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Transboundary Aquifers under Uncertainty: A Case Study from the Mexico-United States Border

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Precursors

State Practice in the Management and Allocation of Transboundary Ground Water Resources in North America, Yearbook of Int'l Envt'l L. 2007, Vol. 13(3), pp. 96-125 (2008) (co-authored with Prof. Amy Hardberger, St. Mary's Law School) (http://ssrn.com/abstract=1330690)

Rethinking Transboundary Ground Water Resources Management: A Local Approach along the Mexico-U.S. Border, Georgetown Int'l Envt'l L.R. , Vol. 25(1), pp. 95–128 (2013) (http://ssrn.com/abstract=2254081)

Mexico-U.S. Border (1,950 mi / 3,140 km)

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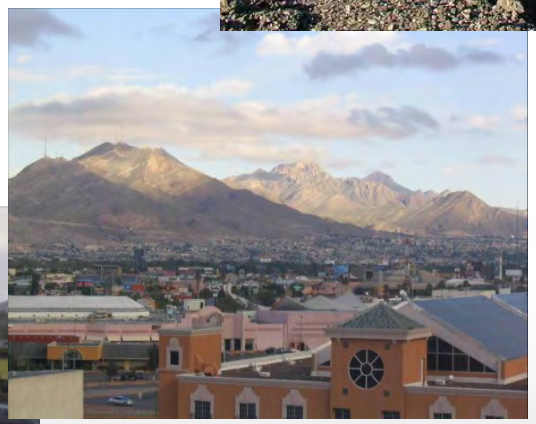
Sole source of potable water for 90% of communities along Mexico-U.S. border

- *Ambos Tecate (California-Baja California)*
- *Ambos Nogales (Arizona-Sonora)*
- *Sonoyta-Lukeville (Arizona-Sonora)*
- *Columbus-Palomas (New Mexico-Chihuahua)*
- *Ciudad Juarez (Chihuahua)*
- *Others …*



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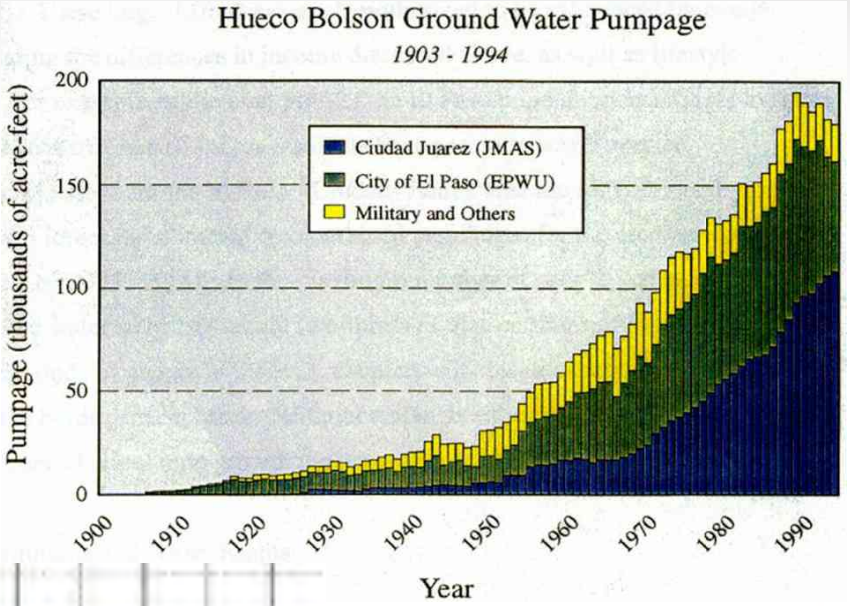
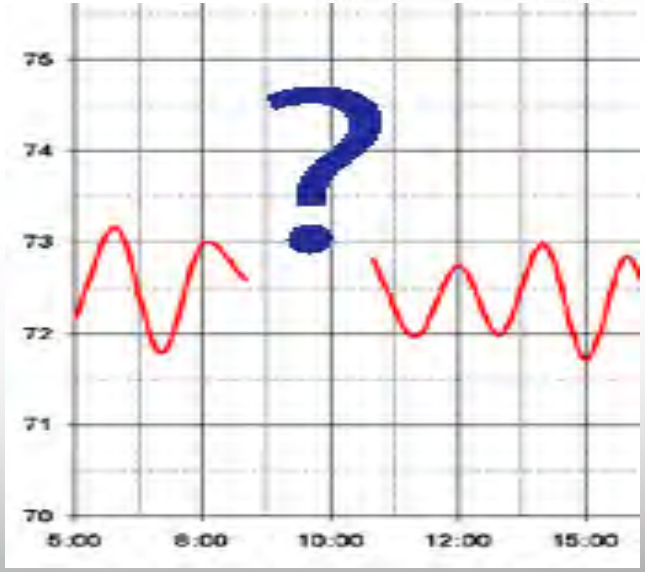
Mexico-U.S. Groundwater Challenges





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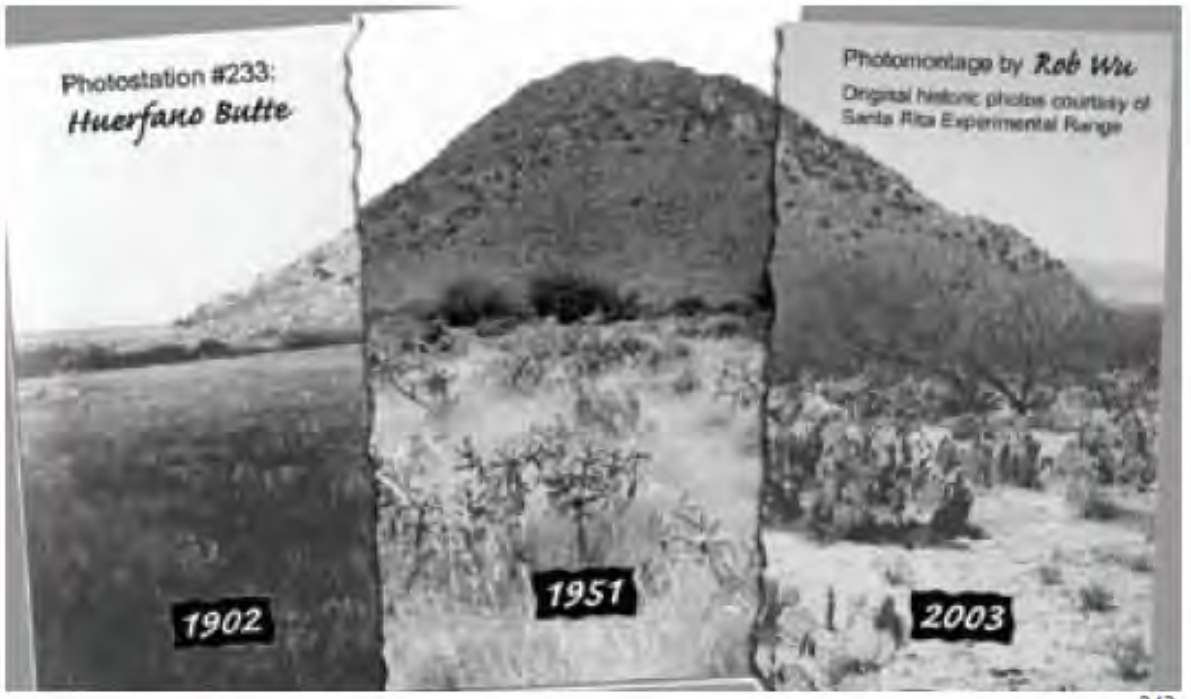
Mexico-U.S. Groundwater Challenges

Desertification of Arid Grassland
near Tucson, Arizona, 1902 to 2003



The photo series shows the progression from arid grassland to desert (desertification) over a 100-year period. The change is the result of grazing management and reduced rainfall in the Southwest.[250,252,253]

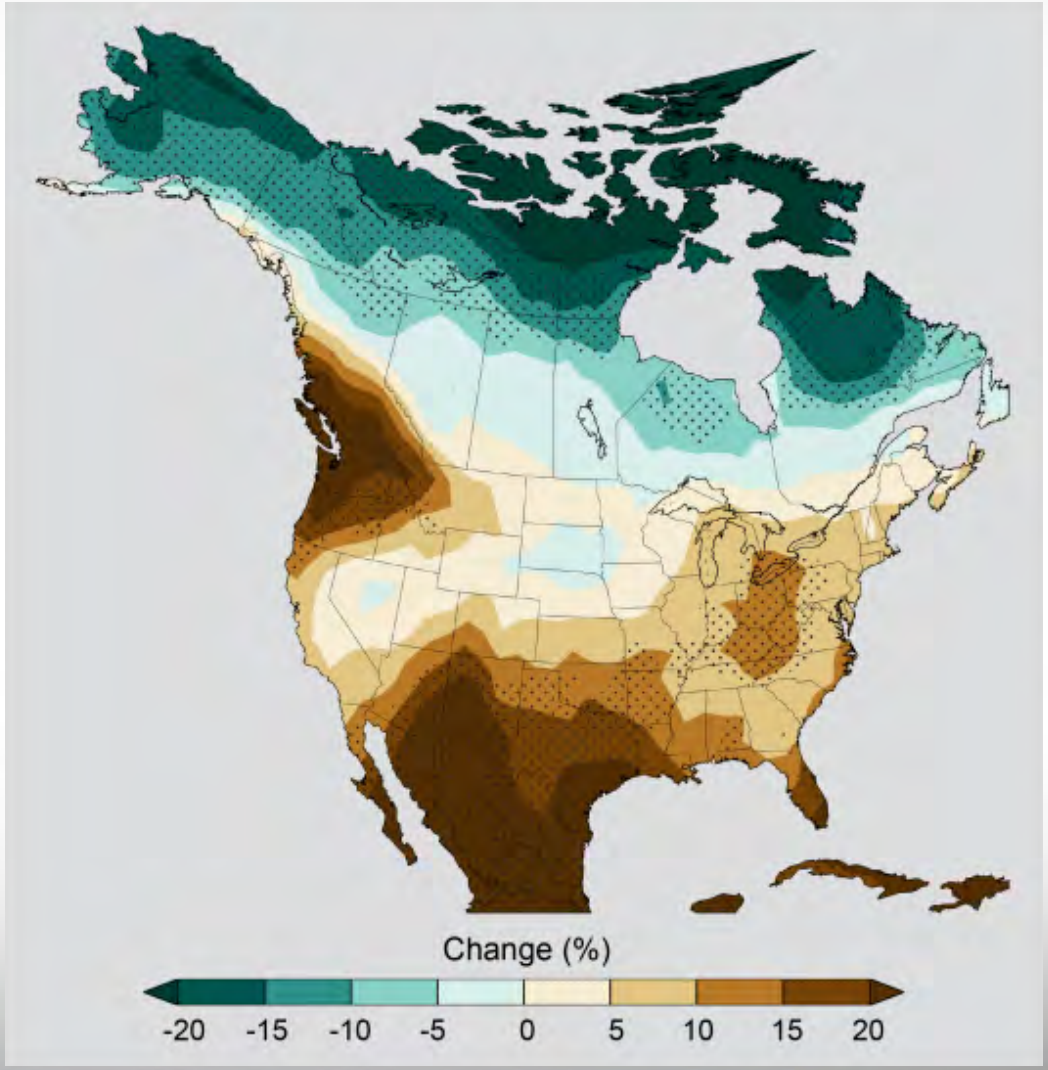
Source: Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009

Current Rainfall Averages:

- *500-750 mm near Gulf of Mexico*
- *50-100 mm in the Sonora-Arizona region*
- *100-250 mm in the Baja California-California*

By 2100, climate models indicate surface runoff will decline 10-30%.

Change in number of consecutive dry days (receiving less than 0.04 inches (1 mm) of precipitation) at the end of this century (2070-2099) relative to the end of last century (1971-2000) under the higher scenario, RCP 8.5.



Source: http://www.globalchange.gov/browse/multimedia/change-maximum-number-consecutive-dry-days

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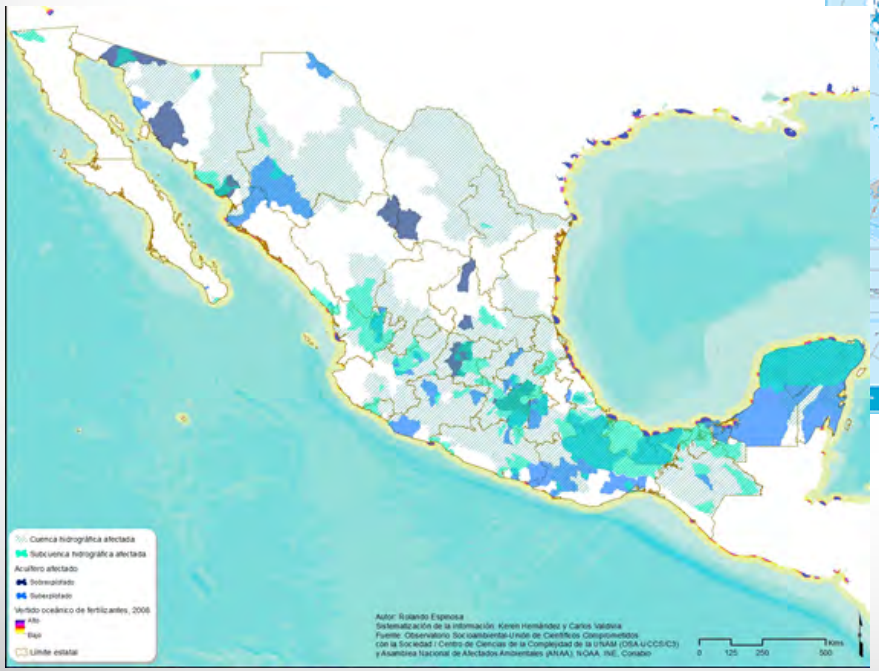
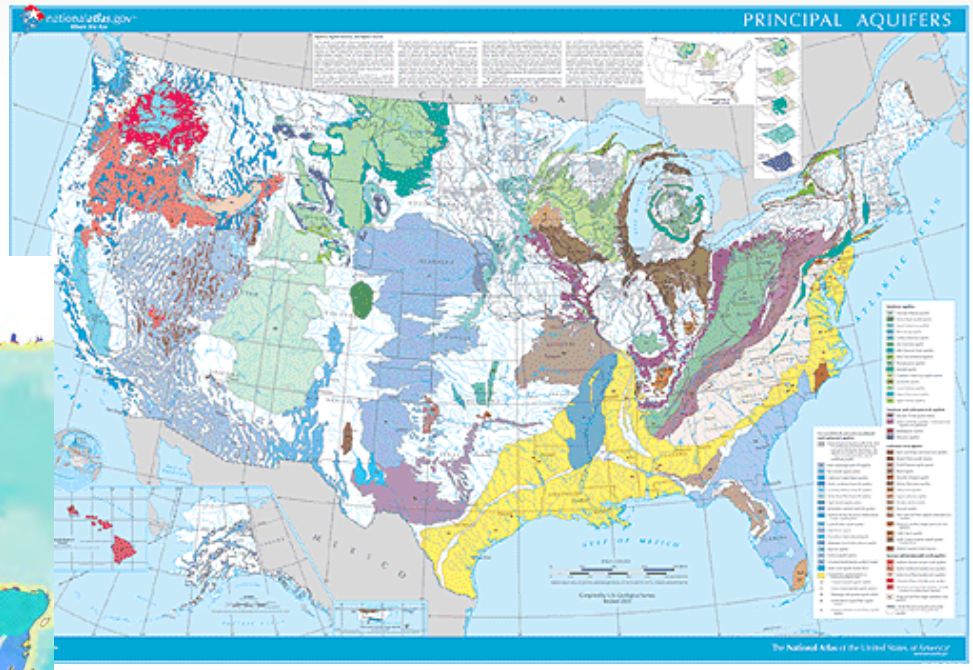
"*Blank-Map Syndrome*"

Where are the TBAs?





How many TBAs are there on the Mexico-U.S. border?

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TBAs on the Mexico-U.S. Border?

- 20 = GNEB (Good Neighbor Environmental Board), Water resources management on the US–Mexico border. Washington, DC: EPA. Eighth report to the President and the Congress of the United States (2005)
- 18 = S. Mumme, *Minute 242 and beyond: challenges and opportu for managing transboundary groundwater on the Mexico–U border*, 40 Nat Resour J. 341 (2000)
- 10 = International Groundwater Resources Assessment Centre (IGRAC) (2009)
- 8 = UNESCO, Final Report: 2nd Coordination Workshop. UNESCO/ OAS ISARM Americas Programme – Transboundary Aquifers of the Americas, El Paso, TX, 10-–12 November 2004 (2005)

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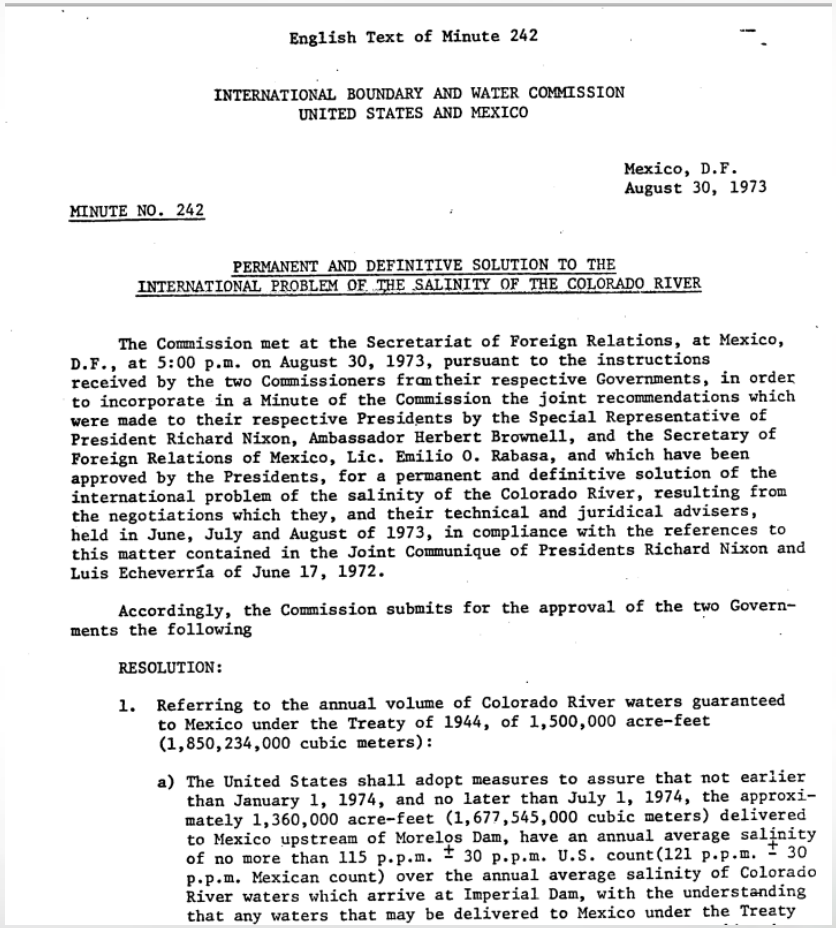
Lack of information = Lack of management/ regulation

Sole Transboundary Aquifer Agreement on the Mexico-U.S. Border

Minute 242 of 1973
(amendment to 1944 Colorado, Tijuana, Rio Grande treaty)

- ¶5 = pending development of a 'comprehensive' groundwater agreement, countries agree to limit withdrawals from aquifer along the Arizona-Sonora border near San Luis
- ¶6 = requires prior consultation prior to pursuing new surface or groundwater projects, or other action that could adversely impact the other side



English Text of Minute 242

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

Mexico, D.F.
August 30, 1973

MINUTE NO. 242

PERMANENT AND DEFINITIVE SOLUTION TO THE
INTERNATIONAL PROBLEM OF THE SALINITY OF THE COLORADO RIVER

The Commission met at the Secretariat of Foreign Relations, at Mexico, D.F., at 5:00 p.m. on August 30, 1973, pursuant to the instructions received by the two Commissioners from their respective Governments, in order to incorporate in a Minute of the Commission the joint recommendations which were made to their respective Presidents by the Special Representative of President Richard Nixon, Ambassador Herbert Brownell, and the Secretary of Foreign Relations of Mexico, Lic. Emilio O. Rabasa, and which have been approved by the Presidents, for a permanent and definitive solution of the international problem of the salinity of the Colorado River, resulting from the negotiations which they, and their technical and juridical advisers, held in June, July and August of 1973, in compliance with the references to this matter contained in the Joint Communique of Presidents Richard Nixon and Luis Echeverría of June 17, 1972.

Accordingly, the Commission submits for the approval of the two Governments the following

RESOLUTION:

1. Referring to the annual volume of Colorado River waters guaranteed to Mexico under the Treaty of 1944, of 1,500,000 acre-feet (1,850,234,000 cubic meters):

   a) The United States shall adopt measures to assure that not earlier than January 1, 1974, and no later than July 1, 1974, the approximately 1,360,000 acre-feet (1,677,545,000 cubic meters) delivered to Mexico upstream of Morelos Dam, have an annual average salinity of no more than 115 p.p.m. ± 30 p.p.m. U.S. count(121 p.p.m. ± 30 p.p.m. Mexican count) over the annual average salinity of Colorado River waters which arrive at Imperial Dam, with the understanding that any waters that may be delivered to Mexico under the Treaty

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Mexico-U.S. TBAs Study

- Study = *Identifying and Characterizing Transboundary Aquifers Along the Mexico-US Border: An initial assessment*
- Purpose = Identify and characterize TBA on Mex-US border in order to ascertain appropriate aquifer units for governance/ management
- General Methodology
  - Collect data and information generated on both sides from federal, state and local agencies, universities, non-governmental organizations, research institutes, and private sources where available
  - Identify and characterize TBA on the border
  - Generate recommendations for appropriate aquifer units for governance/management
- Collaborator = Dr. Rosario Sanchez, Program Coordinator at Texas A&M University Water Management and Hydrological Science Program

Mexico-U.S. TBAs Study

- Types of data/info collected
  - Aquifer characteristics (e.g., hydrogeology, chemistry, flow, etc.)
  - Environmental surroundings (e.g., precipitation and climate, etc.)
  - Geography (e.g., geographic extent, location, etc.)
  - Recharge/discharge (e.g., natural and artificial, rates, locations, etc.)
  - Human uses and dependencies
  - Environmental/ecosystem reliance
  - Climate change projections
- Challenges
  - Locating information especially on US side
  - Disparate methodologies between and within the two countries
  - Inconsistent information between and within the two countries

Mexico-U.S. TBAs Study

Hueco Bolson–Valle de Juarez

[True aquifer (orange) on US side and hydrological basin boundary (green) on Mexican side]

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Mexico-U.S. TBAs Study

Figure 3. Arizona-Sonora Transboundary Aquifers/Basins

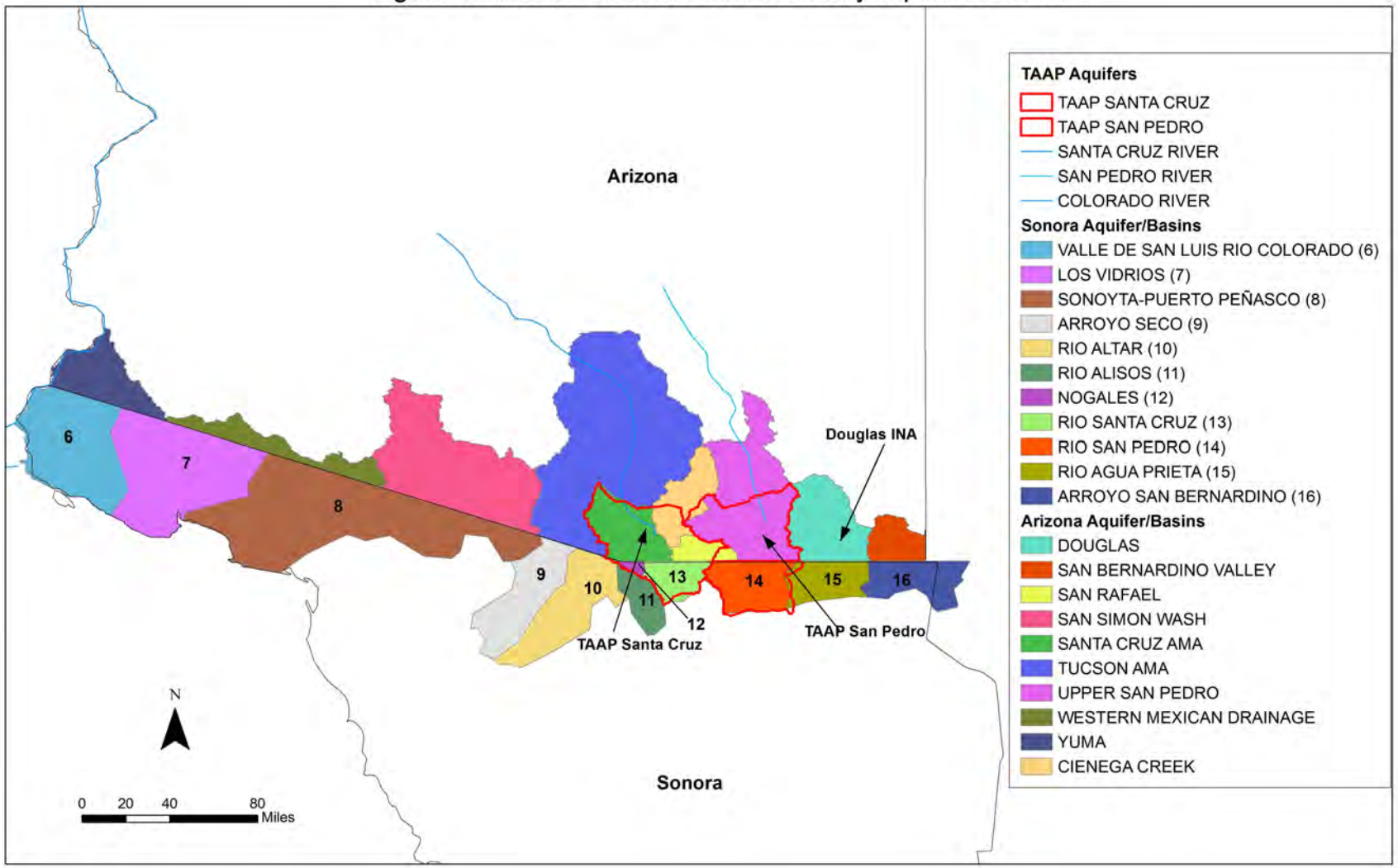
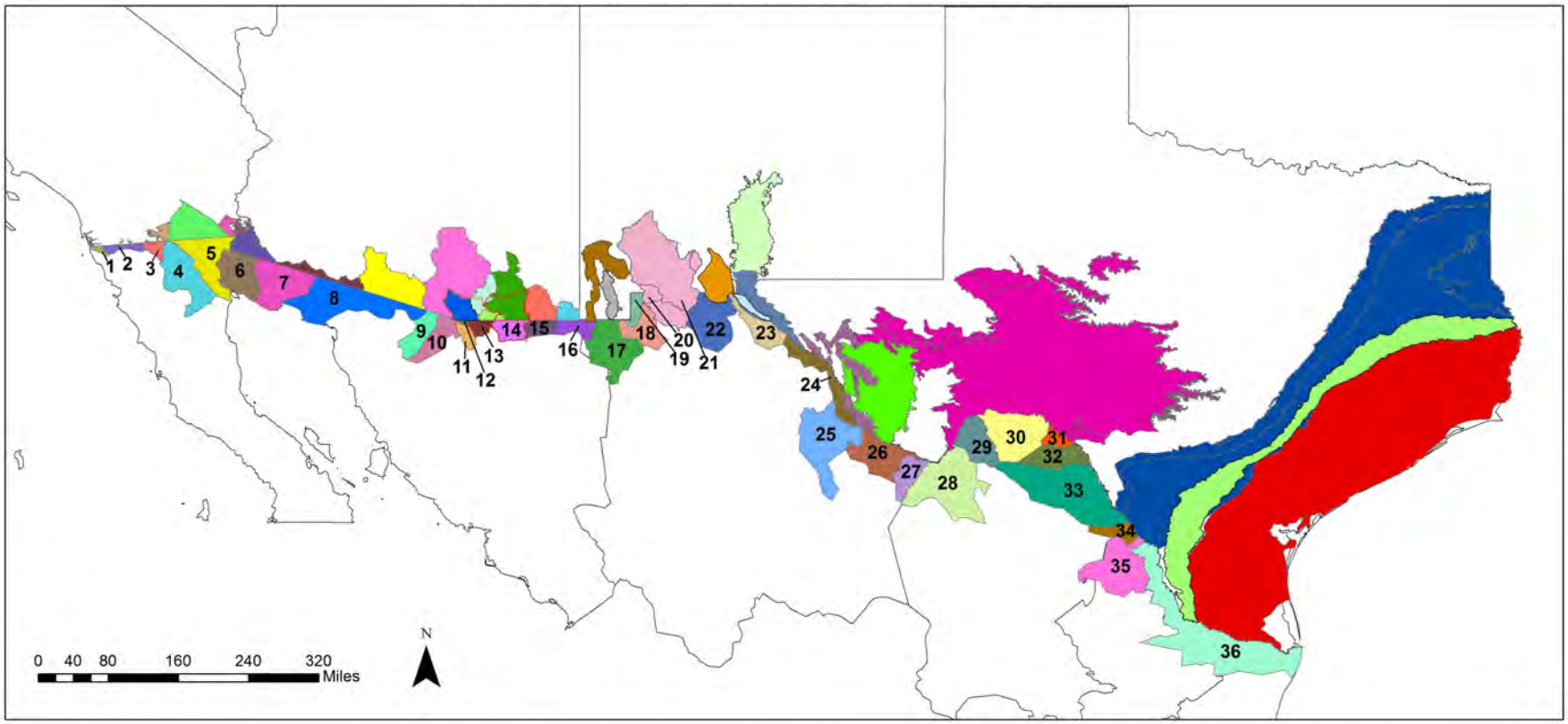


Figure 8. Mexico-U.S. Border Aquifers/Basins



Legend

TAAP SP boundary Project
TAAP SC boundary Project

California Basins
CAMPO VALLEY
COYOTE WELLS VALLEY
DAVIES VALLEY
IMPERIAL VALLEY
JACUMBA VALLEY
MISSION VALLEY
OGILBY VALLEY
OTAY VALLEY
POTRERO VALLEY
SWEETWATER VALLEY
TIJUANA
YUMA VALLEY

Arizona Basins
DOUGLAS
SAN BERNARDINO VALLEY
SAN RAFAEL
SAN SIMON WASH
SANTA CRUZ AMA
TUCSON AMA
UPPER SAN PEDRO
WESTERN MEXICAN DRAINAGE
YUMA
CIENEGA CREEK

New Mexico Basins
HUECO BOLSON
RIO GRANDE ALLUVIUM
MESILLA BASIN
MIMBRES BASIN
PLAYAS BASIN
TULAROSA BASIN
ANIMAS BASIN

Texas Minor Aquifers
IGNEOUS
WEST TEXAS BOLSONS
YEGUA JACKSON

Texas Major Aquifers
CARRIZO
EDWARDS-TRINITY
GULF COAST
HUECO BOLSON

Mexico Aquifers
TIJUANA (1)
TECATE (2)
LA RUMOROSA-TECATE (3)
LAGUNA SALADA (4)
VALLE DE MEXICALI (5)
VALLE DE SAN LUIS RIO COLORADO (6)
LOS VIDRIOS (7)
SONOYTA-PUERTO PEÑASCO (8)
ARROYO SECO (9)
RIO ALTAR (10)
RIO ALISOS (11)
NOGALES (12)
RIO SANTA CRUZ (13)
RIO SAN PEDRO (14)
RIO AGUA PRIETA (15)
ARROYO SAN BERNARDINO (16)
JANOS (17)
ASCENSION (18)
LOS MOSCOS (19)
JOSEFA ORTIZ DE DOMINGUEZ (20)
LAS PALMAS (21)
CONEJOS-MEDANOS (22)
VALLE DE JUAREZ (23)
VALLE DEL PESO (24)
BAJO RIO CONCHOS (25)
ALAMO CHAPO (26)
MANUEL BENAVIDES (27)
SANTA FE DEL PINO (28)
SERRANIA DEL BURRO (29)
CERRO COLORADO-LA PARTIDA (30)
PRESA LA AMISTAD (31)
PALESTINA (32)
ALLENDE-PIEDRAS NEGRAS (33)
HIDALGO (34)
LAMPAZOS-ANAHUAC (35)
BAJO RIO BRAVO (36)

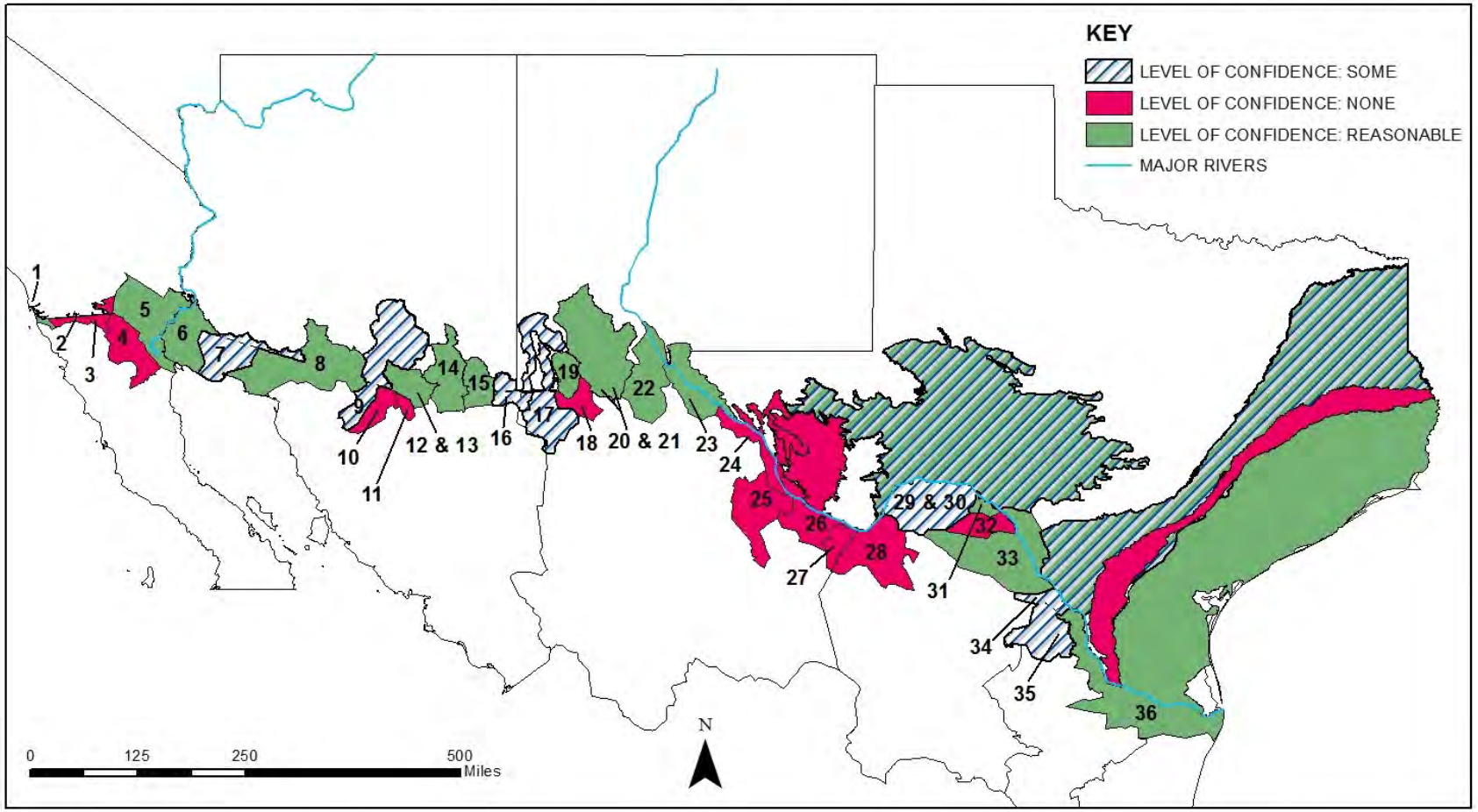
Mexico-U.S. TBAs Study

Proposed Categorization of US-Mexico Transboundary Aquifer/Basins

- *Reasonable Certainty*: technical information from both sides confirms presence of a TBA
- *Some Certainty*: technical information from only one side suggests a possible TBA, or information from both sides is strong but inconclusive
- *Limited Certainty*: technical information from one side suggests a TBA but is not corroborated from other side; or non-technical data from both sides suggests a TBA but technical data not available

STATES (MEXICO-US)	Level of information available/research to define the transboundary character		
BAJA CALIFORNIA-CALIFORNIA	REASONABLE	SOME	LIMITED
	(1) Tijuana/San Diego- (Tia Juana, Otay Sweetwater and Mission system)		(2) Tecate/Potrero Valley and Campo Valley
			(3) La Rumorosa-Tecate/Jacumba Valley and Davies Valley
			(4) Laguna Salada/Coyote Wells Valley
BAJA CALIFORNIA-CALIFORNIA-SONORA-ARIZONA	Cuenca Baja del Rio Colorado system (5) Valle de Mexicali/ Imperial, Ogilby and Yuma Valley		
	Cuenca Baja del Rio Colorado system (6)Valle San Luis Rio Colorado/Yuma		
SONORA-ARIZONA	Sonoyta-Papagos system (8) Sonoyta-Papagos/San Simon Wash	(7) Los Vidrios/Western Mexican Drainage	(10) Rio Altar/Tucson AMA
	(12) Nogales/Santa Cruz (TAAP1)	(9) Arroyo Seco/Tuscon AMA	(11) Rio Alisos/Santa Cruz
	(13) Santa Cruz/Santa Cruz-San Rafael (TAAP1)		
	(14) San Pedro/San Pedro (TAAP2)		
	(15) Rio Agua Prieta/Douglas (INA)		
SONORA-ARIZONA-NEW MEXICO		(16) Arroyo San Bernardino/San Bernardino Valley-San Bernardino basin	
CHIHUAHUA-NEW MEXICO	(19) Los Moscos/Moscos-Hachita	(17) Janos/Animas and Playas aquifer basin	(18) Ascencion/Los Moscos-Hachita
	(20) Josefa Ortiz de Dominguez/Mimbres		
	(21) Las Palmas/Mimbres		
CHIHUAHUA-TEXAS-NEW MEXICO	(22) Conejos Medanos/Mesilla Bolson (TAAP3)		
	(23) Valle de Juarez/Hueco Bolson (TAAP4)		
CHIHUAHUA-TEXAS			(24) Valle del Peso/West Texas Bolsons
			(25) Bajo Rio Conchos/West Texas Bolsons
			(26) Alamo Chapo/Igneous
			(27) Manuel Benavides/Lower aquifers
COAHUILA-TEXAS	(31) Presa La Amistad/Edwards	(29) Serrania del Burro/Edwards	(28) Santa Fe del Pino/Lower aquifers
	(33) Allende-Piedras Negras/Lower aquifers	(30) Cerro Colorado-La Partida/Edwards	(32) Palestina/Lower aquifers
		(34) Hidalgo/Carrizo Wilcox	
NUEVO LEON-TEXAS		(35) Lampazos/Anahuac-Carrizo Wilcox	
TAMAULIPAS-TEXAS	(36) Bajo Rio Bravo/Carrizo Wilcox-Gulf Coast (Yegua Jackson no data)		
Total	16	8	12

Figure 9. Confidence Level of the Transboundary Nature of Aquifers between Mexico and the U.S.



16 Confidence Level: Reasonable

(1) Tijuana/San Diego
-(Tijuana, Otay Sweetwater and Mission system)
(5) Cuenca Baja del Rio Colorado system:
Valle de Mexicali/ Imperial, Ogilby and Yuma Valley
(6) Cuenca Baja del Rio Colorado system:
Valle San Luis Rio Colorado/Yuma
(8) Sonoyta-Papagos system:
Sonoyta-Papagos/San Simon Wash
(12) Nogales/Santa Cruz (TAAP1)
(13) Santa Cruz/Santa Cruz-San Rafael (TAAP1)
(14) San Pedro/San Pedro (TAAP2)
(15) Rio Agua Prieta/Douglas (INA)
(19) Los Moscos/ Hachita Moscos
(20) Josefa Ortiz de Dominguez/Mimbres
(21) Las Palmas/Mimbres
(22) Conejos Medanos/Mesilla Bolson (TAAP3)
(23) Valle de Juarez/Hueco Bolson (TAAP4)
(31) Presa La Amistad/Edwards
(33) Allende-Piedras Negras/Local aquifers
(36) Bajo Rio Bravo/Carrizo Wilcox-Gulf Coast
(Yegua Jackson no data)

8 Confidence Level: Some

(7) Los Vidrios/Western Mexican Drainage
(9) Arroyo Seco/Tuscon AMA
(16) Arroyo San Bernardino/San Bernardino Valley
-San Bernardino basin
(17) Janos/Animas and Playas aquifer basin
(29) Serrania del Burro/Edwards
(30) Cerro Colorado-La Partida/Edwards
(34) Hidalgo/Carrizo Wilcox
(35) Lampazos/Anahuac-Carrizo Wilcox

Mexico-U.S. TBAs Study

Next Steps

- Data and information
  - Continue data collection
  - Continue correlation across boundaries
  - Generate new “layered” maps with geological, environmental, social, and other criteria
  - Calibrate maps in relation to climatic change projections
- Identify climate change and related challenges and concerns for each TBA
- Identify aquifer units for governance / management in light of challenges (s.a., climate change)
- Recommend governance/management approaches tailored to each TBA

More information

Rethinking Transboundary Ground Water Resources Management: A Local Approach along the Mexico-U.S. Border, Georgetown International Environmental Law Review, Vol. 25(1), pp. 95–128 (2013) (http://ssrn.com/abstract=2254081)

Managing Buried Treasure Across Frontiers: The International Law of Transboundary Aquifers, Water International, Vol. 36(5), pp. 573-583 (2011) (http://ssrn.com/abstract=1924469)

State Practice in the Management and Allocation of Transboundary Ground Water Resources in North America, Yearbook of International Environmental Law 2007, Vol. 13(3), pp. 96-125 (2008) (co-authored with Amy Hardberger, Environmental Defense) (http://ssrn.com/abstract=1330690)

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