COLLEGE OF AGRICULTURE & LIFE SCIENCES
COOPERATIVE EXTENSION

WATER RESOURCES RESEARCH CENTER

# Developing Pathways to Solutions to Wicked Water Problems

Dr. Sharon B. Megdal, Director

Water Resources Research Center Brown Bag Webinar

6 May 2020

smegdal@arizona.edu

**wrrc.arizona.edu**

# Outline

- Motivation for this seminar
- Some context
- What are Wicked Water Problems?
- Exploring some Wicked Water Problems
- Developing pathways to solutions
- Bridging through water and the value to sharing lessons learned
- Concluding remarks

# SABBATICAL WATER POLICY AND MANAGEMENT LECTURE TOUR

**Announcement and Call for Invitations for January – July 2020**

**Sharon B. Megdal, Director, University of Arizona**
**Water Resources Research Center**

I am pleased to announce my sabbatical plans for the Spring 2020 semester and inquire if you might be interested in inviting me to give a hosted lecture. The goals of my sabbatical are **(1)** to share knowledge and perspectives I have gained through applied research, teaching, and Extension activities and programs and **(2)** to engage with more audiences than I can during a typical semester. I look forward to gathering feedback and gaining knowledge from my interactions with those with a strong interest in water policy and management. I am seeking funding for my travel and, when possible, I would appreciate a speaking honorarium. Below please find a list seminar topics to give you an idea of the subjects on which I am prepared to speak. I can of course customize to your organization and audience. A short bio and full CV are attached.


### Arizona Water Management

Arizona is a leader in groundwater management in designated active management areas and in water banking and aquifer recharge and recovery. The state's statutory framework and approach can serve as a model for other regions.


### Colorado River Basin Water Issues

River Basin (Arizona, California, and Nevada) and including cooperation between the U.S. and Mexico. Colorado River management is unique and complex. This presentation will include discussion of drought planning and ways to address the gap between demand and supply in parts of the basin. This can include screening and discussion of regional Emmy-award-winning *Beyond the Mirage* Documentary (approximately 1 hour running length).


### Groundwater Governance and Management

This presentation draws from an extensive body of work on groundwater governance and management at the local, regional, and national levels. It also draws from experience working with international partners.


### Comparative Analysis of Water Policy Practices for Water-Scarce Regions

This presentation will include insights from working internationally on water issues of the Middle East region, particularly Israel, Jordan, and the West Bank. Along with exploring the range of solutions, this presentation will explore the feasibility of transferring solutions from one region of the world to another.


### Transboundary Aquifer Assessment

I will draw upon over a decade of successful collaboration at the US-Mexico border that has produced binational and bilingual aquifer studies. The cooperative framework governing the Transboundary Aquifer Assessment Program can serve as a model for others interested in conducting transborder scientific assessments.


### Wicked Water Problems and Bridging Through Water

Water challenges exist in both water-rich and water-scarce areas. The presentation will include analysis of some of the challenging water issues and potential solutions to them and include discussion of how to bridge the academic community and the real world of water management.

smegdal@email.arizona.edu • (520) 621-9591


**Photos (clockwise from top left):** Seminar at the Institute of Water Policy, Lee Kuan Yew School of Public Policy, National University of Singapore; Marina Barrage; Dr. Sharon B. Megdal with Director Dr. Eduardo Araral and Deputy Director Dr. Corinne Ong, Institute of Water Policy; PUB NEWater bottled water; PUB NEWater Visitor Centre and Treatment Plant; Punggol Waterway, ABC Water Catchment Programme

## Reflections: Singapore – A Model for Integrated Water Management

*by Sharon B. Megdal*
02/07/2020

[wrrc.arizona.edu/reflections](wrrc.arizona.edu/reflections)


Jerusalem, March 7, 2020

Sharon B. Megdal and David Lehrer, Executive Director, Arava Institute for Environmental Studies

## Reflections: Being on Sabbatical During the COVID-19 Pandemic

*by Sharon B. Megdal*
03/20/2020

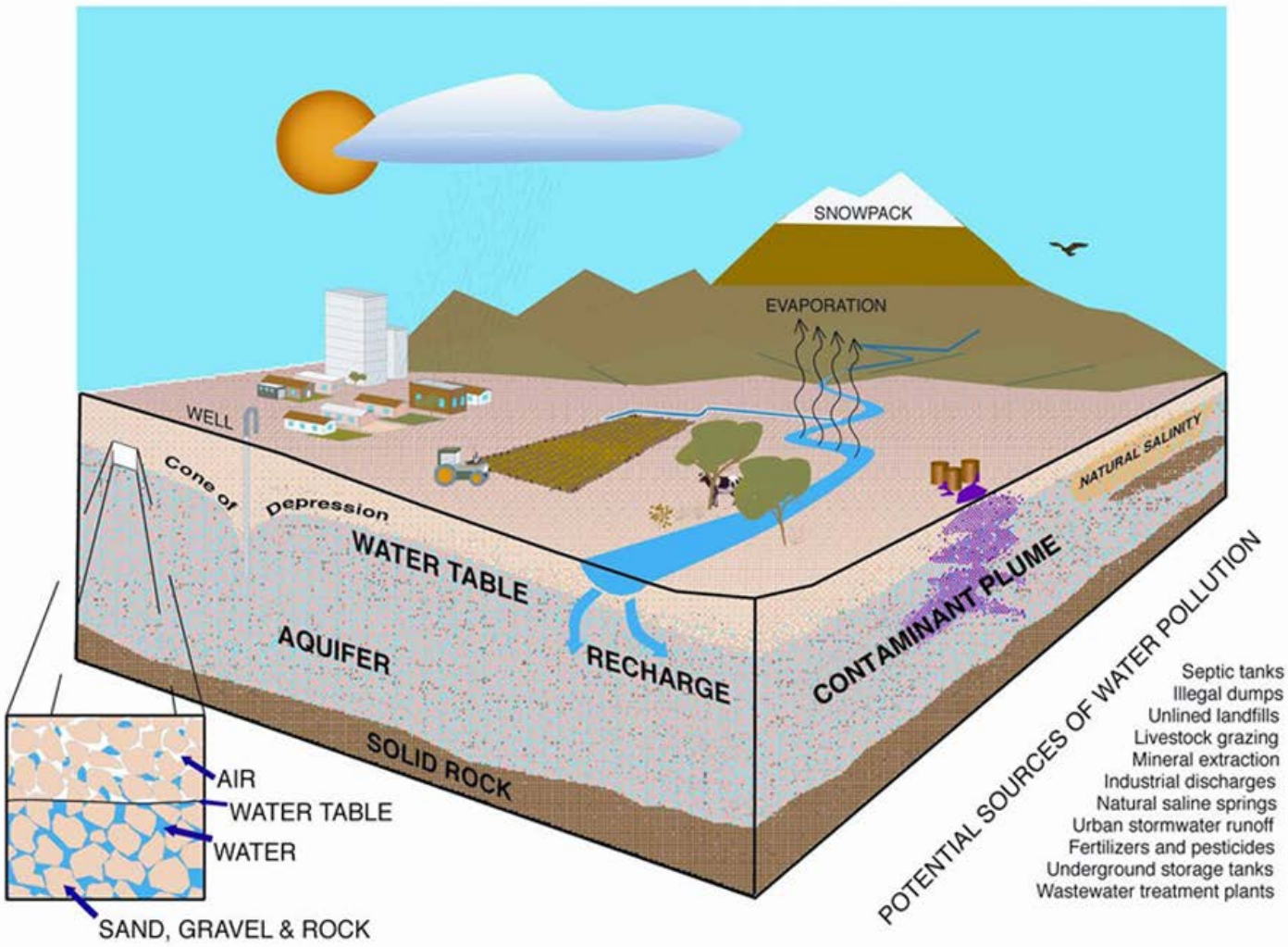
This is the second *Reflections* on my Spring Semester sabbatical activities. While a sabbatical

# Water policy and management reflect many determining 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

# Water Cycle Context

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Source: The University of Arizona Water Resources Research Center, Water Map Poster (Version 2).

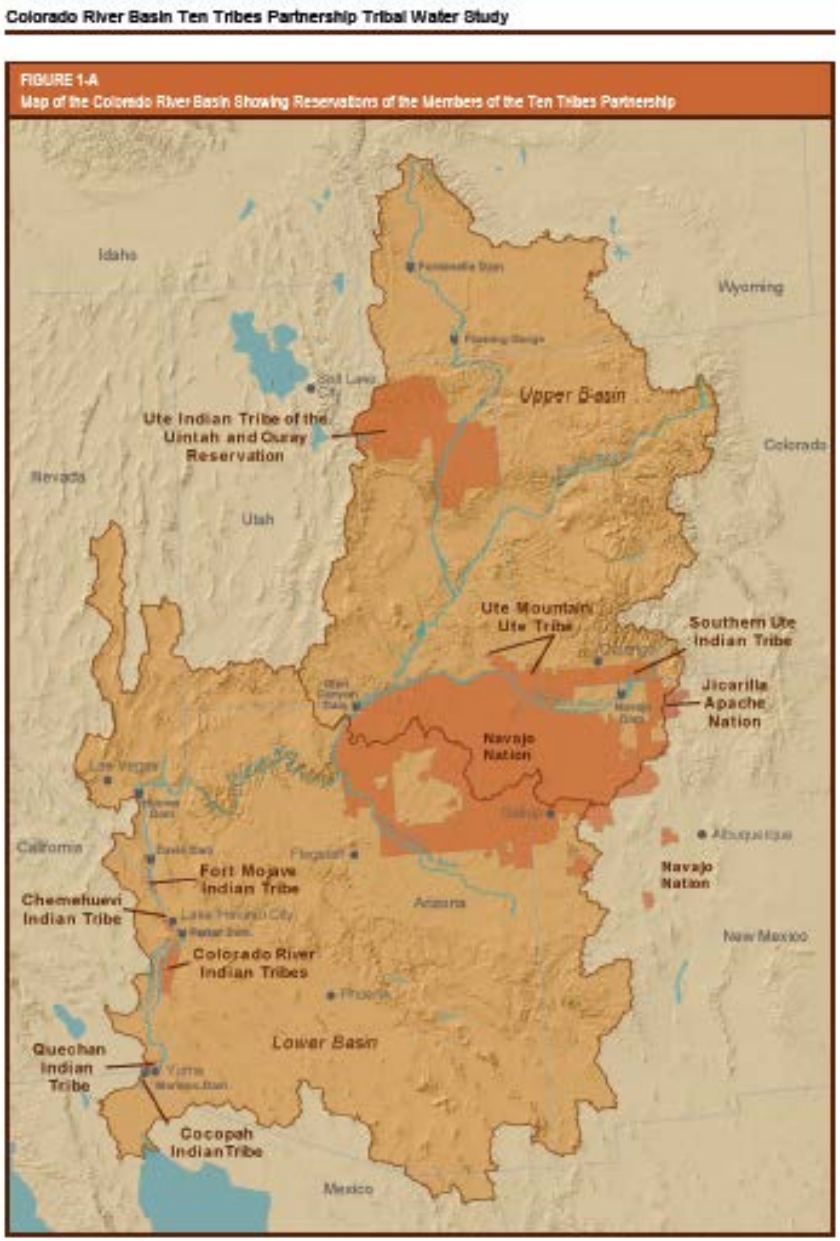
# Colorado River Basin and Border Geographic Context

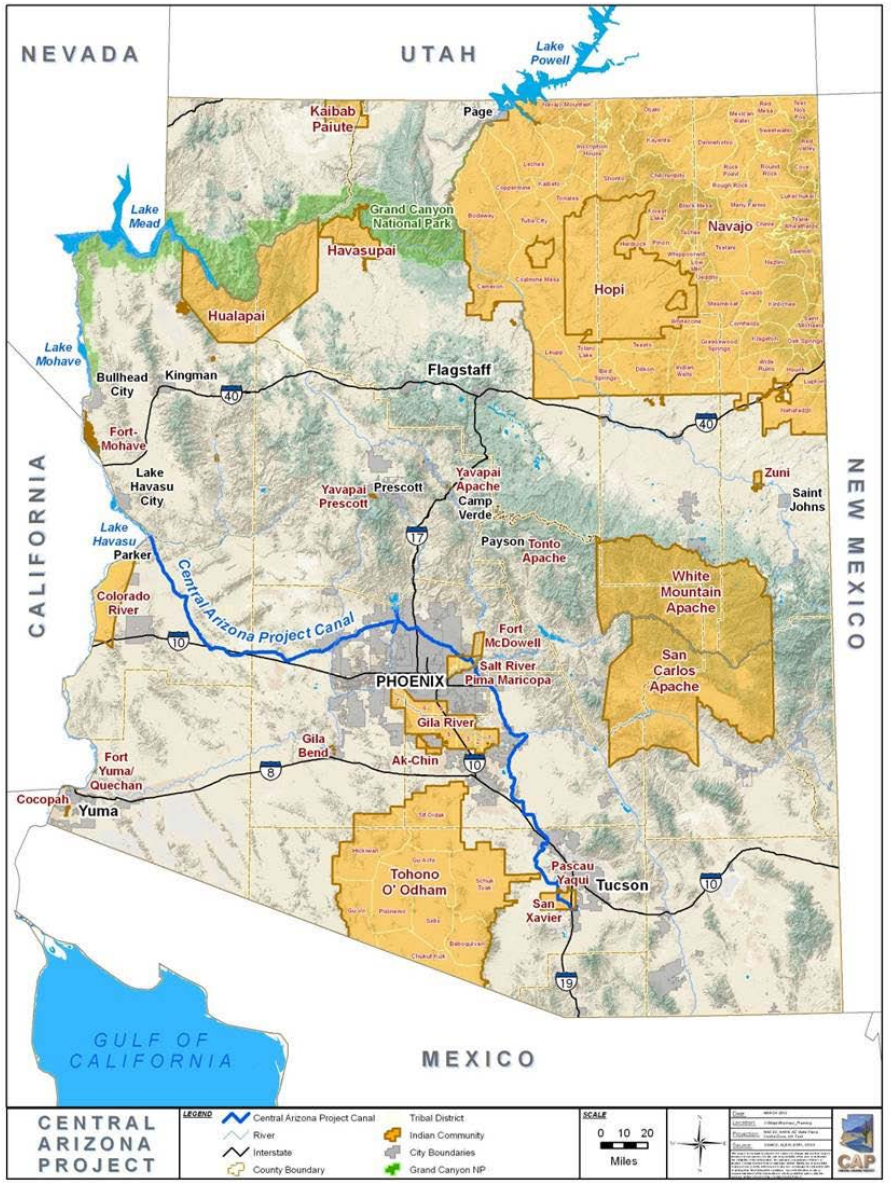

Lake Mead

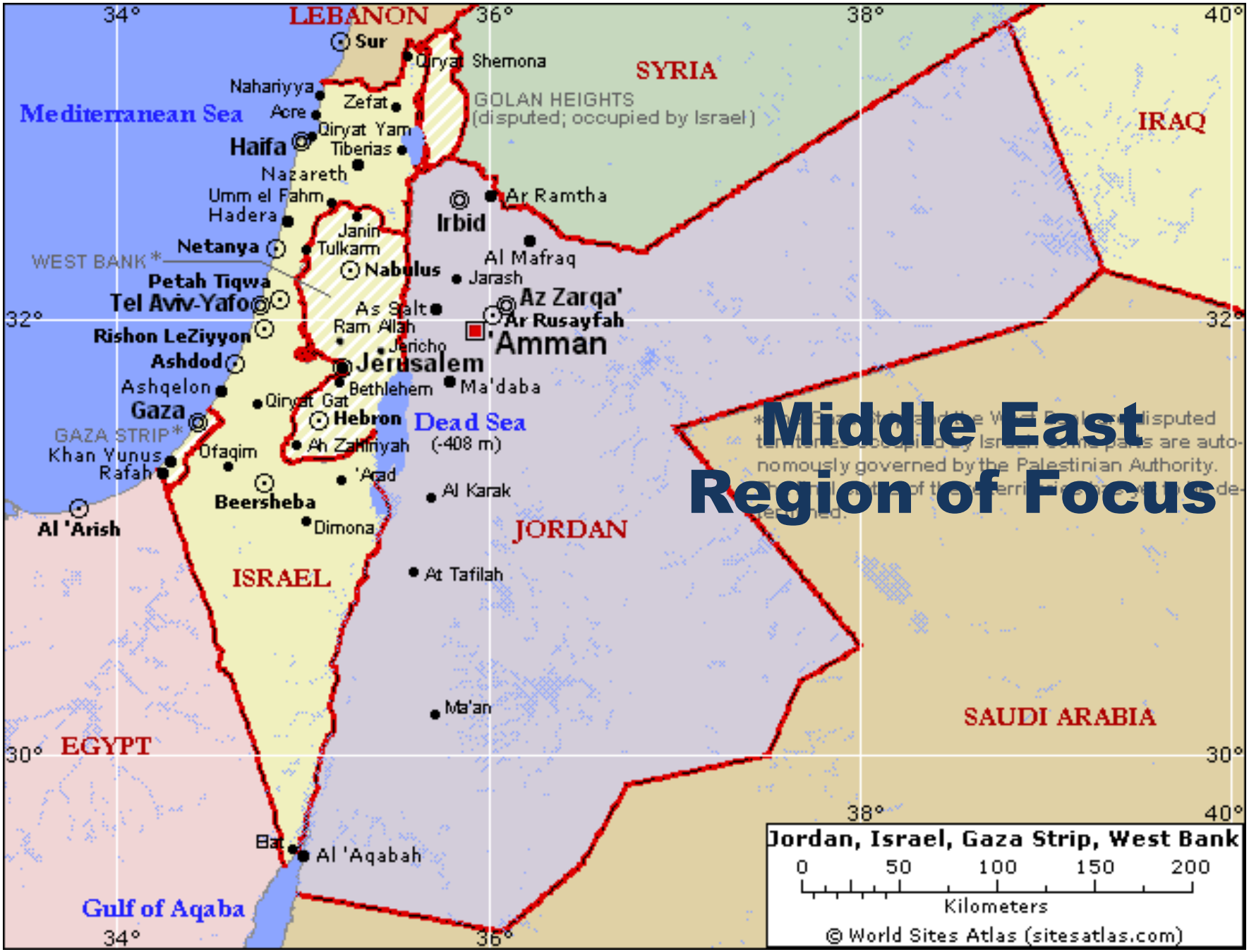



Hoover Dam and Lake Mead

# Sovereign Tribal Nations






# Middle East Region of Focus

SOURCE: http://travelquaz.com/jordan-map-free.html/political-map-of-israel-jordan-and-the-israeli-occupied

# Complex Water Management Issues, Challenges, and Solutions

- Growth and the need for additional supplies (competition)
- Drought/climate variability
- Water-energy-food nexus
- Water quantity assessments, flooding
- Water quality
- Desalination
- Use of recycled water for potable and other water needs
- Access to and utilization of renewable supplies
- Transboundary water issues
- The surface water/groundwater interface
- Riparian areas and other environmental considerations
- Water rights
- Conservation programs
- Water recharge and recovery (water banking)
- Groundwater replenishment
- Water cost/pricing and financing
- Water Planning

**Uncertainty!**

# Wicked Water Problems

Lisa Beutler (2016)

- "Lately, more and more water problems seemingly defy standard solutions."
- Four reasons
  - incomplete or contradictory knowledge
  - the number of people and opinions involved
  - the large economic burden
  - the interconnected nature of these problems with other problems

Special Feature

## What to Do about Wicked Water Problems

By Lisa Beutler, Public Affairs Specialist, MWH Global

It's a rare day when western water managers don't check the weather. A defining feature of this geographic region of the United States is a lack of precipitation. A second feature is great faith by its people in a technical solution to whatever problem a lack of rain creates.

Long before Europeans arrived, predecessors to the Hohokam people migrated from central Mexico to southern Arizona, bringing domesticated crops and their knowledge of irrigation with them. Their descendants constructed networks of diversion dikes to capture runoff rainwater and cultivate fields. Mission priests expanded and enhanced the historic systems, building new rock dams and small earthen reservoirs. In 1902, the U.S. Reclamation Service (later changed to Bureau of Reclamation) was created to advance a federal effort of "irrigation works for the storage, diversion and development of waters"— to irrigate arid and semiarid lands in 16 Western states and territories.

Lisa Beutler
Photo: Lynn Ketcham, University of Arizona College of Agriculture and Life Sciences

It worked. The West bloomed. Planners and engineers cringly defined, understood, and fixed problems through technical solutions. It was not simple, yet problems were solvable. Either solutions worked or they didn't.

Lately, more and more water problems seemingly defy standard solutions. This typically occurs for four reasons: incomplete or contradictory knowledge, the number of people and opinions involved, the large economic burden, and the interconnected nature of these problems with other problems. These are wicked problems. Wicked problems are often hot potatoes tossed back and forth among policy makers, and decried as too substantial for grand solutions.

Wicked problems are not solved—they can only be mitigated through an approach that emphasizes empathy, abductive reasoning, and rapid prototyping. It is not possible to present an elegant solution and be done.

Horst Rittel, one of the first to formalize a theory of wicked problems, cites ten characteristics of these complicated social issues

1. Wicked problems have no definitive formulation. The problem of poverty in Texas is grossly similar but discretely different from poverty in Nairobi, so no practical characteristics describe "poverty."
2. It is hard, maybe impossible, to measure or claim success with wicked problems because they bleed into one another, unlike the boundaries of traditional design problems that can be articulated or defined.
3. Solutions to wicked problems can be only good or bad, not true or false. There is no idealized end state to arrive at, and so approaches to wicked problems should be tractable ways to improve a situation rather than solve it.
4. There is no template to follow when tackling a wicked problem, although history may provide a guide. Teams that approach wicked problems must literally make things up as they go along.
5. There is always more than one explanation for a wicked problem, with the appropriateness of the explanation depending greatly on the individual perspective of the designer.
6. Every wicked problem is a symptom of another problem. The interconnected quality of socio-economic political systems illustrates how, for example, a change in education will cause new behavior in nutrition.
7. No mitigation strategy for a wicked problem has a definitive scientific test because humans invented wicked problems and science exists to understand natural phenomena.
8. Offering a "solution" to a wicked problem frequently is a "one shot" design effort because a significant intervention changes the design space enough to minimize the ability for trial and error.
9. Every wicked problem is unique.
10. Those addressing a wicked problem must have authority and responsibility for their actions.

Water planners and managers play a central role in mitigating the negative consequences of wicked problems. They will be required to position efforts in new and more desirable directions. This will not be easy, quick, or solitary. It requires methodical, rigorous iteration focused on the system qualities of the problem. Interdisciplinary collaboration that captures a broader knowledge of science, economics, statistics, technology, psychology, politics, and more is necessary for effective change.

Water managers and planners will also need to more actively utilize abductive reasoning in addition to deductive and inductive approaches.

Abductive reasoning begins with an incomplete set of observations and proceeds to the likeliest possible explanation for the set. This method yields the kind of daily decision-making that does its best with the information at hand, which often is incomplete. In court cases, judge and jury consider whether the prosecution or the defense has the best explanation to cover all the evidence. While reasonable, it is subjective.

Whereas deductive reasoning creates certainty and inductive reasoning quantifies uncertainty, abductive reasoning attempts to create meaning when uncertainty exists.

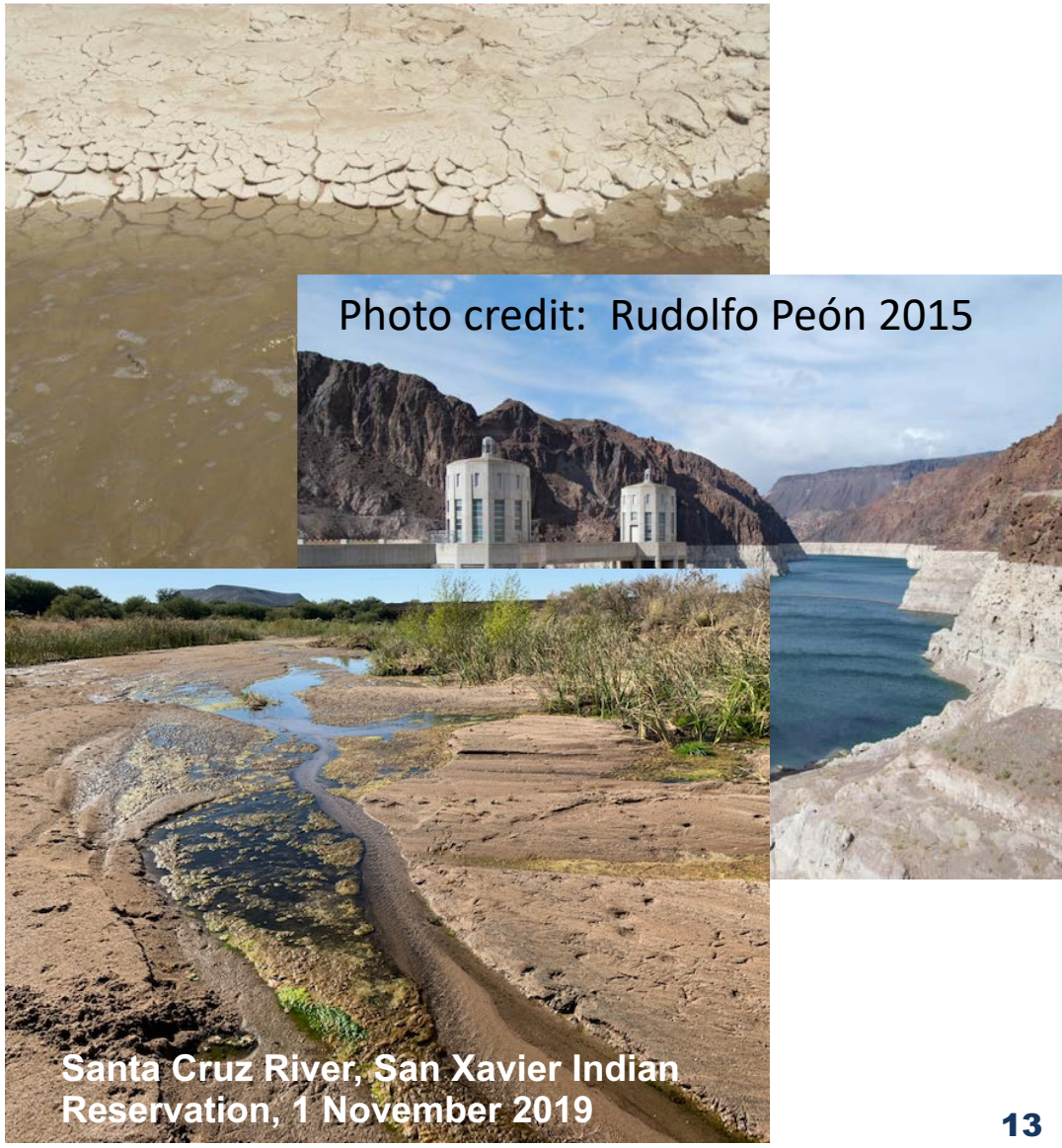
Managing wicked problems is a new kind of work. It requires changing the questions, managing uncertainty, and

*Wicked Problems continues on page 6*

- Wicked problems are often hot potatoes tossed back and forth among policy makers and decried as too substantial for grand solutions.
- Wicked problems are not solved—they can only be mitigated
- Interdisciplinary collaboration that captures a broader knowledge of science, economics, statistics, technology, psychology, politics, and more is necessary for effective change.
- Managing wicked problems is a new kind of work. It requires changing the questions, managing uncertainty, and creating resilience.

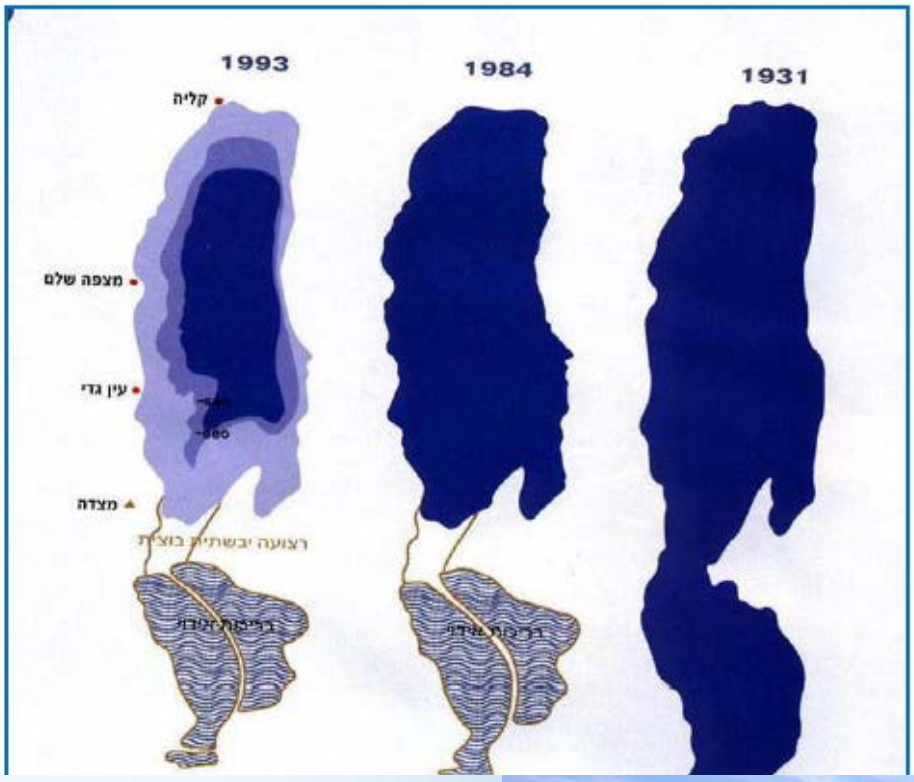
# Some wicked water problems of Arizona and the Colorado River Basin

- Groundwater overdraft and the invisibility of groundwater
- Imbalance of water demand and supply in the Colorado River Basin
- Lack of attention to water for nature (environmental flows)



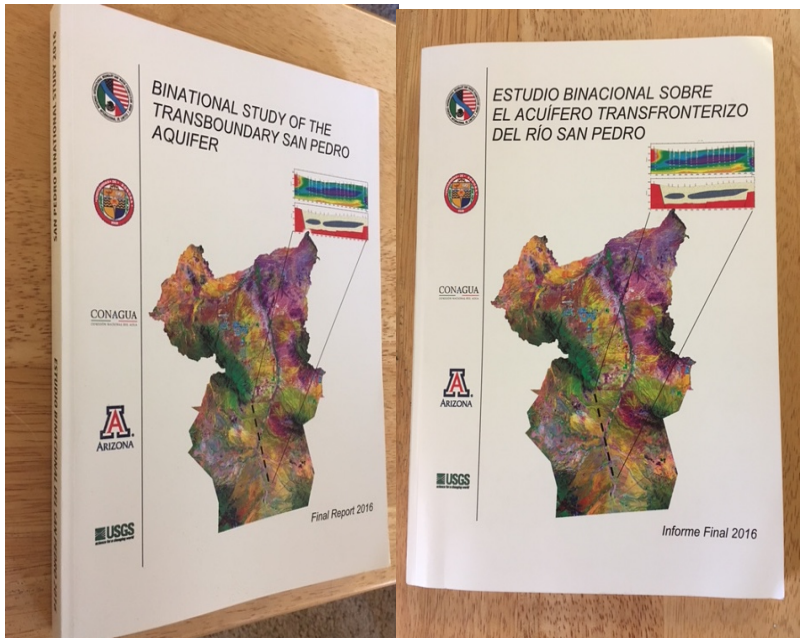
# Some wicked water problems of the Middle East region of focus

- Lower Jordan River flows
- Dead Sea condition
- Wastewater treatment in some areas
- Water provision and sources for the West Bank and Gaza
- Water supplies in Jordan




# Searching for Pathways to Solutions

- Developing information collaboratively
- Developing partnerships
  - Within states and regions
  - Interstate
  - International
  - Tribal Nations
- Considering and implementing options
  - Desalination
  - Reuse
  - Conservation
  - Water banking
  - Voluntary transactions
  - Rainwater harvesting; grey water systems
  - New ways of designing the built environment




**State legislation and many agreements necessary for AZ to Execute the Lower Basin Drought Contingency Plan**

January 31, 2019

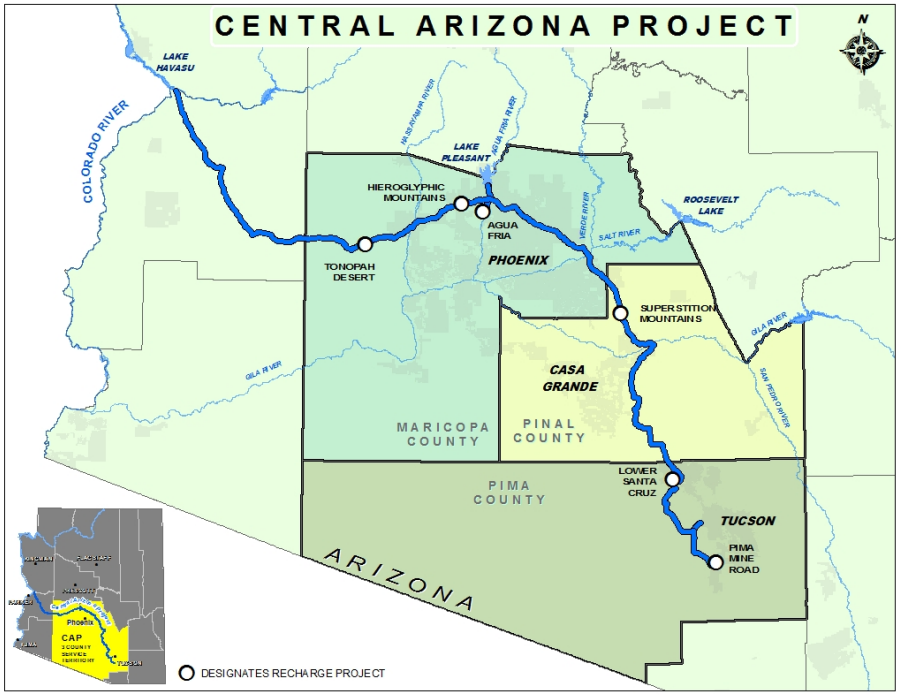
# Wicked Water Problems

Lisa Beutler (2016)

- "Lately, more and more water problems seemingly defy standard solutions."
- Four reasons – Keep in mind as I go through the following slides
  - incomplete or contradictory knowledge
  - the number of people and opinions involved
  - the large economic burden
  - the interconnected nature of these problems with other problems
- There are many connections between the regions I discuss. The pictures shown will indicate some of them.

# Groundwater Challenges in Central Arizona (Pinal County)

1. Low priority of Central Arizona Project (CAP) deliveries of Colorado River water, coupled with over-allocation of Colorado River water compared to average flow conditions means a return to more use of groundwater
2. Reliance on fossil groundwater; localized drawdown and groundwater availability
3. Issues related to patterns of urban growth and how requirements of the Assured Water Supply Rules are met and will be met
4. Ongoing work to understand the modeling and identify options



# Imbalance of Colorado River supply and demand – sharing the burden of shortage

1. The Drought Contingency Plans were approved in 2019
2. Next big step is developing the regulations to follow-on to the interim shortage sharing guidelines, which expire in 2026
3. Work is underway to assess the performance of the interim guidelines
4. Many entities and perspectives will be involved.


# Water for Nature

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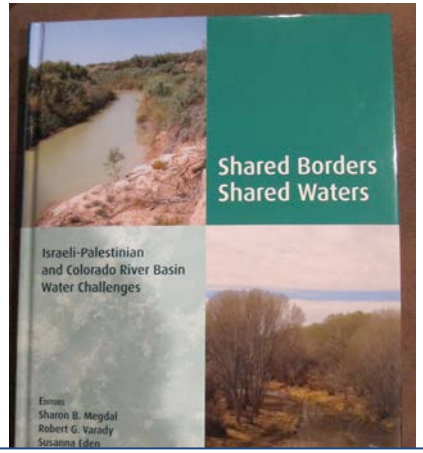
## Thirsty Rivers in Water-Scarce Regions: Experiences from the Colorado River

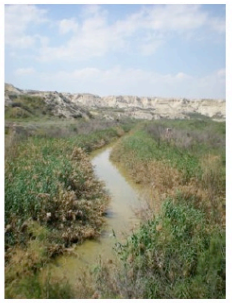
Sharon B. Megdal, Ph.D.
smegdal@email.arizona.edu or megdal.sharon@gmail.com

Rehabilitation of the Lower Jordan River
International Conference
21 October 2014

WRRC 50th Anniversary 1964-2014

**A goal of this conference is to "provide a discussion platform to share our lessons and learn from the experiences of others"**

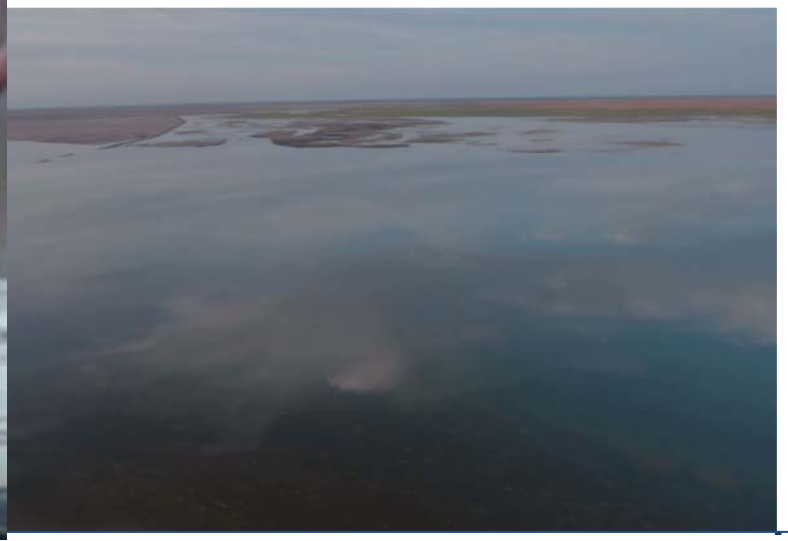



http://youtu.be/TODV7FW746s

**enewal – A Reborn Colorado River**
**ce Again Finds Her Path to the Sea**

http://youtu.be/TODV7FW746s



# Lower Jordan River and Dead Sea Conditions

3/9/2017 Sea of Galilee at lowest level in a century | Jewish News

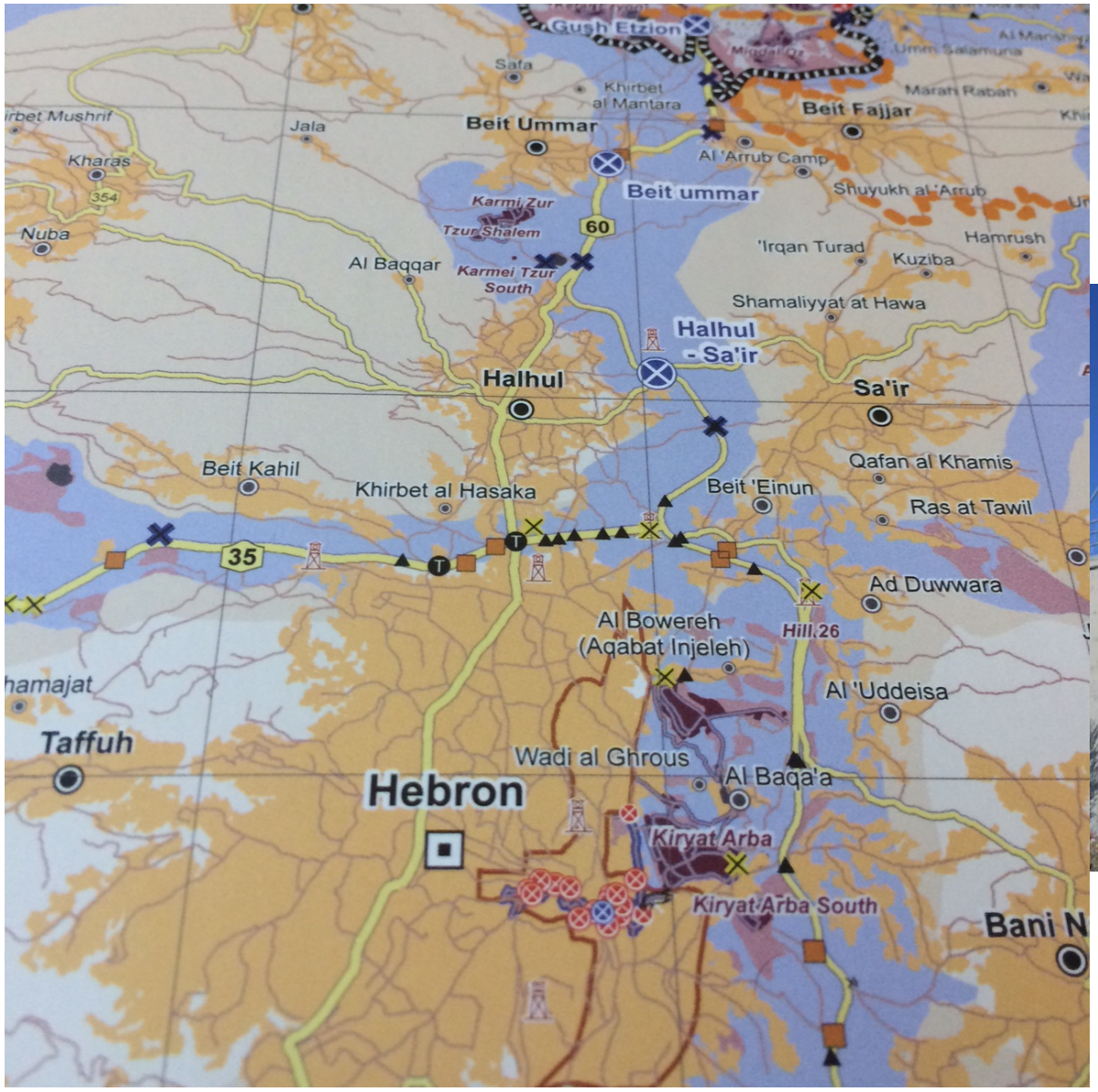
THE JEWISH NEWS | jewishnews.timesofisrael.com

## Sea of Galilee at lowest level in a century

February was one of the driest months on record, with the northern Israeli lake receiving just 10 percent of average rainfall

BY JTA | March 8, 2017, 2:58 pm |


# West Bank


Gush Etzion
Safa
Khirbet al Mantara
Beit Ummar
Jala
Beit Fajjar
Al 'Arrub Camp
Shuyukh al 'Arrub
Kharas
354
Karmi Zur
Tzur Shalem
Beit ummar
60
Nuba
Al Baqqar
Karmei Tzur South
'Irqan Turad
Kuziba
Hamrush
Shamaliyyat at Hawa
Halhul - Sa'ir
Halhul
Sa'ir
Beit Kahil
Khirbet al Hasaka
Beit 'Einun
Qafan al Khamis
Ras at Tawil
35
Ad Duwwara
Hill 26
Al Bowereh (Aqabat Injeleh)
Al 'Uddeisa
Taffuh
Wadi al Ghrous
Hebron
Al Baqa'a
Kiryat Arba
Kiryat Arba South

# Wastewater Treatment

# Water Supply - Jordan

November 22, 2016 high-level meeting in Amman, Jordan. From left to right, H.E. Minister of Water and Irrigation Dr. Hazim El-Nasser, His Royal Highness Prince El Hassan bin Talal, U.S. Ambassador to Jordan Alice Wells, Commissioner Edward Drusina and Commissioner Roberto Salmón.

## Innovative Grey Water System in Jordan

# COVID-19 Incidence on Navajo Nation and water accessibility

## Navajo Nation's water shortage may be supporting COVID-19 spread

Debra Utacia Krol, Arizona Republic  Published 6:57 p.m. MT April 18, 2020 | Updated 3:22 p.m. MT April 28, 2020

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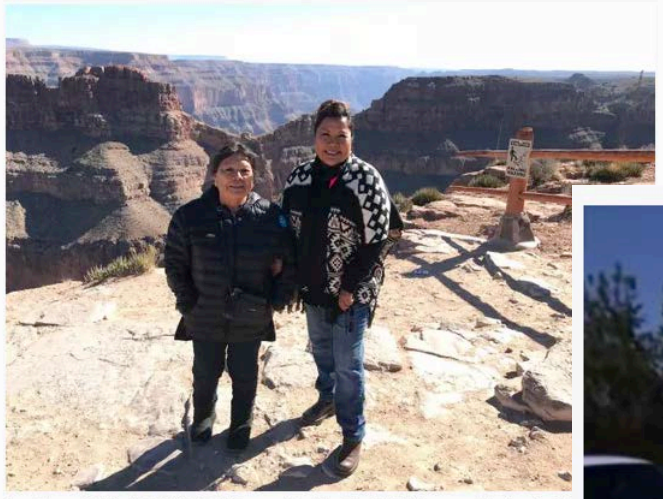
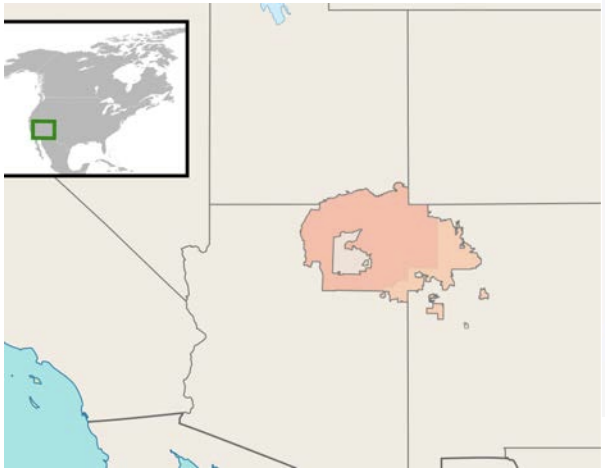


Sen. Jamescita Peshlakai (right) with her mother Mae. Peshlakai's home on the Navajo Nat
running water and electricity, as do about 7,500 other homes in the nation. *(Photo: Jamesci*





https://en.wikipedia.org/wiki/Navajo_Nation


https://www.youtube.com/watch?v=KAPpQA9SCwc&feature=youtu.be

# Some Key Factors that Contribute to Mitigating Wicked Water Problems

- Functioning cooperative mechanism(s)
- Trust and mutual respect
- Involvement of key stakeholders
- Good communication
- Persistence
- Patience
- Sharing experiences and lessons learned

**Traveled with the US-MX IBWC Commissioners, Nov 19-23, 2016**


**Class Field Trip – March 2017**

# Value of Sharing Lessons Learned: Panelists from Three Countries at WATEC 2019 conference

# Technology can play a significant role: Proposed Red Sea-Dead Sea Project

- The Project aims at producing 65 MCM/year of Desalinated Water and discharging 235 MCM/year of Mixed Water to the Dead Sea.
- The 235 MCM/year discharge to the Dead Sea is a mix of Brine Water from the Desalination Plant with Red Sea Water.
- Of the 65 MCM/year of Desalinated Water produced, 30 MCM/year is to be supplied to the Jordanian Delivery Point and 35 MCM/year to the Border Delivery Point.

Source: Document provided by Oded Fixler, Israel Ministry of Regional Cooperation

- Plus exchange (sale) of other water to the north of Israel to Jordan; also water to be provided to the Palestinian Authority

Question: What are the most important variables or factors that contribute to implementing technologies across borders?

Some suggestions based on RESPECT

R – Research

E – Education, Engagement

S – Science

P – Process

E – Engineering

C – Consultation, Cost

T – Trust

Bridging Through Water


**Bridging Through Water**

by Sharon B. Megdal

November 20, our day in Israel, included visiting the Yad Hanna Wastewater Treatment Plant, which is located just on the Israel side of the Green Line and wall separating the West Bank and Israel. Treating the wastewater from the West Bank

# Take-aways: Panel on implementing technology in a binational setting



- "Eat with your partners."
- Functioning relationships.
- Identify what is beneficial to both nations or parties in order to identify win-win opportunities, though identifying such opportunities can be difficult and that relationships can have peaks and lows.
- Especially when working with neighbors with different cultures and languages, good communication, sincerity, and leadership will enable things to happen.
- Panelists came back to noting that eating together helps foster the friendships that then can facilitate the work required to forge formal agreements.

# Concluding Remarks

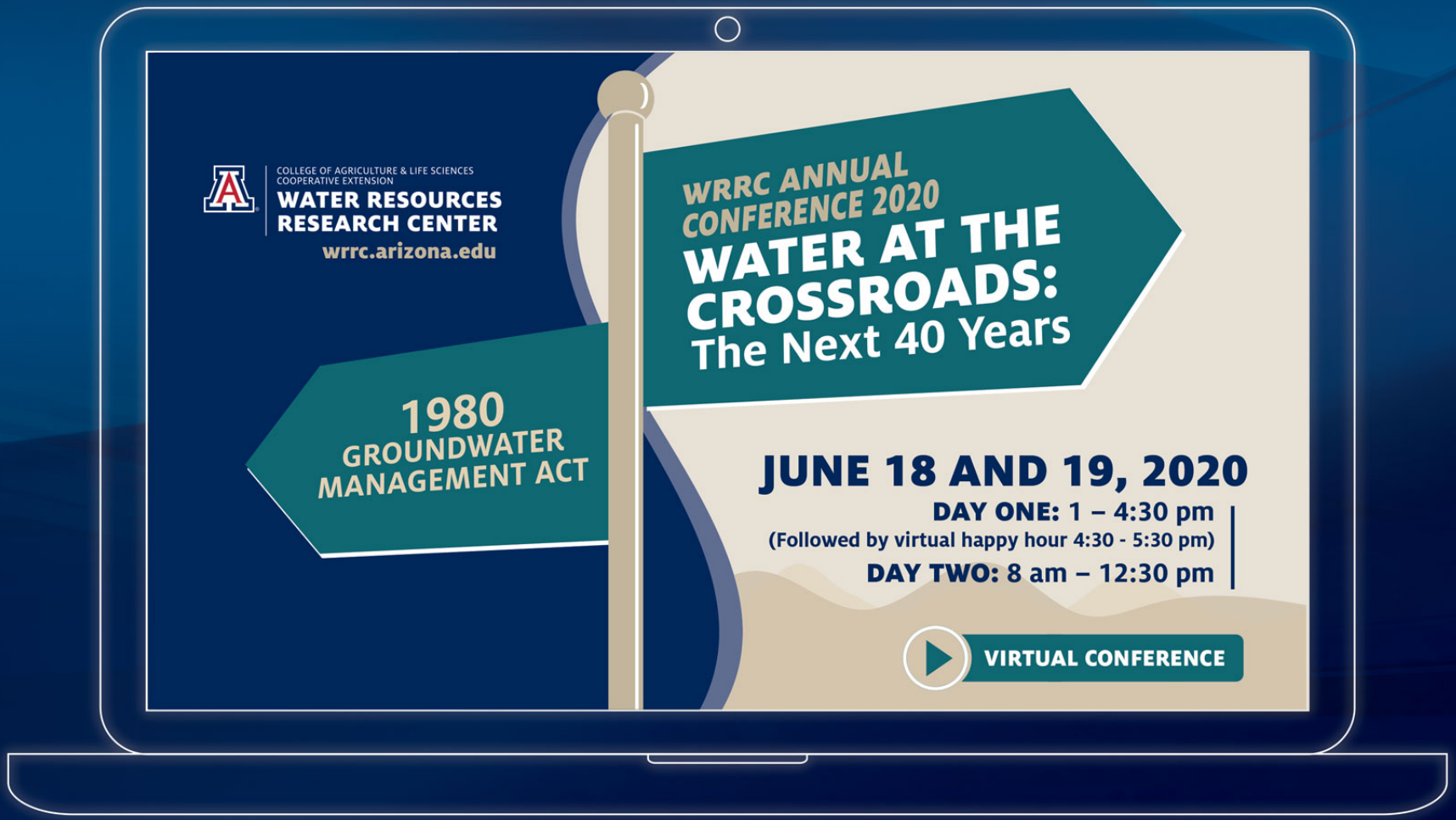
"*Managing wicked problems is a new kind of work. It requires changing the questions, managing uncertainty, and creating resilience*."

- Technology is important, as is economics
- Process of working with and through stakeholders is key to making progress
- Continuing educational efforts at all levels

BUT

When will we be able to meet and eat with our partners?

# WRRC Annual Conference Goes Virtual!




**Register at wrrc.arizona.edu**

# Thank you!

# Questions??

**Sharon B. Megdal**
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**wrrc.arizona.edu**