

# **Transboundary Groundwater Governance in the Western U.S.-Mexico (AZ-Sonora) Border Region**

## **Piecemeal Pragmatism vs. Comprehensive Idealism**

**Robert G. Varady,  
Christopher A. Scott, Sharon B. Megdal, and Margaret O. Wilder**  
University of Arizona

Presented at

“An Uncommon Dialogue on  
U.S.-Mexico Transboundary Water Issues”

Organized by the

Bill Lane Center for the American West  
Stanford University  
Palo Alto, CA

2 June 2014

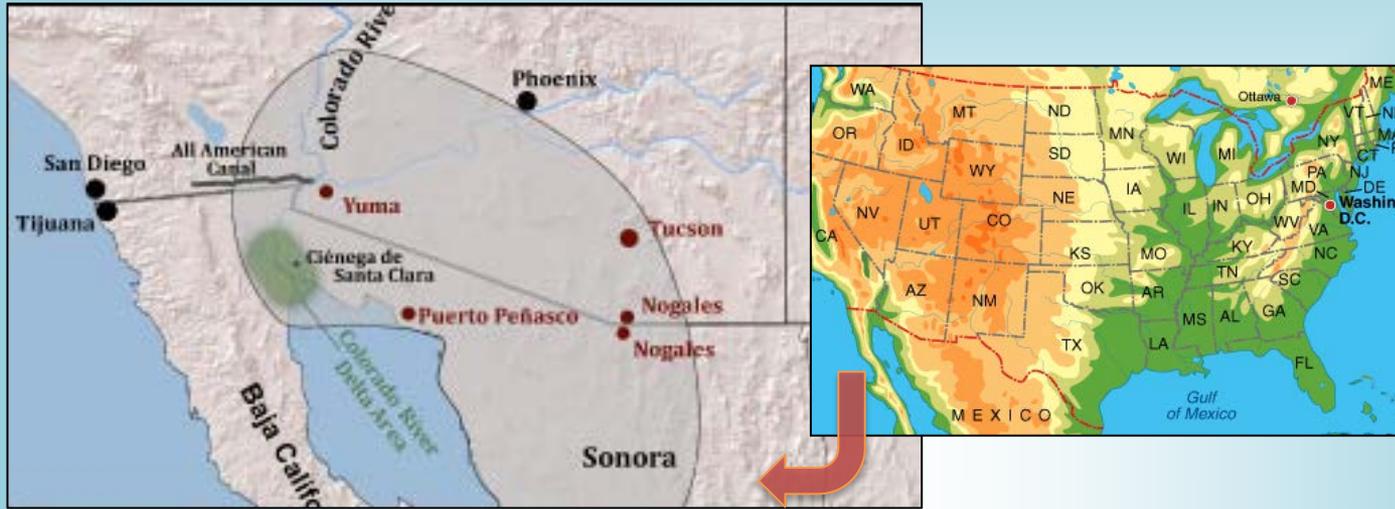
# Mileposts for today's talk



- The Arizona-Sonora part of the U.S.-Mexico border region
- Transboundary asymmetries
- History of transboundary environmental institutions
- Evolution of research on water & climate
- Groundwater use & management in the region
- The U.S.-Mexico Transboundary Aquifer Assessment Program
- Piecemeal pragmatism vs. comprehensive idealism

# Background

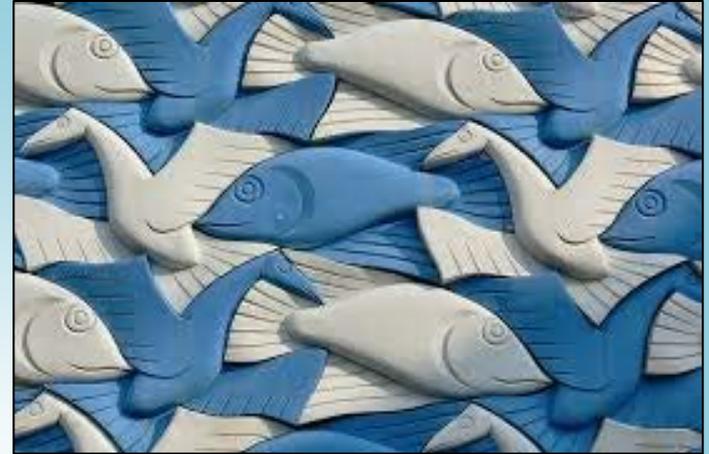
## Conditions in the region



- Monsoon-dependent & water-short; frequent drought, occasional heavy flooding
- Traditional economy: cattle ranching, copper mining, irrigated agriculture
- Fragile ecosystems, bird flyways, wildlife, rare plant species
- Growing urbanization, economic development
- Rising populations

# Transboundary asymmetries

- Culture/language/educational systems
- Economy
- Taxation & revenue-generation
- In Sonora, border region is among most prosperous; in AZ, among least
- Legal framework: Napoleonic vs. British
- Administration: federal vs. decentralized
- Human resources & expertise
- Physical infrastructure, nexus sectors
- Regulation & enforcement
- Robustness of institutions & civil society



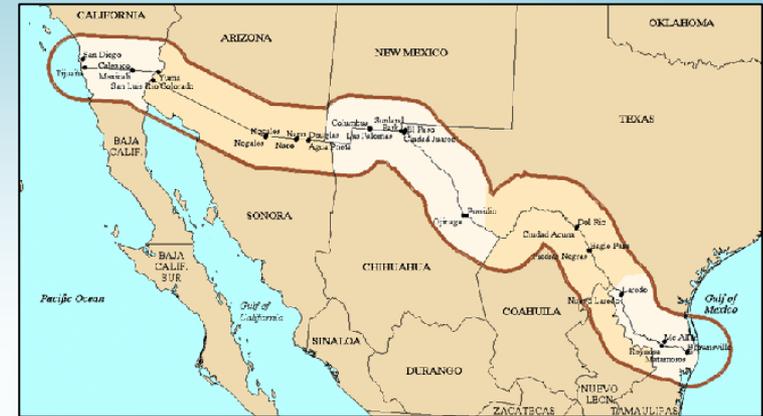
# Transboundary similarities



- Landscape & environment do not respect political borders
- Aridity/water scarcity
- Communities & environments are vulnerable to climate variability & change
- Both sides are distant from the capitals
- Problems require attention at different scales—e.g., in parts of AZ, water is managed via Active Management Areas (AMAs), but basins can cross AMAs & other jurisdictions
- A number of binational environmental institutions are in place

# Transboundary environmental institutions

- IBC (1889-1944)
- IBWC-CILA (1944 - )
  - Minutes
- La Paz Treaty (1983) and task forces
- Arizona-Mexico Commission (1972 - )
- NAFTA-created institutions (1994 - )
  - CEC (trilateral; Canada-U.S.-Mexico)
  - BECC-NADBank (binational; U.S.-Mexico)
- Binational environmental plans
  - IBEP (1992-96)
  - Border XXI (1996-2003)
  - Border 2010 (2003-12)
  - Border 2020 (2012 - )
- Good Neighbor Environmental Board (since mid-1990s; U.S. only)
- TEIA (late 1990s; never implemented)
- TAAP (U.S. Public Law 109-448; since 2006; not really binational)



# Border environmental-policy research c. 1980s-90s



- Mostly technical/engineering studies
- New attention following La Paz Treaty of 1983
- Formation of binational, thematic working groups via EPA & SEDUE
- Rise of environmental NGOs in U.S.
- Interest in binational copper-smelter-related air quality in late 1980s
- Strong private-foundations support for community-oriented research—  
e.g., Ford, Hewlett, Mott, Pew

# Water-climate research in border region



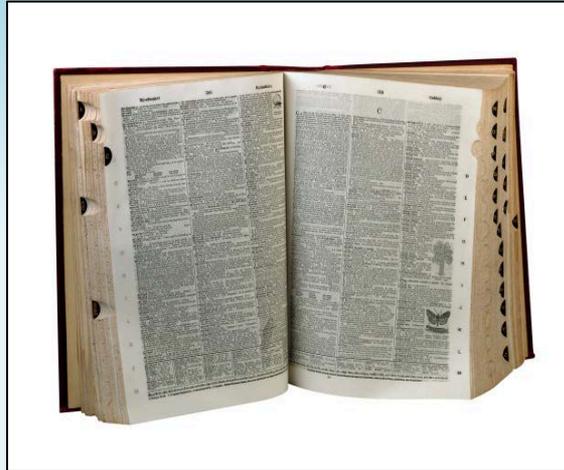
- Impact of NAFTA—new institutions:
  - harmonize regulations (CEC/CCA)
  - fund environmental-infrastructure projects, esp. water (BECC/COCEF, NADBank/BANDAN)
- Existing institutions re-energized (e.g., CONAGUA, IBWC/CILA, EPA, ADWR, other agencies)
- New approach to environ. decisionmaking: stakeholders participation, sustainability, transparency
- Advent of Integrated Water Resources Management (IWRM)
- Increased focus on demand management, role of governance, groundwater use, nexus concept
- Incorporation of these paradigms in research
- New work on policy, governance, equity, conflict, and “soft-path” approaches to development & water security

# Groundwater in the AZ-Sonora portion of the western U.S.-Mexico border region



# Groundwater governance

## A working definition



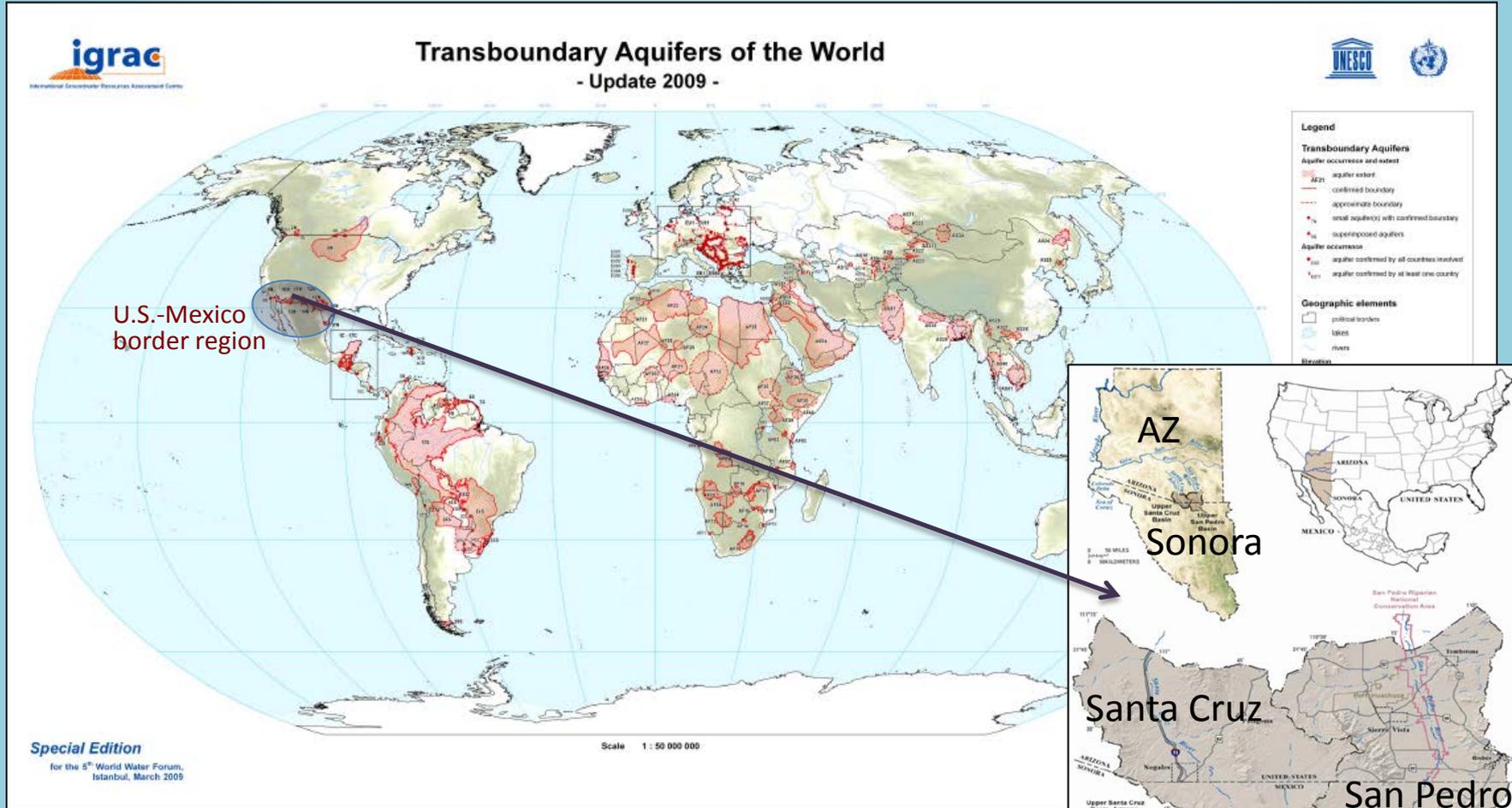
### ***Groundwater governance***

The overarching framework of groundwater-use laws, regulations, & customs, as well as processes of engaging the public sector, private sector, and civil society. It may involve coordinating administrative actions and decisionmaking between/among different jurisdictional levels.

*(Megdal, et al. 2014)*

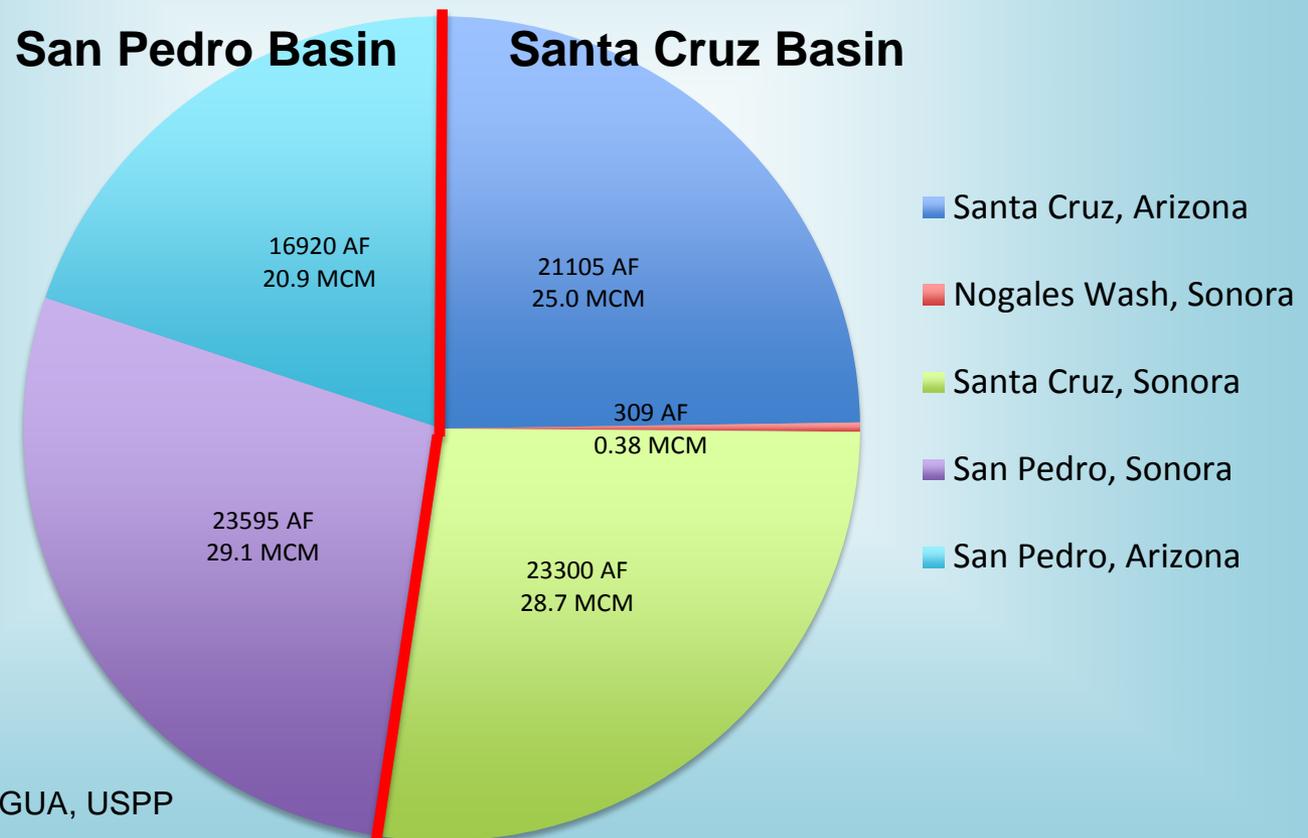
# Groundwater use & management

## Aquifers in the world—and in the U.S.-Mexico border region



# Use/availability in two Arizona-Sonora basins

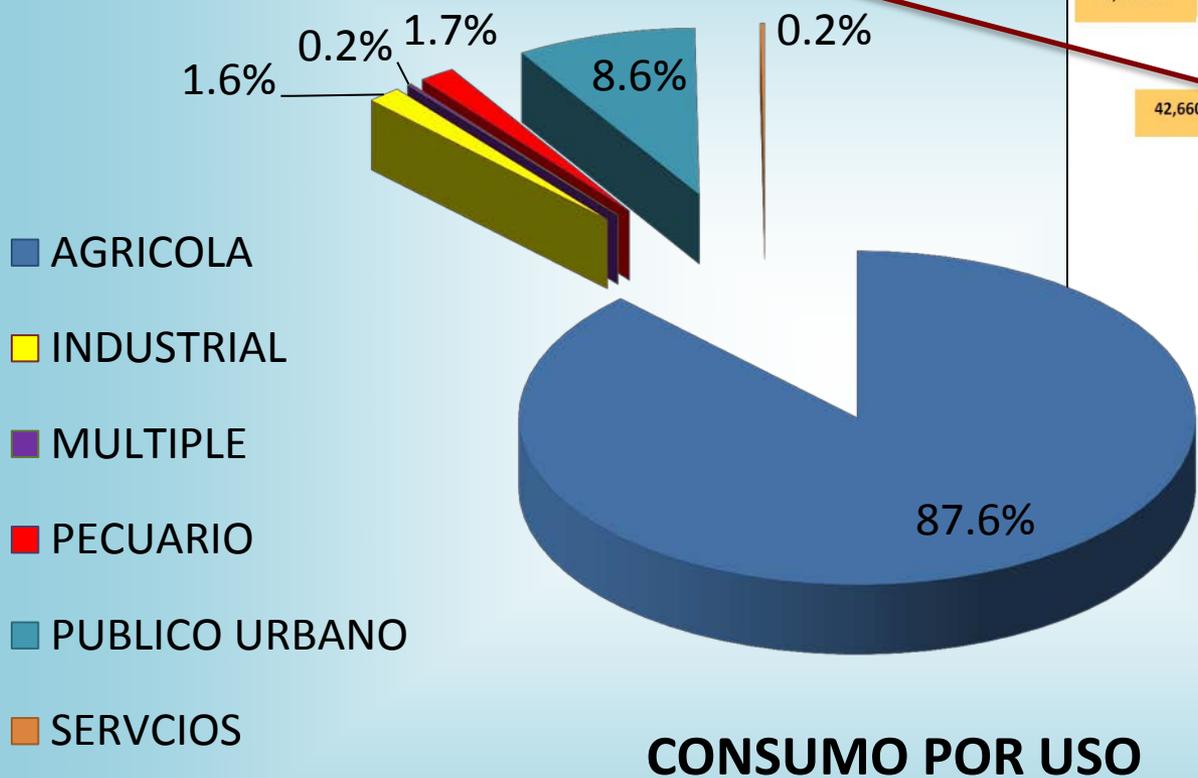
Water withdrawn by basin/nation per year



Sources: ADWR, CONAGUA, USPP

# Sectoral distribution of groundwater use

## Rio Sonora Basin, Mexico



# Groundwater Balance & Management

- **Upper Santa Cruz**
  - SCAMA tasked with maintaining sustainable yield
  - Nogales, Sonora, has at times been forced to purchase water from Nogales, AZ
- **Upper San Pedro**
  - In 2004 stakeholders charged with restoring & maintaining sustainable yield in AA
  - Drawdowns noted of up to 3 meters between 1995-2000 along river channel in Mexico



# Groundwater management plans for Santa Cruz Basin



Comisión Nacional del Agua  
*Subdirección General Técnica*  
Gerencia de Aguas Subterráneas  
*Subgerencia de Evaluación y Ordenamiento de Acuíferos*

**ACTUALIZACIÓN DE LA DISPONIBILIDAD  
MEDIA ANUAL DE AGUA SUBTERRÁNEA**

**ACUÍFERO (2616) RIO SAN PEDRO**

**ESTADO DE SONORA**

PUBLICADA EN EL DIARIO OFICIAL DE LA FEDERACIÓN EL  
28 DE AGOSTO DE 2009

## THIRD MANAGEMENT PLAN

FOR

**SANTA CRUZ**  
ACTIVE MANAGEMENT AREA

**2000-2010**



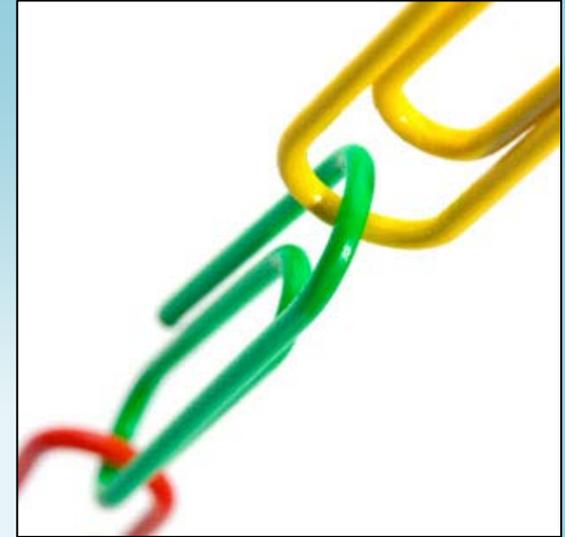
ARIZONA DEPARTMENT OF WATER RESOURCES

- Important to recognize different nature of water management
- How do contrasting management regimes interact across the border within shared basins?
- U.S. Santa Cruz Fourth plan far behind schedule

# Management responsibilities for agencies within basins

## Arizona

- AZ Department of Water Resources
  - Administers & enforces state groundwater code
- U.S. Geological Survey
  - collects info. needed to understand water resources
- U.S. Bureau of Land Management
  - Manages nation's public lands & resources.... balancing recreational, commercial, scientific & cultural interests and striving for long-term protection of renewable & nonrenewable resources
- Utilities



## Sonora

- National Water Commission (CONAGUA)
  - Administers & preserves national waters to achieve sustainable use
- State Water Commission
  - Promote coordinated development & efficiency of water resources in Sonora
- Municipal Utilities
  - Provides & supplies urban users

# Binational cooperation & initiatives on groundwater



- **Arizona-Mexico Commission**
  - State-level work group since 1959 with 13 binational committees (incl. water)
- **Border Environment Cooperation Commission**
  - Preserves, protects, enhances human health & environ. along border
- **Transboundary Aquifer Assessment Program (TAAP)**

# United States-Mexico Transboundary Aquifer Assessment Program (TAAP)

Currently designated priority transboundary aquifers



- U.S. Public Law 109-448 (2006)
- Secy. of Interior to assess priority transboundary aquifers
- Santa Cruz & San Pedro identified on AZ/Son. border
- Approved 10-year appropriation of US \$50M
- U.S. funds can be expended in Mexico with 50% match
- Collab. project betw. USGS & Water Resource Centers in TX, NM, and AZ (CA opted out)
- Binational Santa Cruz & San Pedro reports in Eng. & Span. under review to be released end 2015 (?)

# Transboundary Aquifer Assessment Program (TAAP)

## Background



- Complex binational, bicultural environ.
- Rapid economic growth
- Border population >12 million and rising
- Aridity., declining water tables, contamin., lack of sewage treatment in some Mex. cities
- Occasional flooding during monsoon season
- **Aquifers are sole or next available source of water**
- Knowledge of quantity, quality, movement of transboundary groundwater is inadequate

# Binational partnership

- USGS & Univ. Arizona's Water Resources Research Center (by U.S. law)
- Additional players on U.S. side
  - Government agencies at different levels
  - NGOs
- International Boundary & Water Commission – U.S. Section & Mexican Section (CILA)
- Mexican Government Agencies
  - Comisión Nacional del Agua (CONAGUA)
  - Comisión Estatal del Agua de Sonora
- University of Sonora
  - Contractors for technical work funded by CILA



# Binational Workplan



## Priority studies

- Examine existing models & create hydrologic model of each basin that
  - is physically-based
  - Is binational
  - integrates surface/ground/unsaturated-zone water
- Summary of Approach
  - Integrated assessment of priority aquifers
  - Improve and share data & information
    - ✓ Compile extant data
    - ✓ Identify data gaps
  - Develop unified hydrologic framework
  - Model construction, calibration, estimate of uncertainty
  - Model prediction: climate change, urbanization, drought
  - Create scientific products that
    - ✓ Can be widely disseminated
    - ✓ Provide scientific information to managers on both sides who have insufficient data for effective planning



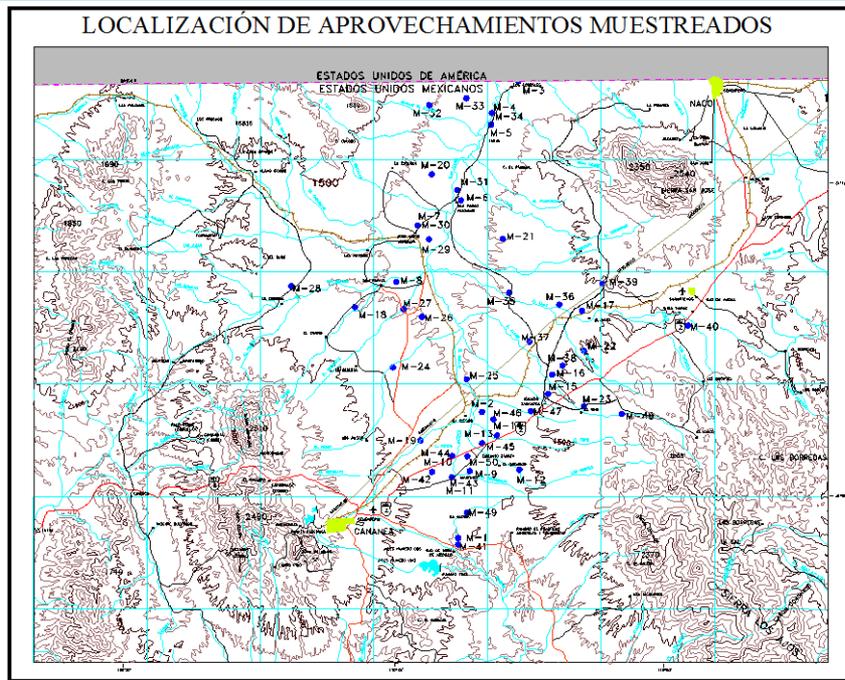
# Extension with TAAP Stakeholders



<b>Mexico govt.</b>	<b>Mexican academic</b>	<b>U.S. govt.</b>	<b>U.S. academic</b>	<b>Binational</b>	<b>Non-govt.</b>
Comisión Nacional del Agua (CONAGUA)	Univ. de Sonora, Instit. Tecnológico de Sonora (ITSON)	Arizona Dept. of Water Resources (ADWR)	Univ. of Arizona	IBWC/CILA	Friends of the Santa Cruz River (FOSCR)
					Upper San Pedro Partnership
Comisión Estatal del Agua (CEA) Sonora	Colegio de Sonora	U.S. Bureau of Reclamation (USBOR)	NMSU		Sonoran Institute
Organismo Operador Municipal de Agua Potable, Alcantarillado y Saneamiento (OOMAPAS) Nogales	Centro de Estudios Superiores del Estado de Sonora (CESUES)	City of Nogales, Arizona	TAMU	UNESCO Intl. Shared Aquifer Resources Management (ISARM) program	Water Committee of Arizona-Mexico Commission

## Calidad del Agua

# Data Sharing with Mexico



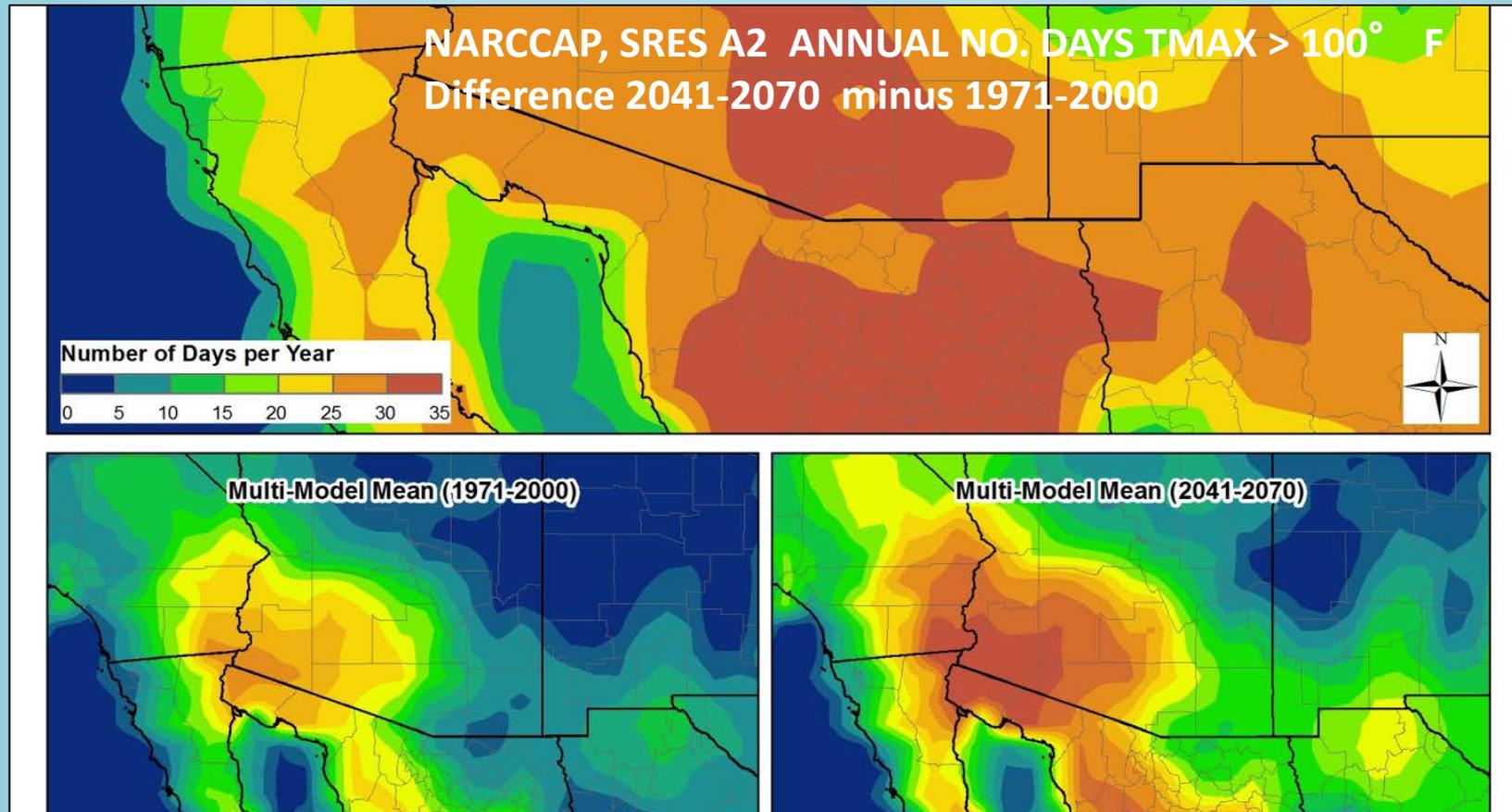
## Estadísticas de piezometría Acuífero Río San Pedro

	1997	2003	2005	2007
Niveles estáticos medidos	58	30	25	49
Mínima profundidad medida	1.97	5.39	2.79	1.60
Máxima profundidad medida	78.75	83.92	93.83	89.95



# “Ground Zero” for Climate Change

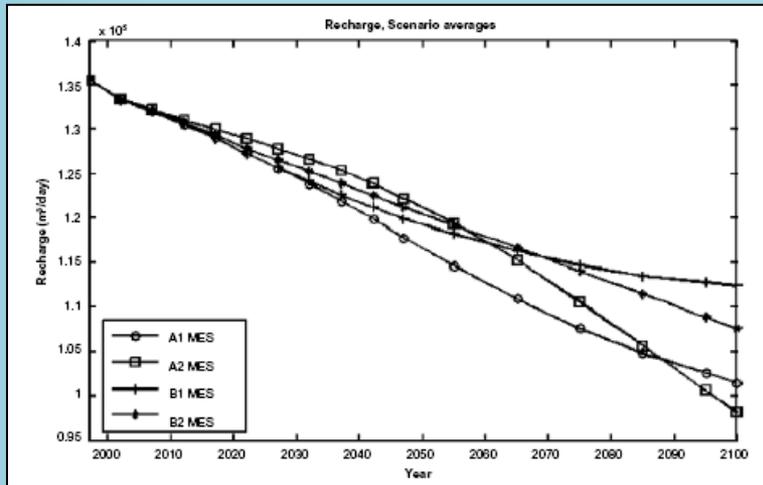
Spatial distribution multi-model mean change in no. of days  $> 100^{\circ}$  F  
U.S.-Mexico Border Region



Source: Adapted from Wilder et al., 2013. *Border Communities, in Southwest Region Report* (Garfin, et al. 2013).

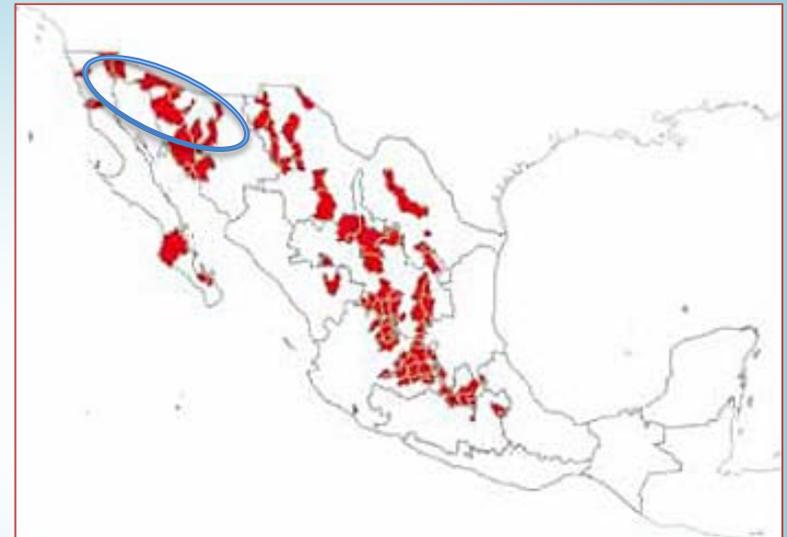
Projections show that days with maximum temperatures greater than  $100^{\circ}$  F will increase in all parts of the Southwest border region, with largest increases, 30-35 days per year, in AZ-Sonora border region.

# Groundwater depletion



**Predicted decline in San Pedro aquifer recharge due to climate change**

Serrat-Capdevila, et al., 2007



**Overexploitation of aquifers in Mexico**

- Rising population + urbanization → growing demand
- Climate change → reduced recharge
- Growing demand + climate change → overdraft
- Overdraft = lowered water table = less storage capacity = less availability

# Institutional framework for transboundary groundwater governance

- **International protocols**
  - Bellagio Model Treaty (drafted by Hayton & Utton, 1989)
  - Convention on Transboundary Aquifers
    - Modeled on Convention on the Law of Non-Navigational Uses of Intl. Watercourses
    - UN Gen. Assembly adopted Resol. A/RES/63/124 in draft form in Dec. 2009 , but ratification highly unlikely in near future
- **AZ Groundwater Management Act (1980)**
  - Applies to AMAs & Irrigation Non-expansion Areas (INAs)
- **Irrigation districts, Sonora—actions in Sonora only**
  - Retiring wells
  - Selling ejidos' water rights
  - Trying to limit “third party” effects
- **No formal binational agreement for managing transboundary aquifers**
- **Science-policy dialogues**
  - e.g., TAAP—does not have force of treaty

# Ingredients of effective transboundary science-policy dialogues

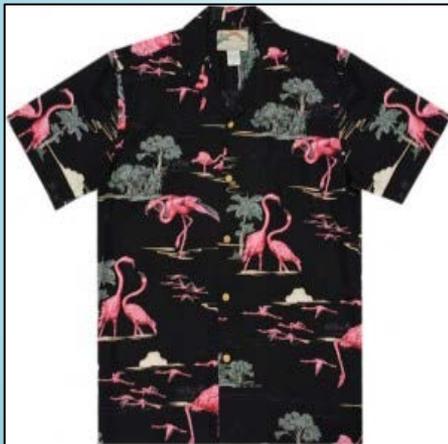


- ***Public participation*** in decisionmaking by stakeholders **from *all sectors***
- Robust ***communities of practice*** that link policymakers, managers, scientists & social scientists
- Strong institutions, esp. ***binational/multinational institutions***
- Recognition of interconnectedness & inseparability of ***all sectors***
- Access to ***comparable data*** & reliable ***information flows***
- Significance of ***governance*** and ***soft-path solutions***
- Need for ***Trust*** for genuine transnational, transborder cooperation

# Formal vs. informal arrangements for transboundary groundwater governance

## Formal arrangements require

- Comparable needs & objectives
- Country-to-country, state-to-state, jurisdiction-to-jurisdiction negotiations
- Legal instruments such as treaties & laws
- Enforcement mechanisms & compliance
- Matching resources & commitments
- *Trust*
- **Idealism**



## Informal arrangements entail

- Common & specific, short-term, small-to-medium-scale objectives that are achievable
- Access to reliable science & information
- Ability to generate & influence research
- Continuing participation of decisionmakers, managers, academics, community groups, NGOs, other stakeholders
- Locally- or regionally-developed action plans
- *Trust*
- **Pragmatism**

# Transboundary Groundwater Governance in the Western U.S.-Mexico Border Region

This presentation is partly based on work within the Americas component of the **International Water Security Network**, which is funded by **Lloyd's Register Foundation**, a charitable foundation helping to protect public life and property by supporting engineering-related education, public engagement and the application of research.

For more information, see: [lrfoundation.org.uk](http://lrfoundation.org.uk)



Additional support has been provided by the Inter-American Institute for Global Change Research, National Oceanic and Atmospheric Administration, National Science Foundation, Transboundary Aquifer Assessment Program, U.S. Geological Survey, and Morris K. & Stewart L. Udall Foundation

