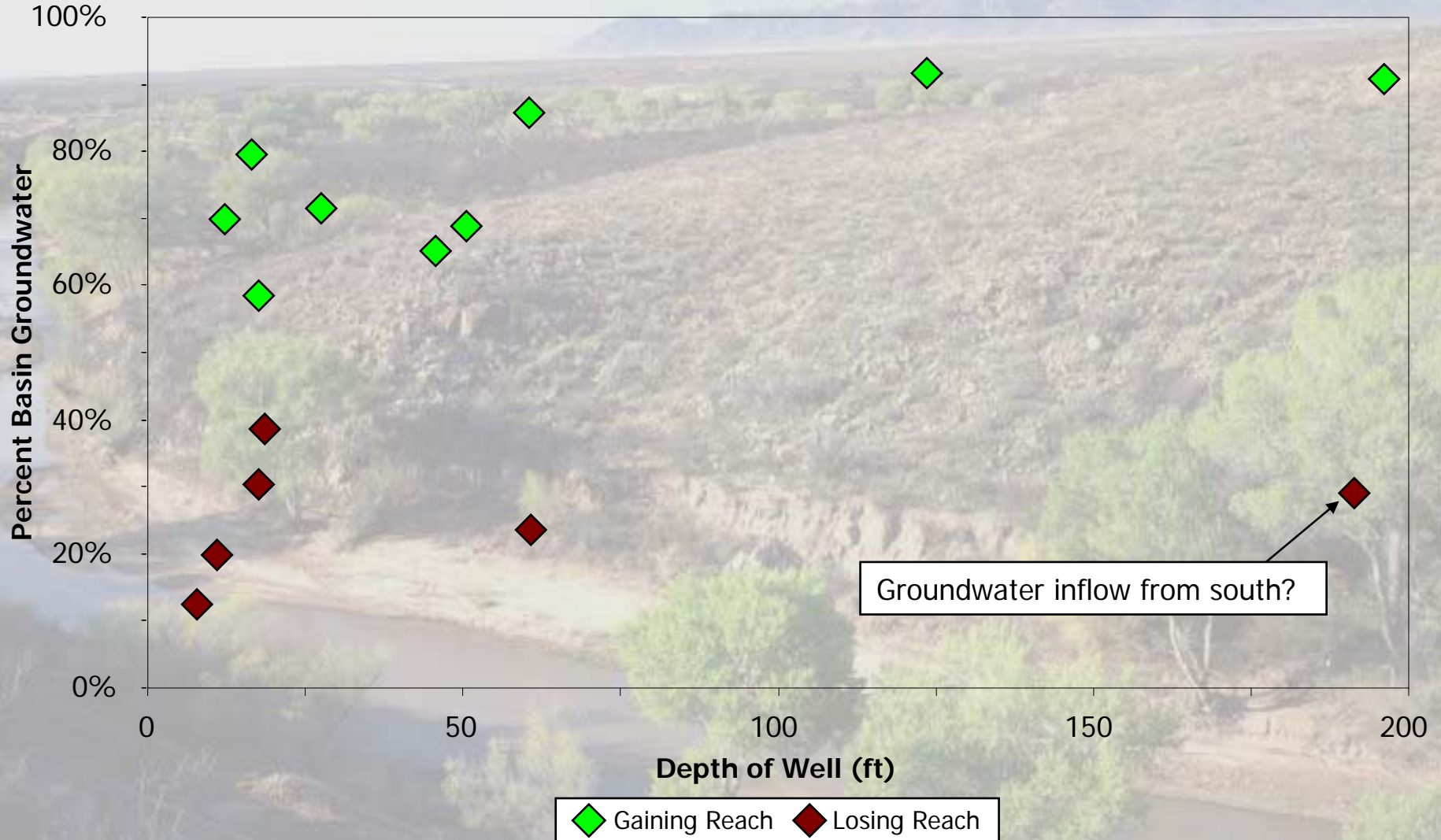


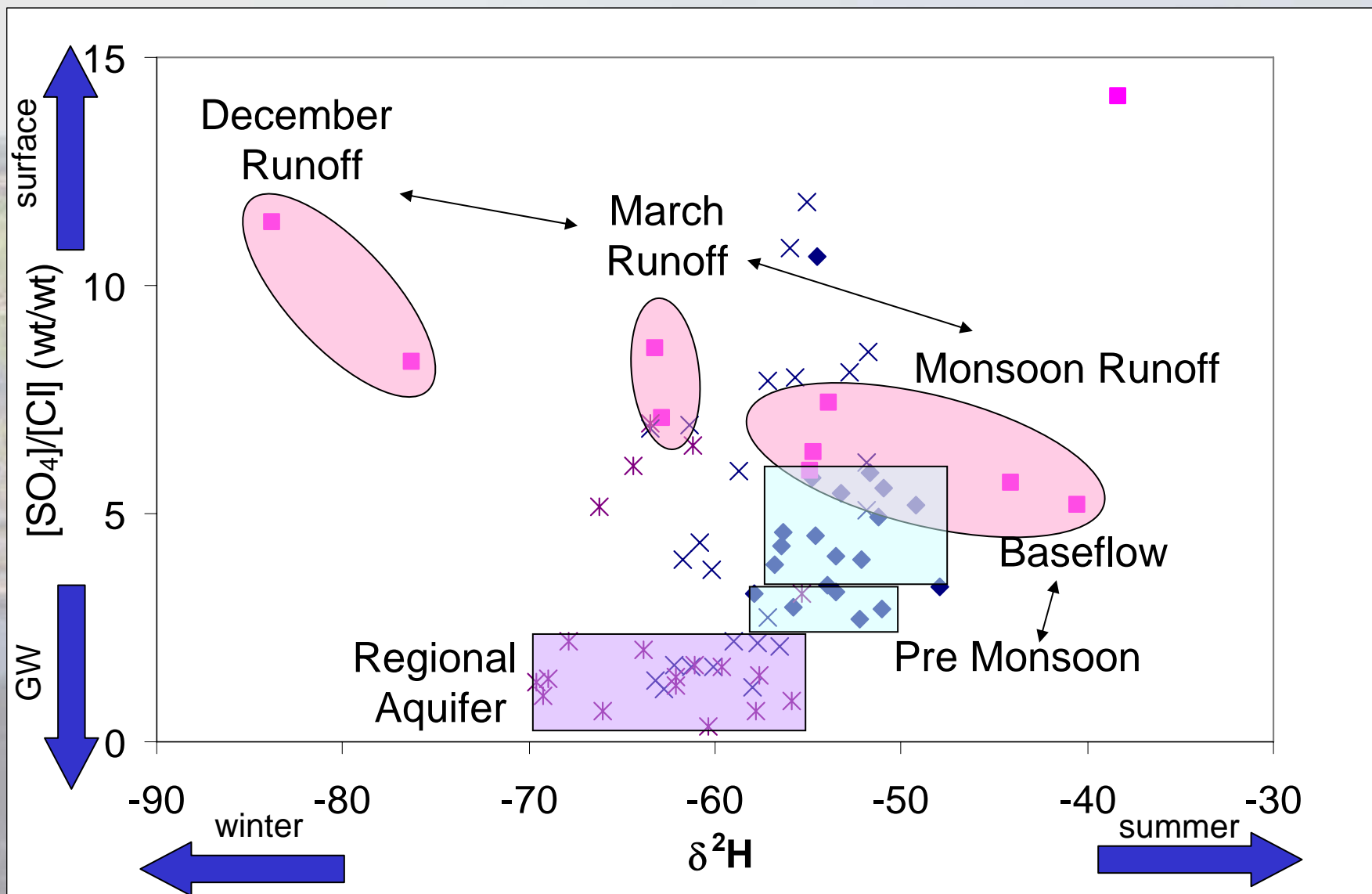
- Isotopes of water – natural tracer of source
- Riparian wells span range between end members
- Baseflow skewed toward monsoon runoff
- Quantify % using simple mixing model
- Uncertainty associated with runoff end member



- Baseflow >50% monsoon runoff regardless of season
- Riparian Groundwater relates to condition class
- Control on this? Gaining vs Losing

Basin Groundwater in Riparian Wells





Hueco Bolson Aquifer

*San Andres
Mts. 2500 m*

*Sacramento
Mts. 2940 m*

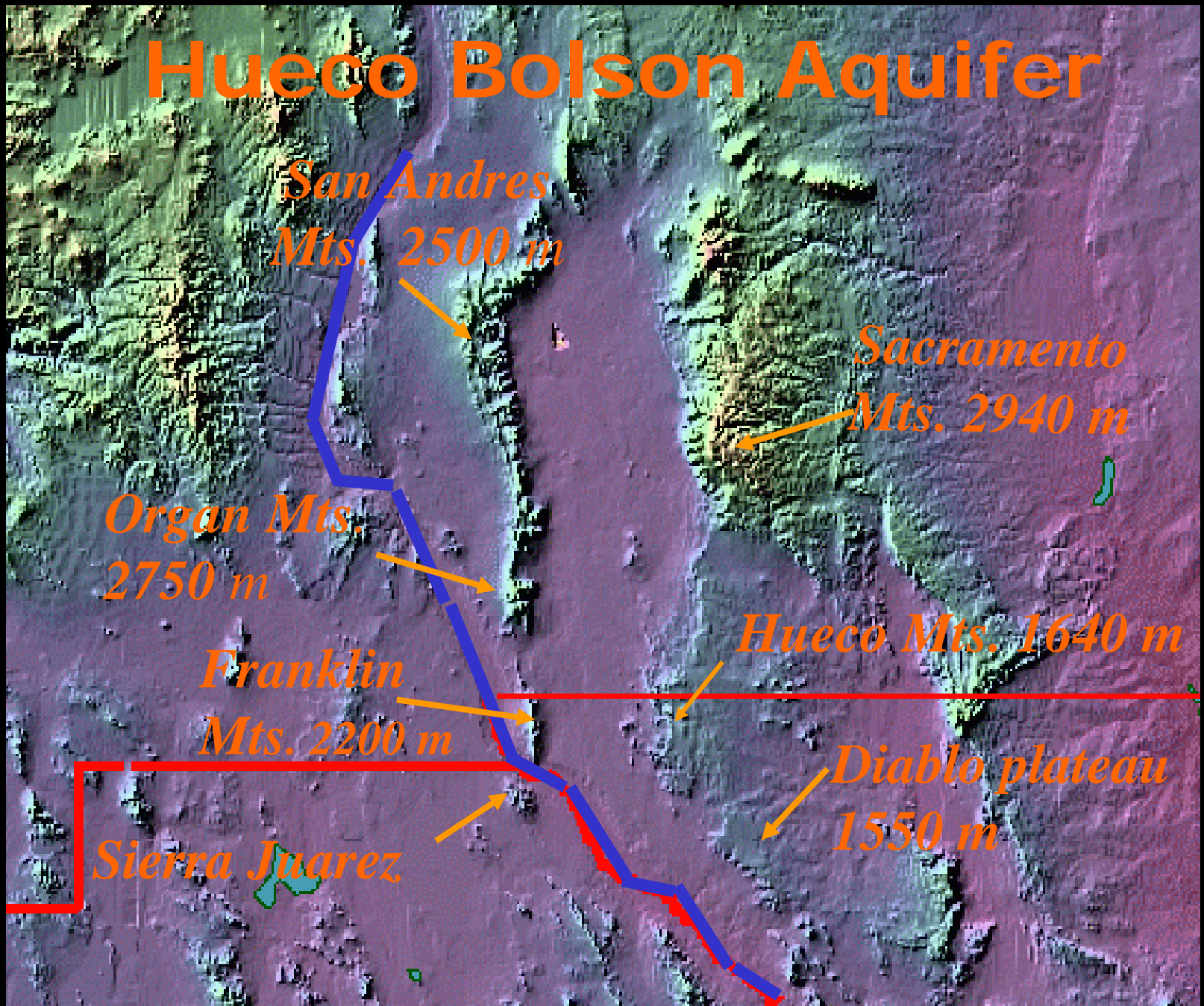
*Organ Mts.
2750 m*

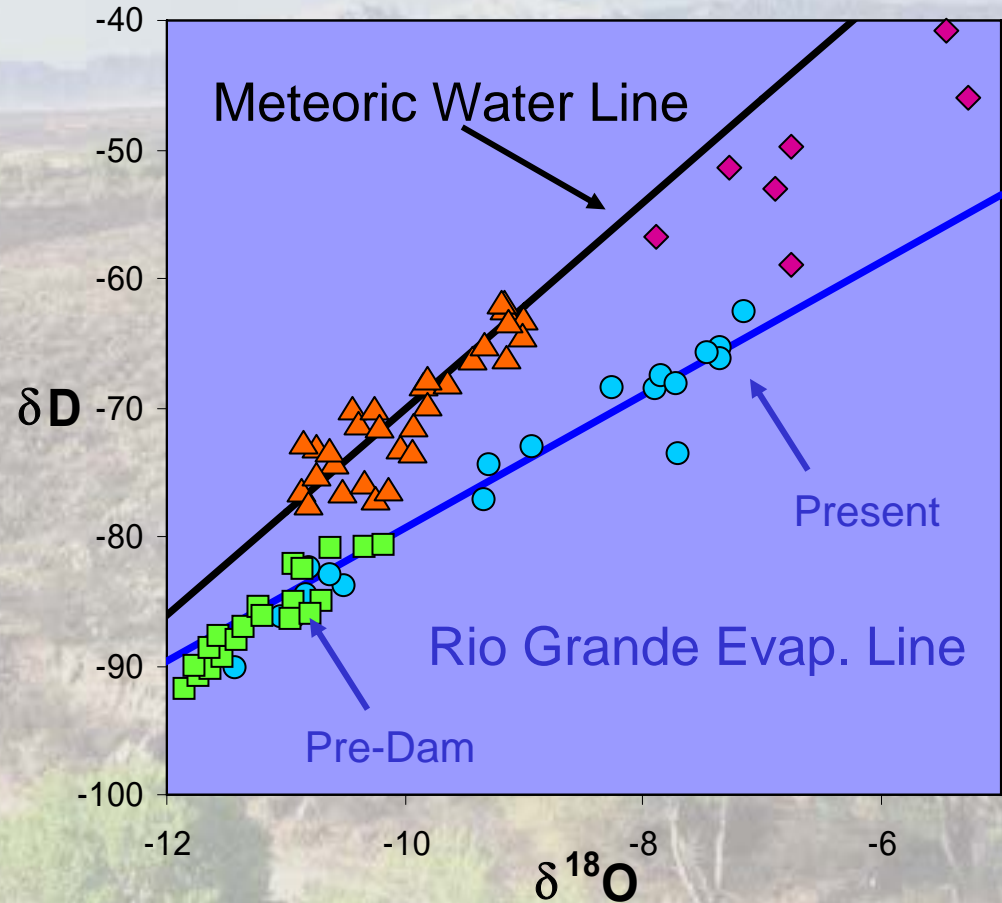
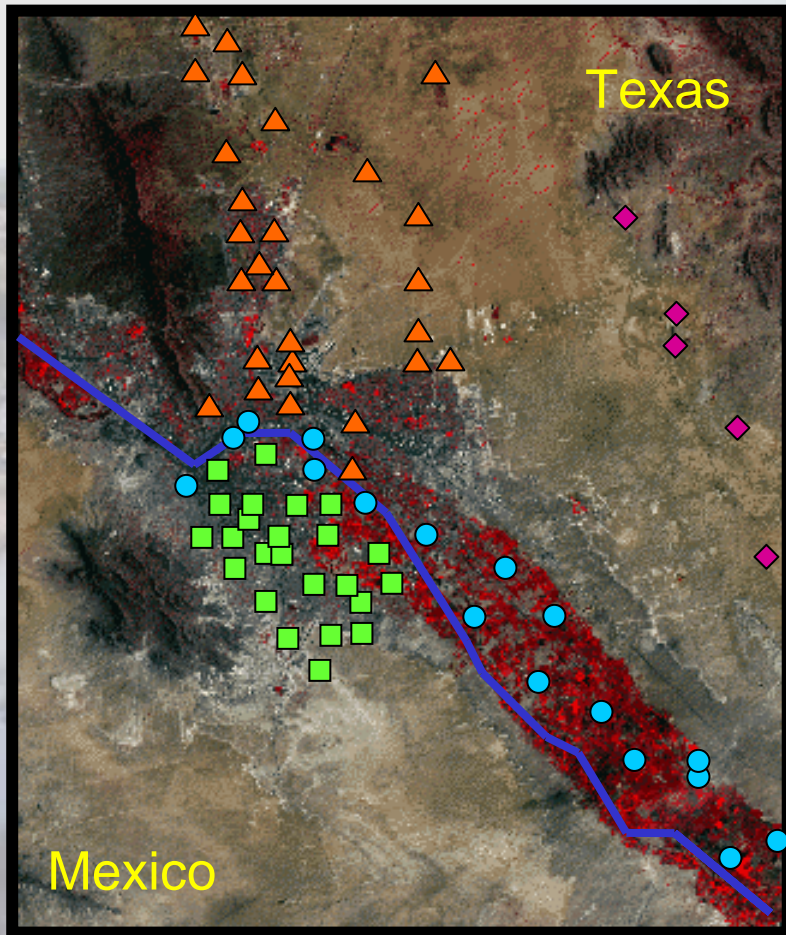
Hueco Mts. 1640 m

*Franklin
Mts. 2200 m*

*Diablo plateau
1550 m*

Sierra Juarez



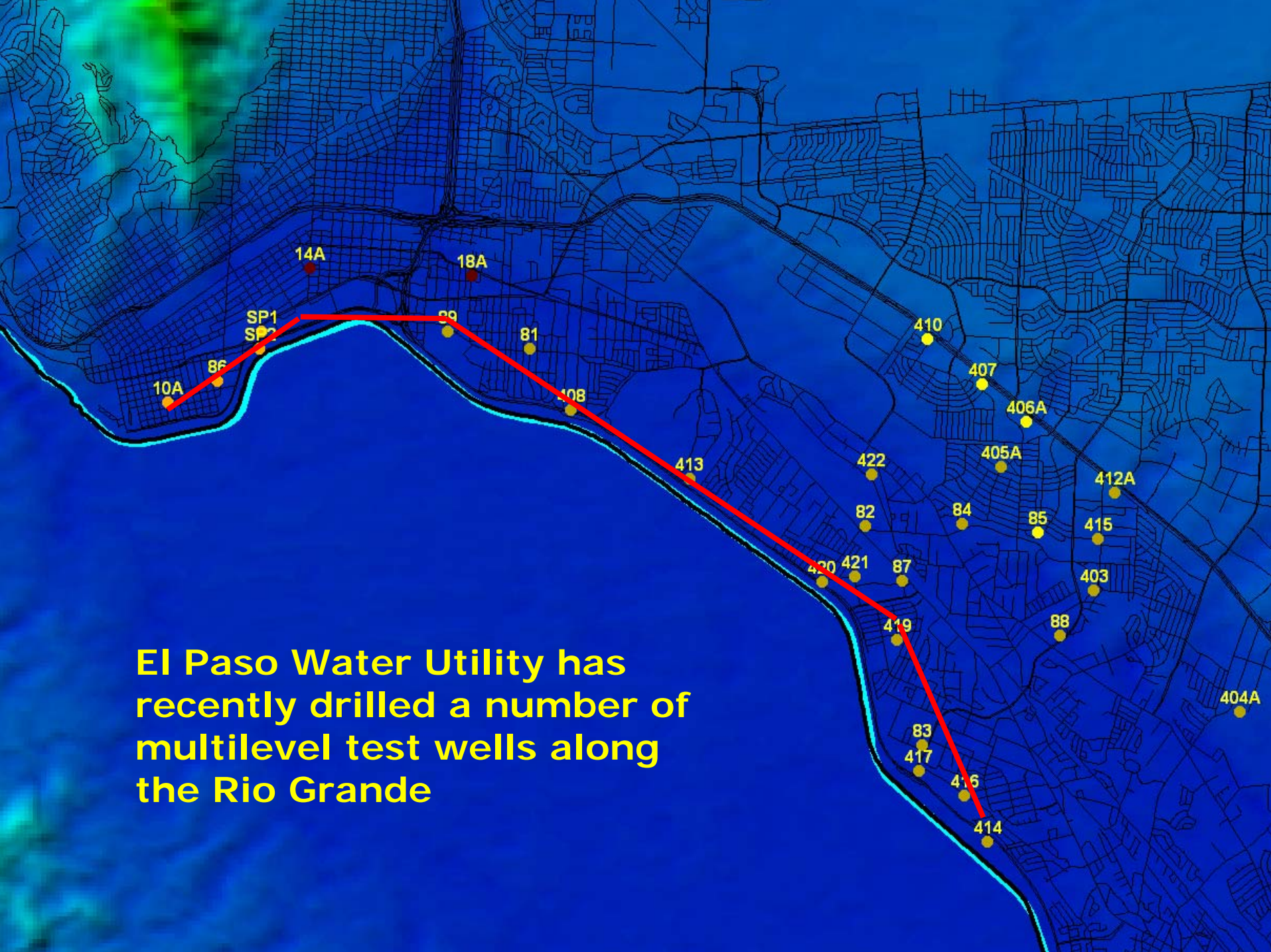


Rio Grande water distinct from basin recharge

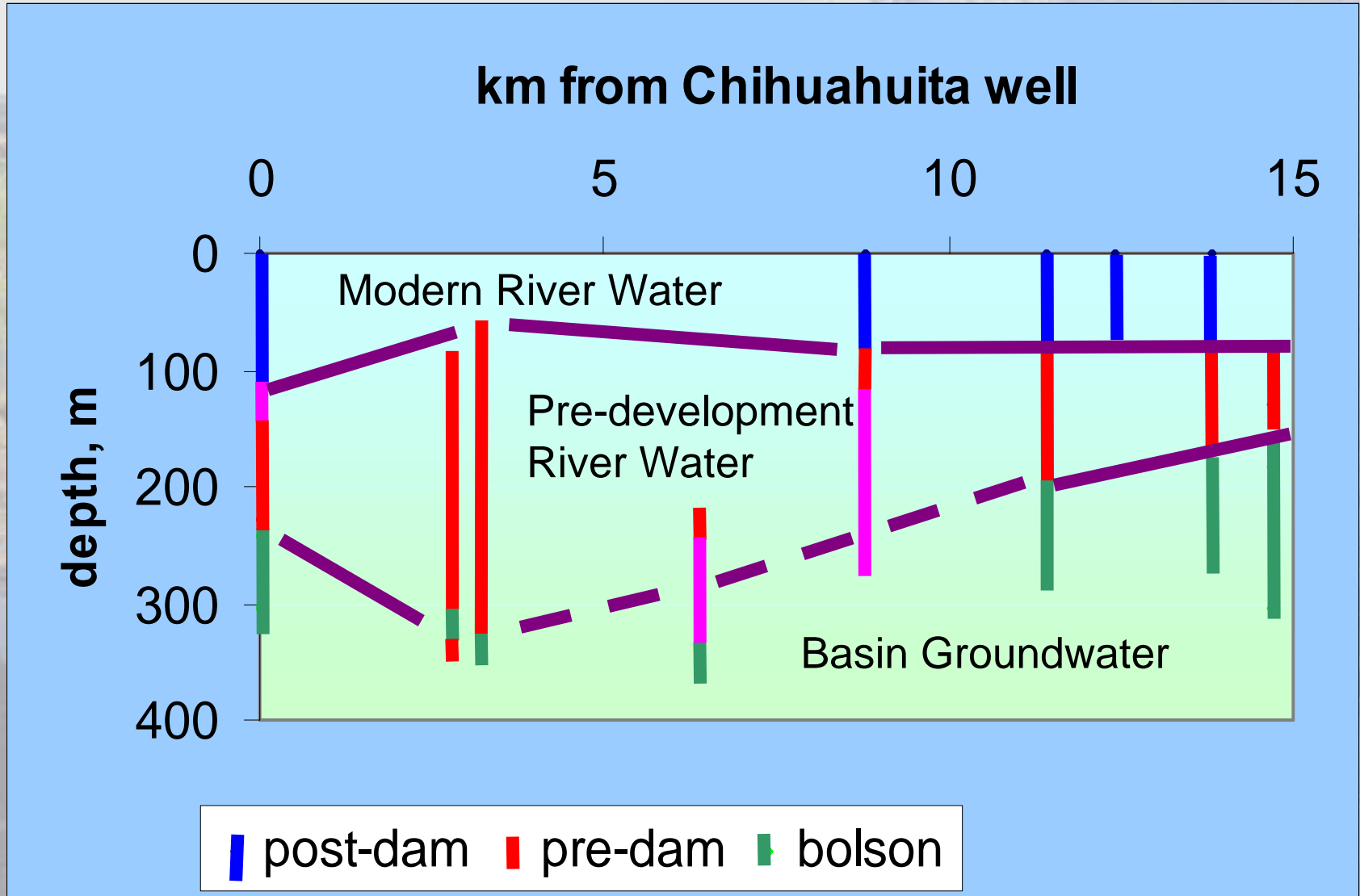
- Snowmelt southern Rocky Mountains

Reservoir development imprints and evaporation signal

- Trace pre / post development groundwater



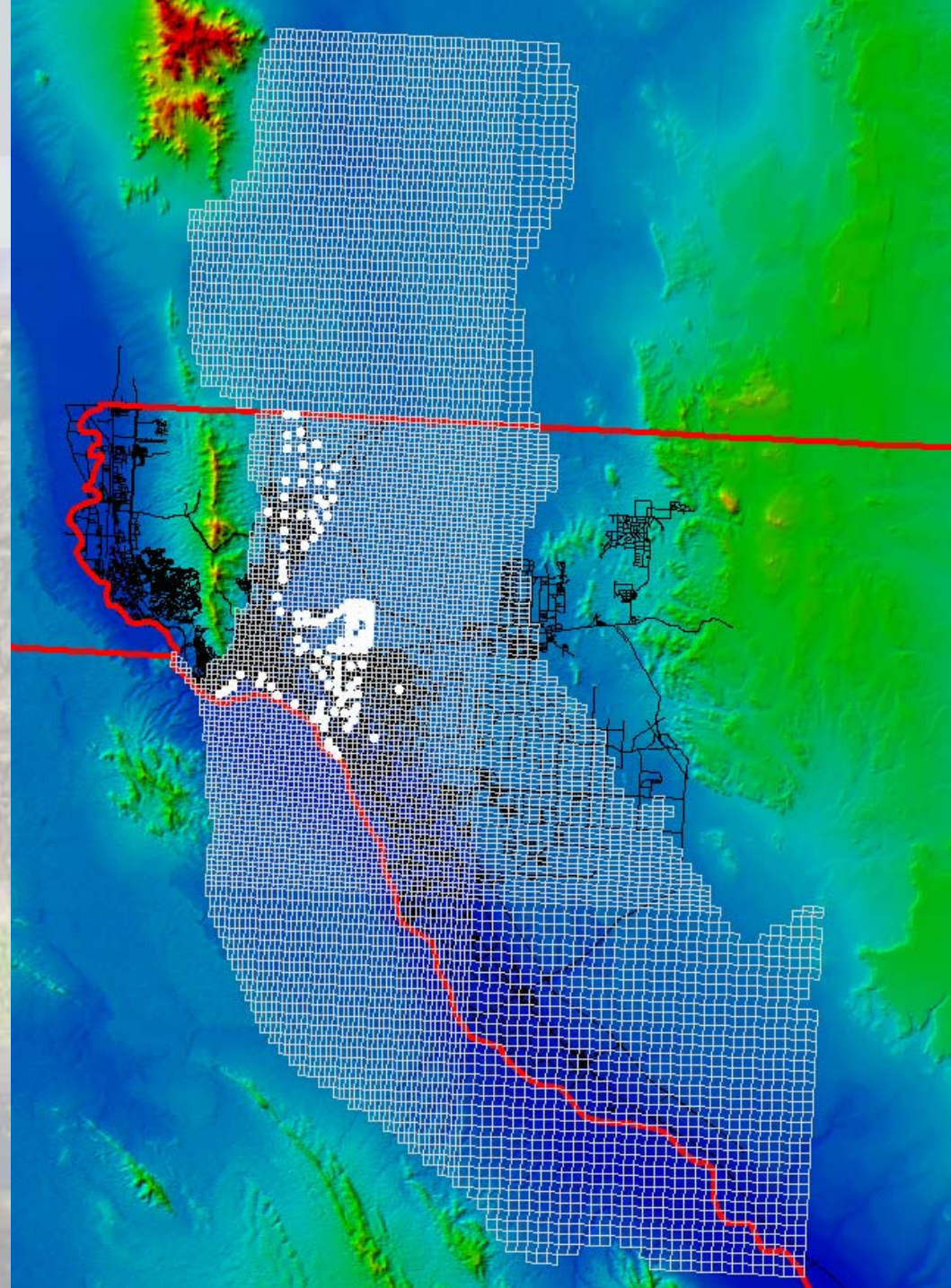
El Paso Water Utility has recently drilled a number of multilevel test wells along the Rio Grande



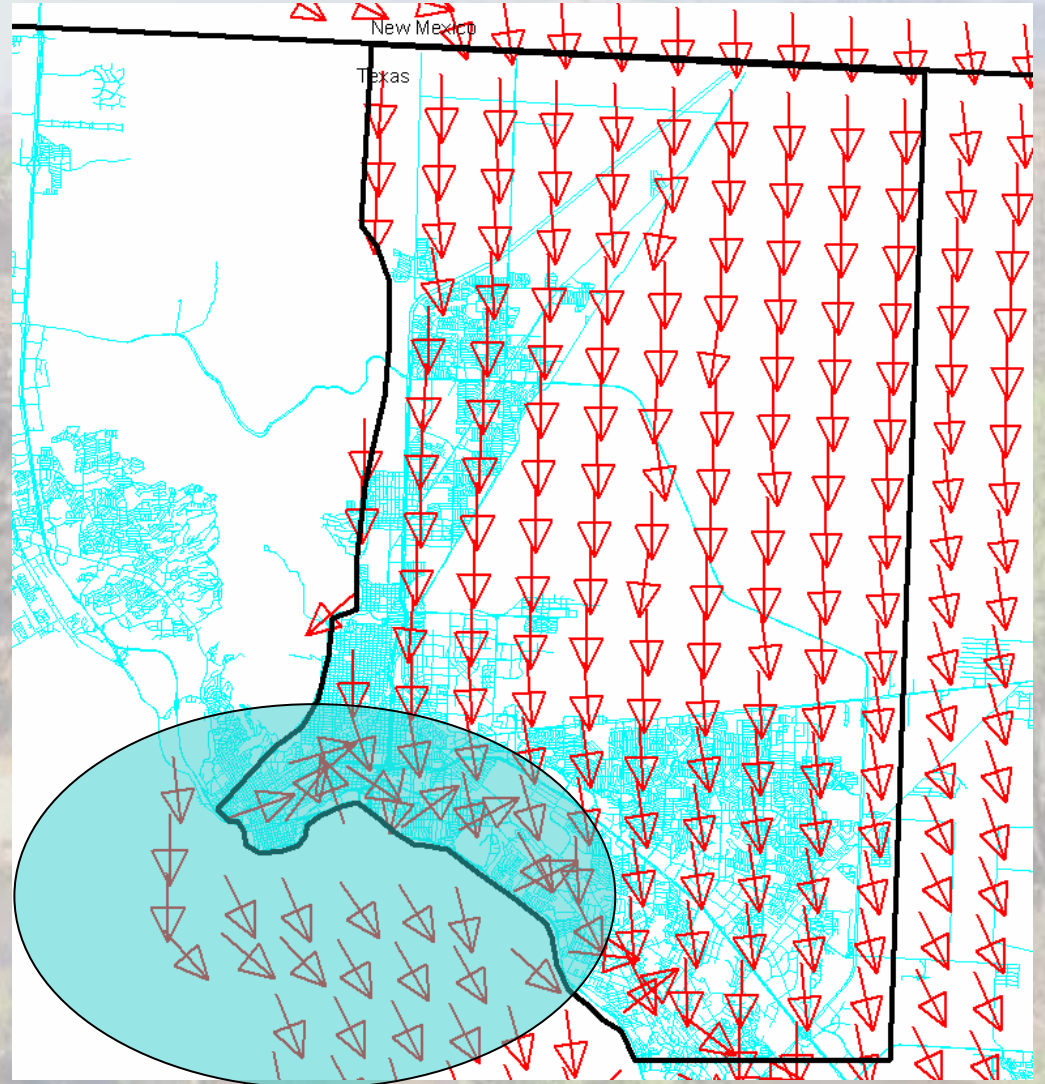
Hueco GW Model

**USGS Model
Grid for
Hueco Bolson**

**Update to
include river
recharge**



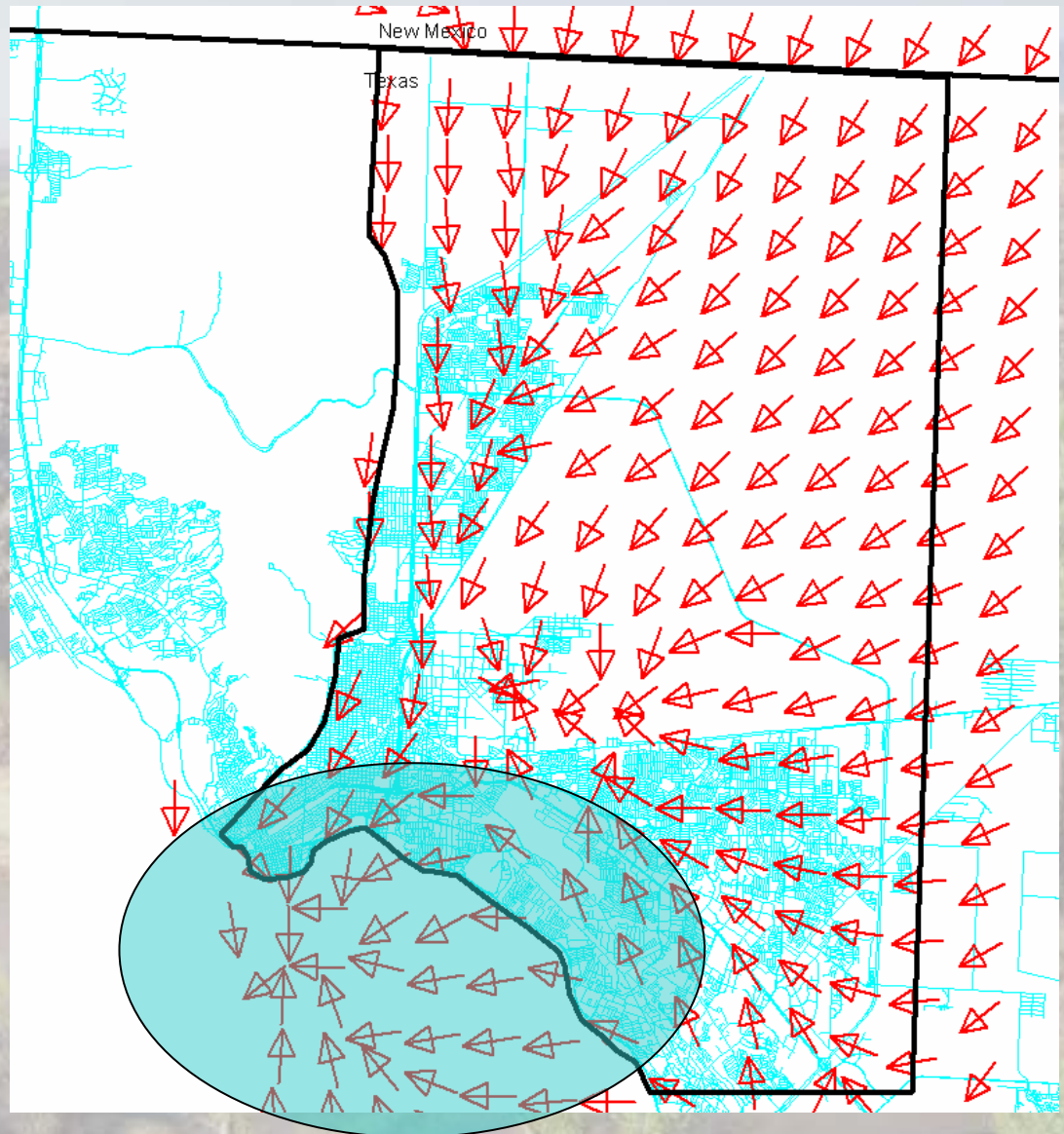
1903 Flow



River recharge for Juarez!!

1996 Flow

Juarez recharge?



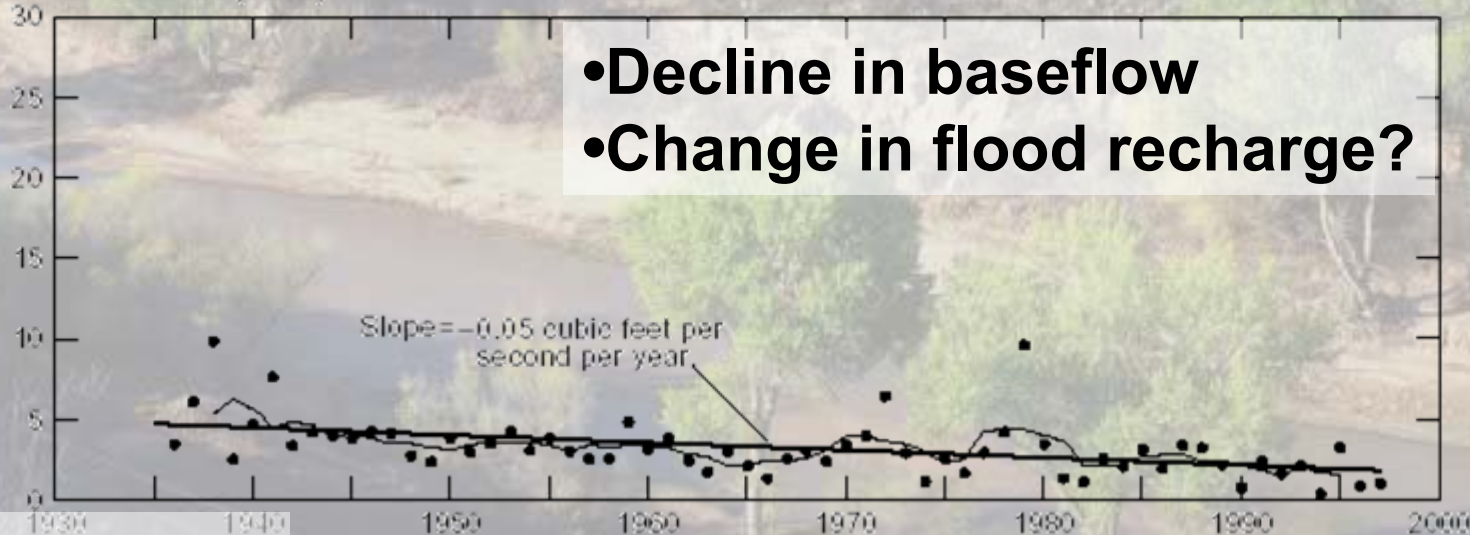
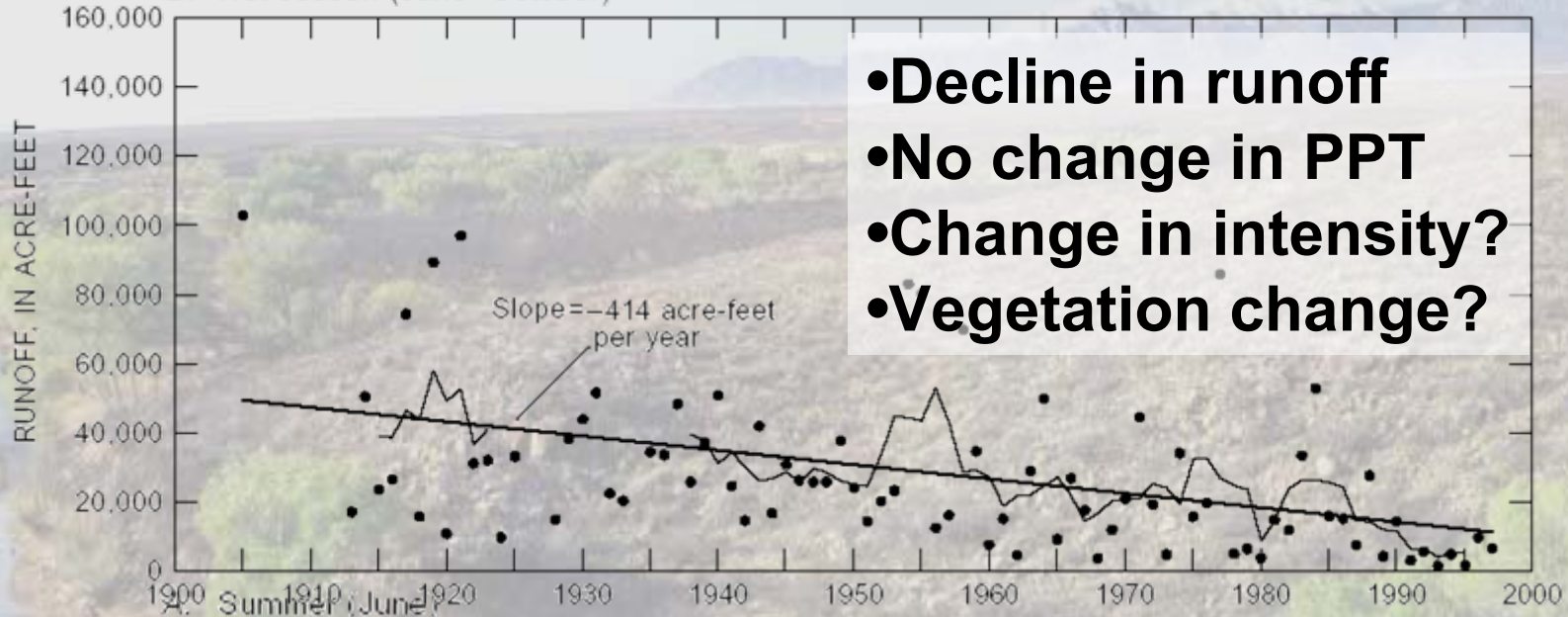
- Evaluate riparian water sources and the climate “sensitivity” of these sources
- Need to worry not just about impacts of groundwater pumping, but also about potential changes to flood runoff
- Groundwater models used for riparian management need to include local riparian recharge and ideally should be calibrated using isotopic data
- Isotopes are a useful tool for analyzing changes in riparian water sources; changes in water chemistry may manifest before changes in baseflow. Thus, monitoring changes in riparian groundwater and baseflow chemistry can be an early indicator for changes in sources



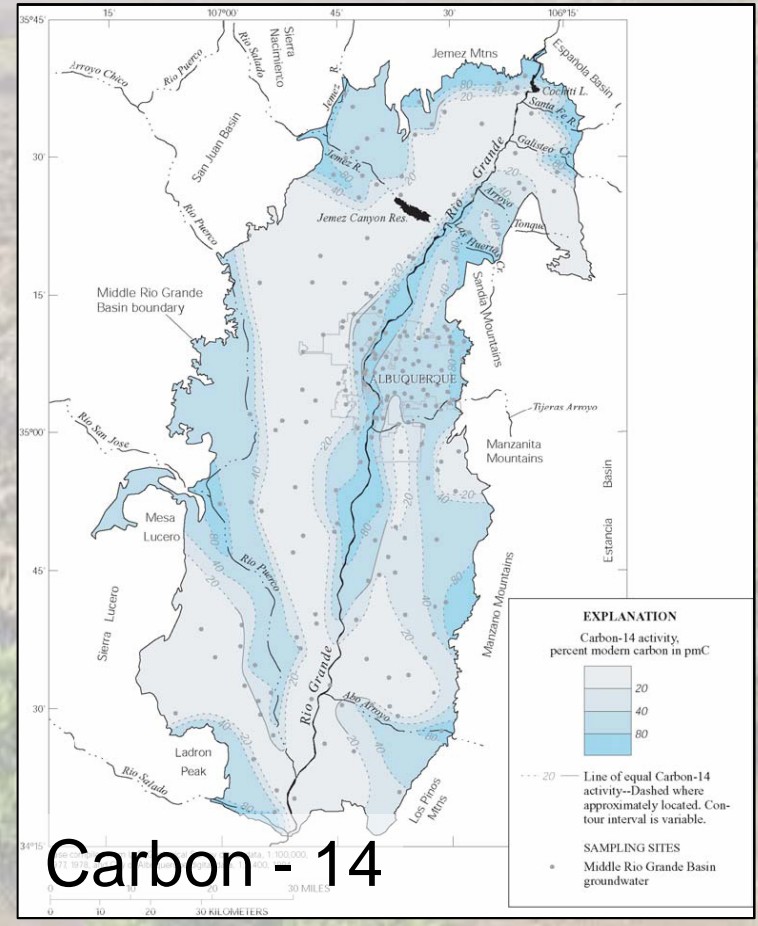
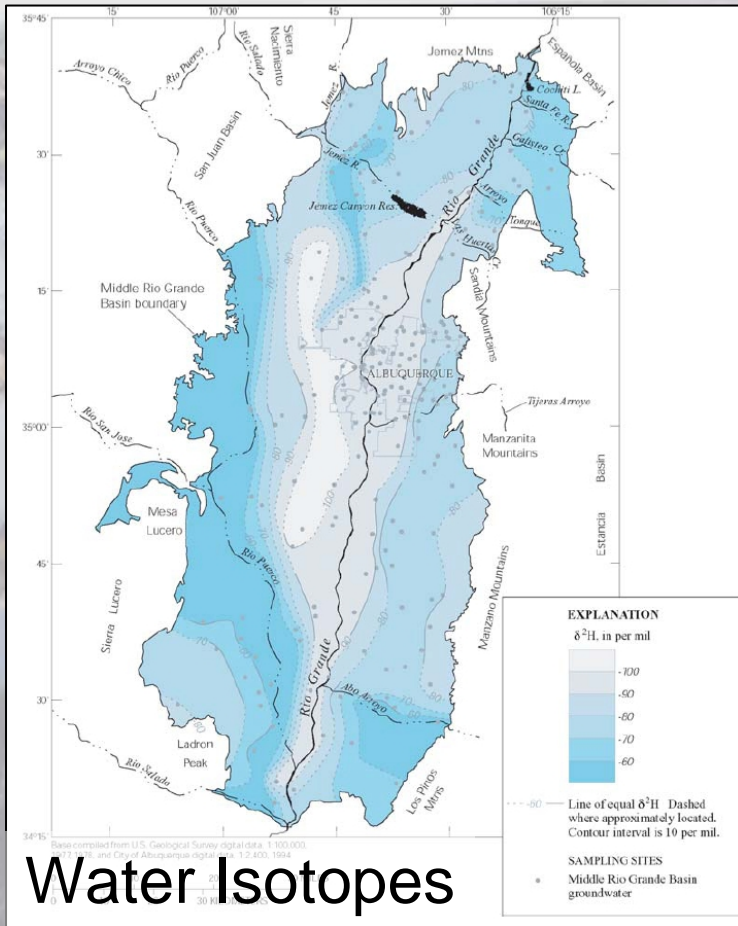
Table 3. Sensitivity Matrix for Woody Riparian Vegetation
Frequency of Seasonal Flooding

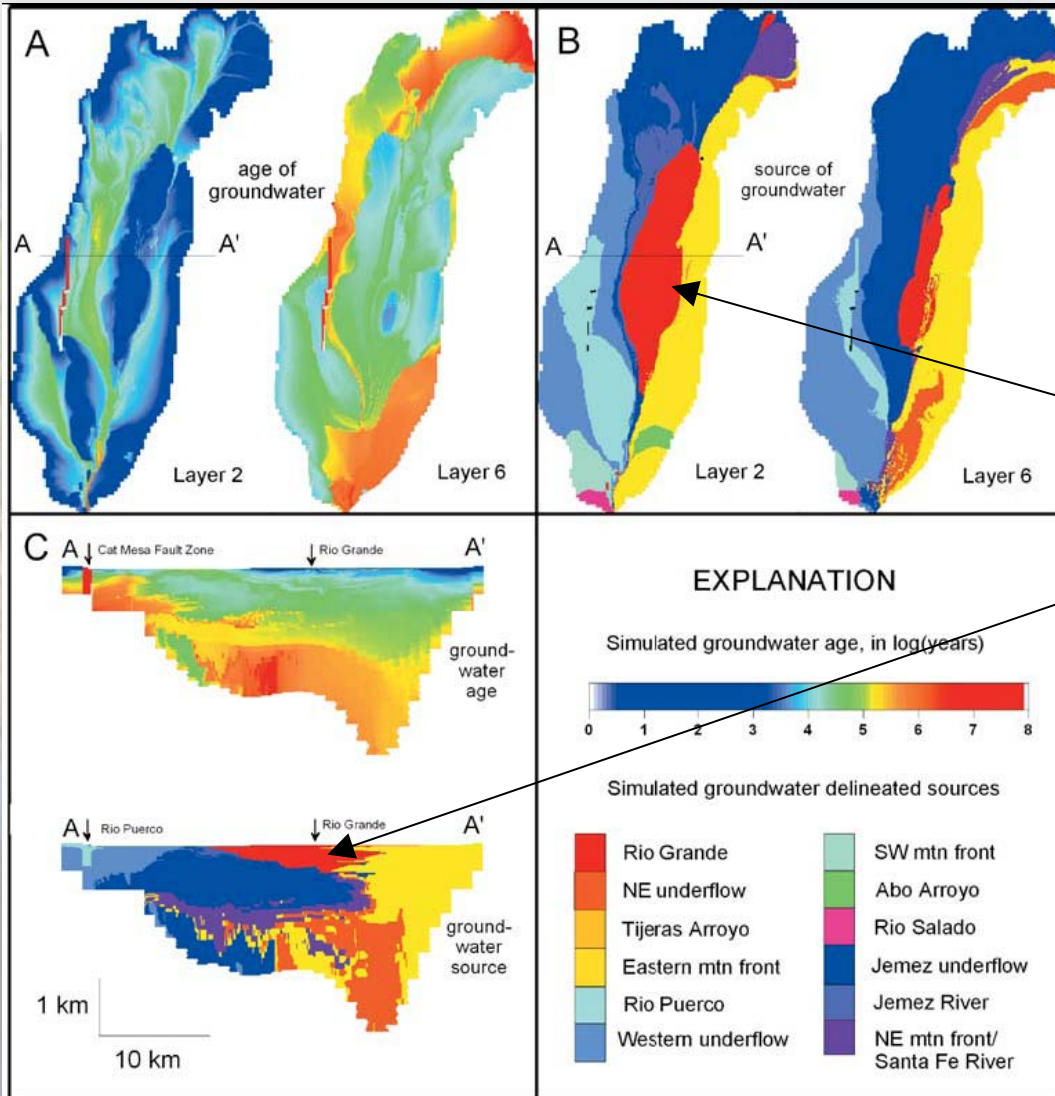
		High	Moderate	Low
Groundwater depth and water source	High/stable (basin GW)	<ul style="list-style-type: none"> Stable established populations, low risk to recruitment Low sensitivity to climate change 	<ul style="list-style-type: none"> Stable established populations, moderate risk to recruitment Low to moderate sensitivity to climate change 	<ul style="list-style-type: none"> Stable established populations, recruitment at high risk Moderate sensitivity to climate change
	Moderate (mixed)	<ul style="list-style-type: none"> Moderate risk to established populations, no risk to recruitment Low sensitivity to climate change 	<ul style="list-style-type: none"> Moderate risk to established populations and recruitment Moderate sensitivity to climate change 	<ul style="list-style-type: none"> High risk to established populations and recruitment High sensitivity to climate change
	Deep (flood recharge)	<ul style="list-style-type: none"> Moderate to high risk to populations, no risk to recruitment Moderate sensitivity to climate change 	<ul style="list-style-type: none"> High risk to populations, moderate risk to recruitment High sensitivity to climate change 	<ul style="list-style-type: none"> Transition to upland very likely High sensitivity to climate change

B. Wet season (June–October)



USGS Albuquerque Basin Study





Rio Grande Water
~10 km wide
~500 m deep

Region	Kernodle et al. (1995)	Tiedeman et al. (1998)	Anderholm (2001)	McAda and Barroll (2002)	This study
Jemez Mountains	0.56	0.27	N/A	0.58	0.08
Western boundary	0.18	0.18	N/A	0.07	0.06
Southwest boundary	0.30	0.09	N/A	0.03	0.17
San Juan Basin	0.05	0.05	N/A	0.04	0.27
Hagan/Espanola Basin	0.21	0.49	N/A	0.55	0.03
Northeast rivers	0.32	0.30	N/A	0.21	0.18
Tijeras Arroyo	0.41	0.41	0.07	0.03	0.00
Abo Arroyo	0.62	0.60	0.05	0.05	0.04
Rio Puerco	0.23	0.12	N/A	0.04	0.14
Jemez River	0.48	0.48	N/A	0.59	0.01
Rio Grande ^a	~0	~0	N/A	N/A	0.78
Rio Salado	0.28	0.28	N/A	0.08	0.06
Sandia Mtn front	0.74	0.41	0.16	0.21	0.16
Southeast Mtn front	1.06	1.16	0.19	0.16	0.17
Total	5.45	4.86	N/A	2.63	2.14

Overall budget with isotopic data – little change

River recharge – significant increase

Basin Source – significant decrease

- **Know your riparian water sources**
 - Basin GW – Flood Recharge – Human Related Source
- **Assess potential for climate impacts on sources**
 - Basin GW – often little impact as residence time long
 - Flood recharge – consider seasonality
 - Human sources?
- **Assess human/other impacts on these sources**
 - Runoff volumes due to uplands vegetation change
 - Groundwater pumping
 - Reservoirs/irrigation management
- **Management implications**
 - Evaluate climate sensitivity
 - Potential for change in runoff – uplands issues
 - Need for GW models with water source accounting
 - Isotopes as tracer of riparian hydrologic change

- **Are other places like San Pedro and Rio Grande?**
 - Stromberg et al. Are condition classes transferable?
 - de la Cruz - PhD student UA - How do alluvial aquifers function on the Verde and Rio San Miguel?
 - Simpson- soon to matriculate PhD student at UA - How do alluvial aquifers function in Hassayampa and Bill Williams
- **How do alluvial aquifer systems influence sustained water quality?**
 - Soto-Lopez - Spatial and temporal variability and structure?
 - Oelsner - Large floodplain agricultural system of Rio Grande interaction with river?
- **What is mechanism of surface-groundwater interaction?**
 - Simpson - UA MS Hydrometric isotopic tracer linkage
 - Treese - UA MS - Biological or physical clogging – importance of floods
 - Coupling KINEROS MODFLOW - Vionet and MS student Kilb
- **What is role and impact of decadal-scale climate variability?**
 - Hogan, Baird, Meixner Stromberg EPA project
 - H. Ajami PhD UA
 - Simpson soon PhD UA
 - Kilb MS UA