WATER USE AND SUSTAINABILITY IN THE TUCSON BASIN: IMPLICATIONS OF A SPATIALLY NEUTRAL GROUNDWATER MANAGEMENT

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Water governance in the Tucson basin

Groundwater Management Act 1980

- Scale: Active Management Areas - groundwater basins
- Goal: Safe yield as sustainability objective for 2025

Natural Recharge + Artificial Recharge ≤ Pumping

Basin wide!

- Strategies
  - Growth control:
    - Limiting agricultural expansion
    - New urban developments: 100 years of Assured Water Supply
  - Efficiency: Conservation programs in municipal, agricultural and industrial sectors
  - New supplies:
    - Central Arizona Project (CAP) and effluent reuse
    - Aquifer recharge and recovery system
- Evaluation systems?

Research objectives

- Understand the water management system at the Tucson basin scale
- Compile and analyze available data on water use and groundwater management, relate them to socioeconomic and environmental variables
- Provide insights on the effectiveness and challenges of the current strategies to achieve safe yield

Research questions

1. How has the water metabolism evolved since the approval of the GMA and the arrival of the CAP to the Tucson Basin?

2. Is water demand decreasing as an effect of conservation programs?

3. How does the spatially neutral approach to groundwater management shape vulnerabilities in the socio-hydrological system?

Methods

Analytical framework: Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism - MuSIASEM

- Multilevel accounting of water use per source (source: water budget 1985-2000)
- Socioeconomic variables: human activity and land use (source: census and USGS national land cover 2000-2010)
- Impacts on ecosystem: groundwater levels, shallow GW areas (source: PAG)

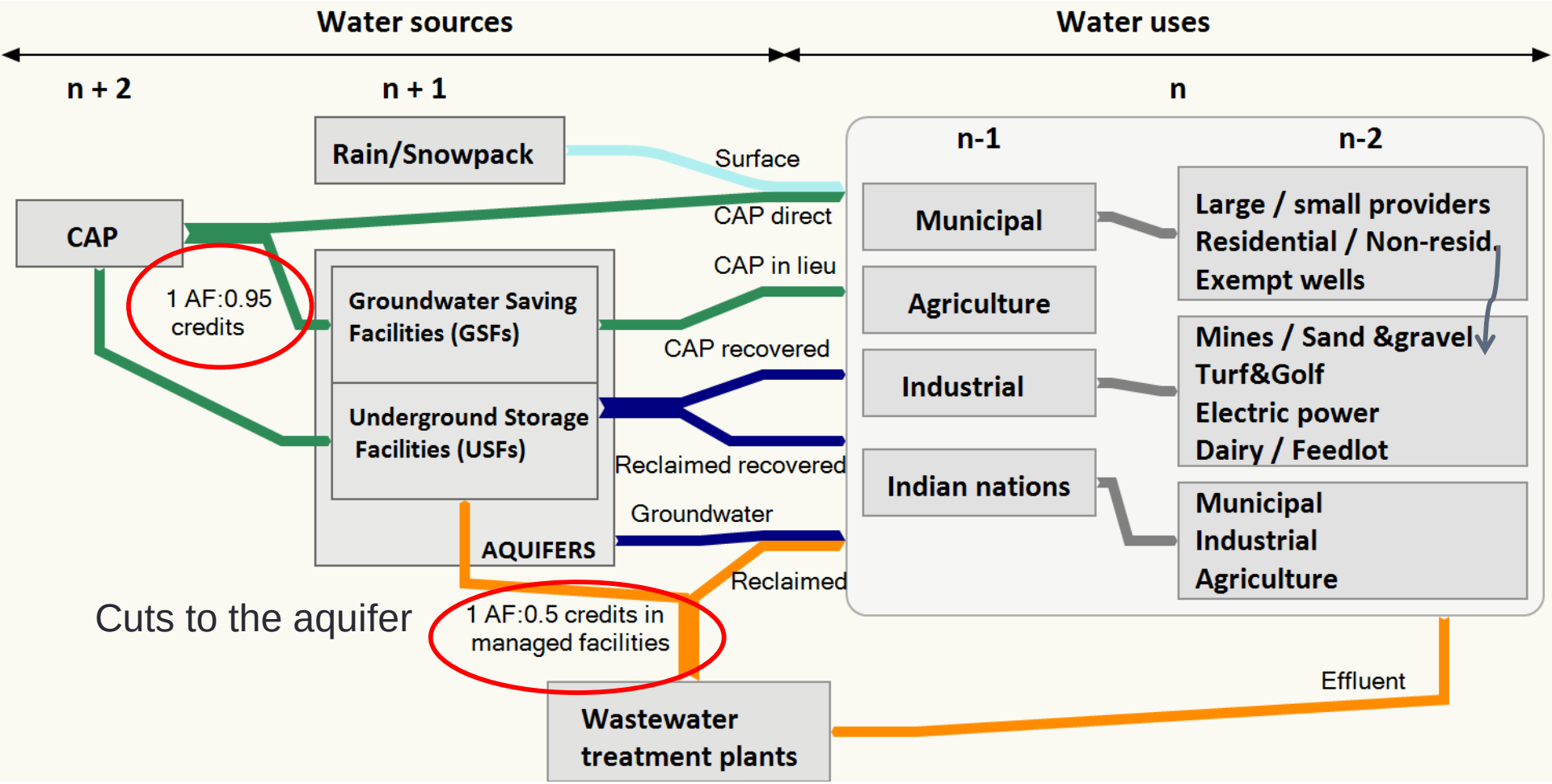
Institutional analysis

- Water planning reports review
- Groundwater management & credits system (source: PAG; AWBA, CAP, AWRD credits accounting)

Collaborative science

- Dialogue with stakeholders: reframing research questions
- Management meetings attendance and diagnosis interviews

Water management & accounting



Key players

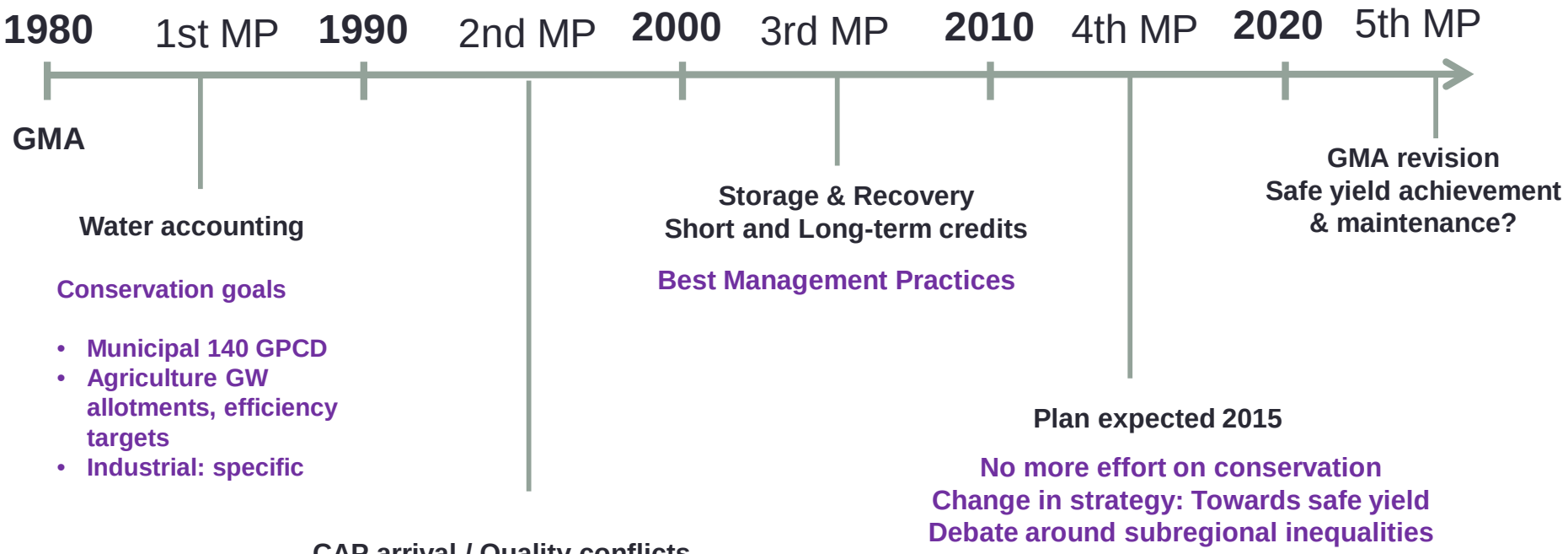
State level

- Arizona Department of Water Resources
- Central Arizona Conservation District (CAP)
- Central Arizona Groundwater Replenishment District
- Arizona Water Banking Authority

Tucson basin level

- Municipal providers. Irrigation Districts. Mining companies
- IPAG: Institutional and Policy Advisory Group
- GUAC: Groundwater Users Association Council
- Safe Yield Task Force

Time line water planning



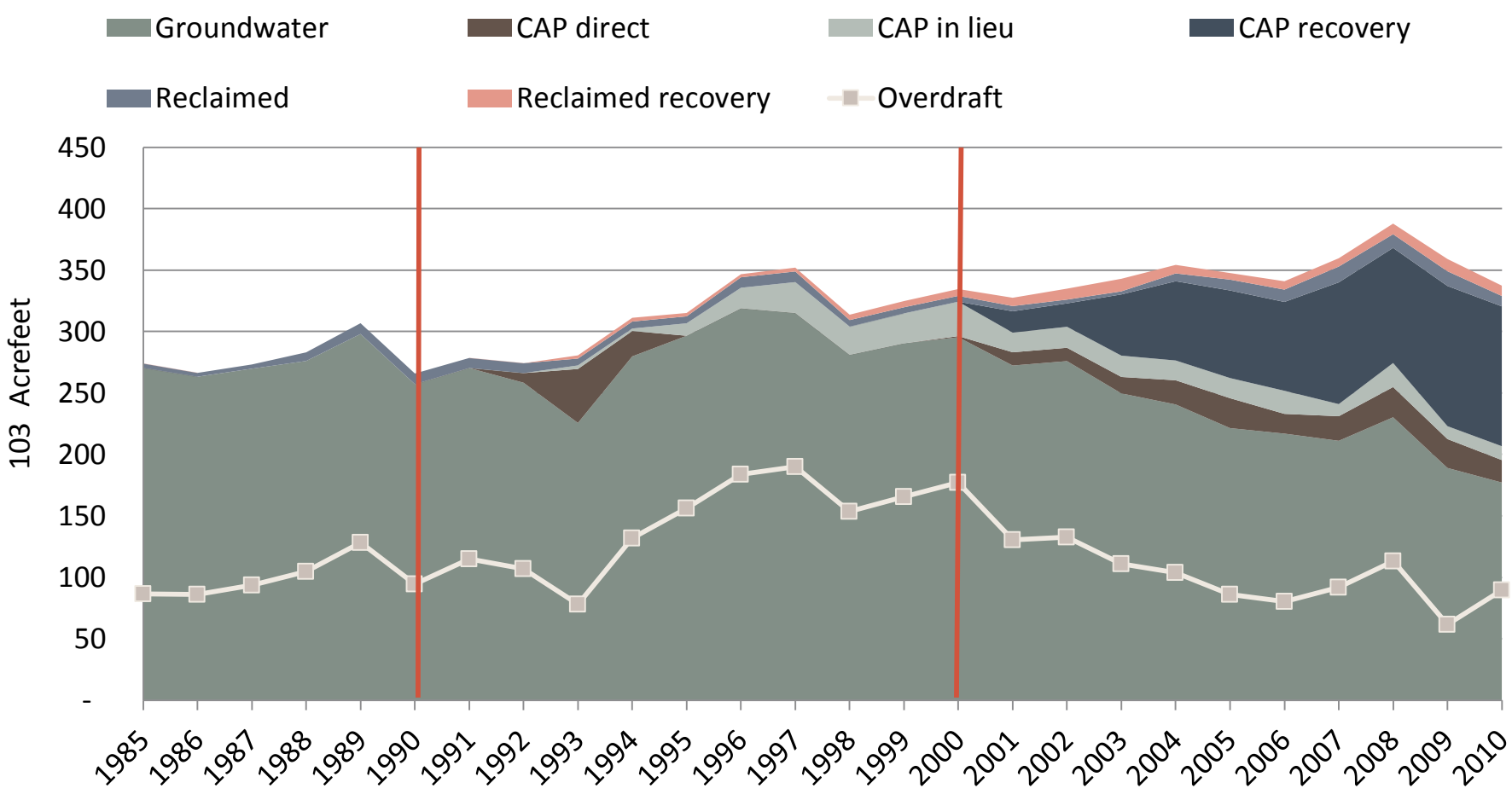
Question 1

How has the water metabolism evolved since the approval of the GMA and the arrival of the CAP to the Tucson Basin***?***

Water uses per source

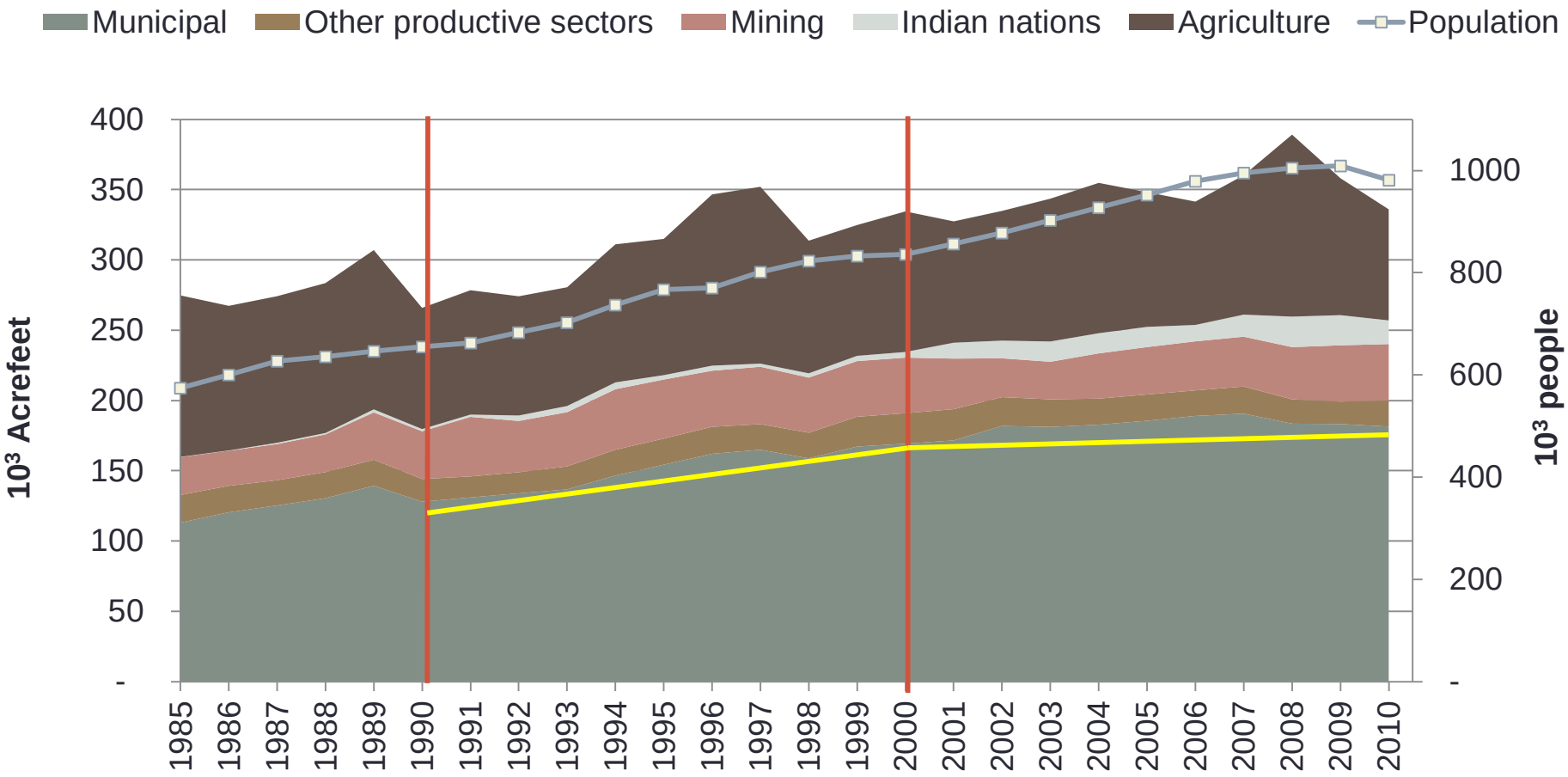
https://violetacabello.quadrigram.com/space/#/vzy/TAMA4

Water sources



Recovery is allowing demand increase & overdraft decrease

Water use sectors



Demand growth pace decreased to 1/3; population increase pace slow down

Agriculture drives variability of overall demand, groundwater use and overdraft

How did water metabolism evolved after GMA and CAP?

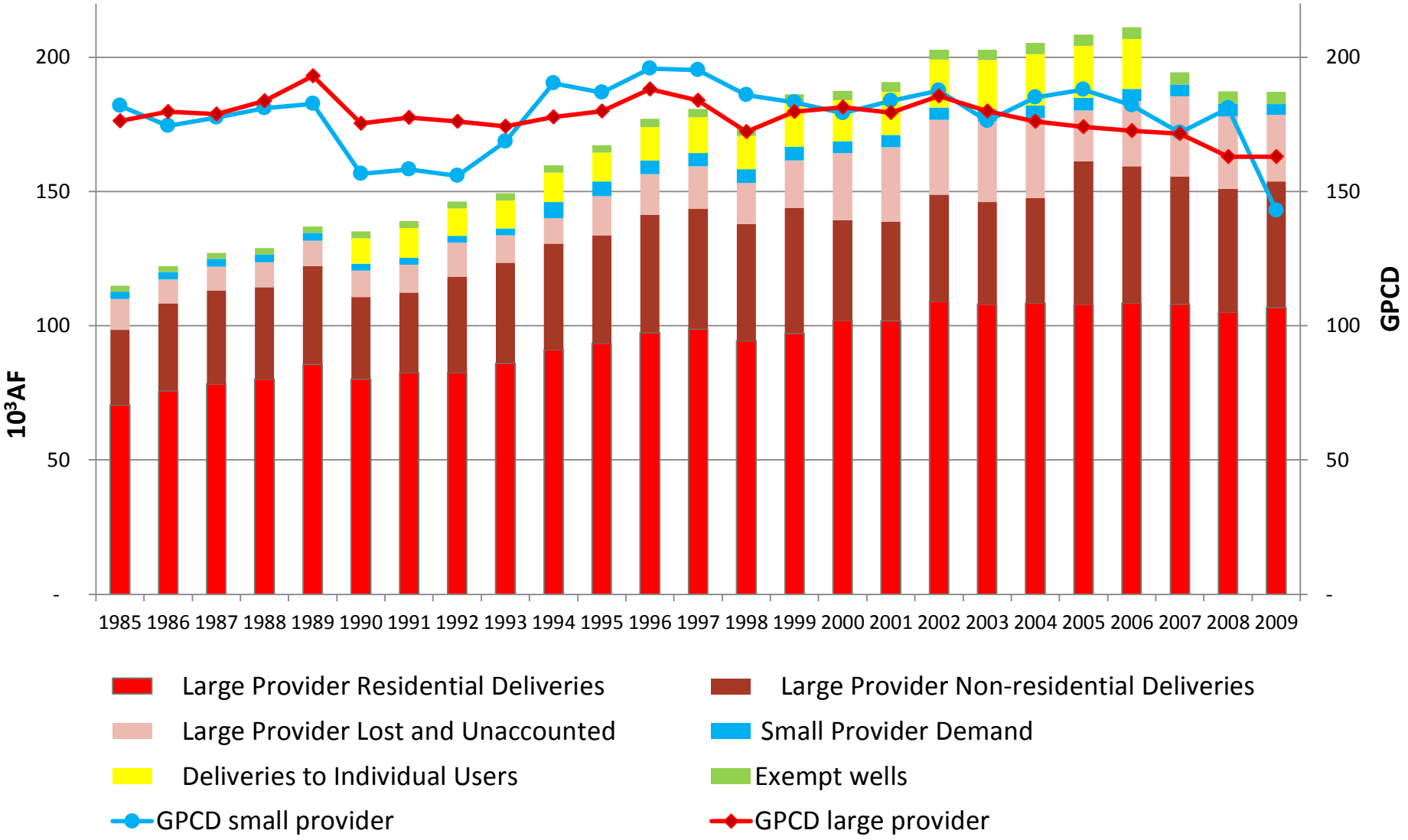
- CAP was a tipping point
  - reconfiguration & diversification of water sources
  - substitution of groundwater enabled by increasing institutional & infrastructural complexity

- Technical achievement of safe yield 2015. Agriculture drives overdraft variability

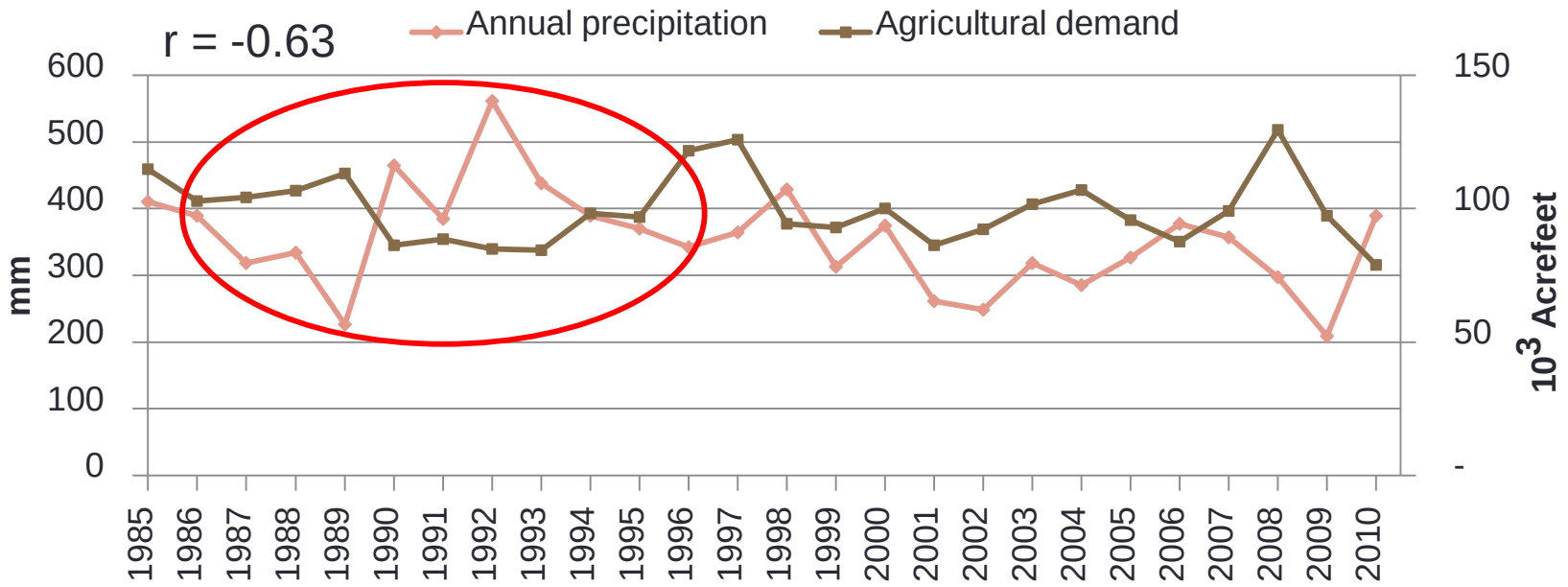
- *More on the paper…* Main increase in water use from the urban domestic and comercial sectors. Mines becoming more efficient-----

Question 2.
Is water demand decreasing as an effect of conservation programs?

Municipal demand break down



Conservation & water demand

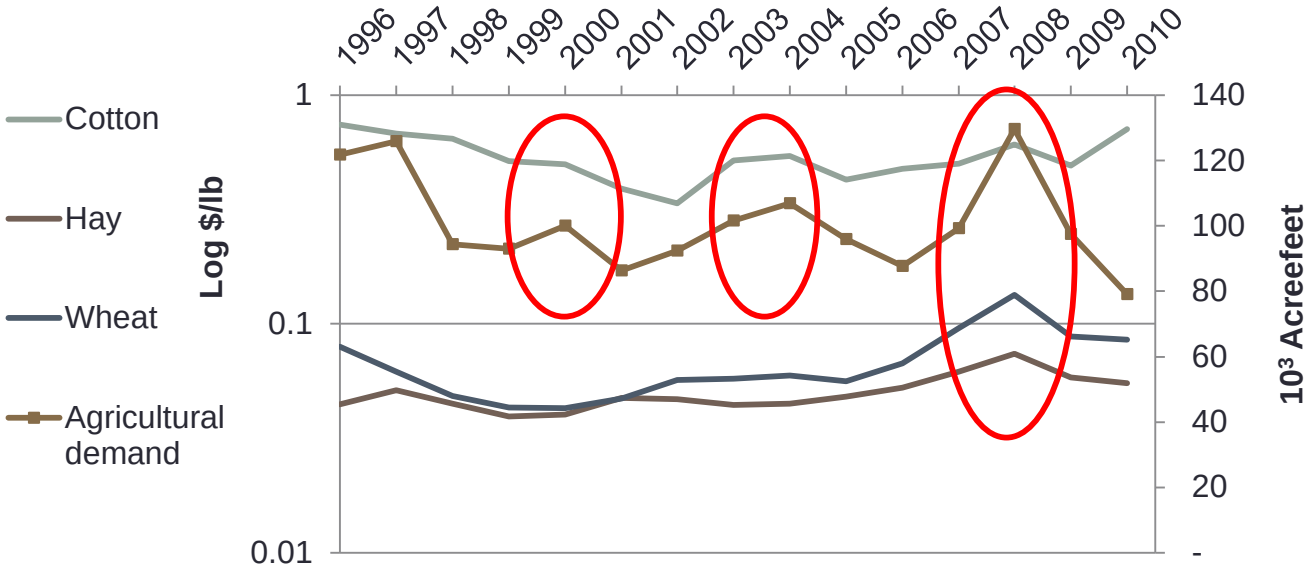


Stable 36,200 irrigable acres (14500 has)

GW allotments ref. 75-79
Conflict efficiency target 85%
Flexibility credits

No data on irrigated acres, techologies & efficiency

Fleck 2014 shows dependency on precipitation & crop prices NOT conservation programs



Is water conservation curbing demand?

- Overall demand in the Tucson basin continues to grow

- Municipal:
  - Large providers are increasing efficiency
  - Growth of residential demand is accomodated through reductions in GPCD
  - Non-residential demand has increased
  - Overall municipal demand slightly decreased in the last 3 years due to change in accounting rules
  - Updated data needed! (last data 2009)

- Agriculture:
  - No significant effect on demand. Great variability affected by rainfall and commodity prices
  - Irrigated land & efficiency data needed!

- Did conservation goals become so flexible as to make them ineffective?

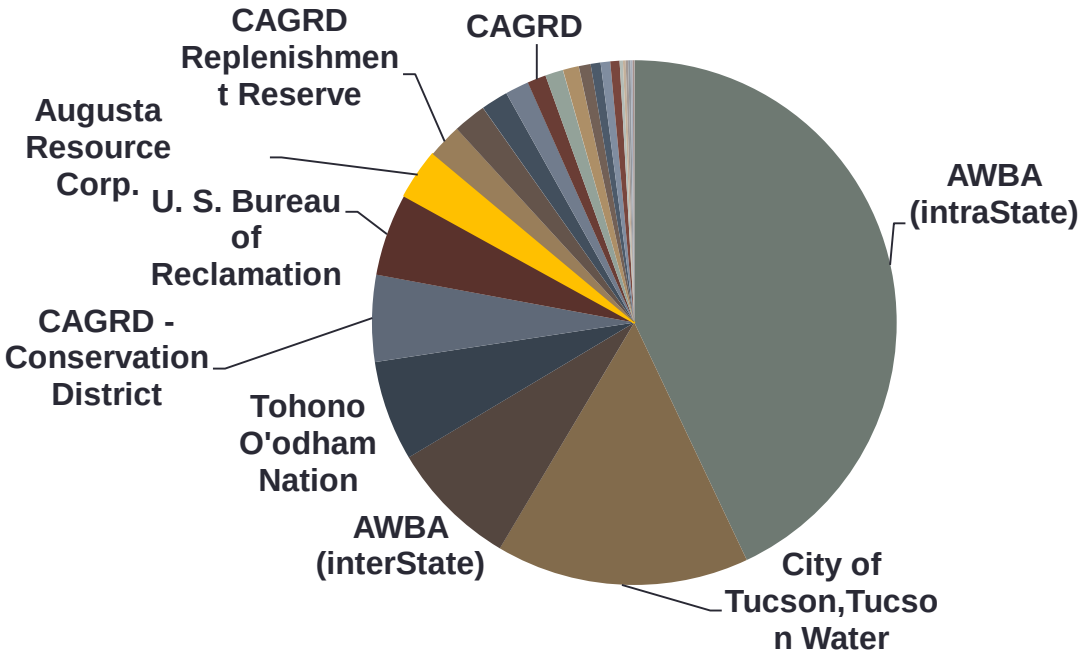
Question 3:
How does the spatially neutral approach to groundwater management shape vulnerabilities in the socio-hydrological system?

Groundwater management system

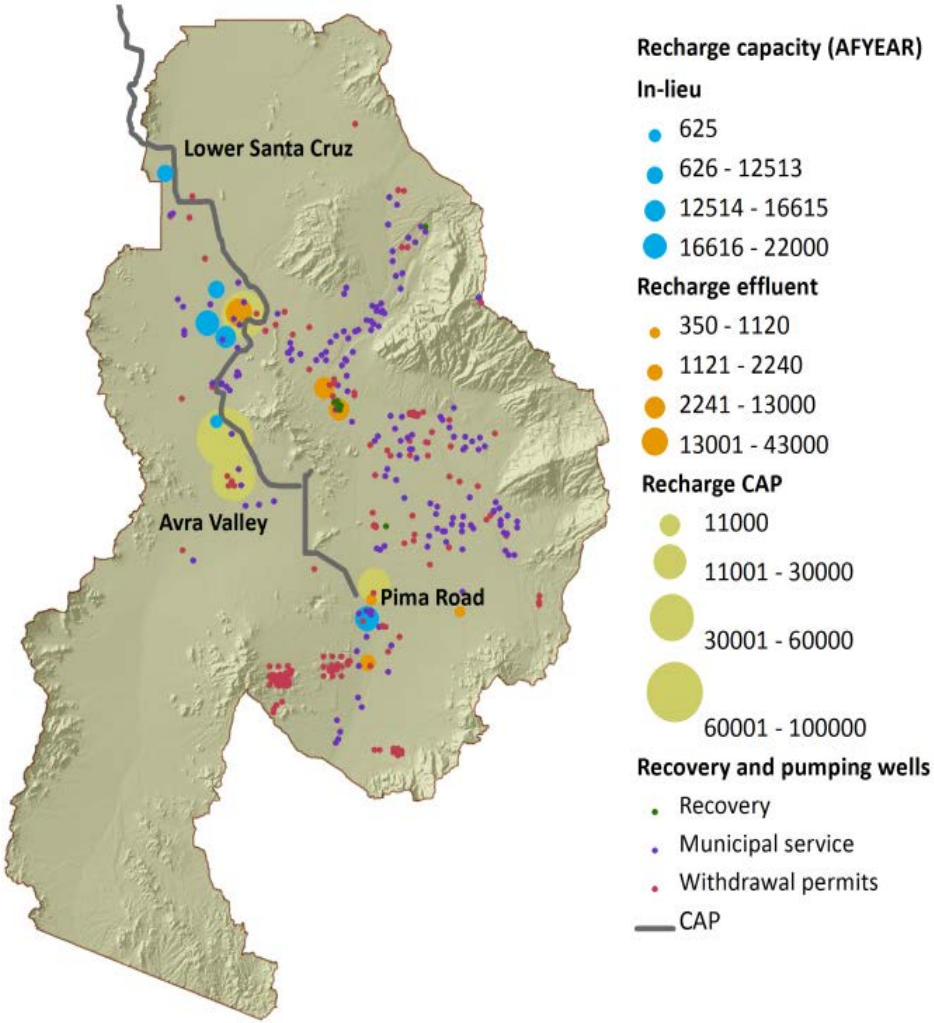
2009	Fund	Natural recharge	81,964
	Flows	CAP inflow	197,289
		Reclamation	50,904
		Artificial recharge	202,201
		Annual recovery	124,118
	Stocks	Long-Term Credits	798,844
		USF-CAP	630,545
		USF-Effluent	89,583
		GSF- CAP in lieu	78,716

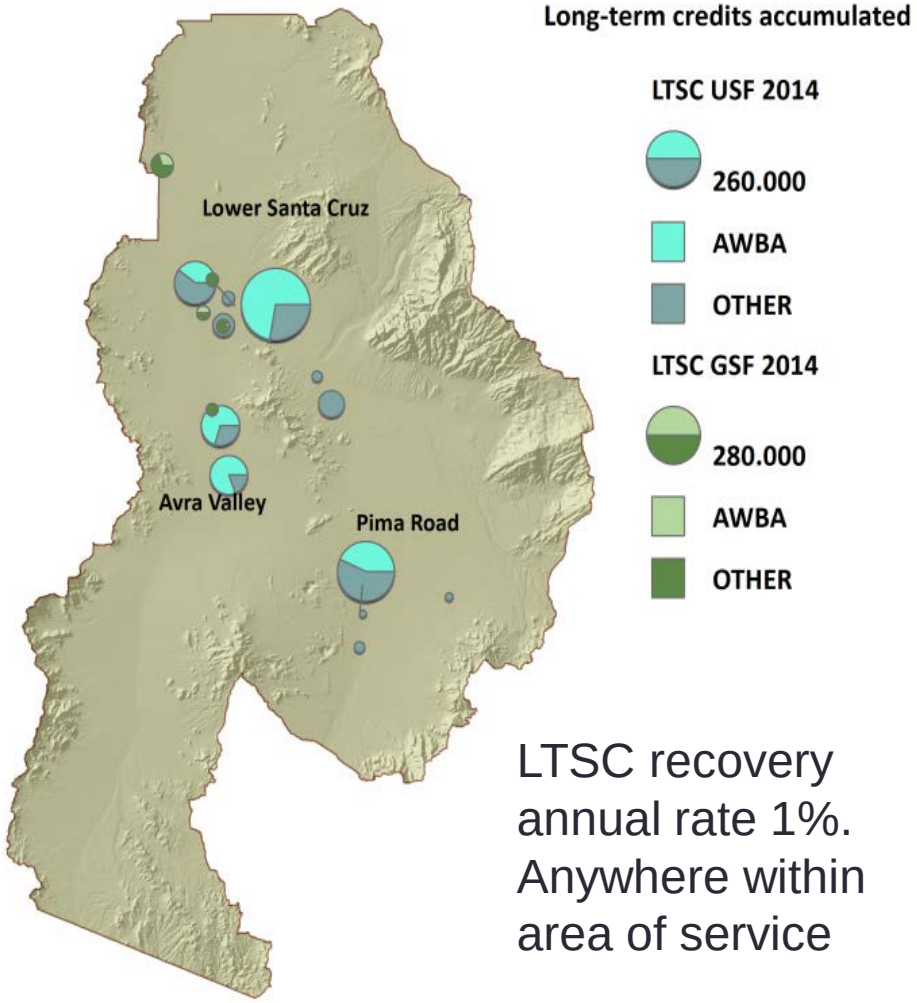
3 times local renewable resources!!

2014 1.4 MAF in Long-Term Storage Credits



Groundwater management system



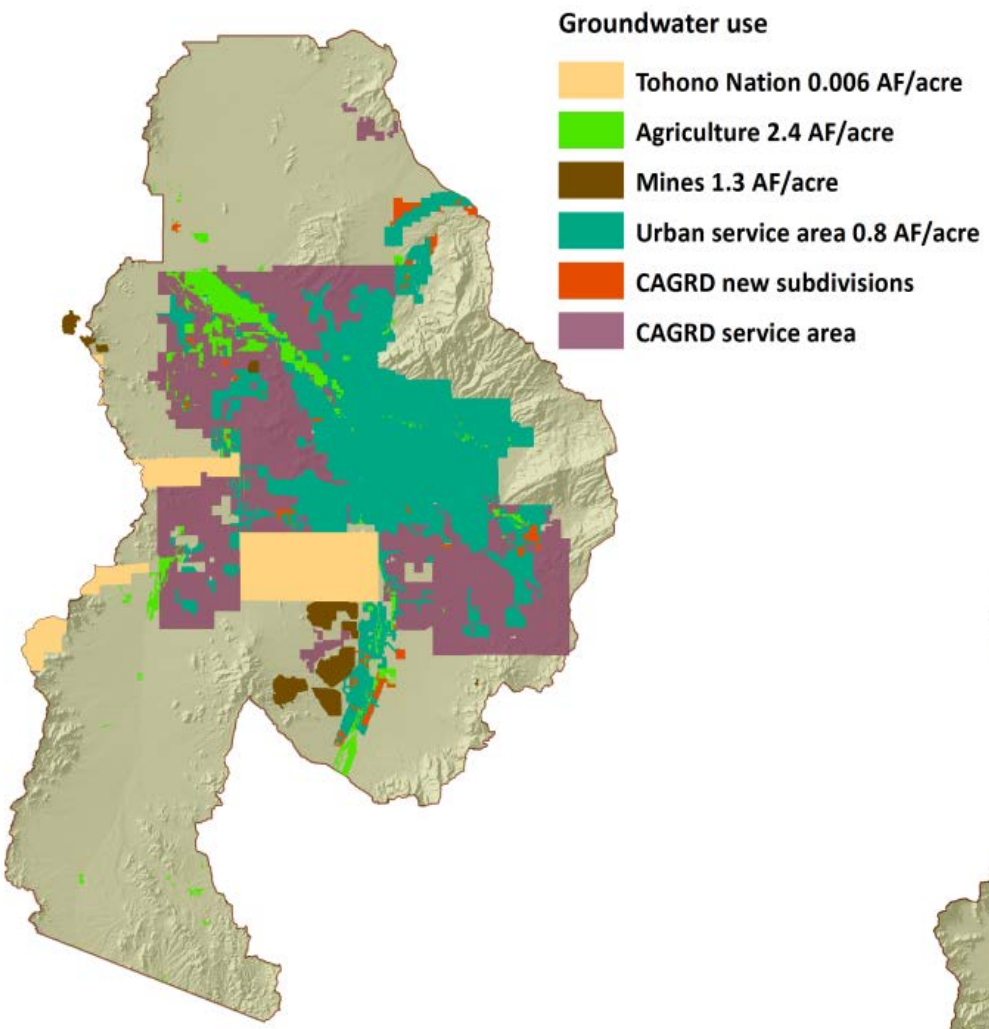


LTSC recovery annual rate 1%. Anywhere within area of service

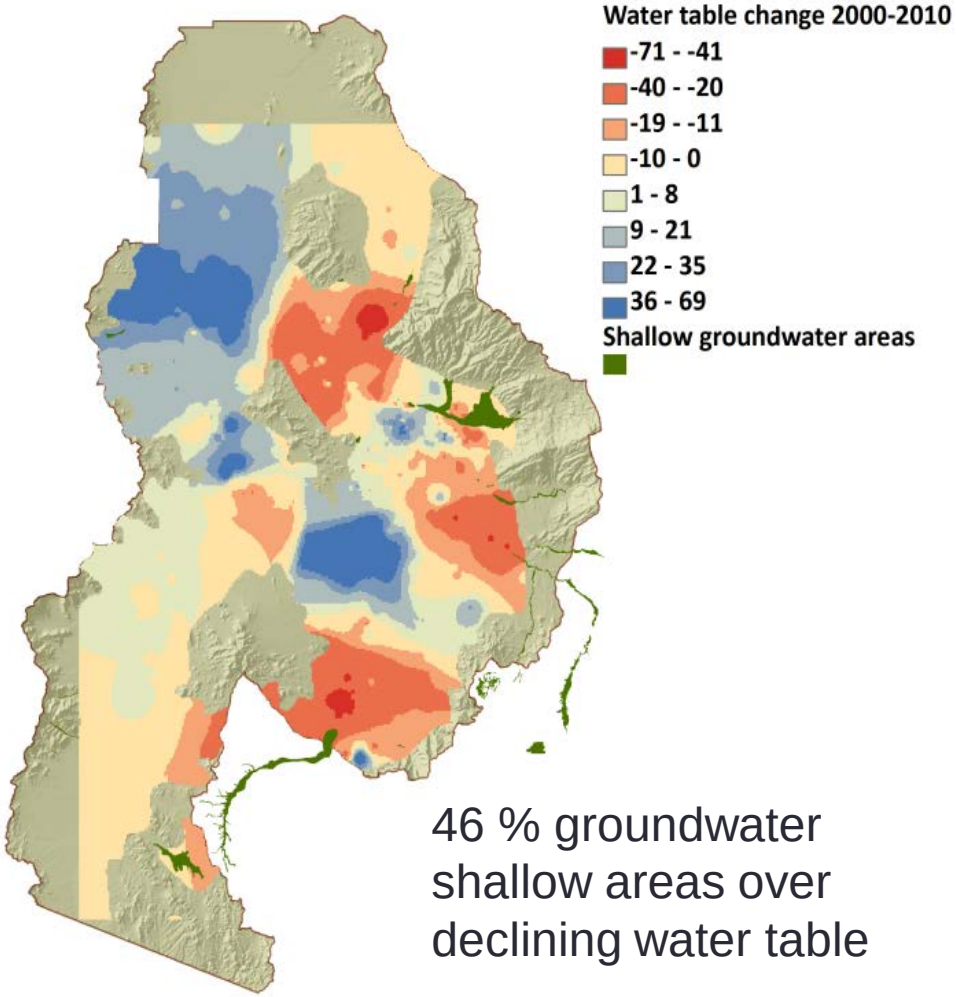
Annual Recovery criteria: 1 mile from recharge or outside if water table decrease < 4ft/year. Not applies to CAGRD members!!

Recovered water tricky: not accounted in overdraft

Groundwater management system



Most aquifer is under 4 ft/year
Everybody is in CAGRD

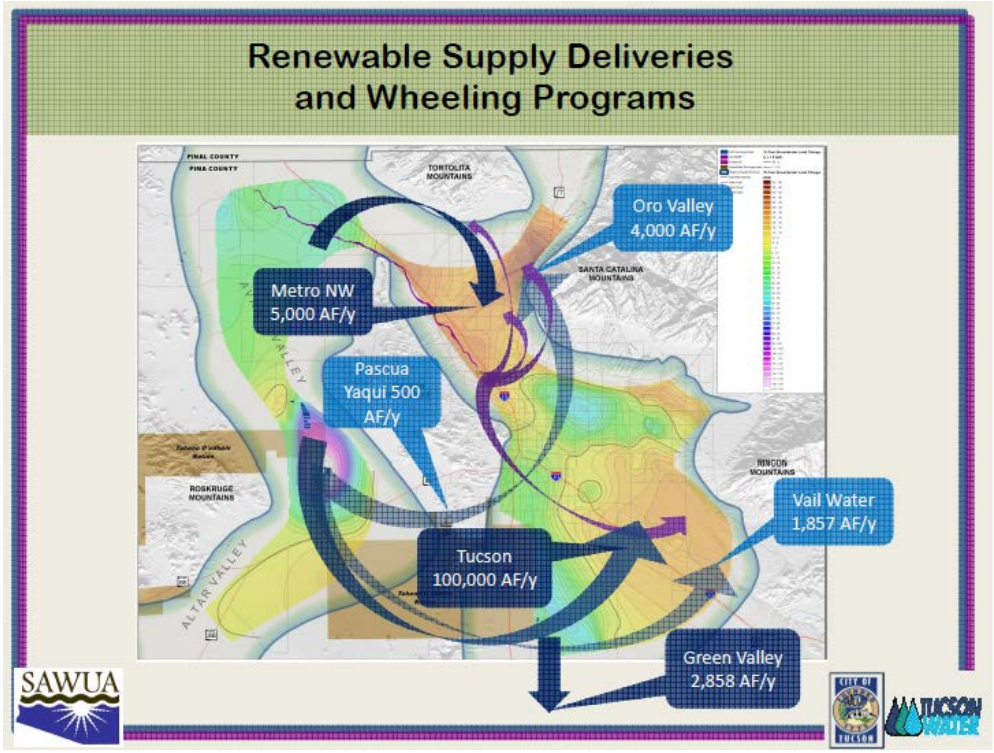


New developments accrue 50% of municipal groundwater pumping (not recovered). 13% is replenished, rest allowed in AWS

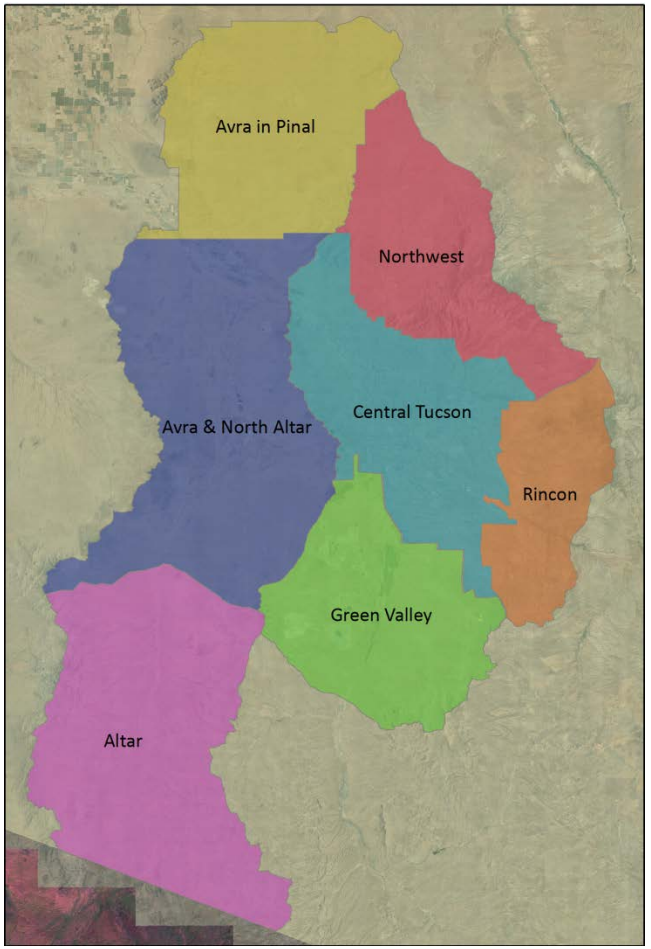
46 % groundwater shallow areas over declining water table

On-going adaptation strategies

ADWR proposal: Enhanced Aquifer Management



Water accounting areas SYTF



Increasing vulnerability to Colorado shortage?

Implications of spatially neutral GW management?

- Disconnection between recharge and pumping →

Uneven achievement of safe yield

- Misleading creative accounting. Renaming withdrawal as recovery leaves it out of the equation. Territorial dissagregated data needed!!

- Unequal priviledged situation of CAGRD members – Effectiveness of AWS as demand growth control mechanism?

- 3 main areas of overlap: developments & mines, water table declines and biodiversity hotspots

Insights on strategies to safe yield

- Growth limitations worked over agriculture but not over municipal. Industrial sector (mines, urban services etc.) have no permit limitations at all

- Conservation programs are enabling growth without mirroring residential demand increment. Not significant effect over other sectors

- Uneven spatial distribution of impacts of the recharge & recovery program on aquifers and dependent systems

- Distributed safe yield assessment needs dissagregated data


Thank you!!!!!