



COLLEGE OF AGRICULTURE & LIFE SCIENCES  
COOPERATIVE EXTENSION

# **WATER RESOURCES RESEARCH CENTER**

## **Water Management Challenges, Pathways to Solutions, and Collaboration Opportunities**

**International Workshop on Sustainable Development of Arid Lands  
Workshop Organized by the Prince El Hassan bin Talal Faculty of Arid  
Lands at the Hashemite University**

**Dr. Sharon B. Megdal, Director  
smegdal@email.arizona.edu**

**14 April 2019**

**[wrrc.arizona.edu/TAAP](http://wrrc.arizona.edu/TAAP)**

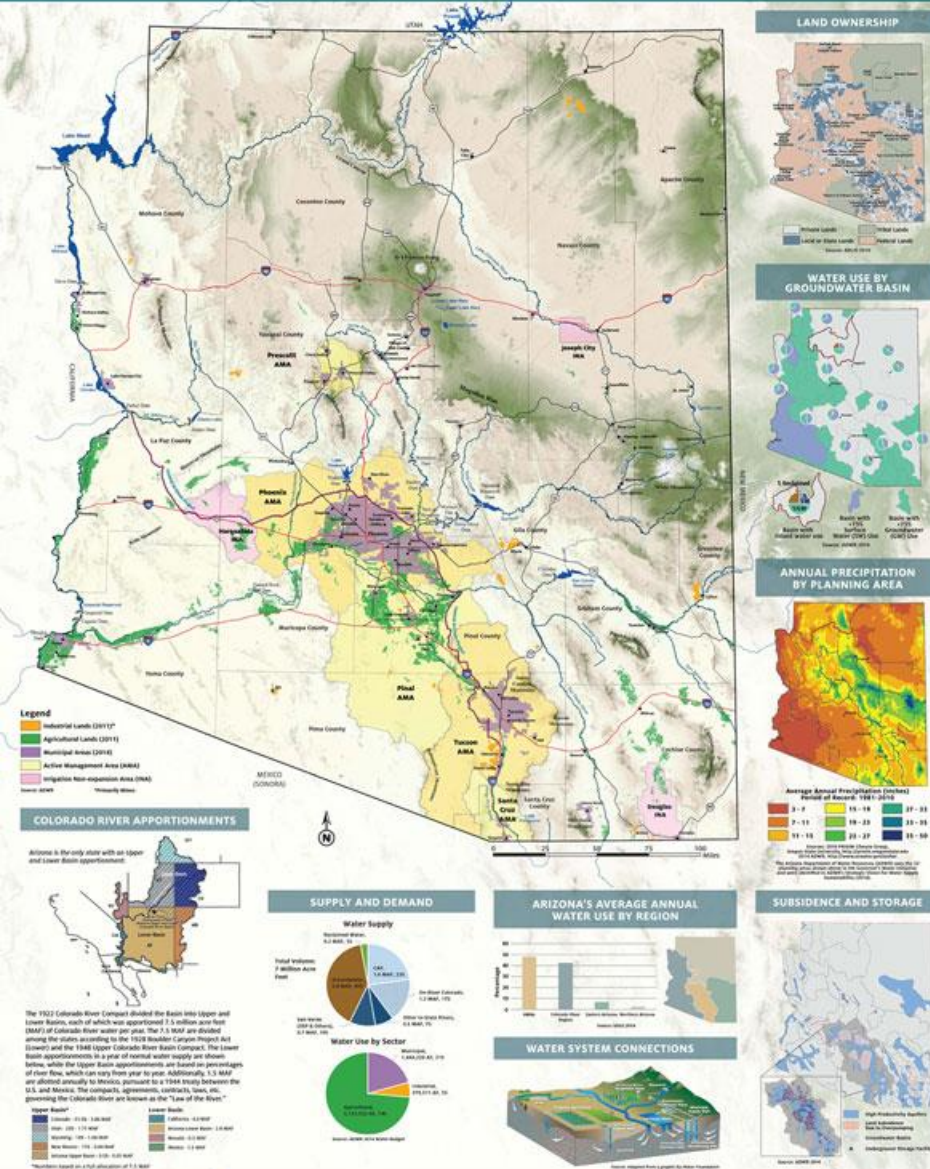


Photo credit: Central Arizona Project

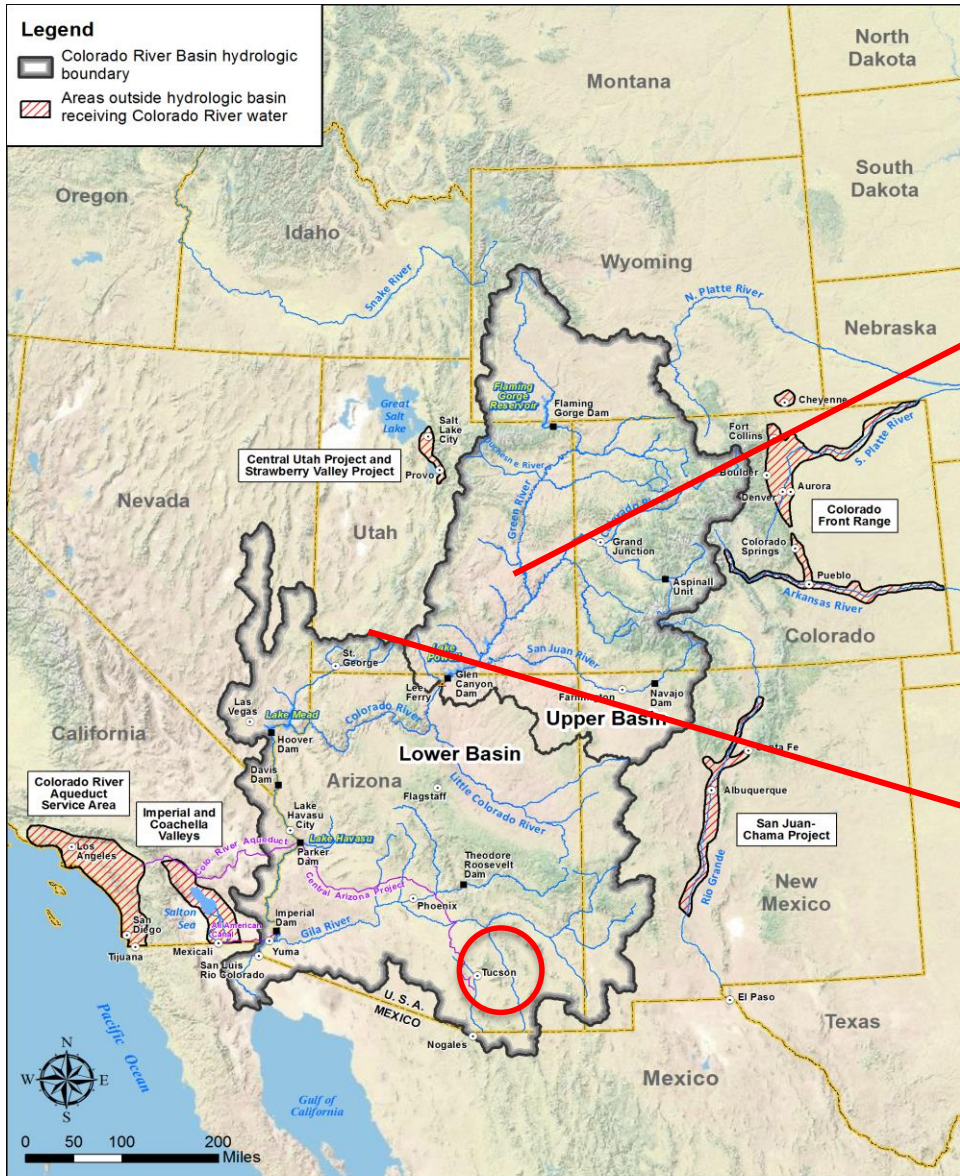


Arizona Land Area is 3.3 times Jordan  
 Population ~ 7.2 million  
 Elevation ranges from about sea level to  
 3,851 m

# Water policy and management reflect many factors

- Resource Availability
- Location of water demands and supplies
- Economics
- Historic and Current Legal/Institutional Framework
- The nature of involvement of multiple governmental and non-governmental entities, including the extent of centralized versus decentralized decision making
- Politics of Area
- Public values and socio-cultural factors
- Historical context
- Information
- Etc...      Importance of Context, especially hydrologic cycle and geographic

# Colorado River Basin



Glen Canyon Dam and Lake Powell



Hoover Dam and Lake Mead

# Long-term drought + over-allocation => Drought Contingency Plan



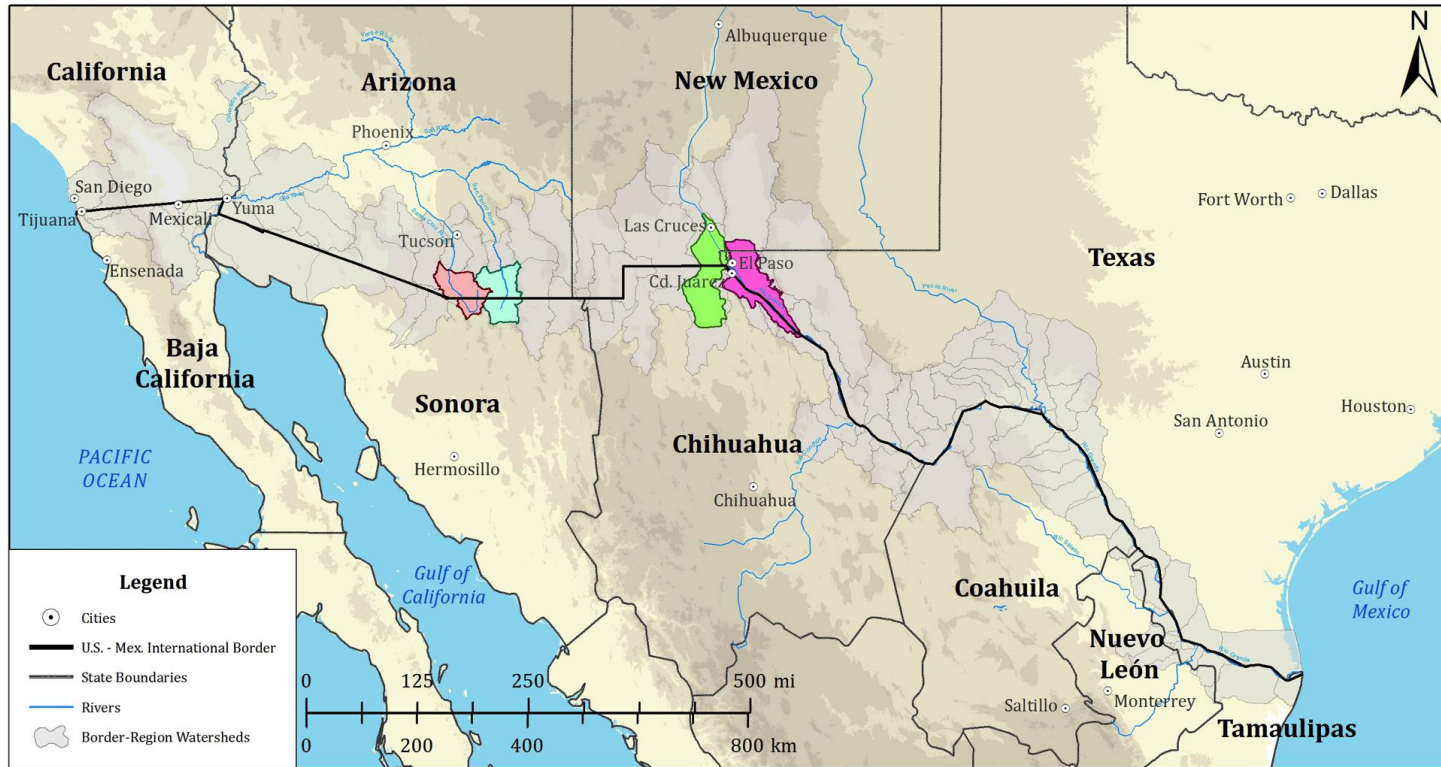
Photo credit: Rudolfo Peón 2015

# Underground Storage and Recovery (Managed Aquifer Recharge)



# The Transboundary Aquifer Assessment Program (TAAP)

## Transboundary Aquifer Assessment Program Aquifers of Focus




# Completion of the San Pedro Report


Binational work group for the states of Arizona, US and Sonora, MX 11 April 2019




**EL ESTUDIO**  
**THE BINATIONAL** **BINACIONAL SOBRE**  
**STUDY OF THE**  
**EL ACUÍFERO**  
**TRANSBOUNDARY**  
**SAN PEDRO AQUIFER** **TRANSFRONTERIZO**  
**SAN PEDRO**




THE UNIVERSITY OF ARIZONA





USGS  
science for a changing world



CONAGUA  
COMISIÓN NACIONAL DEL AGUA


**The Transboundary Aquifer Assessment Program (TAAP)** is a joint effort between Mexico and the United States to evaluate shared aquifers. Under this program, scientists from each country collaborate on producing binational studies on shared waters. The Mexican and U.S. Principal Engineers of the International Boundary and Water Commission (IBWC) signed the "Joint Report of the Principal Engineers Regarding the Joint Cooperative Process United States-Mexico" for the TAAP. This IBWC "Joint Report" serves as the framework for coordination and dialogue to implement these studies.

*The Binational Study of the Transboundary San Pedro Aquifer* is a milestone output of this joint effort. Both countries contributed scientific knowledge and data on climate, geology, soils, land cover, land use, and hydrology. The report compiles and creates a database of scientific information and identifies data gaps and information to be updated in subsequent phases.

**El Programa de Evaluación de Acuíferos Transfronterizos** es un esfuerzo conjunto entre México y Estados Unidos para evaluar acuíferos compartidos. Bajo este programa, científicos de cada país colaboran para producir estudios binacionales sobre aguas compartidas. Los Ingenieros Principales de la sección mexicana y estadounidense de la Comisión Internacional de Límites y Aguas (CILA) firmaron el "Informe Común Referente al Proceso de Cooperación Conjunta México-Estados Unidos Para El Programa de Evaluación de Acuíferos Transfronterizos". Este "Informe Común", sirve como marco de referencia en la coordinación y diálogo para la implementación de estos estudios.

*El Estudio Binacional sobre el Acuífero Transfronterizo San Pedro* es uno de los logros principales de este esfuerzo conjunto. Ambos países contribuyeron con conocimiento científico y datos acerca del clima, geología, tipo, cobertura y uso de suelo e hidrología. El estudio compila y crea una base de datos de información científica e identifica datos faltantes e información que necesita ser actualizada en fases subsiguientes.

**The San Pedro Aquifer**



**Acuífero del Río San Pedro**



**Full report:**  
[https://ibwc.gov/EMD/reports\\_studies.html#WQ\\_Reports](https://ibwc.gov/EMD/reports_studies.html#WQ_Reports)




**Informe completo:**  
[www.cila.gob.mx/sa/ebatrsp2016.pdf](http://www.cila.gob.mx/sa/ebatrsp2016.pdf)

For more information, please visit:  
[cila.sre.gob.mx/cilanorte](http://cila.sre.gob.mx/cilanorte)  
 IBWC.gov  
[wrrc.arizona.edu/TAAP](http://wrrc.arizona.edu/TAAP)

Para más información por favor visite:  
[cila.sre.gob.mx/cilanorte](http://cila.sre.gob.mx/cilanorte)  
 IBWC.gov  
[wrrc.arizona.edu/TAAP](http://wrrc.arizona.edu/TAAP)



**BINATIONAL STUDY OF THE TRANSBOUNDARY SAN PEDRO AQUIFER**







Final Report 2016

**ESTUDIO BINACIONAL SOBRE EL ACUÍFERO TRANSFRONTERIZO DEL RÍO SAN PEDRO**

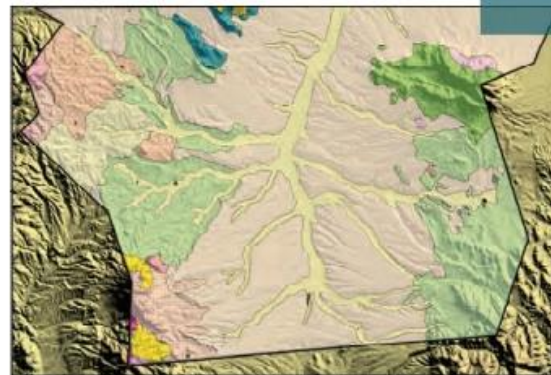
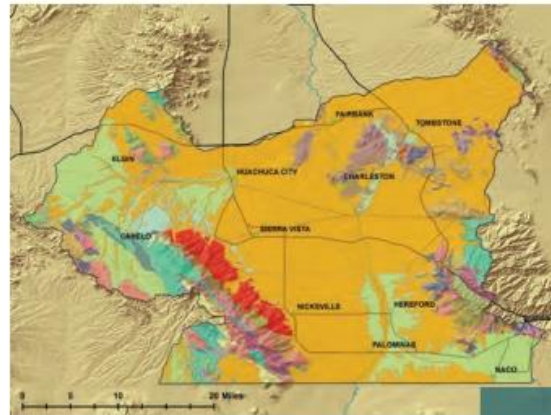
Informe Final



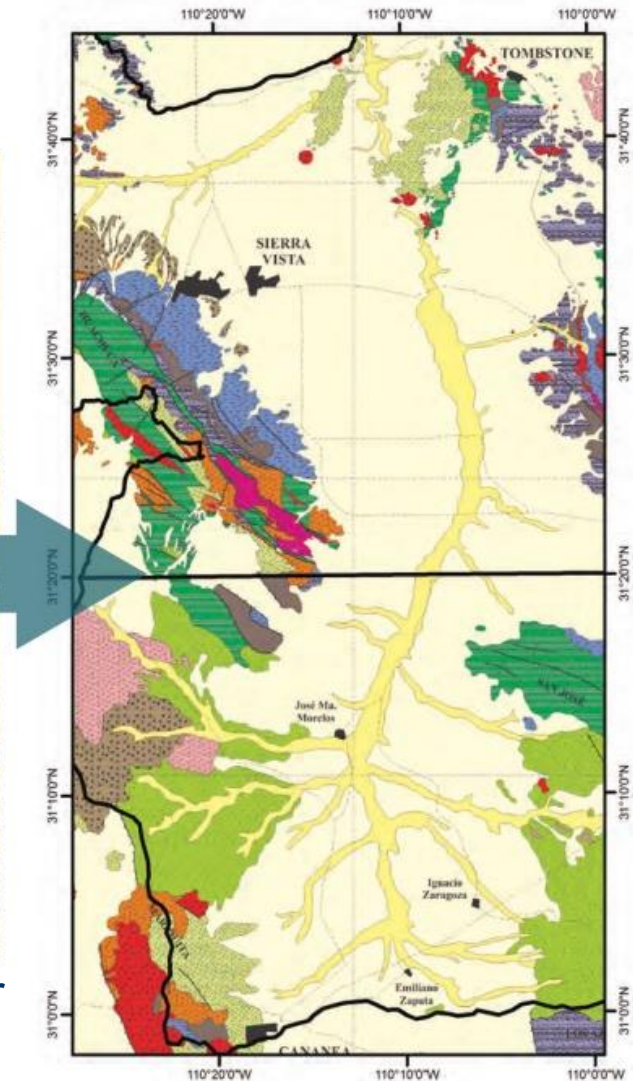
# Mapping Challenges



US side of the border



Mexico side of the border



- Merging different classification systems.
- Harmonization of measurement units.
- Different cartographic preferences.

# Mutual respect and trust are fundamental to collaboration of any type, including across disciplines

Journal of Hydrology: Regional Studies 20 (2018) 60–73

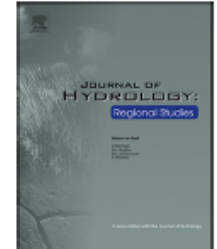


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Journal of Hydrology: Regional Studies

journal homepage: [www.elsevier.com/locate/ejrh](http://www.elsevier.com/locate/ejrh)



Findings and lessons learned from the assessment of the Mexico-United States transboundary San Pedro and Santa Cruz aquifers: The utility of social science in applied hydrologic research



J.B. Callegary<sup>a,\*</sup>, S.B. Megdal<sup>b</sup>, E.M. Tapia Villaseñor<sup>b</sup>, J.D. Petersen-Perlman<sup>b</sup>, I. Minjárez Sosa<sup>c</sup>, R. Monreal<sup>c</sup>, F. Gray<sup>a</sup>, F. Grijalva Noriega<sup>c</sup>

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# **Sampling of University of Arizona Research – Outreach Efforts Transdisciplinary, Interdisciplinary**



# **Agrivoltaics: Co-location of renewable energy + agriculture = win-win-win for water, energy, & food**

*We are harvesting the sun twice!*

- **Shade from panels = reduces evaporation of irrigation water resources**
- **Shade from panels = improves plants growth because of reduced temperature and drought stress**
- **Transpiration from plants = actually cools panels overhead, increasing their efficiency**



*Source: Professor Greg Barron-Gafford [www.GreeningEnergy.org](http://www.GreeningEnergy.org)*

<https://wrrc.arizona.edu/events/brown-bag/agrivoltaics-co-locating-agriculture-and-photovoltaics-increase-food-and-energy>

Biosphere2, Univ of Arizona



Researcher Greg Barron-Gafford and undergraduate research assistant Dan Blackett tend to the greens at the agrivoltaic test site at Biosphere 2. (Photo: Bob Demers/UANews)

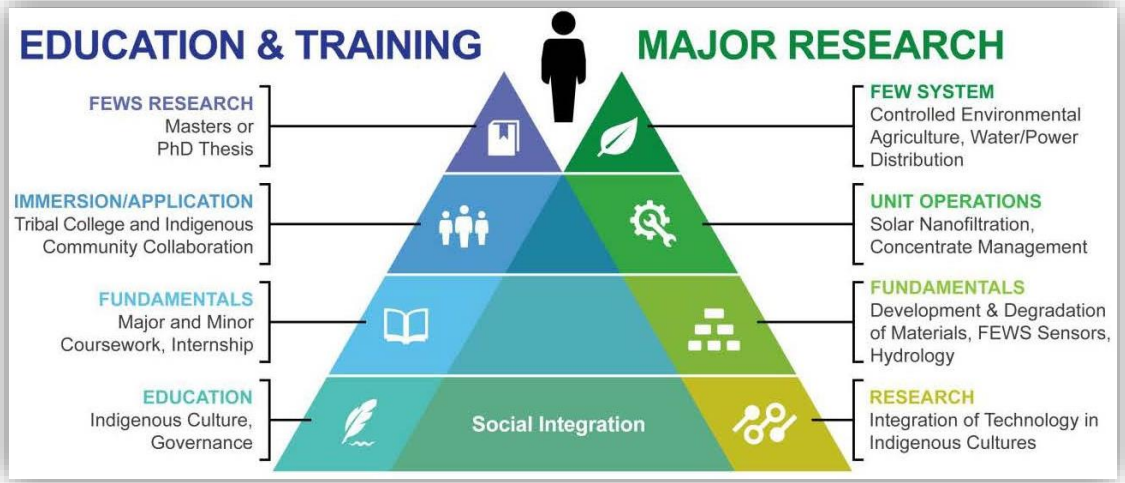
# Indige-FEWS: Indigenous Food, Energy, & Water Security-Sovereignty



## & Water Security-Sovereignty

*Majority of 370 million indigenous people do not have secure access to FEW*

**GOAL:** Develop a diverse workforce with intercultural awareness and FEWS expertise to address FEWS challenges in indigenous communities.



**RESEARCH:** Development of novel and sustainable solutions for off-grid production of safe drinking water, brine management operations, and controlled environment agriculture systems.



**Source: Professor Karletta Chief**

# Indige-FEWSS Vision



*Majority of 370 million indigenous people do not have secure access to FEW*

Inter-cultural awareness

Water & Food Security

Develop Diverse Workforce

FEWS expertise

12 trainees (9 PhDs, 3 MS)  
42% Native American  
58% Minorities  
50% Male & Female

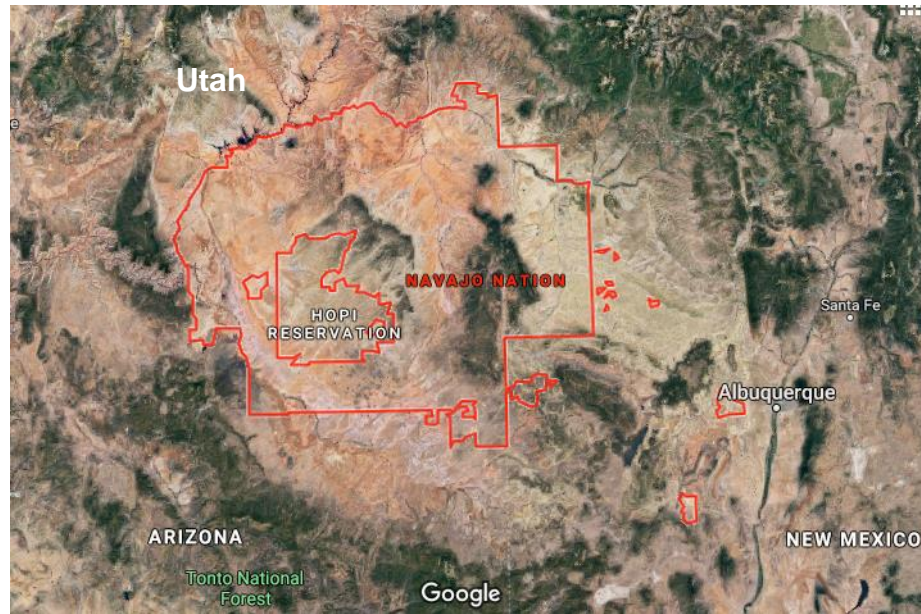
Water & Ag Tech



**Source: Professor Karletta Chief**



# The Navajo Nation land area is about 80% that of Jordan



3/29/2019

Indige-FEWSS Spring Break Immersion in Navajo Country | Institute for Energy Solutions



Torran Anderson

Fellow, Caitlyn Leo, fills a bucket to help with water hauling for a community member in Tuba City, AZ

## Indige-FEWSS Spring Break Immersion in Navajo Country

Monday, March 25, 2019



"It was an incredible honor to be allowed to learn some of the oral histories of the Navajo people," said Indige-FEWSS fellow, Kyle Boyer.



# Udall Center for Studies in Public Policy – Professor Chris Scott, Director

## *Water security*

Science-policy approach

Focus on institutions,  
governance, decision-making

Water-scarce regions comparison

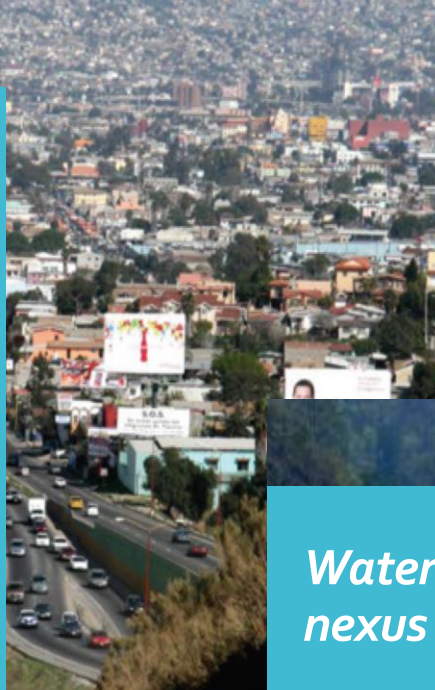
Arizona, Southwest U.S.

Mexico

International

Transboundary waters

U.S.-Mexico border



## *Water energy-food nexus*

Resource nexus, infrastructure

Groundwater pumping, agriculture

Hydropower-irrigation tradeoffs

Wastewater reclamation, reuse

Desalination

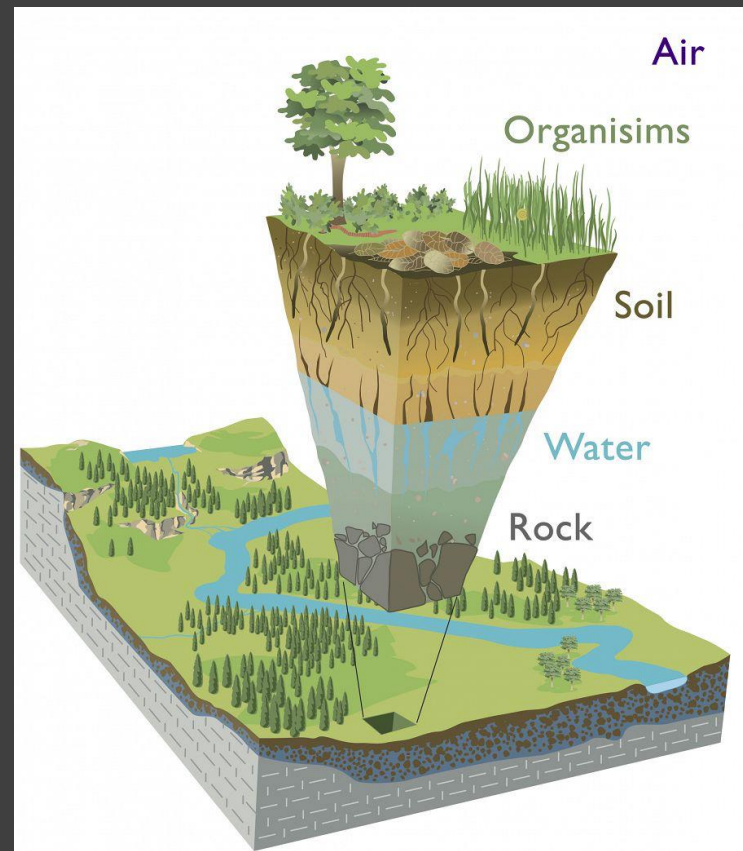
Nexus institutions and policy

Decision-making

Climate adaptation and resilience

# Water, soil, rock weathering, life, and landscapes

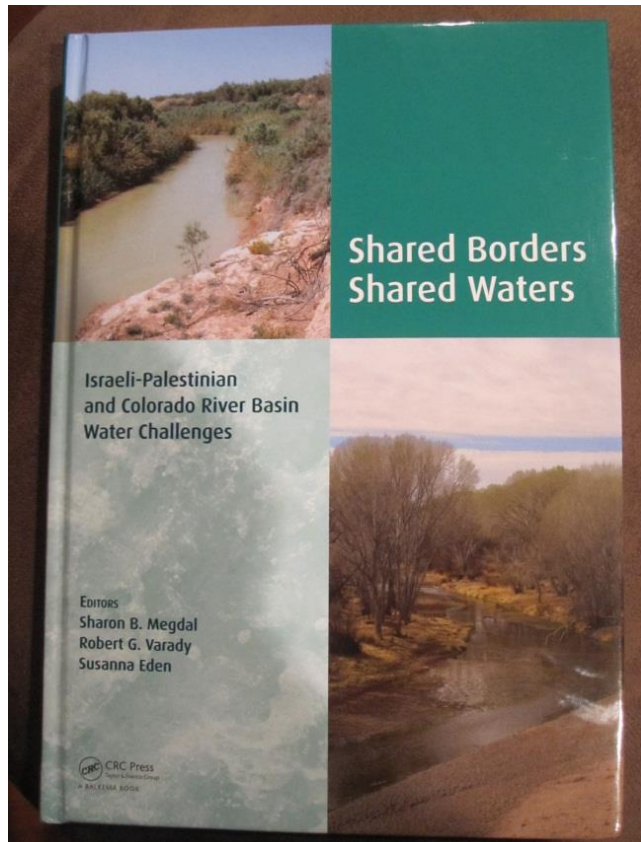
- How does water, carbon, and energy flux control the long-term evolution of the “critical zone”?
- UA-led “Catalina-Jemez Critical Zone Observatory”, one of nine funded nationwide by NSF.
- Intensively instrumented field sites that track the transport and reactions mediated by water from lower atmospheric boundary to impermeable bedrock.



# Water Reuse



# Similarities across our regions make for fruitful collaborations



Shared Borders  
Shared Waters

Israeli-Palestinian  
and Colorado River Basin  
Water Challenges

Editors  
Sharon B. Megdal  
Robert G. Varady  
Susanna Eden

CRC Press  
Taylor & Francis Group  
A BALKEMA BOOK

Journal of Arid Environments 112 (2015) 109–123

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Journal of Arid Environments

journal homepage: [www.elsevier.com/locate/jaridenv](http://www.elsevier.com/locate/jaridenv)

A tale of two rivers: Pathways for improving water management in the Jordan and Colorado River basins

Assaf Chen <sup>a,\*</sup>, Adam Abramson <sup>b</sup>, Nir Becker <sup>c</sup>, Sharon B. Megdal <sup>d</sup>



RSS Grey Water Project  
Research Team  
November 2012



الجمعية العلمية الملكية  
Royal Scientific Society



*Water* 2012, 4, 580-596; doi:10.3390/w4030580

OPEN ACCESS

*water*

ISSN 2073-4441

[www.mdpi.com/journal/water](http://www.mdpi.com/journal/water)

Article

**Grey Water Reuse for Agricultural Purposes in the Jordan Valley: Household Survey Results in Deir Alla**

Othman A. Al-Mashaqbeh <sup>1,\*</sup>, Ayouf M. Ghrair <sup>1</sup> and Sharon B. Megdal <sup>2</sup>

# Collaborations, Sharing Experiences



International Boundary and Water Commissioners visit, November 2016

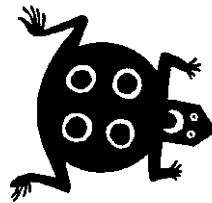


International Arid Lands Consortium Board Members visit, September 2017



# Shukran!

The frog does not drink up the pond  
in which he lives. – *American Indian  
(Lakota) Proverb*



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