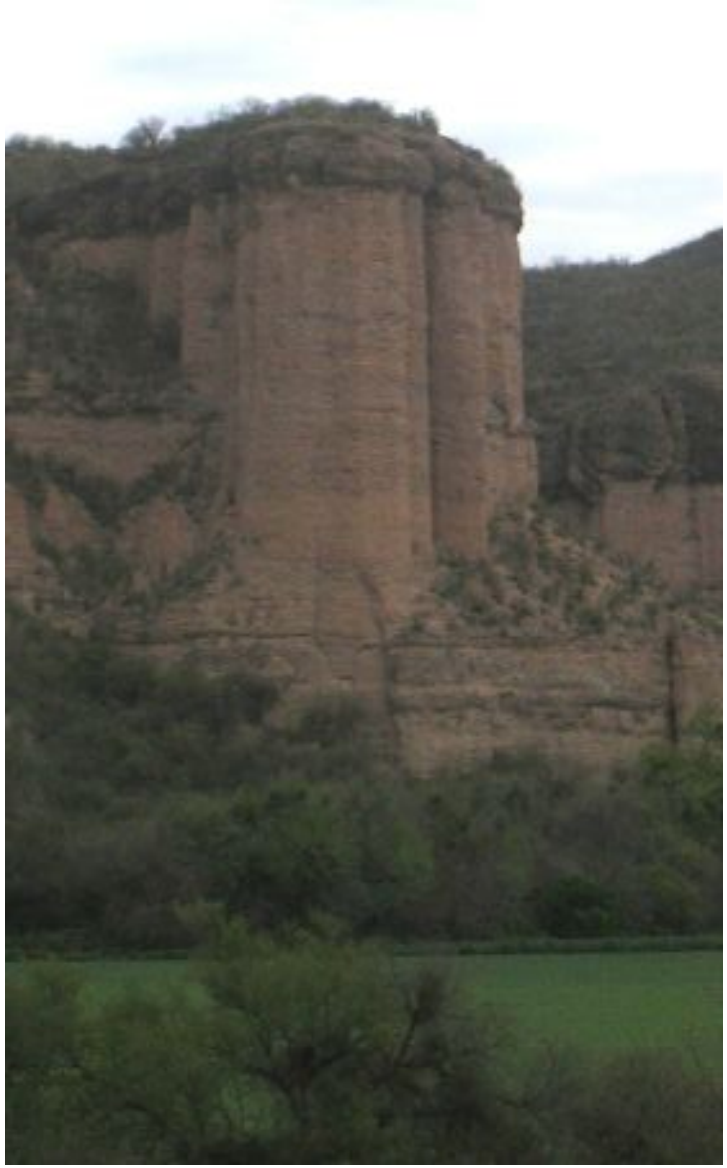


Strengthening resilience of riparian corridors in the US-Mexico borderlands

University of Arizona and partners, supported by the National Science Foundation's Dynamics of Coupled Natural and Human (CNH) Systems Program, 2010-2016

Research team

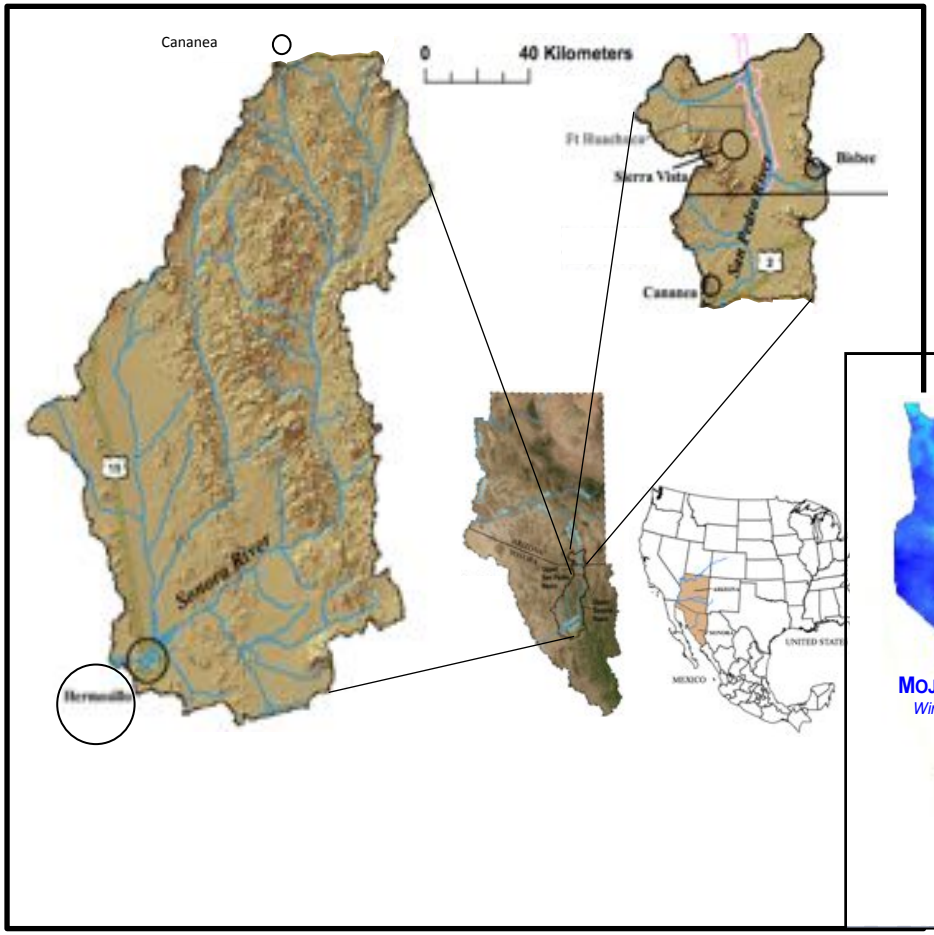
- Chris Scott, Mitch Pavao-Zuckerman, Randy Gimblett, Kevin Lansey, Tom Meixner, Stephanie Buechler, Ben Columbi, Ryan Lee, Moira Hough, Aloah Pope, Lily House-Peters, Kirsten Neff, Darin Kopp, Arica Crootof, Chloé Fandel – *UA*
- Alejandro Castellanos, Miguel Rangel, Raul Romo, students – *Universidad de Sonora*
- José Luis Moreno, Alan Navarro, students - *Colegio de Sonora*
- Hans Skov-Petersen - *University of Copenhagen, Denmark*

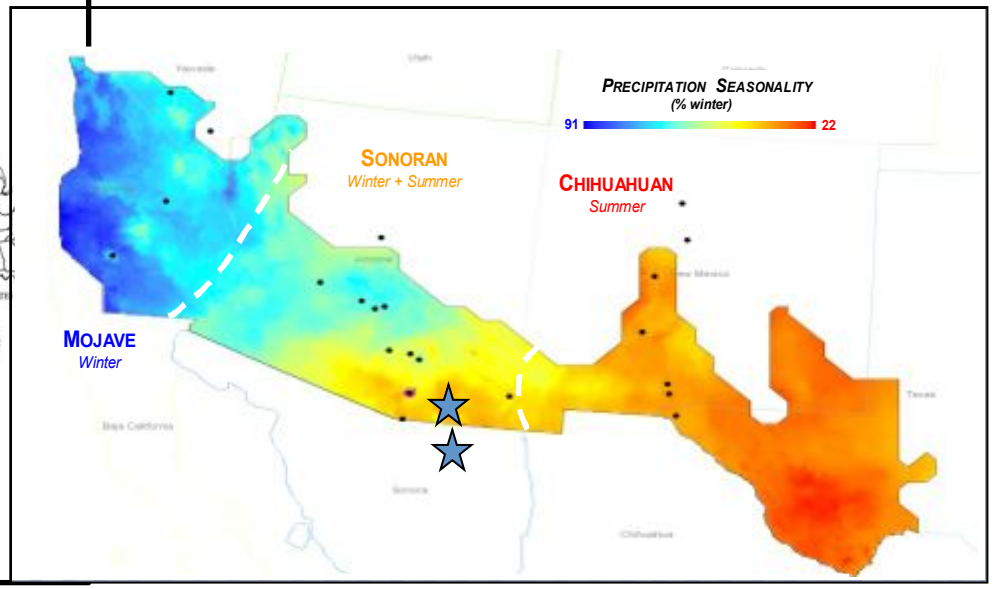
Research design & methods

- Eco-hydrological dynamics
  - Land-cover/land-use modeling
  - Ecosystem physiological metrics
  - Ecosystem service modeling
  - Characterize sources and variability of recharge
  - Quantify pumping and surface withdrawals
  - Estimate hydrologic state over time, link to ecological conditions
- Social-institutional dynamics
  - Documentary analysis
  - Institutional analysis
  - Semi-structured interviews and focus groups
  - Workshops

Study watersheds

- Sonoran Desert, grassland, desert scrub, riparian forests, upland oak-conifer forests
- Climate: monsoon-dominated Río Sonora, bimodal precipitation - San Pedro
- Urban growth, military, mining, ranching
- San Pedro Riparian National Conservation Area (SPRNCA); Ajos-Bavispe Reserve

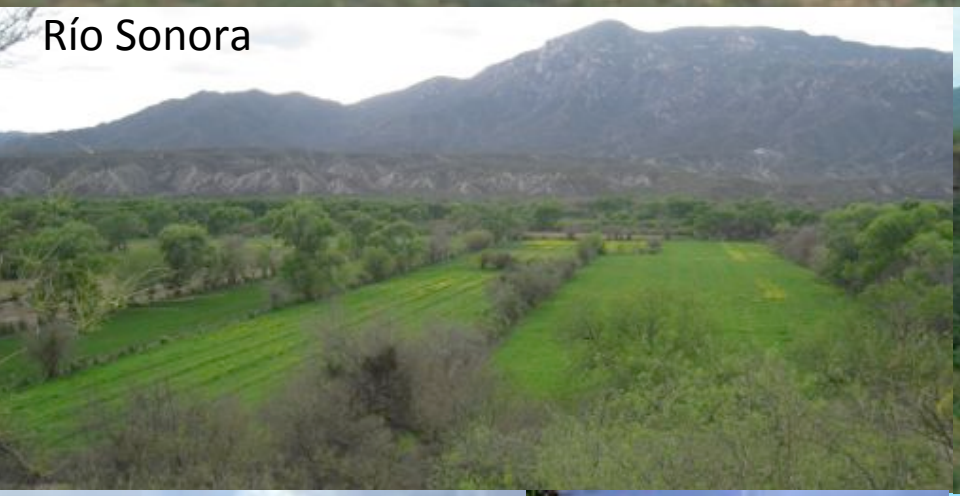


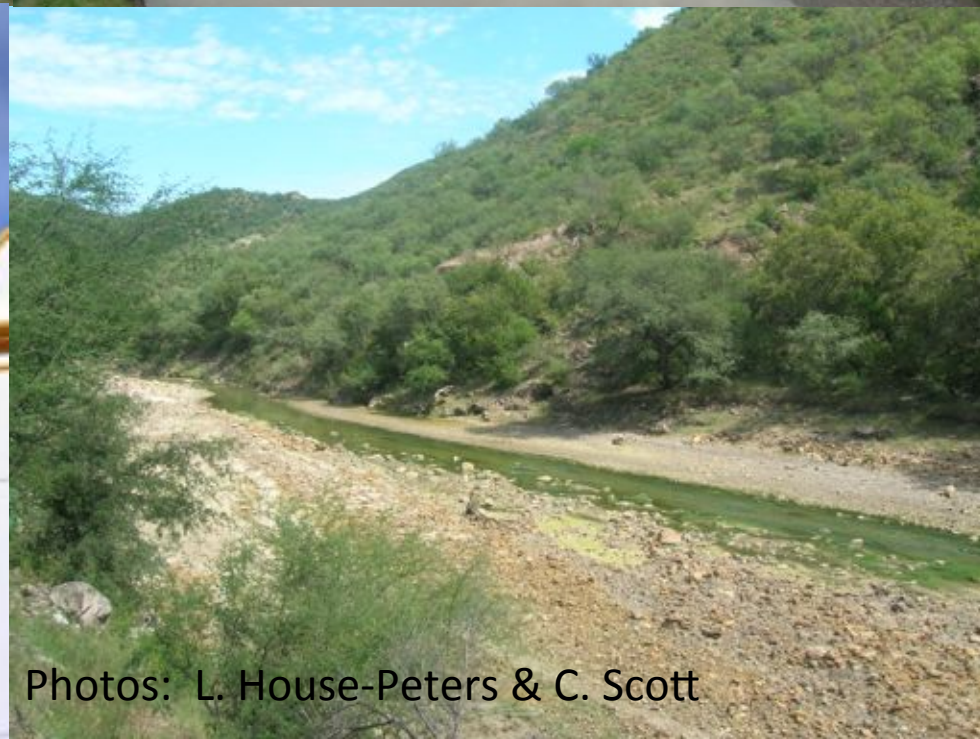


Río San Pedro - Mexico

Photos: L. House-Peters

San Pedro River – U.S.





Photos: L. House-Peters & C. Scott

Arizona Daily Star
tucson.com
Sunday, October 5, 2014

LIVELIHOODS WASHED AWAY BY ACID SPILL

2 months after mine accident, farmers, families don't know what to believe

Arizona Daily Star
tucson.com
Final
Monday, October 6, 2014
$1 plus tax • $3 outside Southern Arizona

Toxic spill in Mexico leaves fear, anger in its wake

Answers on long-term impact on the land, water, difficult to get

By Perla Trevizo
Arizona Daily Star

BACANUCHI, Sonora — The makeshift town hall was packed by the time Mayor **Vidal Vázquez** arrived. The residents of this small town of a few hundred people, which shares the name with the nearby river where millions of gallons of toxic solution were dumped, had been waiting for him.

A few sat in plastic chairs; most stood against the wall or sat on boxes of bottled water. Those outside strained to get a look through the windows.

Nearly two months after the Aug. 6 and 7 copper mine spill, which was followed by heavy rains brought by Hurricane Odile that further contaminated the land, residents are frustrated and feel as though they've been forgotten.

"This is the town that's worse off, and no one is doing anything about it," said a man in a blue baseball cap. "How is it possible that in nearly two months they are digging wells in other places but not here?"

Vázquez explained what the federal, state and local governments are doing.

"Remember, when you told me there was a spill, I got on my horse; it took me two hours," he said, "but I went to check it out and reported it to the authorities."

Vázquez was referring to a second spill, after rains from Odile caused the dams to overflow.

He also told them about a new committee that all the mayors, the government and the mine's owners, Grupo Modeno, are part of.

They will oversee the $150 million trust Grupo Modeno established to begin covering damages.

Farmers will get about $700 per acre of land up to approximately 25 acres.

They will also get about $1,000 for up to 40 head of cattle and $27 for each additional head, up to 300.

None of this sat well with the community, many of them ejidatarios who work the communal land, nor with the Cananea attorney they hired to

See WATER, A4

Romeo Castro, a chemical biologist with the state of Sonora, gets samples to test for contamination at the Arizpe Well #3 site near the Río Bacanuchi last week.

KELLY PRIMMER / ARIZONA DAILY STAR

Video
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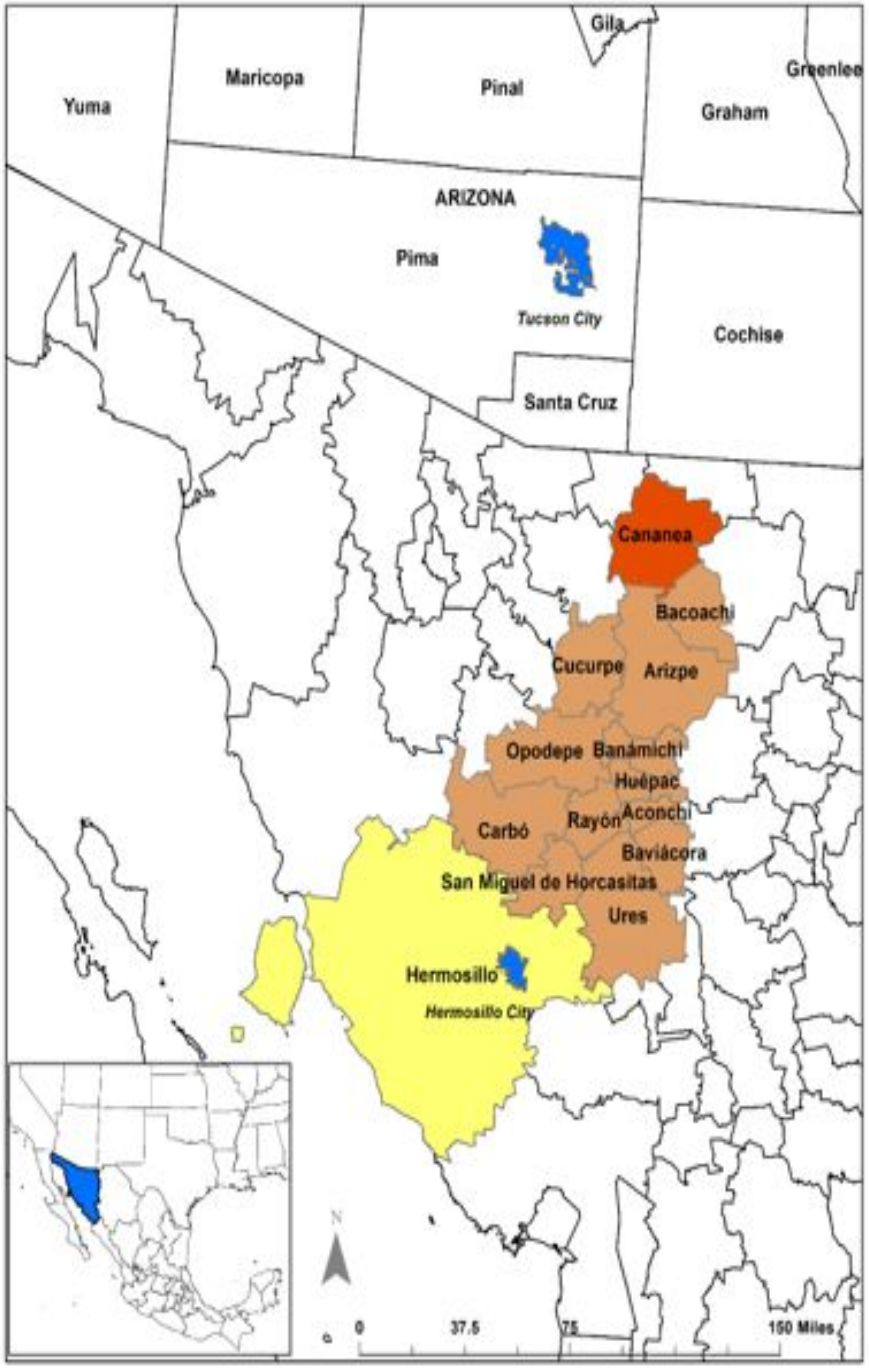
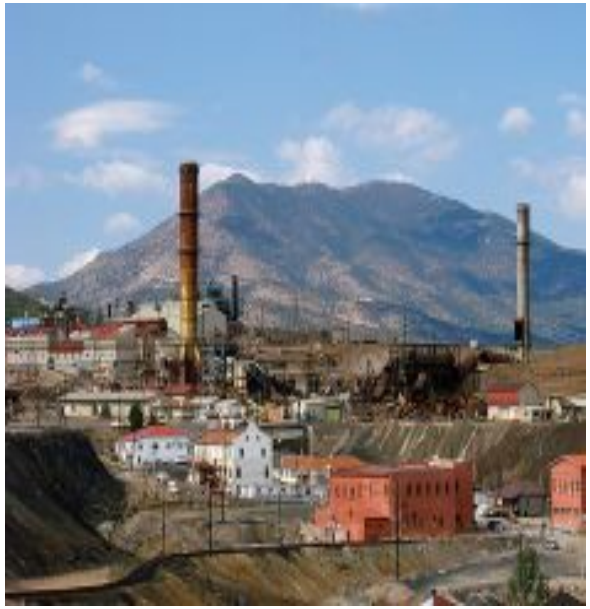
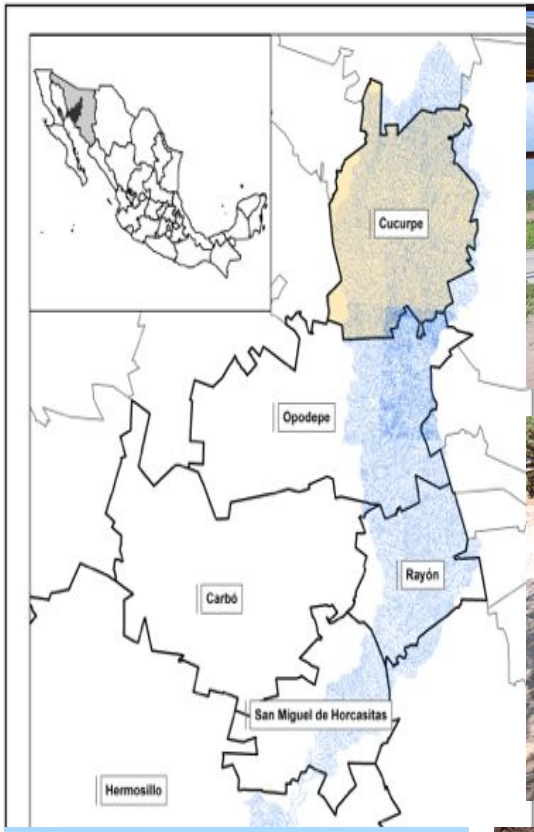
Plan your Surgery with TraumaCad



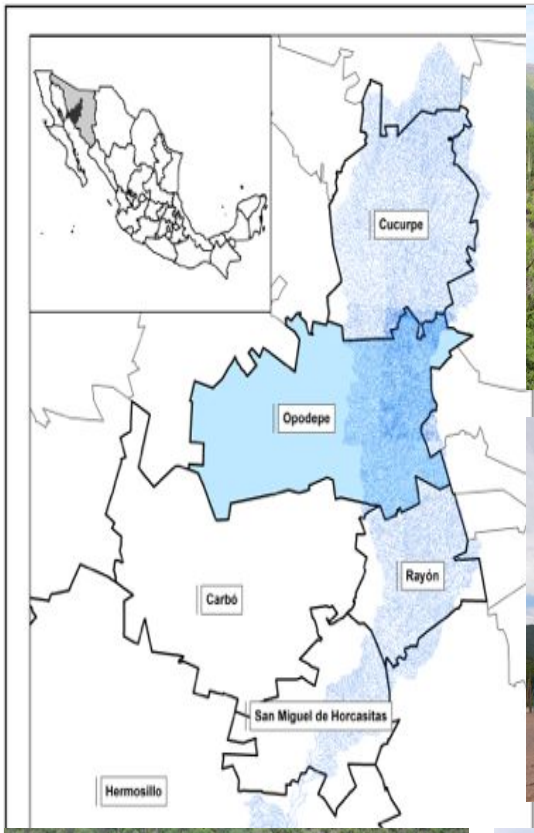


- **August 7th, 2014**
- **32.4 acre-feet of copper leaching solution**
- **Río Bacanuchi: Headwaters of Rio Sonora**
- **More than 20,000 people affected, not including Hermosillo City**
- **Hundreds of millions of pesos of estimated damages**



Ongoing work in adjacent San Miguel basin: CUCURPE

- **Concerns for re-opened mining operations.**
- **Extreme aridity.**
- **Low livestock productivity.**
- **Obstacles for launching other economic opportunities.**



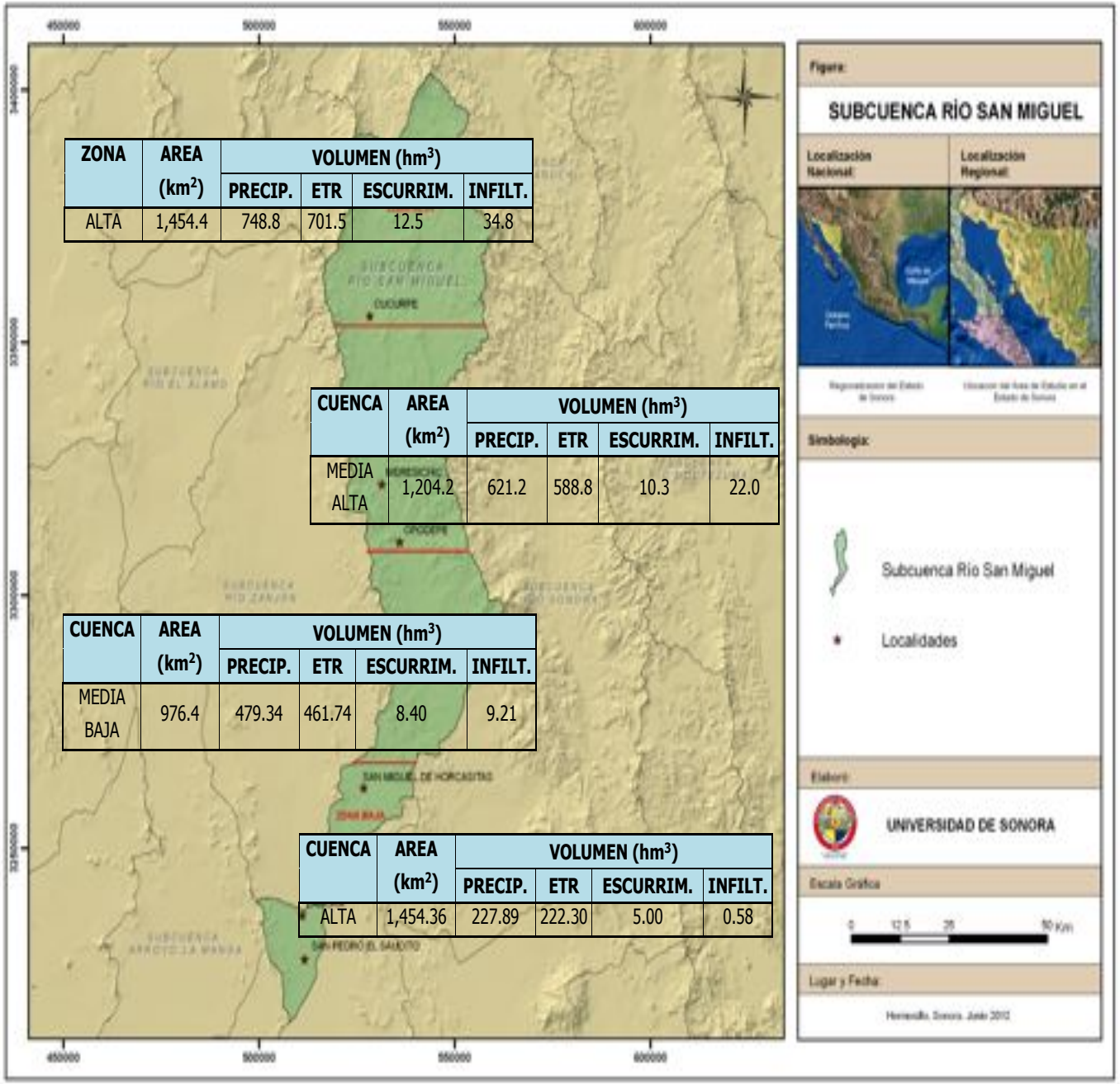
OPODEPE

- **Inadequate roads, communication networks.**
- **Notably rural.**
- **Large number of ejidos in the San Miguel Basin**

SAN MIGUEL HORCASITAS

- **Rural-urban competition.**
- **Intra-rural competition (private vs communal)**
- **Issues to supply water for domestic use.**
- **Land monopolies by a few in the ejidos.**
- **Poverty in general.**

SAN MIGUEL WATER BALANCE 1974-2012

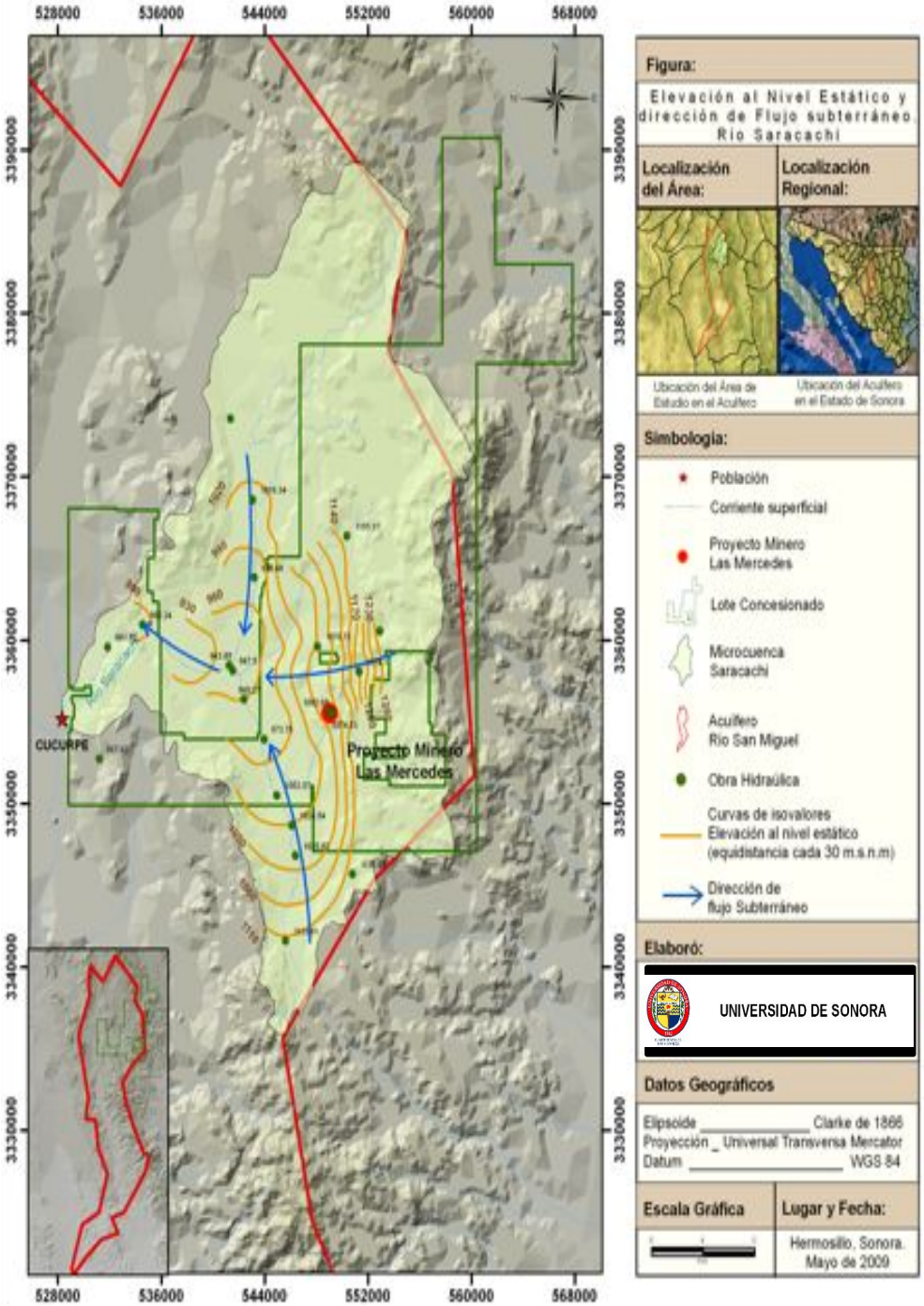


ZONA	AREA (km^2)	VOLUMEN (hm^3)			
		PRECIP.	ETR	ESCURRIM.	INFILT.
ALTA	1,454.4	748.8	701.5	12.5	34.8

CUENCA	AREA (km^2)	VOLUMEN (hm^3)			
		PRECIP.	ETR	ESCURRIM.	INFILT.
MEDIA ALTA	1,204.2	621.2	588.8	10.3	22.0

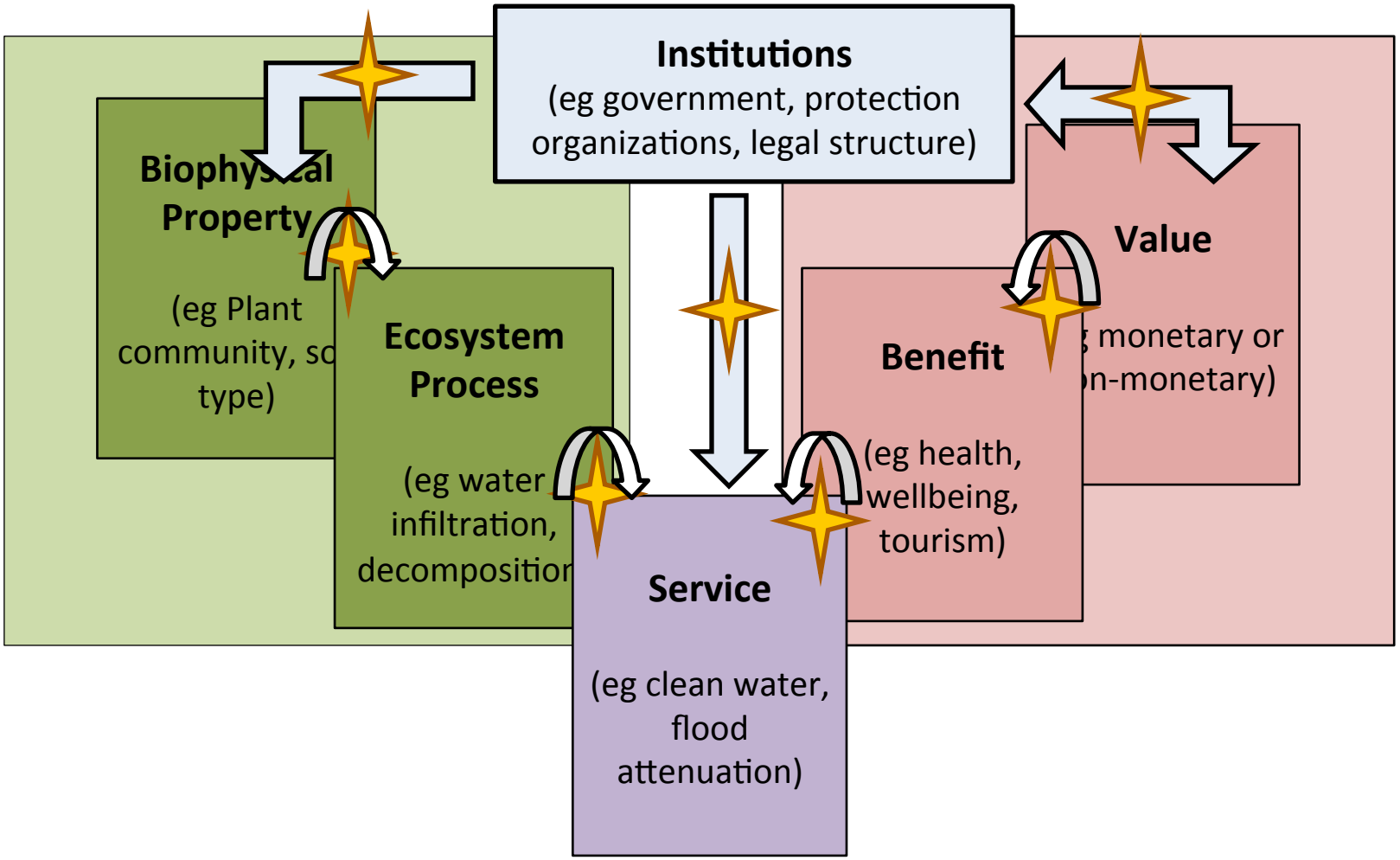
CUENCA	AREA (km^2)	VOLUMEN (hm^3)			
		PRECIP.	ETR	ESCURRIM.	INFILT.
MEDIA BAJA	976.4	479.34	461.74	8.40	9.21

CUENCA	AREA (km^2)	VOLUMEN (hm^3)			
		PRECIP.	ETR	ESCURRIM.	INFILT.
ALTA	1,454.36	227.89	222.30	5.00	0.58



Elevation of the static level, Saracachi sub-basin of the San Miguel.

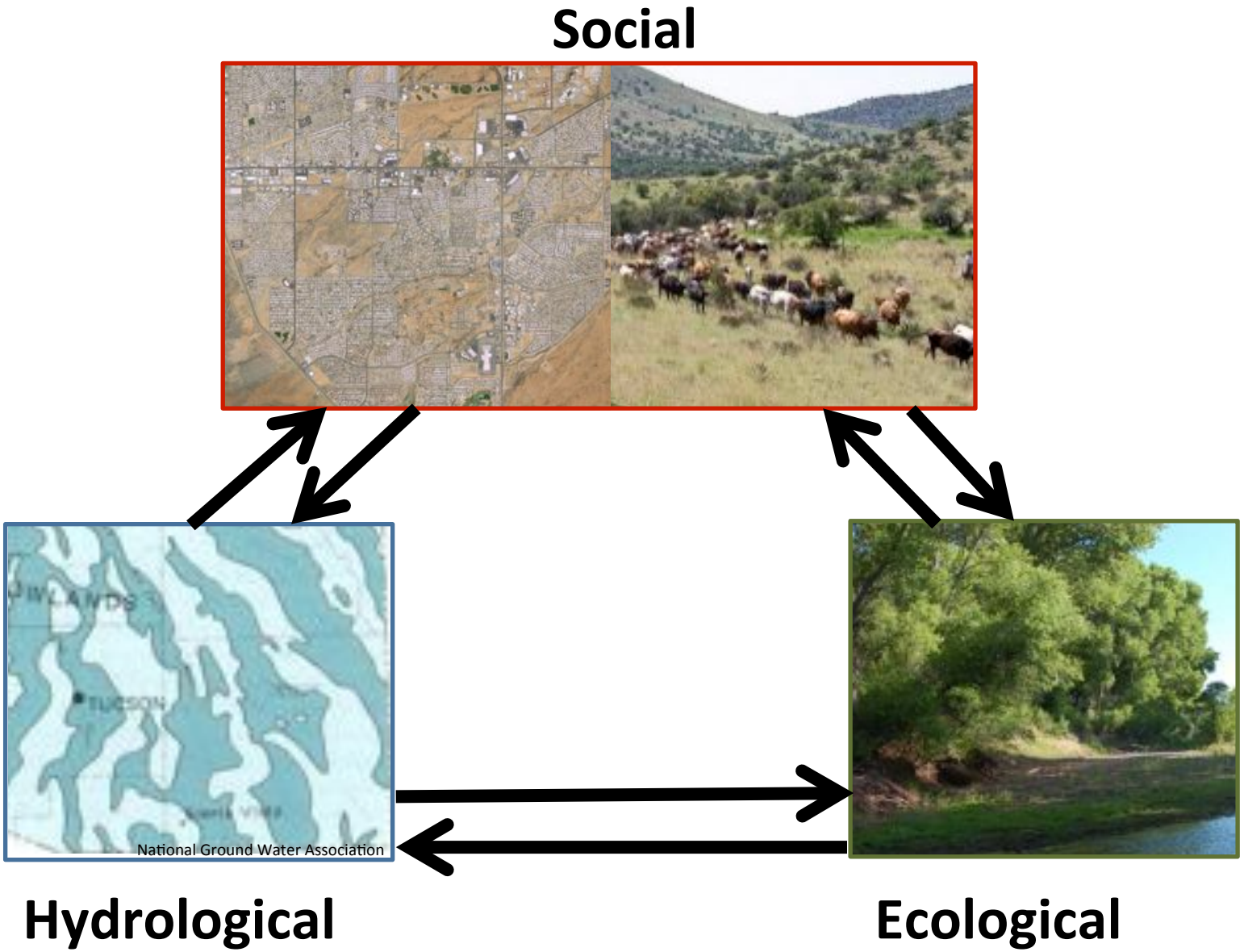
Hydrology linked to Ecosystem Services: Emerge from the Social-ecological System



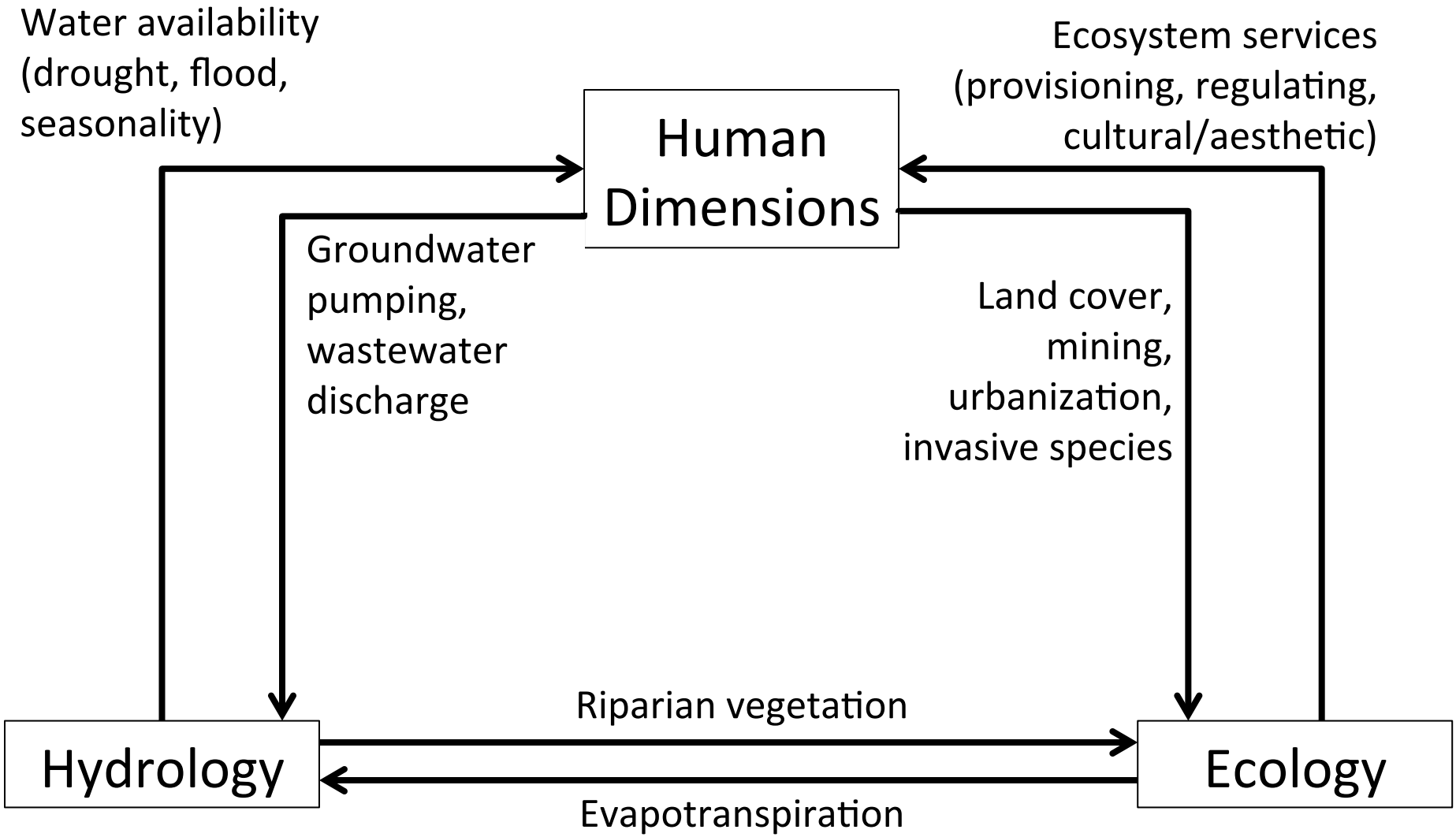
Dominant Species

Arid Adapted		Native Riparian	
Tamarix spp.	*Prosopis velutina*	*Populus fremontii*	*Salix gooddingii*

Agent-Based Modeling (ABM) Approach



Upper San Pedro Watershed Social-Ecological System



Available Data

Social, Economic

- Land Management
- Census Tracts
- Ownership
- Pastures
- Cochise County GIS data ($)
  - Comprehensive Plan
  - Zoning
  - Growth Area Boundaries
- Additional GIS data
- Mining, copper prices

Ecological

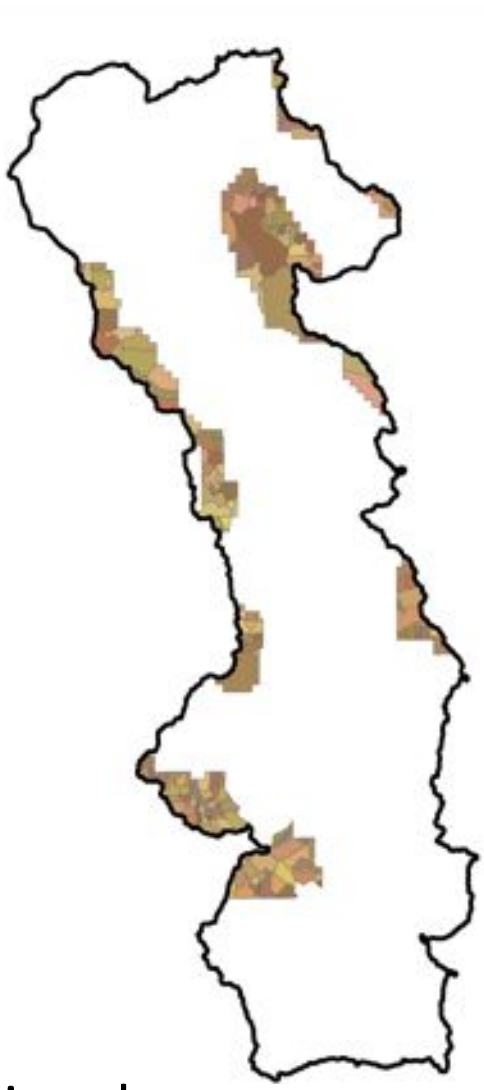
- Land Cover
- Ecosystem Services Mapping

Hydrology

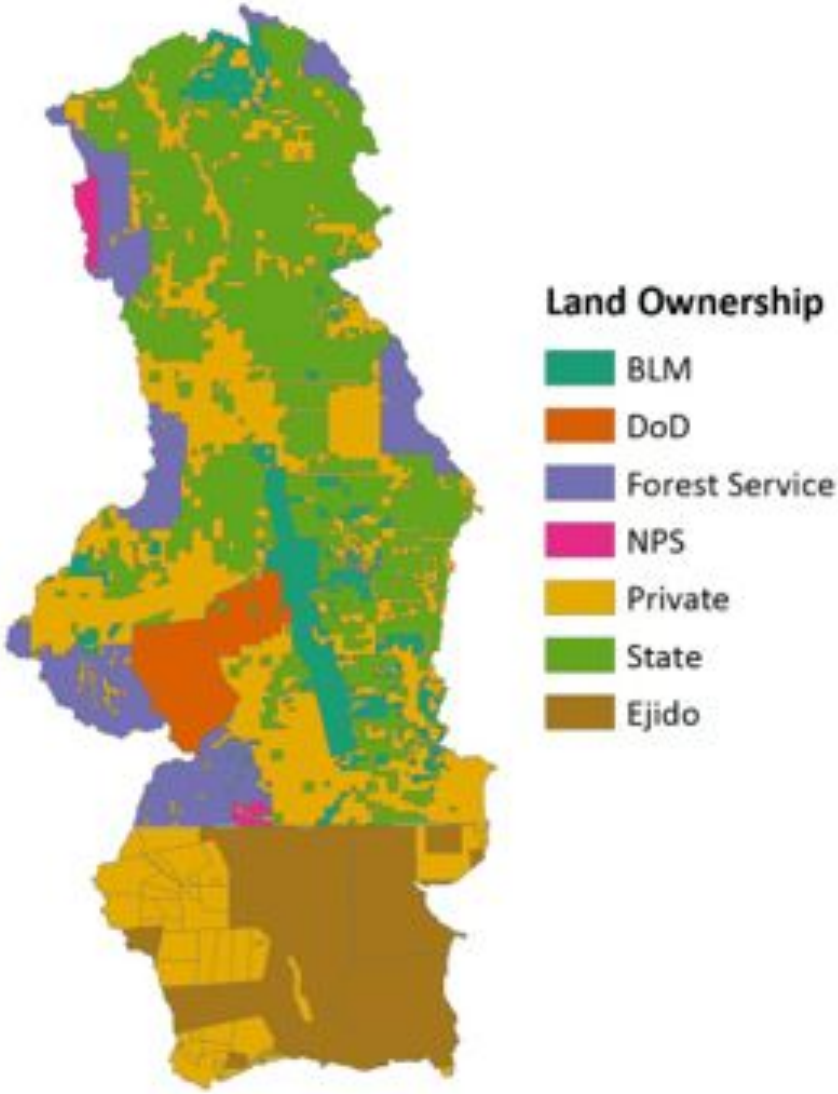
- Groundwater Model (MODFLOW)
- Wet/Dry River Mapping
- FAO Soils
- Automated Geospatial Watershed Assessment Tool (Runoff and Erosion)

Example Social Data

County/ International Boundaries

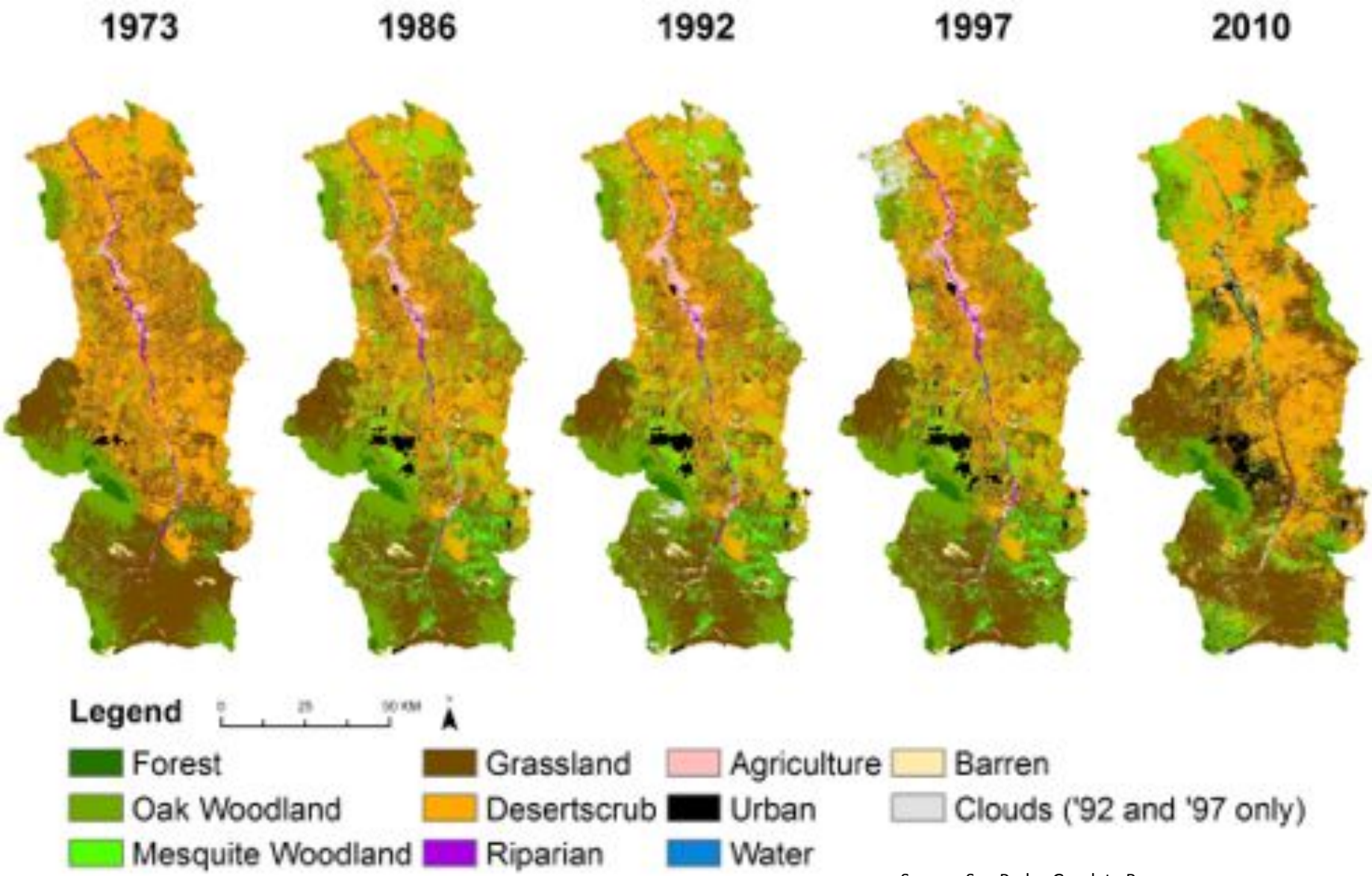


Pastures



Land Management

Land Cover GIS Data

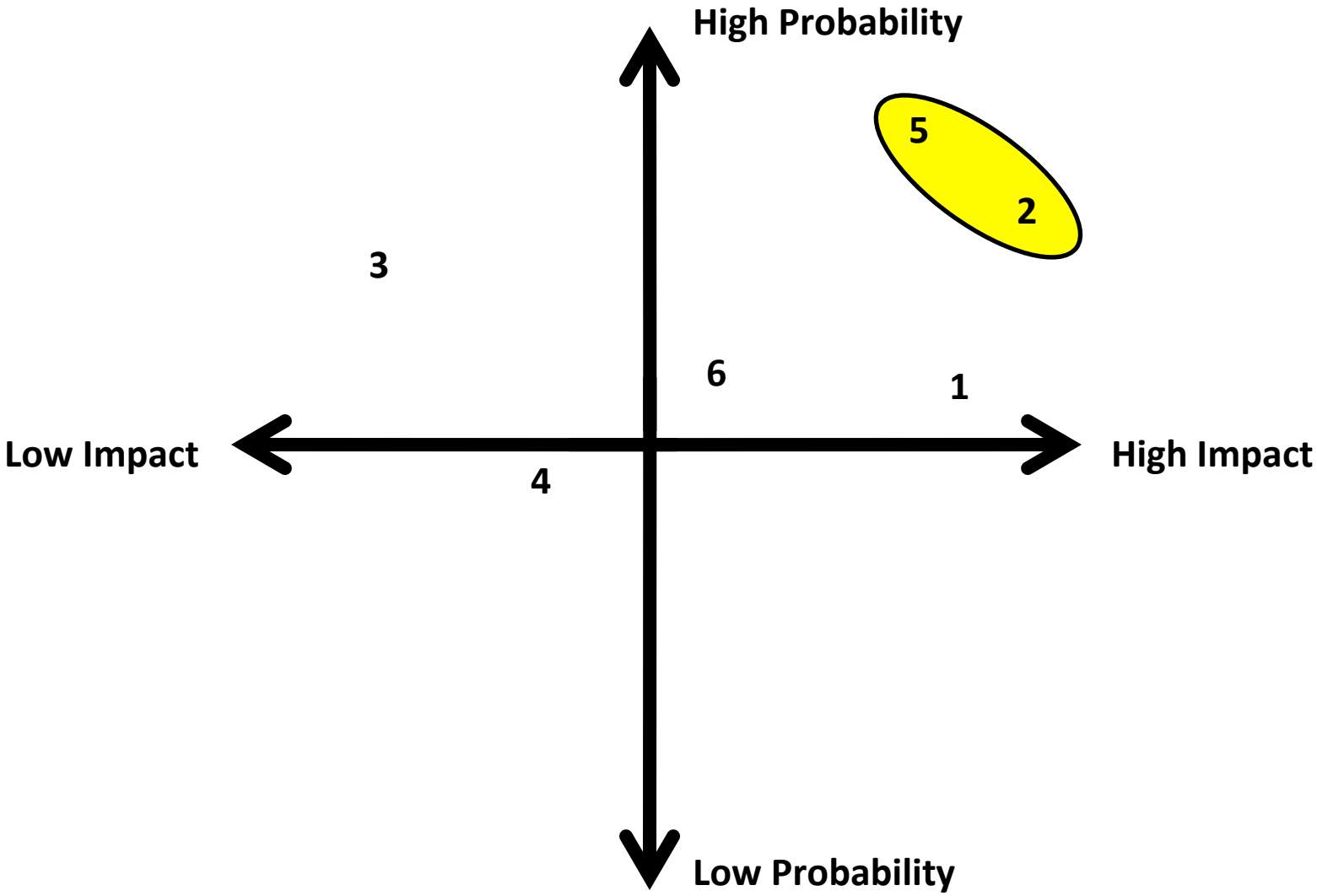


Source: San Pedro Geodata Browser

Probability-Impact for Social-Ecological Systems (SES) Scenario Assessment

		Potential for impact on SES	
		Low	High
Probability of Occuring	Low	**High-value, low-water crops replace grains**	**Ft. Huachuca closure**
	High	**Rapid invasion of non-native grasses**	**Drought frequency increases with climate change**

Scenario Development (Jan. 2013, 2014 workshops; 2015 planned)



Thanks

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http://aquasec.org/wrpg/research-projects/ecosystem-resilience/