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Agriculture, food, and water policy: The case of the Colorado River Basin

Tel Aviv University Food Security Workshop

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7 July 2022
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Abstract

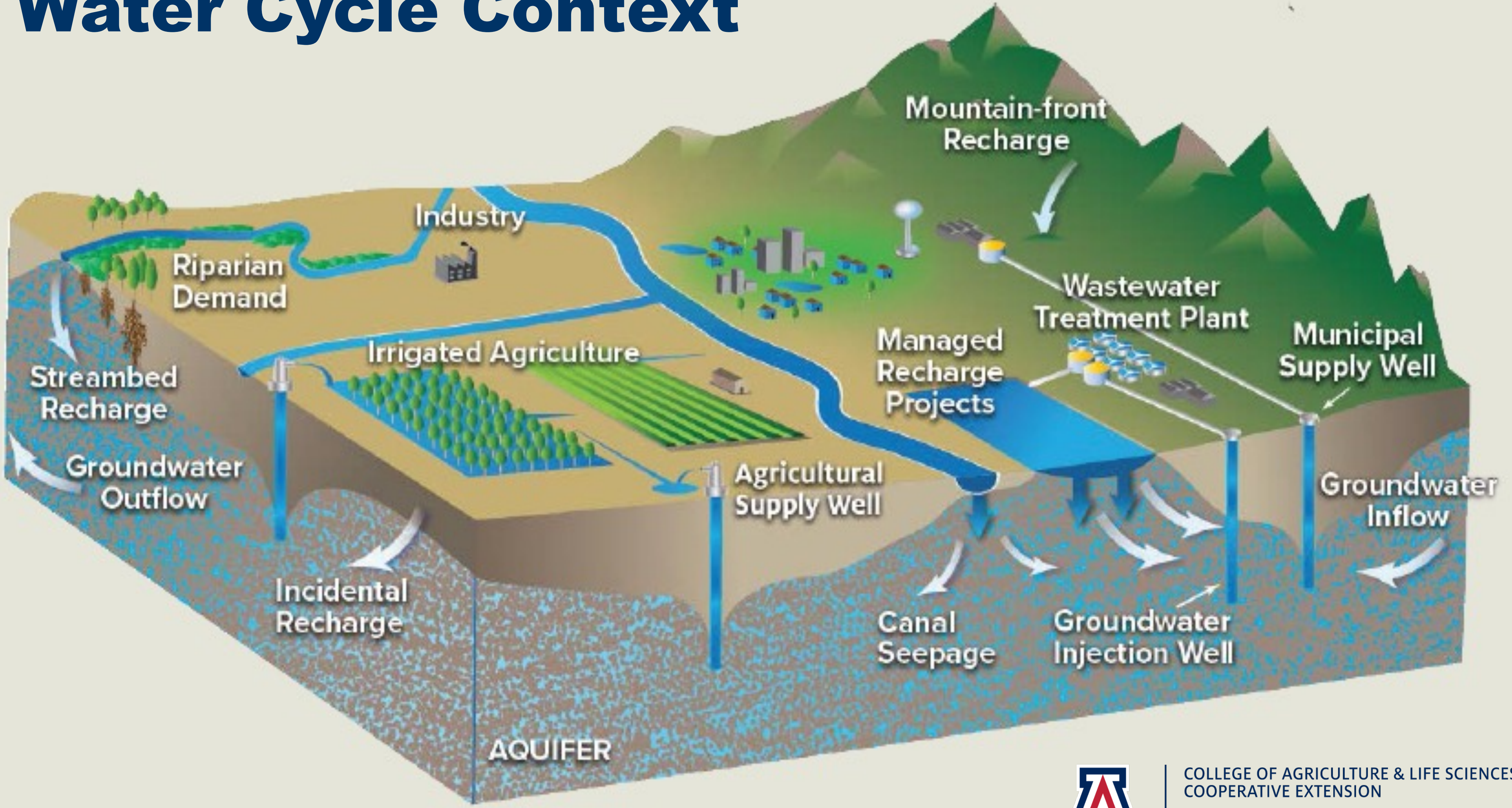
- This presentation addresses challenges faced by the agricultural sector in the Colorado River Basin, which has been experiencing low flows due to climate change for over 20 years.
- Agricultural activities include those of private landowners in multiple states and countries, as well as those of sovereign Tribal Nations.
- The significant and growing imbalance between water demand and supply in the Basin can be considered a wicked water problem.
- Highlighting the complexities associated with a layered governance and the legal system of water rights, the options for adapting to reduced river flows are discussed.
- The presentation underscores how the governance framework is a critical determinant of the processes for identifying and implementing solutions.

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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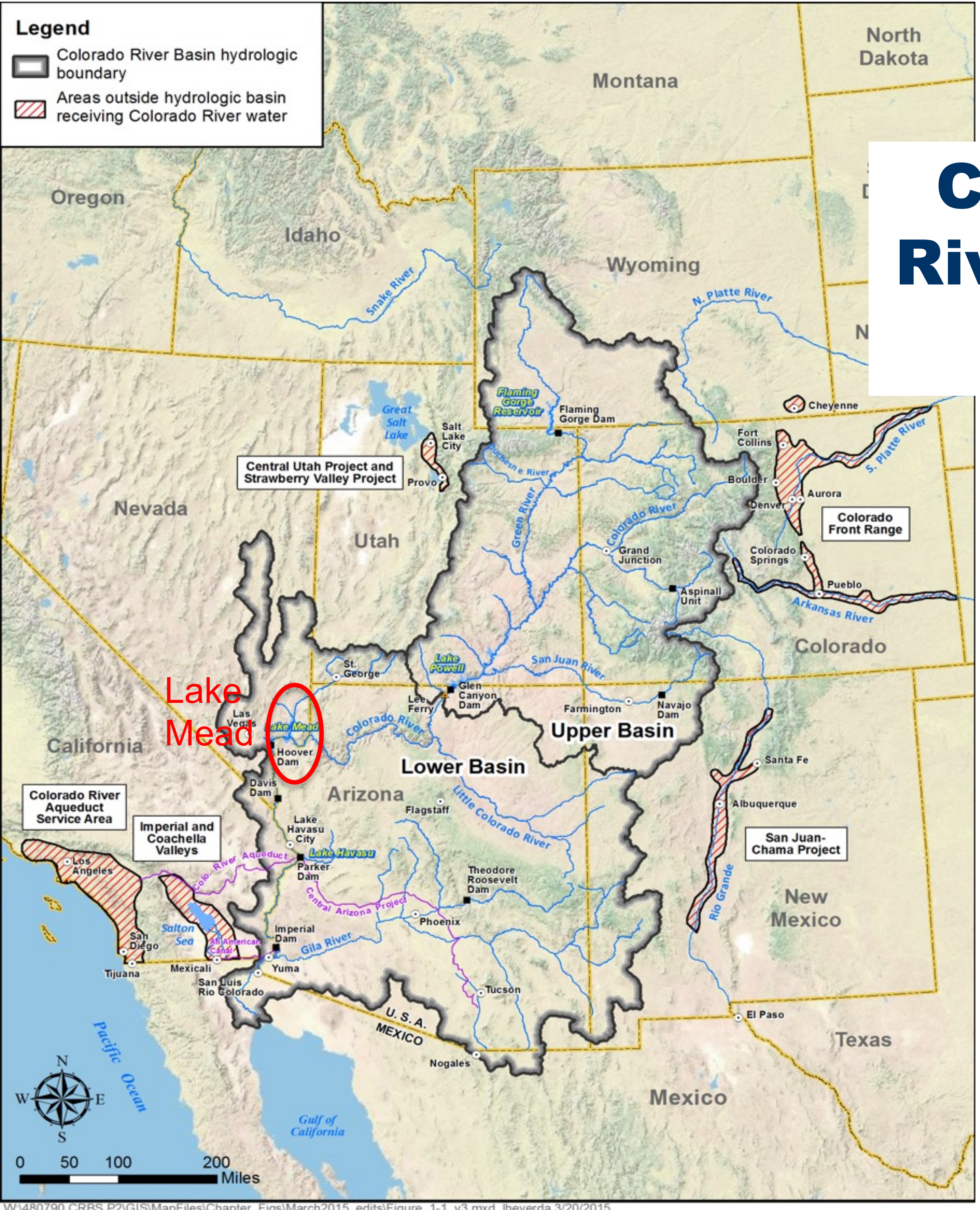
Geographic Context

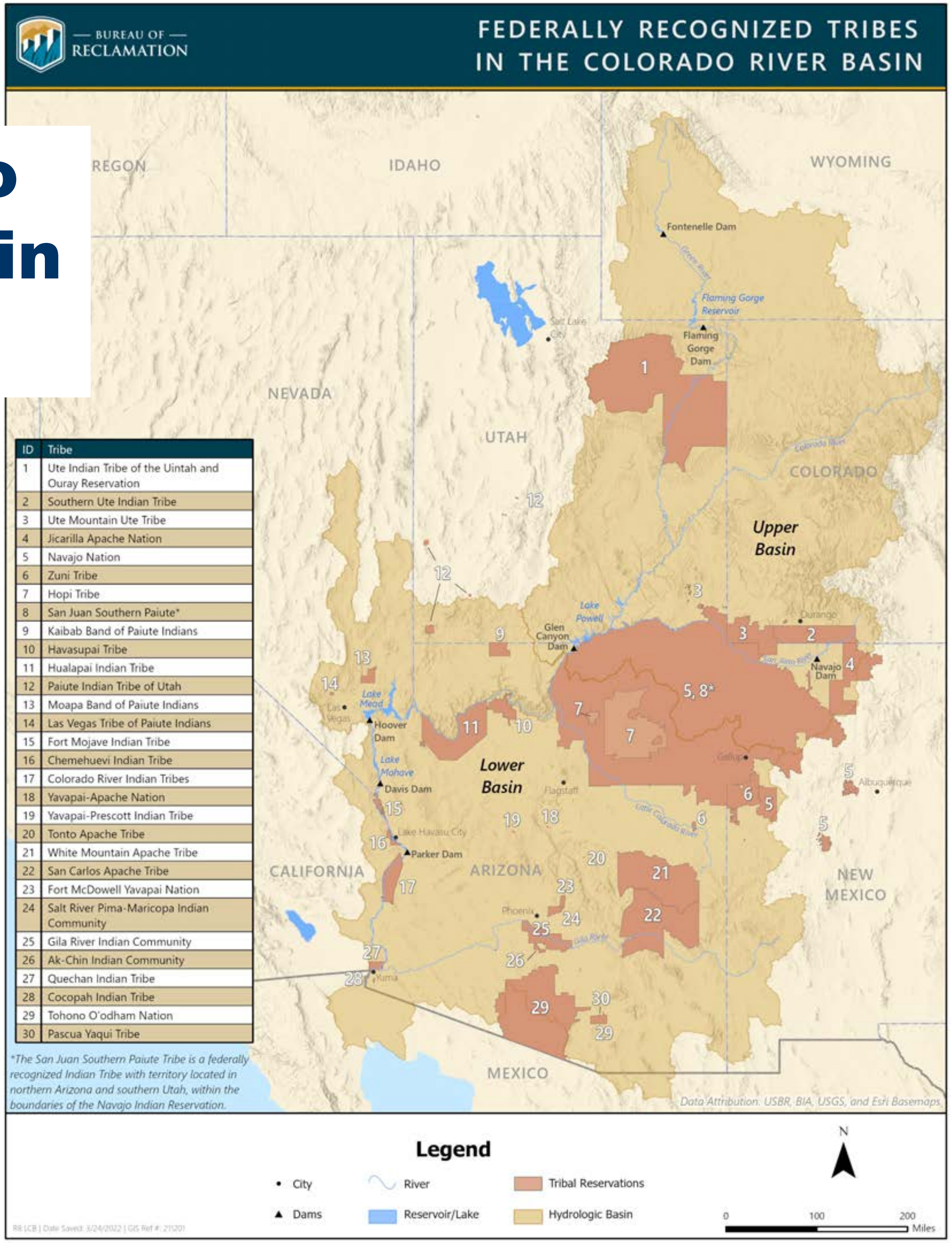
Colorado River Drainage Basin 637,000 km^2
~40 million people depend on Colorado River water

Arizona land area 295,253 km²
Population = 7.4 million in 2020

Israel land area 22,140 km²

Colorado River Basin (CRB)





ID	Tribe
1	Ute Indian Tribe of the Uintah and Ouray Reservation
2	Southern Ute Indian Tribe
3	Ute Mountain Ute Tribe
4	Jicarilla Apache Nation
5	Navajo Nation
6	Zuni Tribe
7	Hopi Tribe
8	San Juan Southern Paiute*
9	Kaibab Band of Paiute Indians
10	Havasupai Tribe
11	Hualapai Indian Tribe
12	Paiute Indian Tribe of Utah
13	Moapa Band of Paiute Indians
14	Las Vegas Tribe of Paiute Indians
15	Fort Mojave Indian Tribe
16	Chemehuevi Indian Tribe
17	Colorado River Indian Tribes
18	Yavapai-Apache Nation
19	Yavapai-Prescott Indian Tribe
20	Tonto Apache Tribe
21	White Mountain Apache Tribe
22	San Carlos Apache Tribe
23	Fort McDowell Yavapai Nation
24	Salt River Pima-Maricopa Indian Community
25	Gila River Indian Community
26	Ak-Chin Indian Community
27	Quechan Indian Tribe
28	Cocopah Indian Tribe
29	Tohono O'odham Nation
30	Pascua Yaqui Tribe

Legal-governance context
U.S. water governance is highly decentralized
Layered, sometimes overlapping responsibilities

DECENTRALIZED GROUNDWATER GOVERNANCE AND WATER NEXUS IMPLICATIONS IN THE UNITED STATES

Sharon B. Megdal and Jacob D. Petersen-Perlman*

ABSTRACT: Groundwater is essential to meeting water demands across the United States. Effective groundwater governance (making laws, policies, and regulations) and management (implementing governance framework) are needed to ensure its sustainable use. Groundwater governance in the United States is decentralized, resulting in considerable variations in practices across states. This Article reports on two state-level surveys and three regional case studies conducted to better understand groundwater governance strategies and practices. This Article also relates the results of these research efforts to food, energy, and climate. The first survey sampled state agency officials about the extent and scope of groundwater use, groundwater laws and regulations, and groundwater tools and strategies within their states. The second survey focused on groundwater quality, surveying state-level water quality professionals to better understand the diverse strategies and practices for managing groundwater quality. The three case studies highlighted innovations in sub-state approaches to manage groundwater.

This Article explains the study results related to the interconnectivities of groundwater to food, energy, and the climate, along with the strengths and shortcomings of state-level groundwater governance in addressing these interconnectivities. The analysis points to the importance of identifying best practices for addressing nexus challenges for groundwater.

CITATION: Sharon B. Megdal & Jacob D. Petersen-Perlman, *Decentralized Groundwater Governance and Water Nexus Implications in the United States*, 59 JURIMETRICS J. 99–119 (2018).

A. Groundwater and Food

Groundwater and food are inextricably linked, as the agricultural sector is easily the largest user of groundwater.[126] This linkage is manifested through water availability and productivity,[127] "virtual water,"[128] improving water efficiencies through reducing residual soil moisture or shifting to "low water consuming crops,"[129] and recharging aquifers for agriculture production.[130] Figure 4, included below, combines information on states where more than 30 percent of human needs are met by groundwater (USGS, 2010) and reported declining aquifer levels (data from the Initial Survey).[131] There is a clear geographic pattern to the thirteen states that could be considered under groundwater stress. Nearly all the states with these characteristics are located in the southern and western United States.[132] Several of these states host large agricultural sectors, including High Plains states using the Ogallala Aquifer.[133]

Decentralized Groundwater Governance & Water Nexus Implications

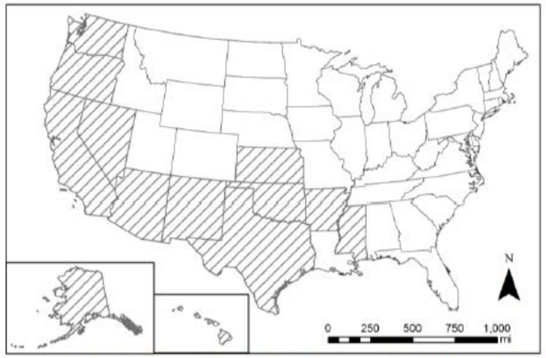


Figure 4. States Where More than 30 percent of Human Needs Are Met by Declining Groundwater and Reported Declining Aquifer Levels, Shaded in Diagonal Lines[134]

Wicked Water Problems Context

- "Wicked Water Problems" are big problems that do not have a simple pathway to resolving them.
- Some 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 [e.g., geopolitics, poverty]
- Collaboration and interdisciplinary work are necessary for addressing Wicked Water Problems. Process is important
- Supply-demand imbalance in the Colorado River Basin is a wicked problem.

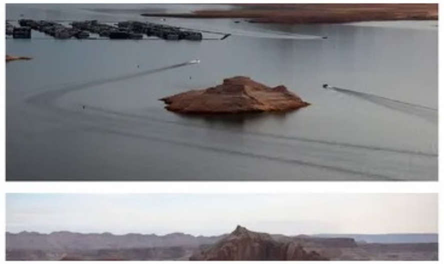
Water supply-demand imbalances – The Colorado River Basin – An example of a wicked water problem

May 8, 2022
Guest Opinion
Arizona Republic

No exaggeration: Record lows at Lake Powell and Lake Mead call for drastic action

Lake Powell's elevation requires immediate protective actions. Everyone will be asked to conserve to delay or reduce further mandatory reductions.

OP ED **Tom Buschatzke and Ted Cooke** 6:00 a.m. MT May 8



Elevations in Lake Mead over time.

The intake towers that feed Hoover Dam's power generators are almost fully exposed as the Lake Mead water level continues to decline. (Luis Sinco/Los Angeles Times)

Source: Municipal Leader Magazine, April 2022

Source: Los Angeles Times article, link here

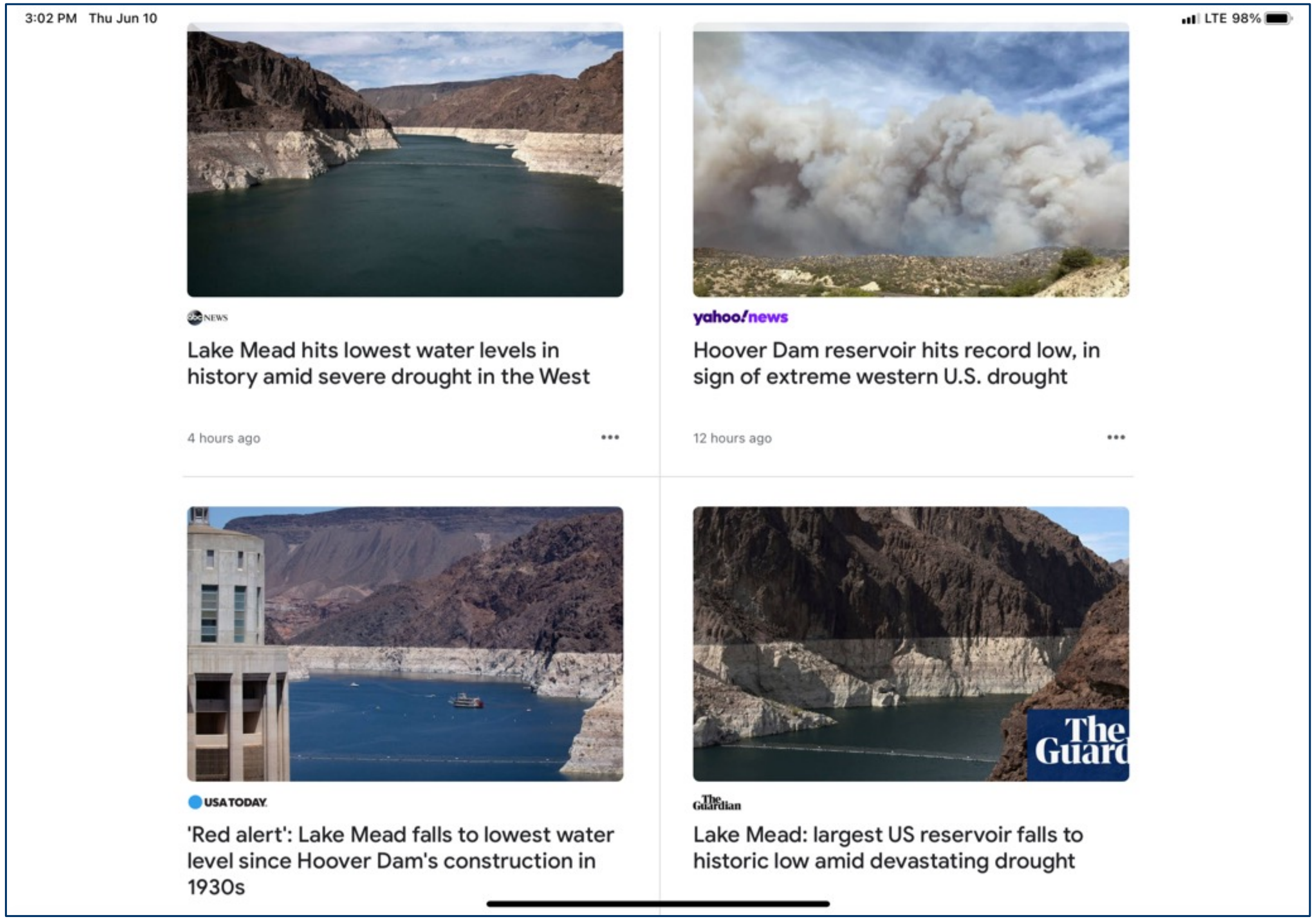
ENVIRONMENT

'Red alert': Lake Mead falls to record-low level, a milestone in Colorado River's crisis

Ian James Arizona Republic

June 2021

Published 10:00 a.m. MT Jun. 10, 2021 | **Updated 1:53 p.m. MT Jun. 11, 2021**



June 2022

Big Colorado River water cuts needed next year, top US official warns

Tony Davis
Jun 14, 2022

Boats float on Lake Powell, a vast reservoir of Colorado River water situated near the Utah-Arizona border. A white "bathtub ring" on the lake's shores shows how much water levels have dropped during a decade of severe drought.
Luis Sinco, Los Angeles Times 2022

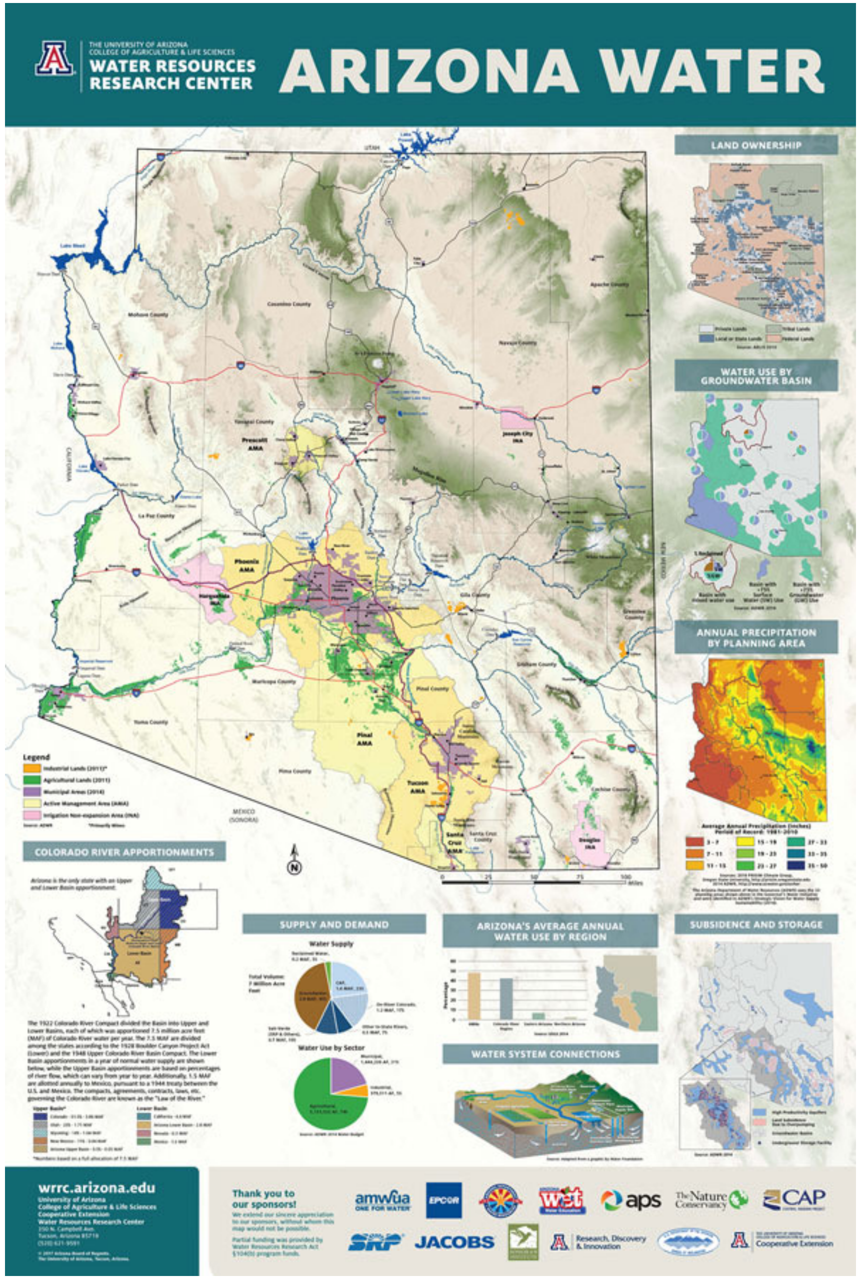
Tony Davis

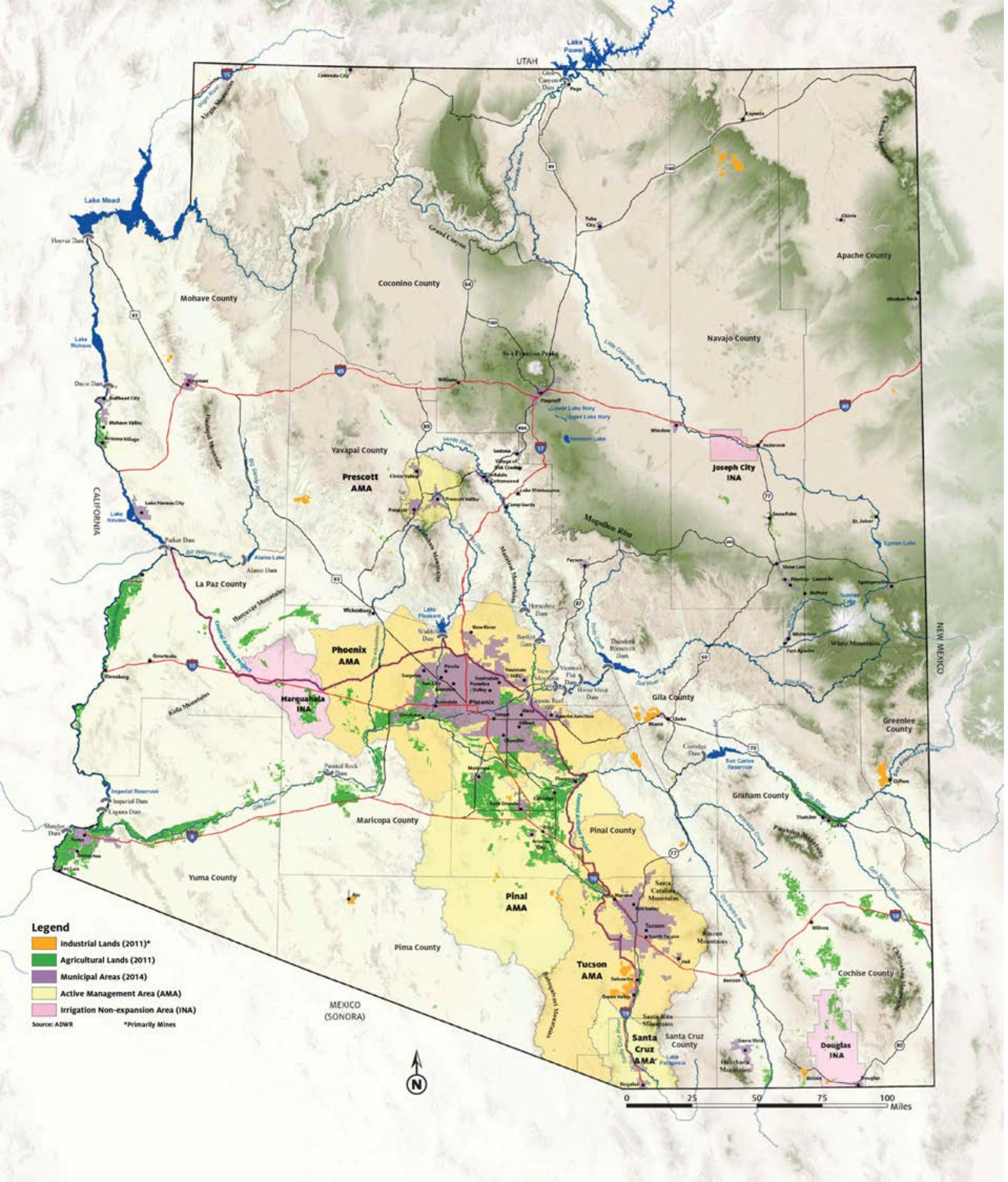
The largest single batch of water-use cuts ever carried out on the Colorado River is needed in 2023 to keep Lakes Mead and Powell from falling to critically low levels, the U.S. Bureau of Reclamation commissioner told a congressional hearing Tuesday.

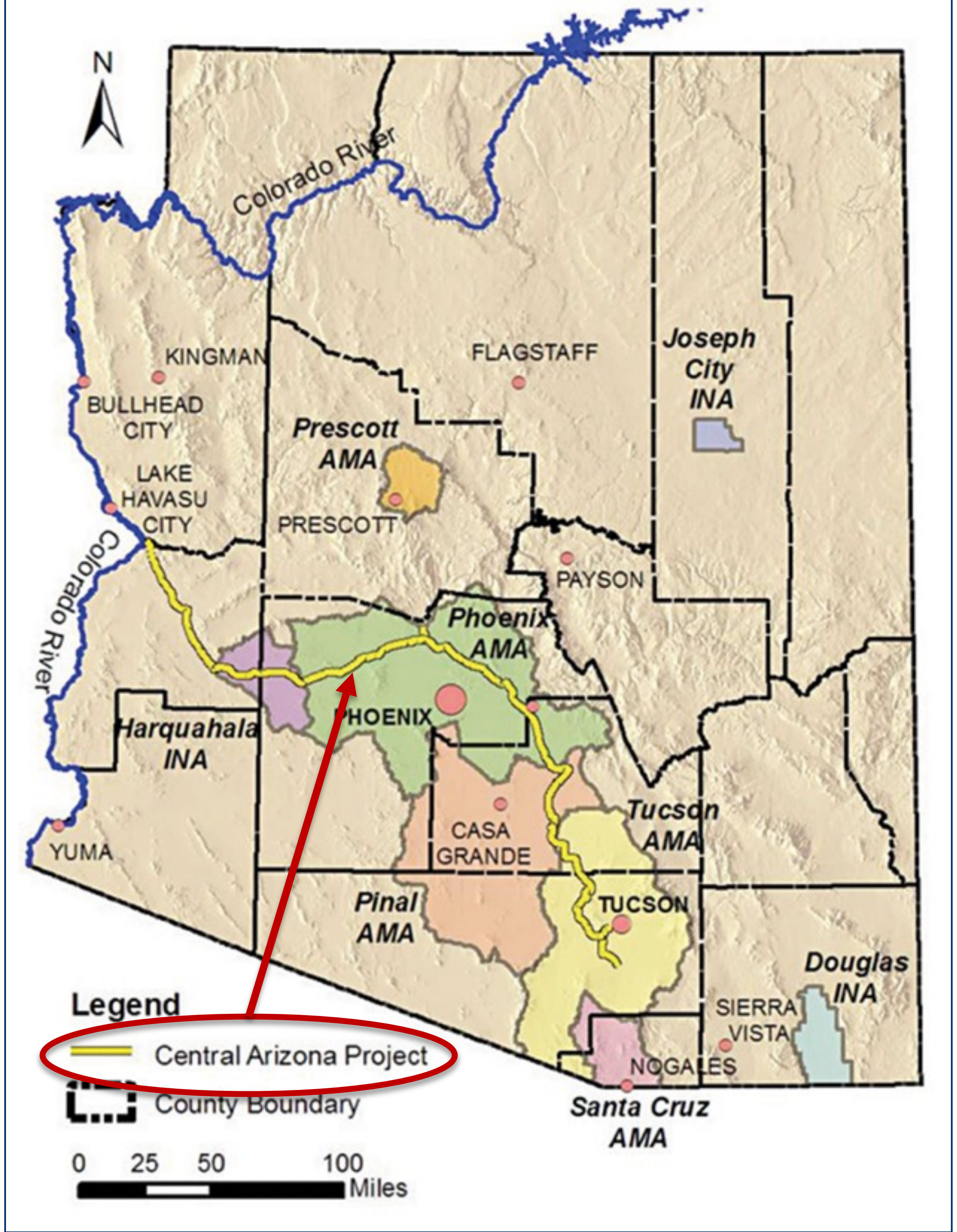
Between 2 million and 4 million acre feet of water use must be cut for 2023 across the river basin to cope with continued declines in reservoir levels, said Reclamation Commissioner Camille Touton.

Arizona Snapshot

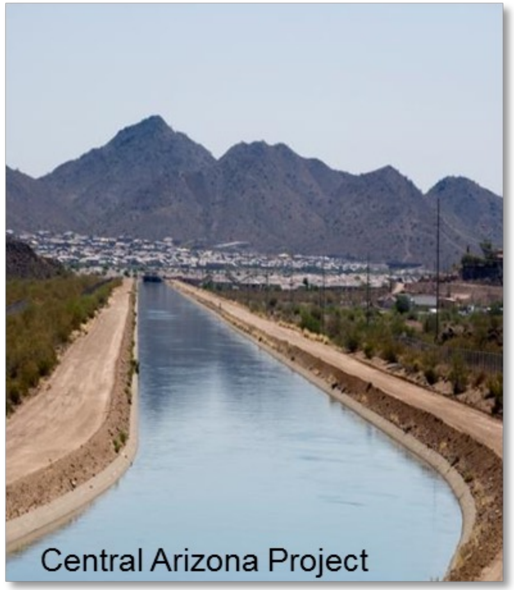
- Population of 7.2 million people expected to almost double by 2050.
- Land area = 295,254 km², compared to Singapore's 721.5 km²; highly urbanized
- Water use estimated to be about 7 Million Acre Feet (MAF) (8,633 MCM)
  - Slightly > 40% of total is groundwater
  - Approx. 3% is reclaimed water
  - Of the remaining use, which is surface water, 2.8 MAF (3,453 MCM) has been from the Colorado River
    - **Central Arizona Project (CAP)** can deliver 1.5 to 1.6 MAF (1,850 MCM) annually
- Approx. 70% of water in Arizona diverted or extracted by agriculture
- Groundwater managed in designated Active Management Areas (AMAs) only
- Groundwater and surface water laws not integrated

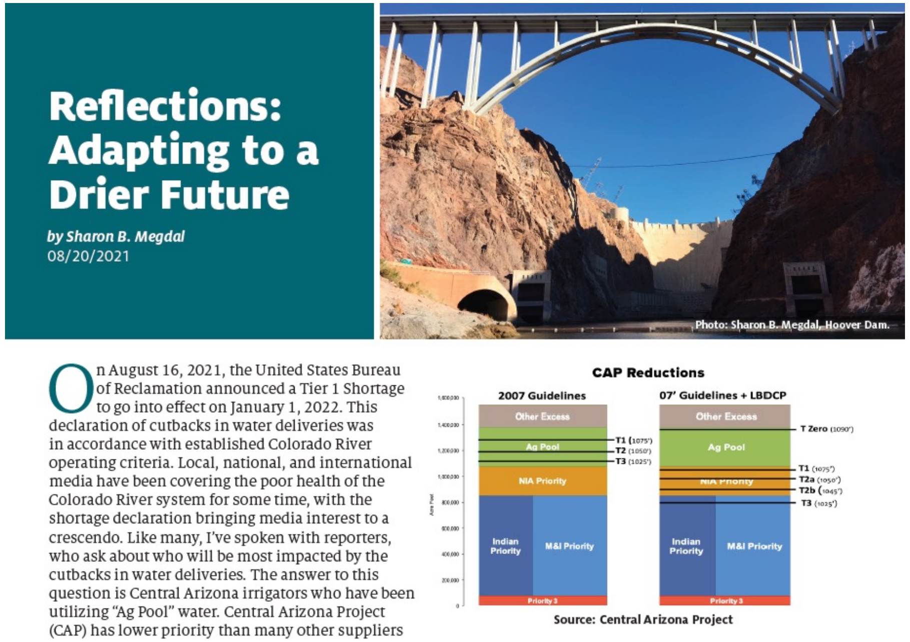



Lake Mead
Lake Powell
UTAH
Mohave County
Coconino County
Navajo County
Apache County
Yavapai County
Prescott AMA
Joseph City INA
La Paz County
Phoenix AMA
Harquahala INA
Gila County
Greenlee County
Maricopa County
Graham County
Pinal County
Yuma County
Pinal AMA
Pima County
Tucson AMA
Santa Cruz AMA
Santa Cruz County
Cochise County
Douglas INA
CALIFORNIA
NEW MEXICO
MEXICO (SONORA)
Legend
Industrial Lands (2011)*
Agricultural Lands (2011)
Municipal Areas (2014)
Active Management Area (AMA)
Irrigation Non-expansion Area (INA)
Source: ADWR
*Primarily Mines
0 25 50 75 100 Miles


N
Colorado River
KINGMAN
BULLHEAD CITY
LAKE HAVASU CITY
FLAGSTAFF
Joseph City INA
Prescott AMA
PRESCOTT
PAYSON
Phoenix AMA
PHOENIX
Harquahala INA
CASA GRANDE
Tucson AMA
YUMA
Pinal AMA
TUCSON
Douglas INA
SIERRA VISTA
NOGALES
Santa Cruz AMA
Legend
Central Arizona Project
County Boundary
0 25 50 100 Miles

Central Arizona Project





Reflections: Adapting to a Drier Future

by Sharon B. Megdal
08/20/2021

Photo: Sharon B. Megdal, Hoover Dam.

On August 16, 2021, the United States Bureau of Reclamation announced a Tier 1 Shortage to go into effect on January 1, 2022. This declaration of cutbacks in water deliveries was in accordance with established Colorado River operating criteria. Local, national, and international media have been covering the poor health of the Colorado River system for some time, with the shortage declaration bringing media interest to a crescendo. Like many, I've spoken with reporters, who ask about who will be most impacted by the cutbacks in water deliveries. The answer to this question is Central Arizona irrigators who have been utilizing "Ag Pool" water. Central Arizona Project (CAP) has lower priority than many other suppliers

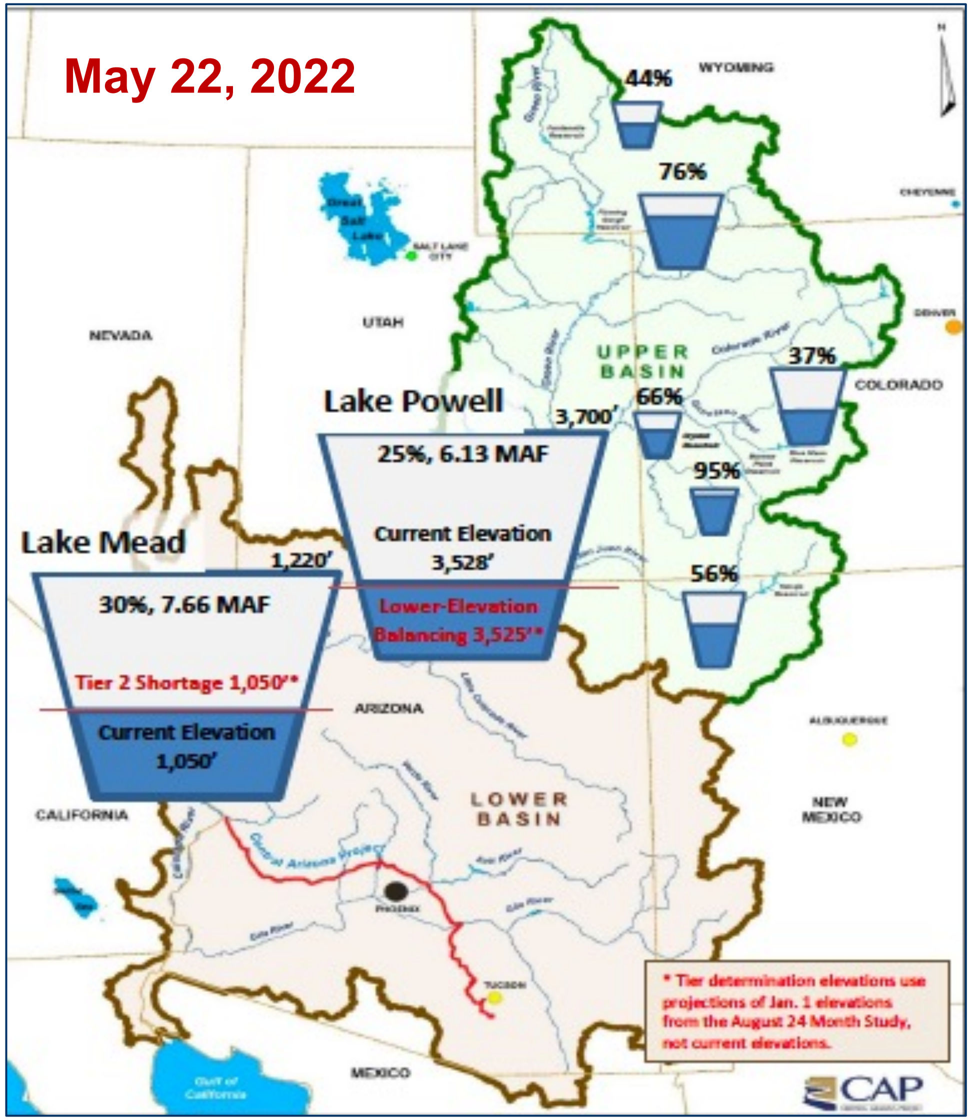
https://wrrc.arizona.edu/reflections

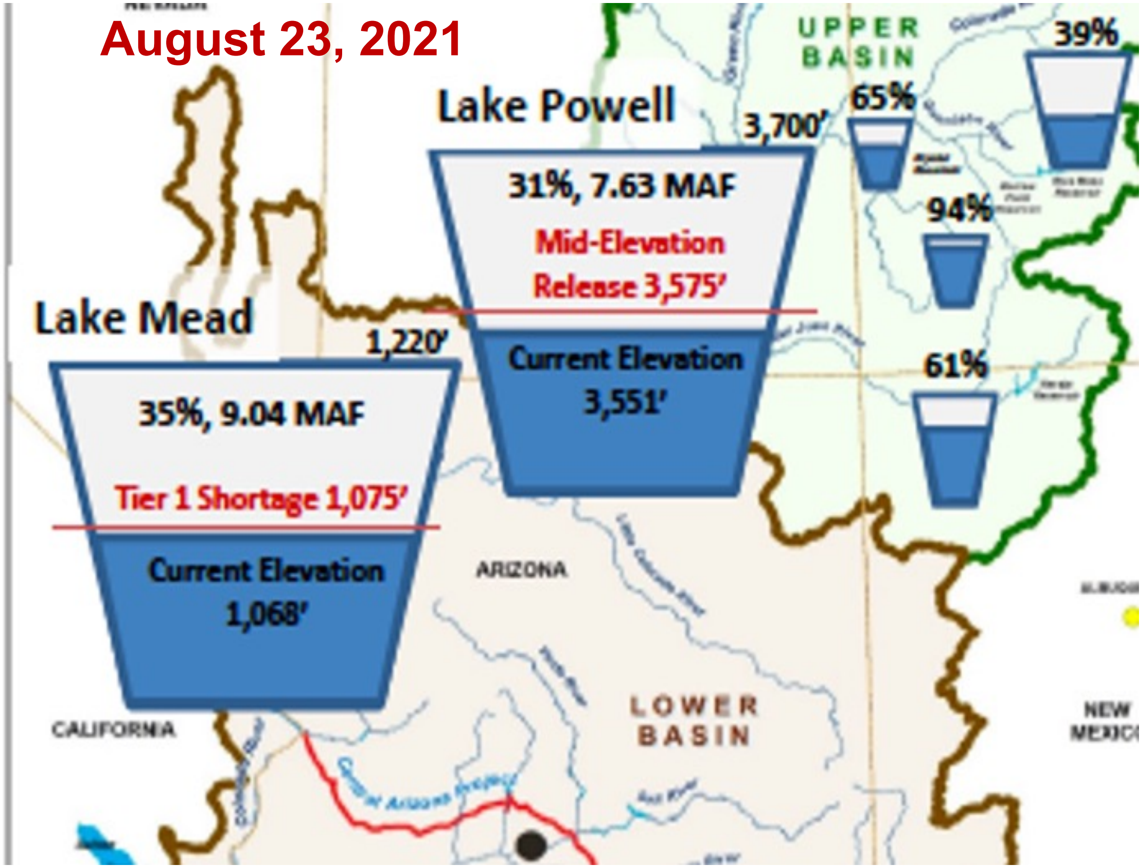
Central Arizona Project canal is 540 km long, pumps water to 730 m, and was designed to deliver ~1850 MCM annually. CAP is the largest consumer of electricity in Arizona.
https://www.cap-az.com/

Arizona is highly impacted by cutbacks in deliveries of Colorado River Water

Things have gone from bad to worse quickly.

Lake Mead only 30% full as of May 2022





Recently published article on Arizona policy options

RENEWABLE RESOURCES JOURNAL

RNRF

VOLUME 37 NUMBER 3

CONTENTS

Water Policy Options as Arizona Adapts to a Drier Colorado River: A Perspective

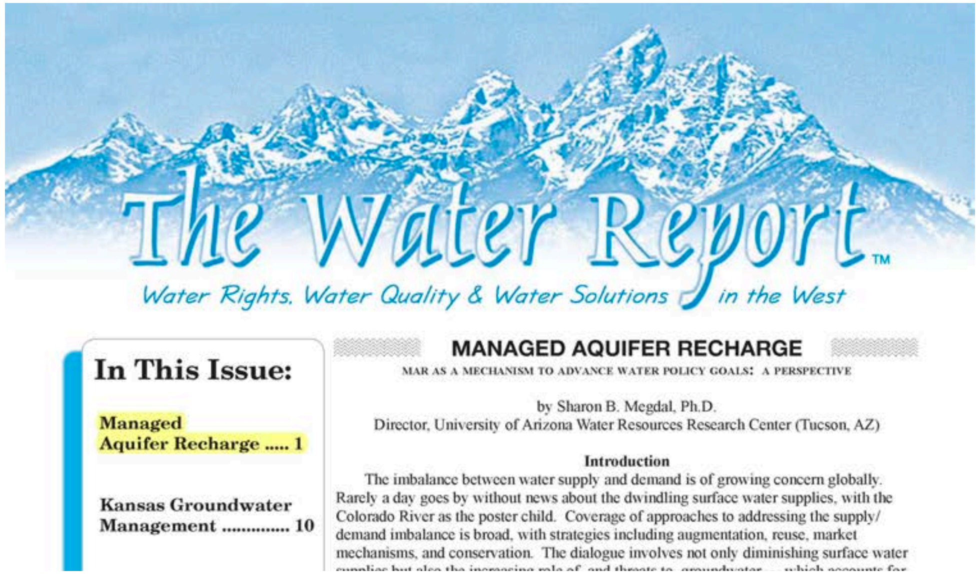
Sharon B. Megdal

The Colorado Basin Context

On August 16, 2021, the U.S. Bureau of Reclamation announced the first-ever Tier 1 Colorado River shortage. The water delivery cutbacks, which went into effect on January 1, 2022, per the "Colorado River Interim Guidelines for Low Basin Shortages and Coordinate Operations for Lake Powell and Lake Mead" (2007 Interim Guidelines), are most significant for the Central Arizona Project (CAP). Governed by the is divided into an Upper Division and a Lower Division. Different formulas govern the distribution of water. Upper Basin water is distributed on a percentage basis but each of the Lower Basin states have a set amount of water that is expected to be delivered in non-shortage years. The 1944 Treaty for Utilization of Waters from the Colorado and Tijuana Rivers and of the Rio Grande between the United States and Mexico, which is implemented by the International

https://rnrf.org/wp-content/uploads/2022/05/RRJV37N3.pdf

Another recently published article on Managed Aquifer Recharge


The Water Report™
Water Rights, Water Quality & Water Solutions in the West

In This Issue:

Managed Aquifer Recharge 1

Kansas Groundwater Management 10

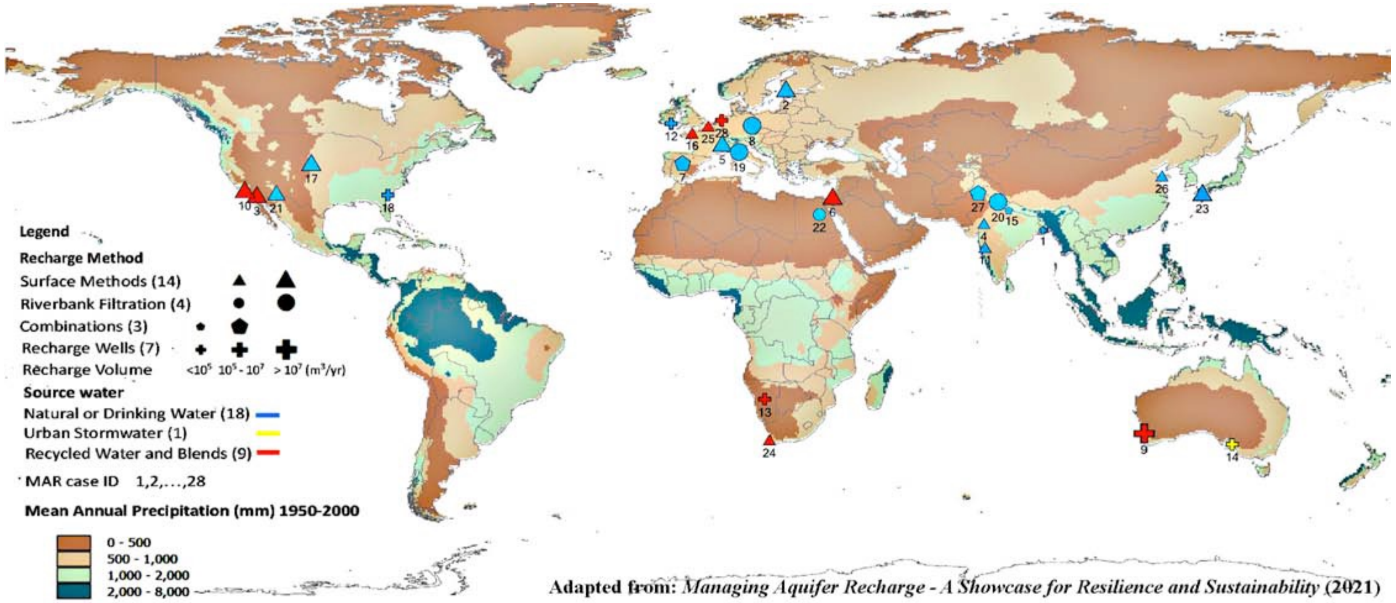
MANAGED AQUIFER RECHARGE

MAR AS A MECHANISM TO ADVANCE WATER POLICY GOALS: A PERSPECTIVE

by Sharon B. Megdal, Ph.D.
Director, University of Arizona Water Resources Research Center (Tucson, AZ)

Introduction

The imbalance between water supply and demand is of growing concern globally. Rarely a day goes by without news about the dwindling surface water supplies, with the Colorado River as the poster child. Coverage of approaches to addressing the supply/demand imbalance is broad, with strategies including augmentation, reuse, market mechanisms, and conservation. The dialogue involves not only diminishing surface water



Adapted from: *Managing Aquifer Recharge - A Showcase for Resilience and Sustainability* (2021)

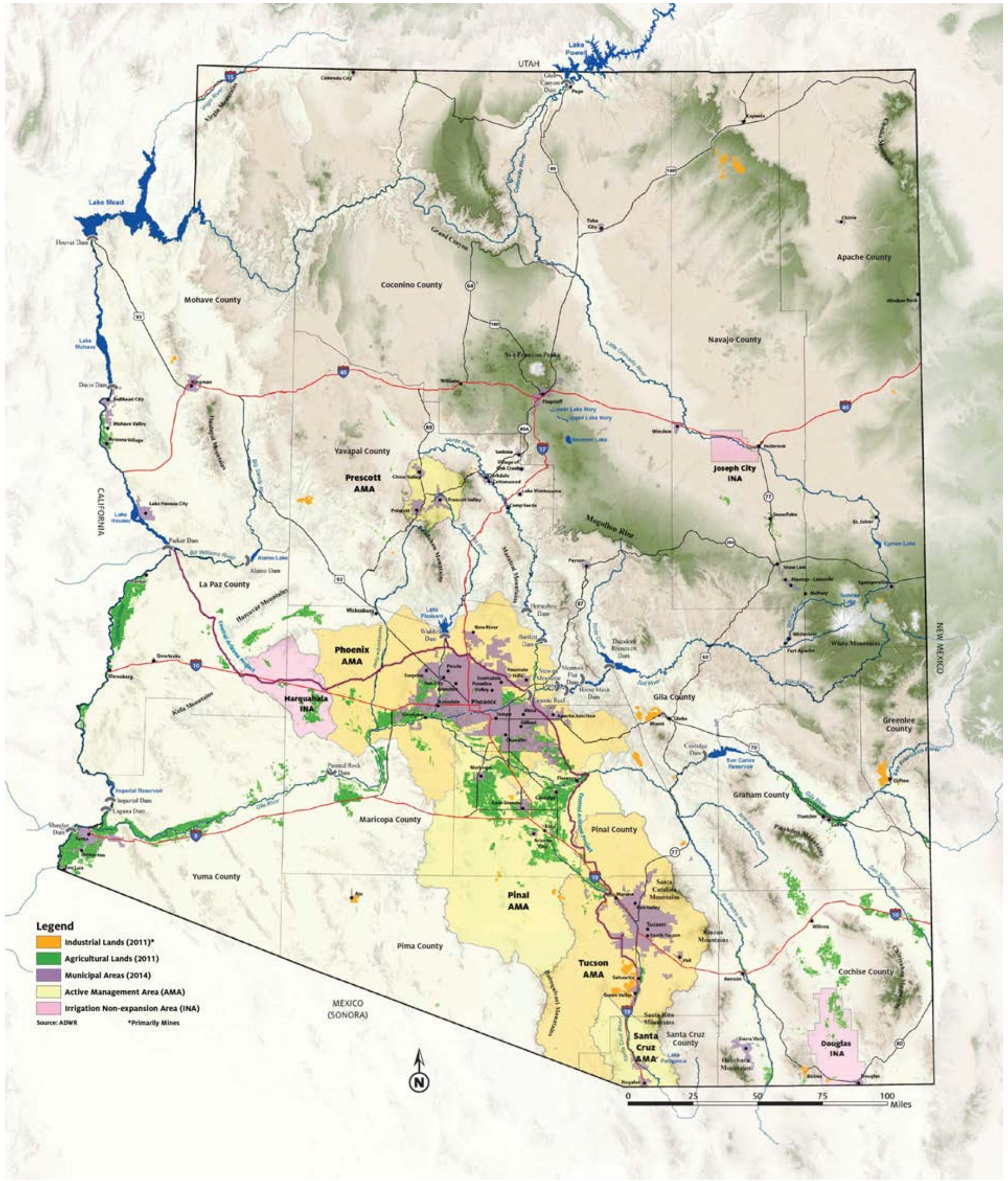
Recent Article (June 15, 2022)
Managed Aquifer Recharge – MAR as a mechanism to advance water policy goals

https://wrrc.arizona.edu/publications/reports/managed-aquifer-recharge

What does all this mean for food security?

- Basin-wide, agriculture uses about 80% of Colorado River water
- In Arizona, agriculture uses about 70% of all water sources
- California is a major agricultural producer for the national and world
- In addition to the water supply issues of the Colorado River Basin, California watersheds are experiences severe drought/aridification

Therefore, in addition to all the issues about food safety and water quality, there are significant questions about water supply at a time food production must increase globally.



Agriculture in Central Arizona

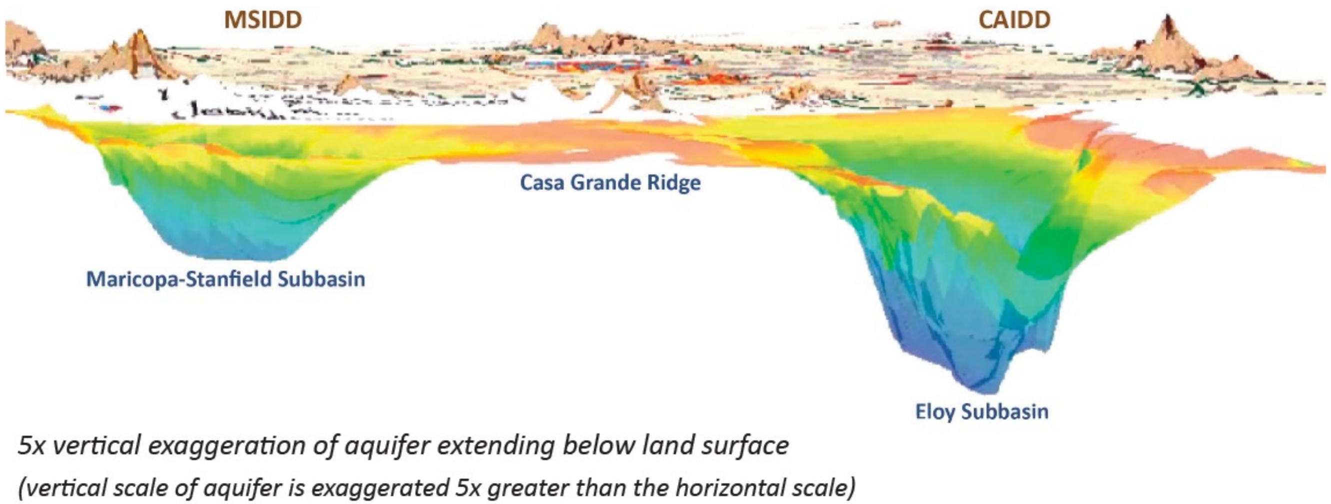


Figure 8. 3-D Representation of the Pinal AMA Aquifer from 2019 ADWR model, extended to 3000 feet below land surface, based on ADWR's 2014 geology update (Seasholes 2020) - Note: the aquifer bottom is modeled to 3000 feet and is deeper in certain areas

Agriculture in Yuma, Arizona

The Yuma area, including the Imperial Valley across the California border, produces about 90 percent of all the leafy vegetables grown in the United States from November to March, when it's too cold to grow produce in most of the rest of the country. https://www.huffpost.com/entry/yuma-lettuce_n_6796398

sustainability MDPI

Article

Evaluating Gravity-Flow Irrigation with Lessons from Yuma, Arizona, USA

George Frisvold [1], Charles Sanchez [2], Noel Gollehon [3], Sharon B. Megdal [4,*] and Paul Brown [5]

Abstract: Many consider gravity-flow irrigation inefficient and deride its use. Yet, there are cases where gravity-flow irrigation can play an important role in highly productive and profitable agriculture. This perspective article reviews the literature on the profitability and efficiency of gravity systems. It then reviews the history of water management in Yuma, Arizona, which is one of the most productive agricultural areas in the United States. Through extensive changes in irrigation technologies, changes in production practices, and investments in irrigation infrastructure, Yuma agriculture dramatically shifted from perennial and summer-centric crop production to winter-centric, multi-crop systems that are focused on high-value vegetable crops. These innovations have led to improvement in various irrigation efficiency measures and overall water conservation. Return flows from the system, which were once characterized as an indicator of inefficiency, provide valuable environmental services to the Colorado River Delta ecosystem. Yuma's history illustrates that innovative gravity-flow systems can be productive and water-conserving, and that a system-wide perspective is critical in evaluating irrigation systems.

https://www.mdpi.com/2071-1050/10/5/1548

Back to Wicked Water Problems Context: Searching for Pathways to Solutions

- Developing information collaboratively
- Developing partnerships
- Considering and implementing options
  - Conservation (<u>efficiency ≠ conservation</u>)
  - Desalination
  - Reuse
  - Water banking – managed aquifer recharge
  - Voluntary transactions, marketing, moving water
  - Rainwater harvesting; grey water systems
  - New ways of designing the built environment
- Agricultural options discussion: Fallowing, different crops, different irrigation technology and water sources.
  - What about water source(s)?

<u>Process and governance matter</u>

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

https://wrrc.arizona.edu/conference/2022

Questions??

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