Integrated Water Resource Management- An Ecological Perspective to Stakeholder Engagement

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The Nature Conservancy

Ecological Perspective to IWRM

Definition of Integrated Water Resource Management:

A comprehensive approach that encompasses all aspects of water supply, demand, and use in a watershed, including the natural system.

IWRM: Realistic goal?

- Many definitions & approaches
- Complex topic (multiple jurisdictions, water uses, laws, policies)
- Needs larger context (energy, economics, social values, quality of life)
- Water allocation in time of increasingly scarce resource (drought, climate change, growth)
- Environment often left out of the equation
- Social & political issue (who ultimately decides?)
- Key decisions impact quality of life- crucial to involve stakeholders meaningfully (trade-offs)

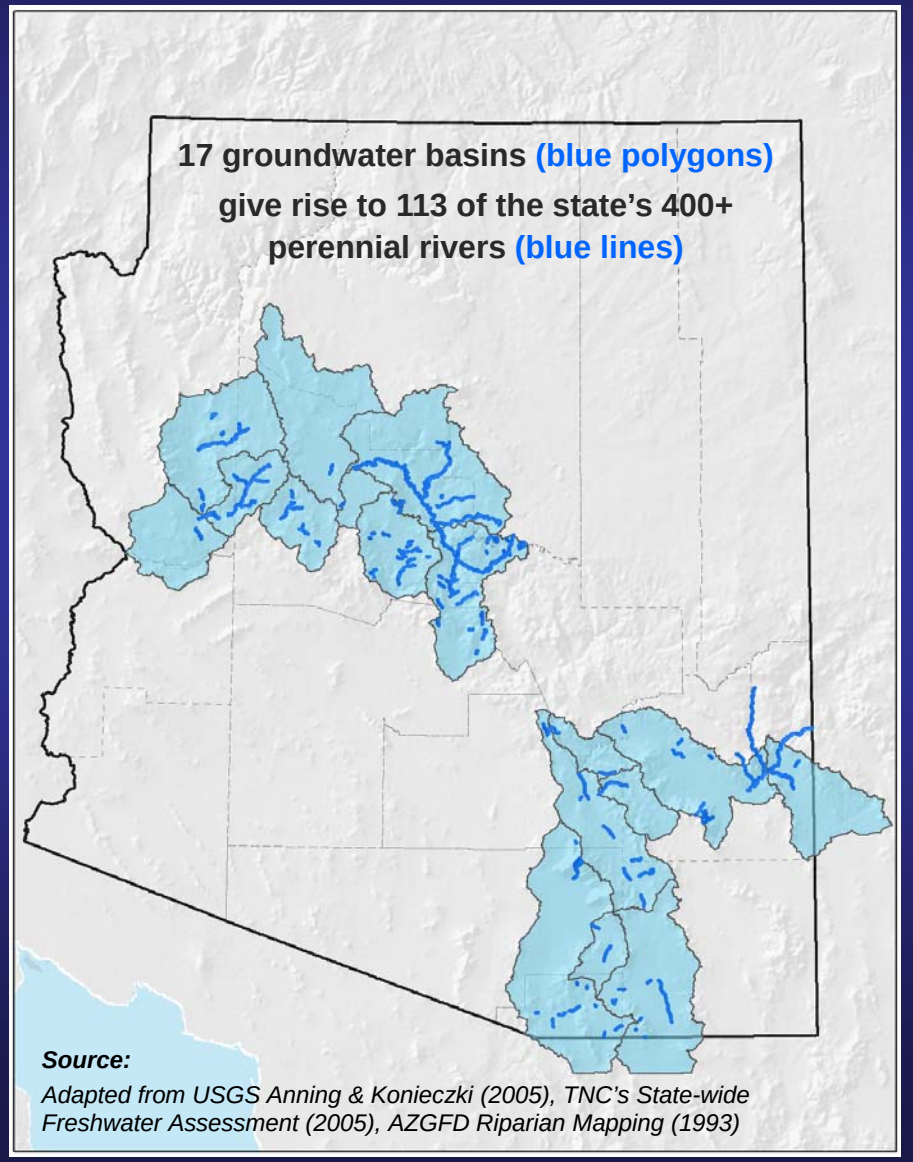
Key to stakeholder engagement in ecologically-sensitive water resource planning

- Seek balance between human & ecosystem needs; aim for sustainability
- Use best science & decision tools to make informed decisions supported by stakeholders
- Transparency & empowerment- communicate honestly the implications to community & environment of different alternatives

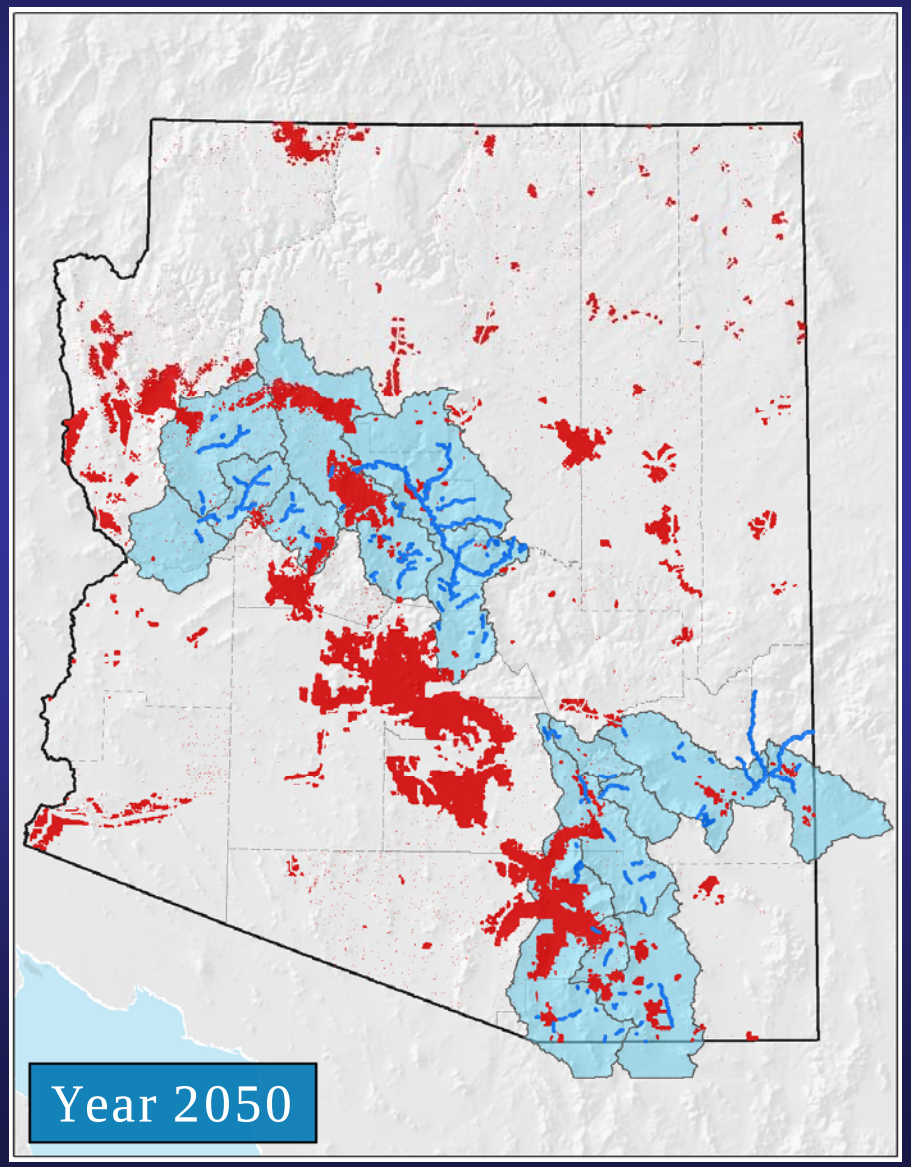
Groundwater-Dependent Rivers

State's major alluvial aquifers that give rise to our rivers

- ✓ 1,000 miles groundwater-dependent rivers & streams
- ✓ 32% of our perennial waters



Future Growth & Water

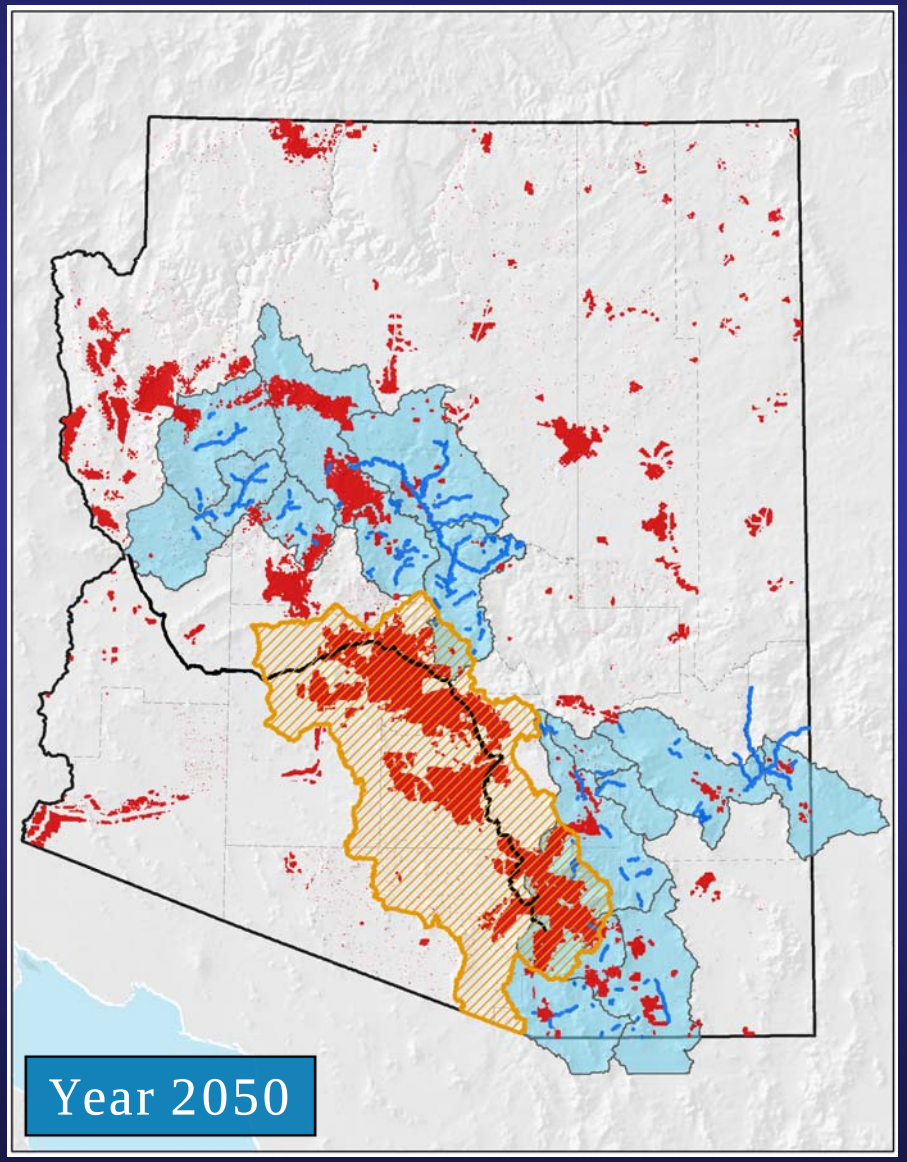


30% of projected growth footprint to occur within groundwater basins vulnerable to pumping

Groundwater basins

Projected growth footprint 2050

Future Growth & Water



distribution of renewable supplies of water versus reliance on groundwater

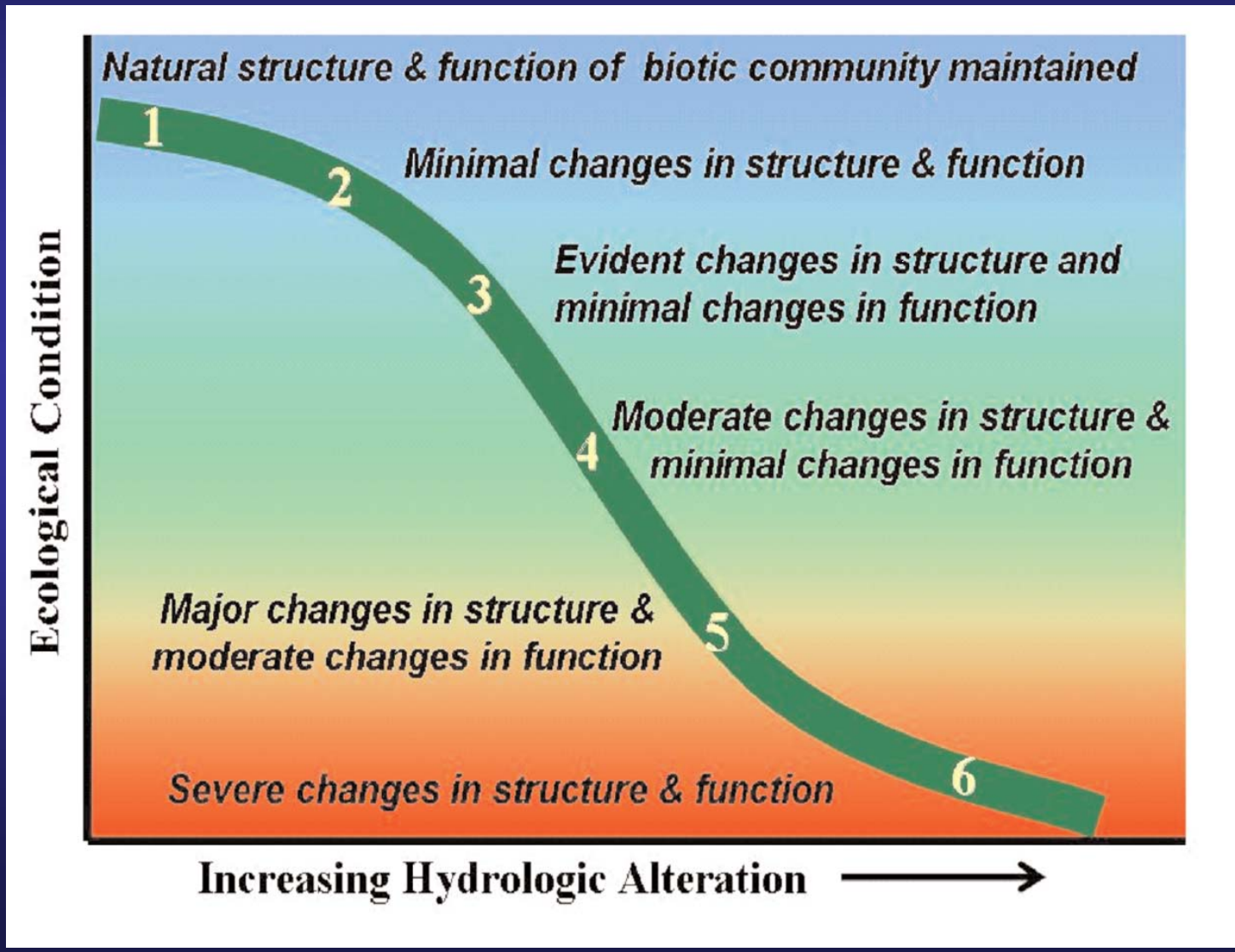
Groundwater basins

Projected growth footprint 2050

Approximate distribution of renewable supplies

Environmental Flows

Flow alteration leads to loss of ecosystem services



INFORMED DECISION-MAKING: PUMPING

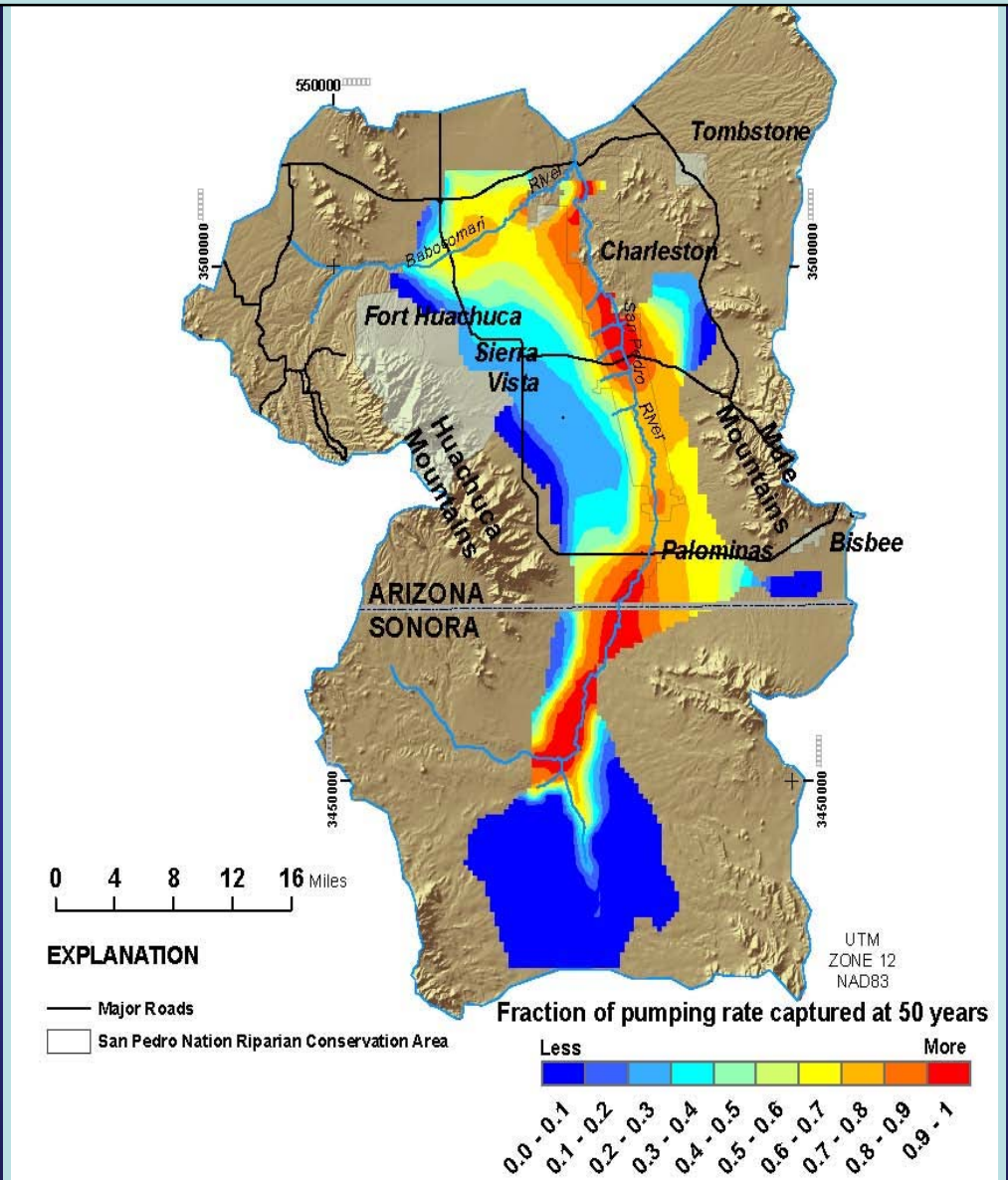


Figure 4b. Computed capture of streamflow, riparian evapotranspiration, and springflow that would result for withdrawal of water from model layer 4 at a constant rate for 50 years. The color at any location represents the fraction of the withdrawal rate by a well at that location that can be accounted for as changes in outflow from and or inflow to the aquifer for model boundaries representing streams, riparian vegetation, and springs.

Courtesy USGS

INFORMED DECISION-MAKING: RECHARGE

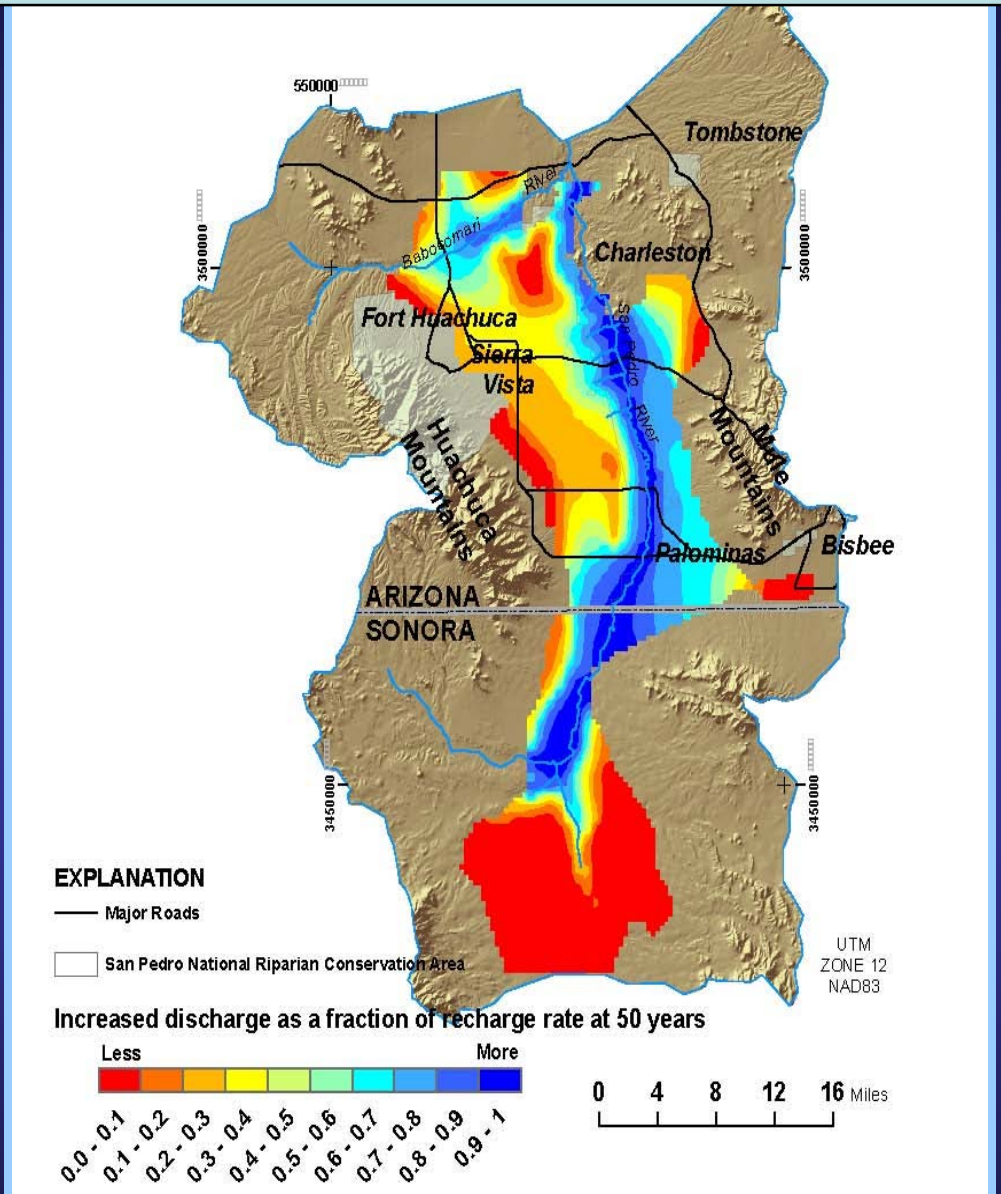
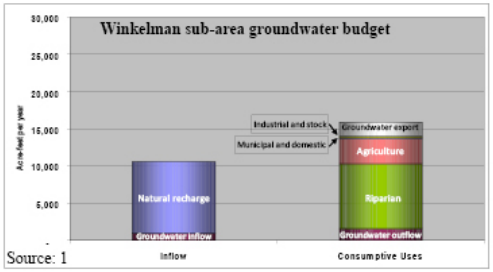
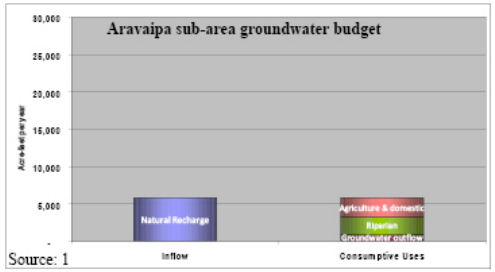


Figure 5b. Computed increase of streamflow, riparian evapotranspiration, and springflow that would result for recharge of water to the uppermost model layer at a constant rate for 50 years. The color at any location represents the fraction of the recharge rate at that location that can be accounted for as changes in outflow to model boundaries representing streams, riparian vegetation, and springs.

Courtesy USGS



Source: 1



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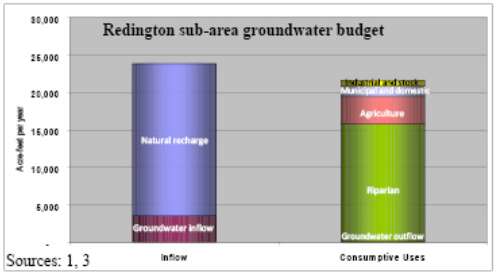
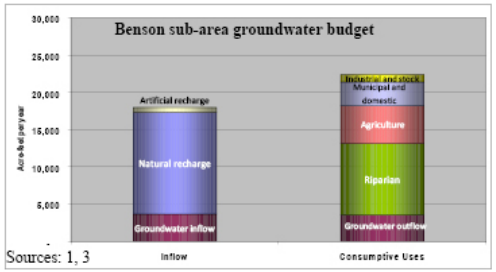


Sources: 1, 3



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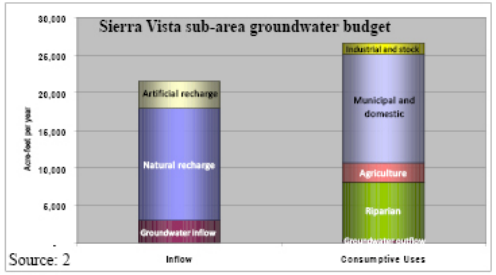
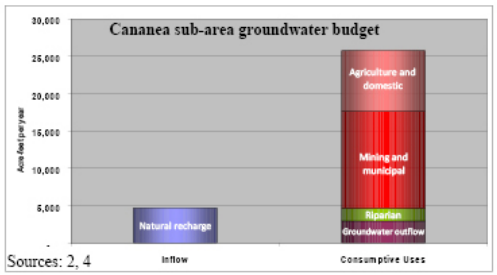


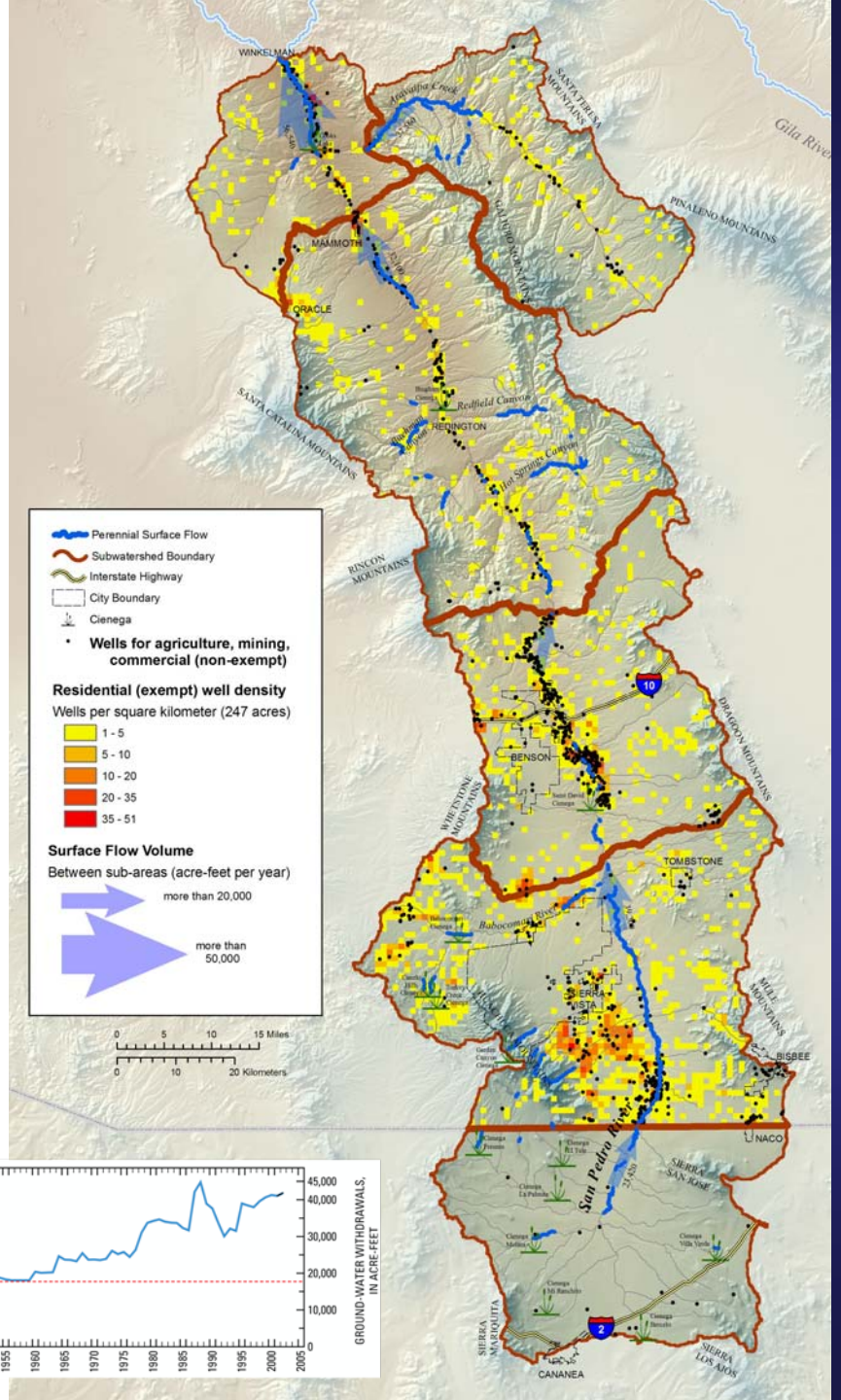
Source: 2

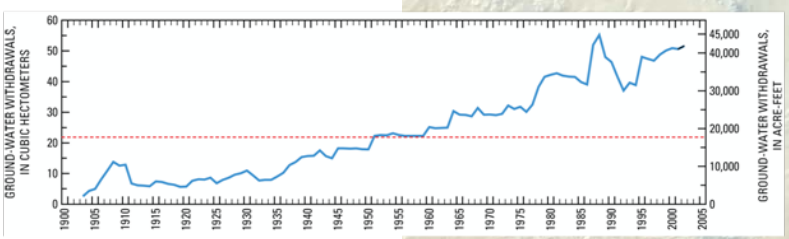


Sources: 2, 4

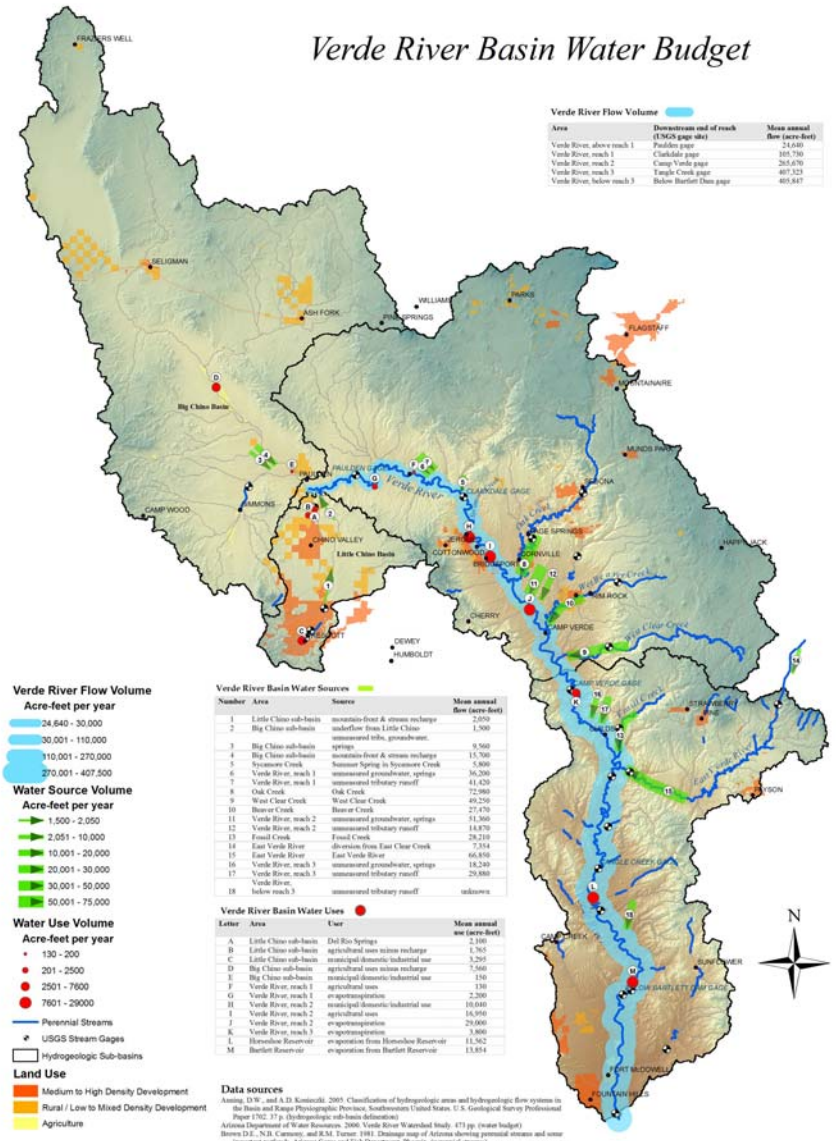
San Pedro River Basin Water Budget

Data sources
1) Arizona Department of Water Resources. 1991. Hydrographic survey report for the San Pedro River watershed, Volume 1.
2) Arizona Department of Water Resources. 2005. Upper San Pedro Basin Active Management Area review report.
3) Haney, J., and J. Lombard. 2005. Southwest Hydrology 4:8-9.
4) Pool, D.R., and J.E. Dickinson. 2007. U.S. Geological Survey Scientific Investigations Report 2006-5228.





Verde River Basin Water Budget



Verde River Flow Volume

Area	Downstream end of reach (USGS gage site)	Mean annual flow (acre-feet)
Verde River, above reach 1	Paulden gage	24,640
Verde River, reach 1	Clarkdale gage	105,730
Verde River, reach 2	Camp Verde gage	265,670
Verde River, reach 3	Tangle Creek gage	407,323
Verde River, below reach 3	Below Bartlett Dam gage	405,847

Verde River Flow Volume
Acre-feet per year
- 24,640 - 30,000
- 30,001 - 110,000
- 110,001 - 270,000
- 270,001 - 407,500

Water Source Volume
Acre-feet per year
- 1,500 - 2,050
- 2,051 - 10,000
- 10,001 - 20,000
- 20,001 - 30,000
- 30,001 - 50,000
- 50,001 - 75,000

Water Use Volume
Acre-feet per year
- 130 - 200
- 201 - 2500
- 2501 - 7600
- 7601 - 29000

- Perennial Streams
- USGS Stream Gages
- Hydrogeologic Sub-basins

Land Use
- Medium to High Density Development
- Rural / Low to Mixed Density Development
- Agriculture

Verde River Basin Water Sources

Number	Area	Source	Mean annual flow (acre-feet)
1	Little Chino sub-basin	mountain-front & stream recharge	2,050
2	Big Chino sub-basin	underflow from Little Chino	1,500
		unmeasured tribs, groundwater,	
3	Big Chino sub-basin	springs	9,560
4	Big Chino sub-basin	mountain-front & stream recharge	15,700
5	Sycamore Creek	Summer Spring in Sycamore Creek	5,800
6	Verde River, reach 1	unmeasured groundwater, springs	36,200
7	Verde River, reach 1	unmeasured tributary runoff	41,420
8	Oak Creek	Oak Creek	72,980
9	West Clear Creek	West Clear Creek	49,250
10	Beaver Creek	Beaver Creek	27,470
11	Verde River, reach 2	unmeasured groundwater, springs	51,360
12	Verde River, reach 2	unmeasured tributary runoff	14,870
13	Fossil Creek	Fossil Creek	28,210
14	East Verde River	diversion from East Clear Creek	7,354
15	East Verde River	East Verde River	66,850
16	Verde River, reach 3	unmeasured groundwater, springs	18,240
17	Verde River, reach 3	unmeasured tributary runoff	29,880
18	Verde River, below reach 3	unmeasured tributary runoff	unknown

Verde River Basin Water Uses

Letter	Area	User	Mean annual use (acre-feet)
A	Little Chino sub-basin	Del Rio Springs	2,100
B	Little Chino sub-basin	agricultural uses minus recharge	1,765
C	Little Chino sub-basin	municipal/domestic/industrial use	3,295
D	Big Chino sub-basin	agricultural uses minus recharge	7,560
E	Big Chino sub-basin	municipal/domestic/industrial use	150
F	Verde River, reach 1	agricultural uses	130
G	Verde River, reach 1	evapotranspiration	2,200
H	Verde River, reach 2	municipal/domestic/industrial use	10,040
I	Verde River, reach 2	agricultural uses	16,950
J	Verde River, reach 2	evapotranspiration	29,000
K	Verde River, reach 3	evapotranspiration	3,800
L	Horseshoe Reservoir	evaporation from Horseshoe Reservoir	11,562
M	Bartlett Reservoir	evaporation from Bartlett Reservoir	13,854

Data sources

Anning, D.W., and A.D. Konieczki. 2005. Classification of hydrogeologic areas and hydrogeologic flow systems in the Basin and Range Physiographic Province, Southwestern United States. U.S. Geological Survey Professional Paper 1702. 37 p. (hydrogeologic sub-basin delineation)

Arizona Department of Water Resources. 2000. Verde River Watershed Study. 473 pp. (water budget)

Brown D.E., N.B. Carmony, and R.M. Turner. 1981. Drainage map of Arizona showing perennial streams and some important wetlands. Arizona Game and Fish Department, Phoenix. (perennial streams)

Bureau of Land Management. Undated. GIS data on housing density based on aerial photography. (land use mapping)

Flora, S.P. 2004. Hydrogeological characterization and discharge variability of springs in the middle Verde River watershed, central Arizona. M.S. thesis, Northern Arizona University. (water budget)

U.S. Environmental Protection Agency, National Assessment Database
http://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=C2&p_list_type=SUMMARY&p_cycle=2006&p_state=AZ (size of lakes)

U.S. Geological Survey, National Water Information System: Web Interface
http://waterdata.usgs.gov/AZ/nwis/current/?type=flow (annual stream flow volume)

University of Arizona, Geotechnical, Rock & Water (GROW) Digital Library http://www.grow.arizona.edu/Grow~GrowResources.php?ResourceId=208 (evaporation rate from lakes)

USGS National Gap Analysis Program. 2004. Provisional Digital Land Cover Map for the Southwestern United States. Version 1.0. RS/GIS Laboratory, College of Natural Resources, Utah State University. (land use mapping)

0 5 10 20 30 40 Miles

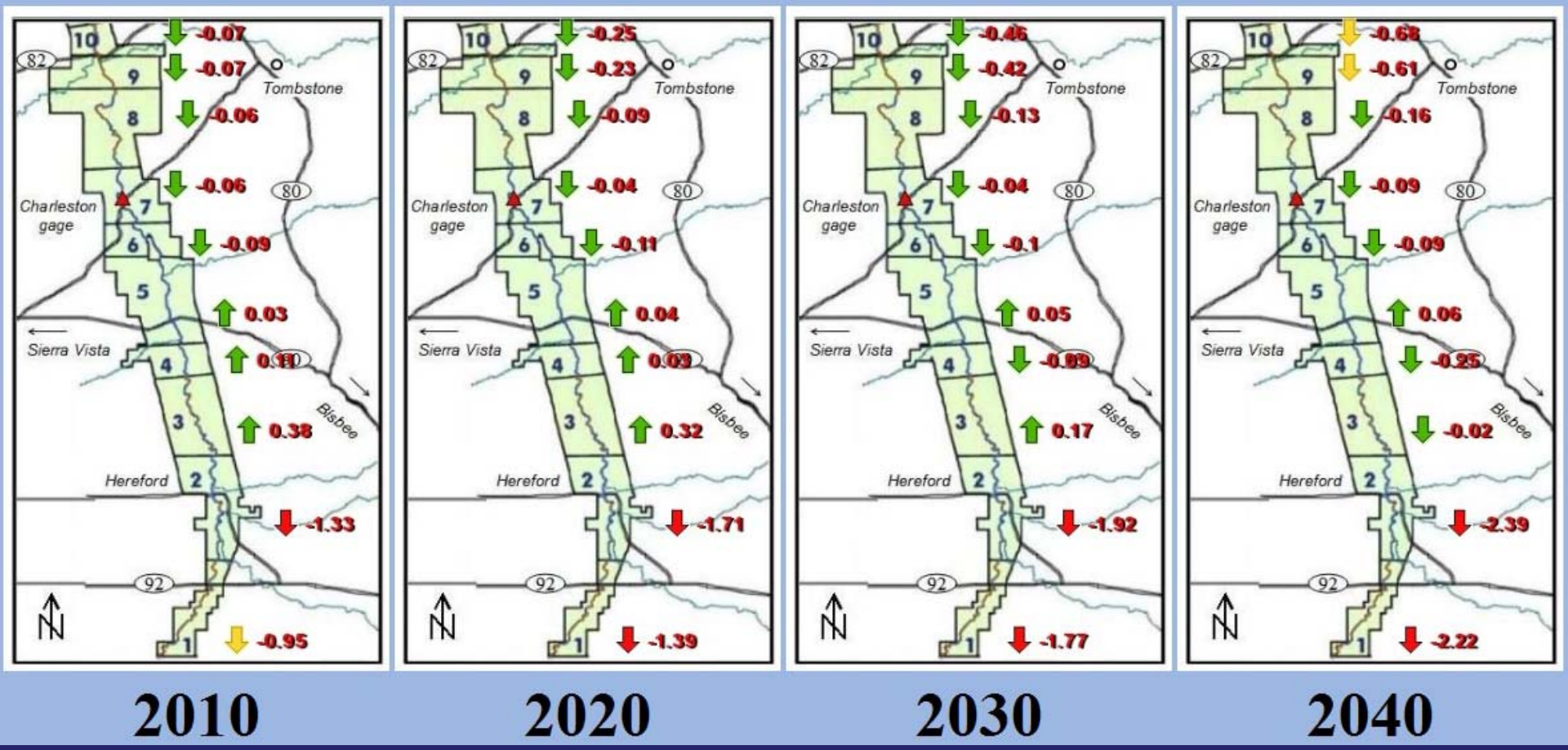
November 2006
Map prepared by Dale Turner
The Nature Conservancy in Arizona
Available at www.azconservation.org

Water source and use symbols are diagrammatic for subbasin or river reach and do not indicate specific locations of discharge and use.

Decision Support System (SAHRA)

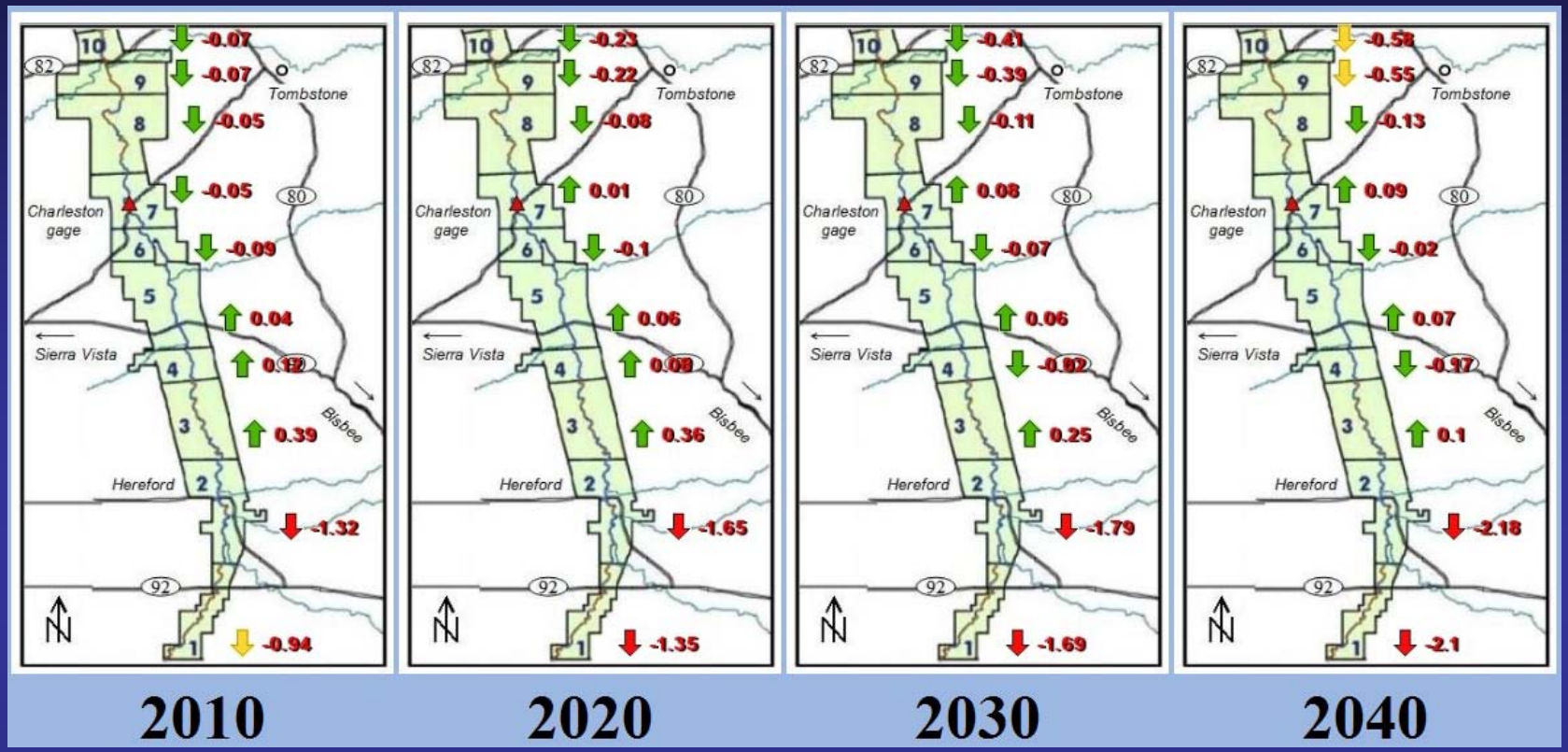
- **Model's Purpose:** To provide decision makers with the technical information needed to assist in selecting a set of water management & conservation measures for long term sustainability of the Upper San Pedro River system.

Decision Support System (SAHRA model)
Base Run (current condition through year 2048)



Groundwater level change relative to year 2003 (unit: ft)
Results computed using expected population growth rates

Code Requirements Package (starting in year 2008)

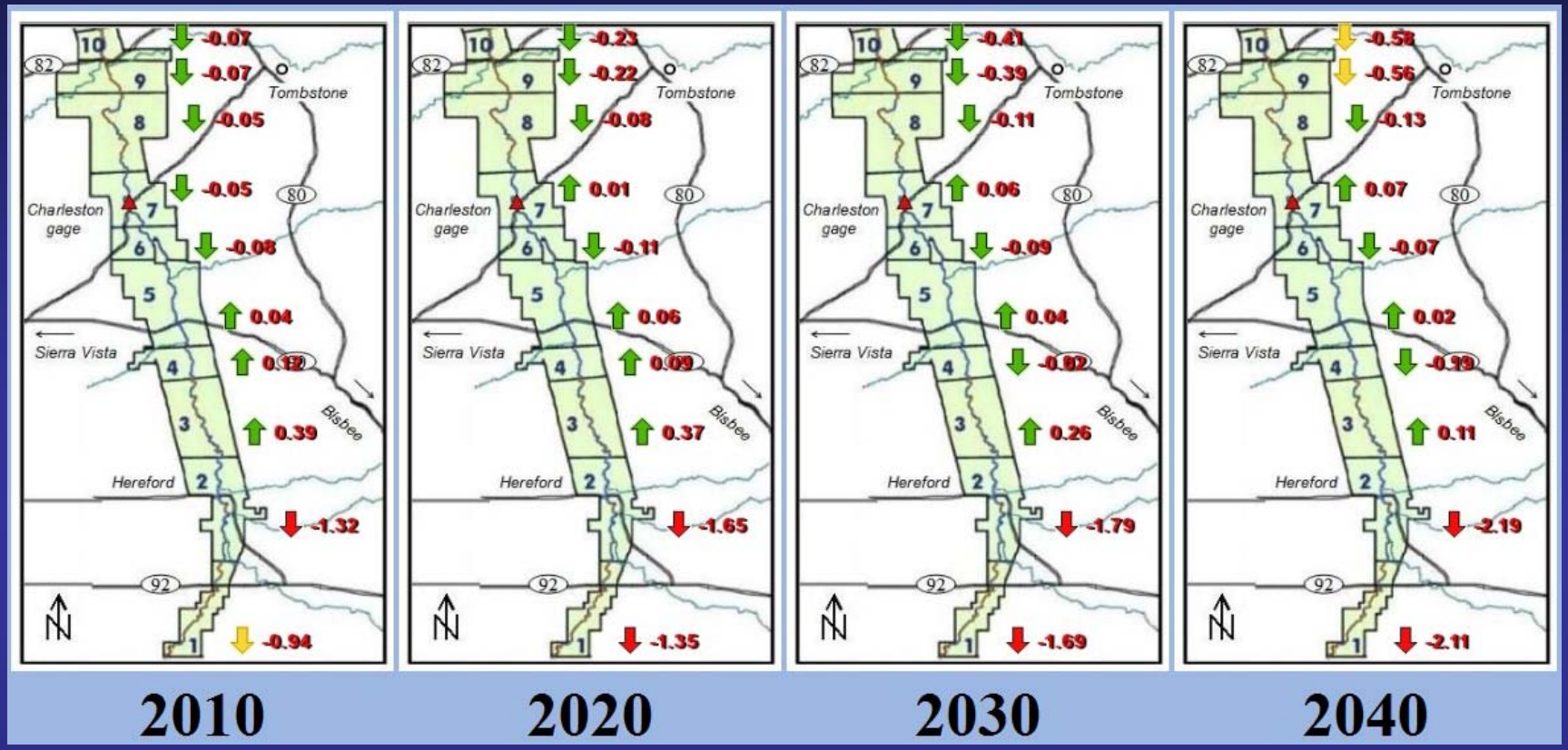


Water wasting ordinance, New development offsets, Gray water reuse, Rainwater harvesting, Restrict new swimming pools, Outdoor use restrictions, Landscaping standards, Restrict landscaping, & Restrict new golf courses.

Results (compared to base run):

- ***Aquifer Storage***: Reduction in deficit by 5595 acre-feet/yr
- ***Consumptive use***: Decrease by 5389 acre-feet/yr
- ***Impact on SPRNCA***: Improvements in all reaches

Water Saving Incentives Package (starting in year 2008)



Fixture retrofits, Improved outdoor irrigation efficiency, Mandatory pool covers, and Landscaping standards.

Results (compared to base run):

- ***Aquifer Storage***: Reduction in deficit by 4184 acre-feet/yr
- ***Consumptive use***: Decrease by 4350 acre-feet/yr
- ***Impact on SPRNCA***: Improvements in reaches 1~4 and 6~10

Summary- Stakeholder Engagement

- Consider the environment as well as the community when making water management decisions
- Use the best available science & decision tools to select the most sustainable water management alternatives with stakeholder input
- Recognize the need to integrate energy, economics, social values, quality of life issues
- Don’t be a Pollyanna- honestly discuss the difficult choices, implications, tradeoffs


Maps available at
www.azconservation.org