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

Violeta Cabello, Nuria Hernández-Mora, Aleix Serrat-Capdevila, Leandro del Moral and Ed Curley
Water governance in the Tucson basin

Groundwater Management Act 1980

• Scale: Active Management Areas - groundwater basins

• Goal: Safe yield as sustainability objective for 2025

\[ \text{Natural Recharge} + \text{Artificial Recharge} \leq \text{Pumping} \]

• 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?

Basin wide!
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

- 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

Water management system

Water sources:
- Rain/Snowpack
- Groundwater Saving Facilities (GSFs)
- Underground Storage Facilities (USFs)
- AQUIFERS
- Wastewater treatment plants

Water uses:
- Municipal
- Agriculture
- Industrial
- Indian nations

Cuts to the aquifer:
- 1 AF: 0.95 credits
- 1 AF: 0.5 credits in managed facilities

Effluent
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
Water management system

Time line water planning


GMA

Water accounting

Conservation goals

- Municipal 140 GPCD
- Agriculture GW allotments, efficiency targets
- Industrial: specific

Storage & Recovery
Short and Long-term credits

Best Management Practices

Plan expected 2015

No more effort on conservation
Change in strategy: Towards safe yield
Debate around subregional inequalities

CAP arrival / Quality conflicts
Institutional reconfiguration for CAP firming
In lieu program / Regional Recharge Plan

Conservation programs flexibilized

GMA revision
Safe yield achievement & maintenance?
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
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 commercial sectors. Mines becoming more efficient
Question 2.
Is water demand decreasing as an effect of conservation programs?
Stable 36,200 irrigable acres (14500 has)

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

No data on irrigated acres, technologies & 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 accommodated 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

<table>
<thead>
<tr>
<th>2009 Flows</th>
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<tbody>
<tr>
<td>Natural recharge</td>
<td>81,964</td>
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<tr>
<td>CAP inflow</td>
<td>197,289</td>
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<tr>
<td>Reclamation</td>
<td>50,904</td>
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<tr>
<td>Artificial recharge</td>
<td>202,201</td>
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<tr>
<td>Annual recovery</td>
<td>124,118</td>
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<tr>
<td>Long-Term Credits</td>
<td>798,844</td>
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<tr>
<td>USF-CAP</td>
<td>630,545</td>
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<tr>
<td>USF-Effluent</td>
<td>89,583</td>
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<tr>
<td>GSF-CAP in lieu</td>
<td>78,716</td>
</tr>
</tbody>
</table>

3 times local renewable resources!!

2014 1.4 MAF in Long-Term Storage Credits
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

Groundwater use
- Tohono Nation 0.006 AF/acre
- Agriculture 2.4 AF/acre
- Mines 1.3 AF/acre
- Urban service area 0.8 AF/acre
- CAGRD new subdivisions
- CAGRD service area

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 disaggregated data needed!!

• Unequal privileged 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 disaggregated data
Thank you!!!!!