

 Chris Scott, Randy Gimblett, Mitch Pavao-Zuckerman, Kevin Lansey, Tom Meixner, Stephanie Buechler, Ben Columbi, Barbara Morehouse, David Chan, Kate Curl, Moira Hough, Lily House-Peters, Hans Hutchison, Ryan Lee, Robin Lewis, Iman Mallakpour, Kirsten Neff, Raul Romo, Anne Browning-Aiken – UA
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 José Luis Moreno, students - Colegio de Sonora

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3

Important class of social-ecological systems

(SESs)

- valuable ecosystem services
- vulnerable to changing water demand and land-
- use
- vulnerable to climate change and variability
- high levels of recreational and human migration
- usage

SES structures and functions

- collapse and reorganization periodic w/
- multiple equilibria

Cross-scale SES responses

- from within and outside the watershed
- crucial influence of transborder context

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



RESERVA FORESTAL NACIONAL Y REFUGIO DE FAUNA SILVESTRE AJOS-BAVISPE



Photos: L. House-Peters

San Pedro River – U.S.







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Social and institutional response to climate change



Moving Forward from Vulnerability to Adaptation:

Climate Change, Drought, and Water Demand in the Urbanizing Southwestern United States and Northern Mexico



Avanzando desde la Vulnerabilidad hacia la Adaptación: El Cambio Climático, la Sequía, y la Demanda del Agua en Áreas Urbanas del



CASEBOOK Ambos Nogales • Puerto Peñasco • Tucson • Hermosillo

Edited by Margaret Wilder, Christopher A. Scott, Nicolás Pineda-Pablos, Robert G. Varady, and Gregg M. Garfin

Adapting Across Boundaries: Climate Change, Social Learning, and Resilience in the U.S.-Mexico Border Region

Margaret Wilder,* Christopher A. Scott,[†] Nicolás Pineda Pablos,[‡] Robert G. Varady,[§] Gregg M. Garfin,[¶] and Jamie McEvoy[#]

Annals of the Association of American Geographers, 100(4) 2010, pp. 917-928 (2) 2010

Wilder, M., et al. (eds). 2012. Moving Forward from Vulnerability to Adaptation: Climate Change, Drought, and Water Demand in the Urbanizing Southwestern United States and Northern Mexico - Casebook. Udall Center for Studies in Public Policy, University of Arizona, Tucson.







Ability to absorb disturbances, change and reorganize, but

still have the same basic structure and functioning

Reflects adaptive capacity of a system - includes the ability to

learn from the disturbance

1902

Rob Wu, Santa Rita Experimental Range

 $\dot{\sigma}$

- 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

Crossing thresholds can lead to collapse and reorganization of riparian systems: <u>Component</u> ecological communities

stream-aquifer interactions

water management

institutions

- native cottonwood, willow
- threatened by mesquite
- declines in shallow groundwater intercept streamflow
- land and water conservation do
- not counteract effects of growth
- agents' decision space influenced
- in manner that enhances or
- reduces risk of crossing thresholds



Lite and Stromberg. 2005. Biol. Cons. 125:152-167

seosystemistenyteesterteilinkeettoiwetten



	Condition	System State	Provisioning Services	Regulating Services	Supporting Services	Cultural Services	Multi- sectoral Tradeoffs
	Winter rain dominance of annual precipitation decreases	 Flow regime in river ESA litigation 		Ļ	Ļ	Ļ	Low
 Natural 	Annual precipitation overall decreases	 Flow regime in river Riparian ground water ESA litigation 	Ļ	ļ	Ļ	Ļ	Medium
	Mesquite cover increases	 Grassland cover Transpiration increases 	\longleftrightarrow	Ļ	\longleftrightarrow	↔	Low
	Riparian groundwater levels decreases	 Mesquite vs. Cottonwood /Willow cover Species richness 	ļ	Ļ	Ļ	ļ	Medium
	Urban cover in the watershed increases	 Groundwater levels decline Surface runoff increases 	ļ	ļ	Ļ	Ļ	High
	Increased water use by Cananea Mine	 Flow regime in river Water quality 					High
ogenic	Fort H. closes or missions are reduced	 Flow regime in river Groundwater levels increase 	Î	1	Î	Î	High
Anthrop	Water Supply Augmentation to Sierra Vista and SPRNCA	 Flow regime in river Groundwater levels increase 	Î	1	Î	Î	High

Linking Traits to Ecosystem Services





UppenSan Pedro River Groundwater Withdrawal (1900-2005)



SPRNCA Designation (1988)



Pre-1988



Post-1995



Agricultural fields between Rayon and Cucurpe



Small Dam



Agricultural fields adjacent to the river

Landsat Imagery

Data

1984 1990 1994

2005

2010

1999

May 3 May 4 October 11 May 15 October 22 May 13 October 4 May 13 October 20 May 11 October 2

Methods Landsat Imagery





Unsupervised Classification





Normalized Difference Vegetation Index (NDVI)

Pre-Monsoon (May)

Rio

Post-Monsoon (Oct.)





Nater

Imigated Agriculture

Forest

Barren

San Pedro River Land Cover (5km Riparian Buffer) 1984-2010



Modeling Coupled Natural-Human Systems

Models provide:

- -a better understanding of CNH systems
- -a method to examine future conditions of proposed ecohydrological and societal changes

-an interactive tool non-experts and experts can use to understand impacts of human disturbances

Challenges in Modeling CNH Systems

or

How to turn this...





- must re-envision a dynamic system as a series of feedbacks



- Determine how the different components interact

What changes?



- Now to get this into a computer...



-Incorporate the influence of exogenous factors



Bayesian Belief Networks

- Parameterize workshop results in probability functions
- Build probability functions for decisions and drivers
- Simulate probabilities in ABM using scenarios



Figure 3. Example network model for riparian trees

Potential for impact on SES

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Integration in secondaseo model (ABM) Stool a la ceston su pontsystem (DSS)

Field research and characterization of functional relationships

> Functional relationships & constraints

Decision support system development

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User interface (graphical/tabular/GIS)

Resource decisions

Decision rules &

scenarios

System responses

Decision-maker response e evaluation, & feedback

Agent-based model development and user interaction

Decision evaluation and rule refinement

Figure 4. Schematic of model design

http://udallcenter.arizona.edu/wrpg/cnh/

Strengthening Resilience of Arid Region Riparian Corridors

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Strengthening Resilience of Arid Region Riparian Corridors Desiryhology and Decision-Valuing in the Seriera and San Pedro Watershees

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http://riparianres.blogspot.com/

THURSDAY, JANUARY 20, 2011

Riparian resilience in the San Pedro and Rio Sonora watersheds

The purpose of this blog will be for enhanced communication between the members of the Riparian Restlience CNH team (http://udaticenter.arizona.edu/orpg/cnh/) and the interested public.

Photos:



San Pedro riparian corridor, November 2010