COLLEGE OF AGRICULTURE & LIFE SCIENCES
COOPERATIVE EXTENSION

WATER RESOURCES RESEARCH CENTER

The Transboundary Aquifer Assessment Program

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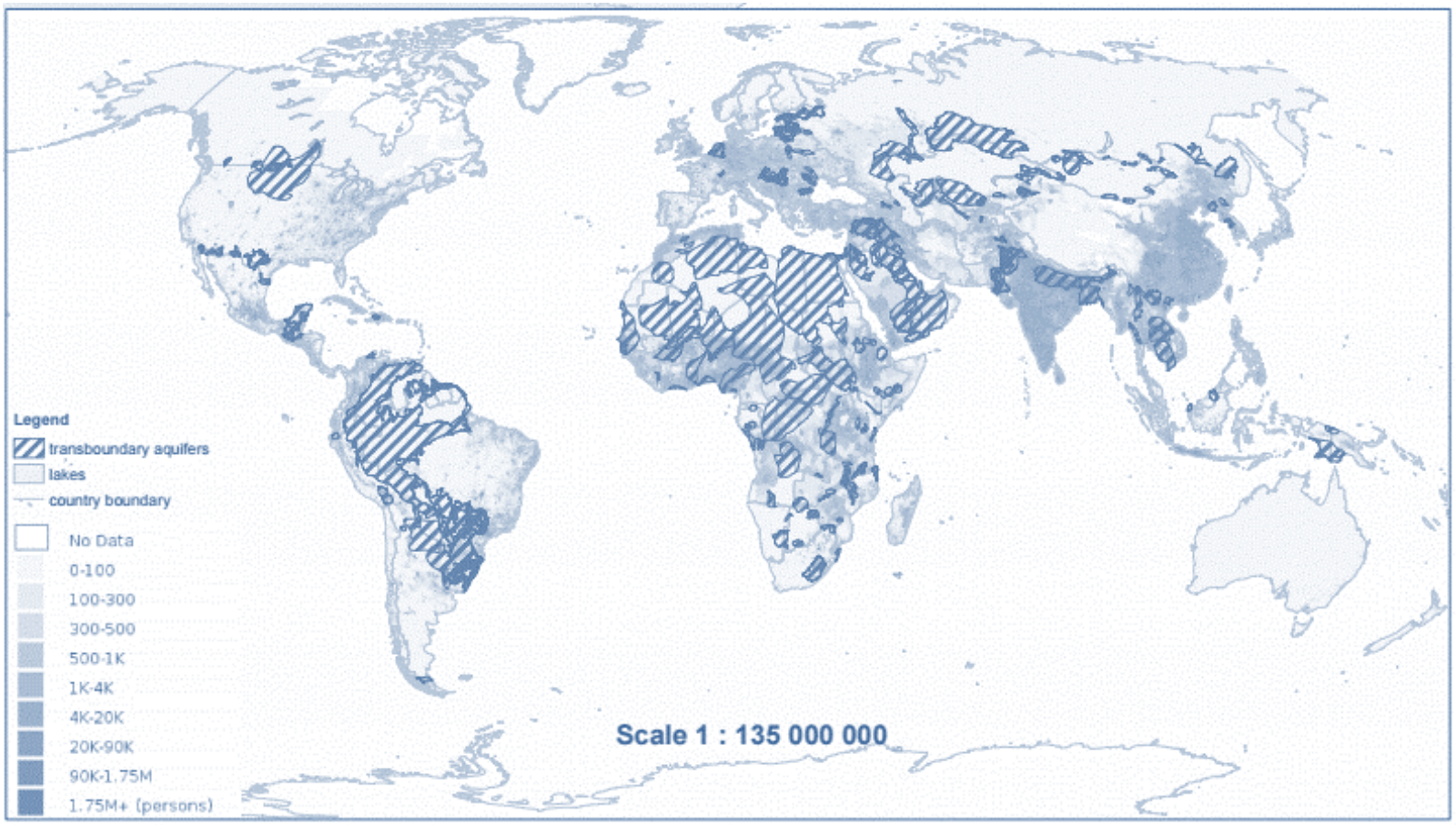
December 6, 2018

Groundwater Resources in the World

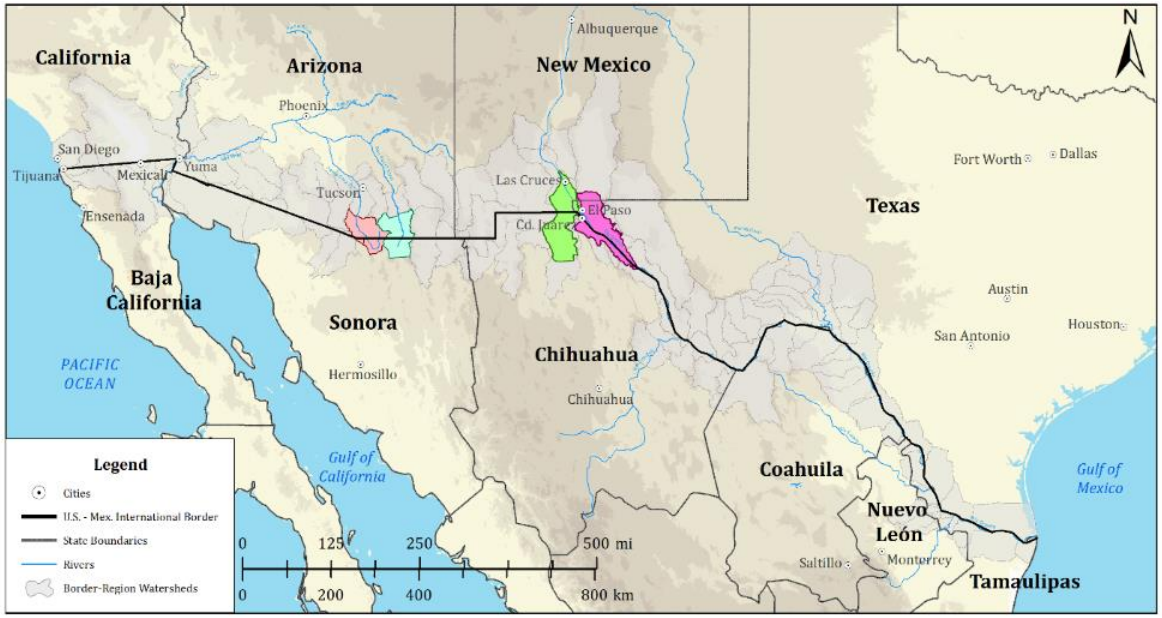


Transboundary Aquifers of the World and Population Estimate
(Source: Socioeconomic Data and Applications Center; layer name: Population Count Future Estimate 2015)

Recursos de Agua Subterránea en el Mundo

Acuíferos de Interés del Programa de Evaluación de Acuíferos Transfronterizos
Transboundary Aquifer Assessment Program Aquifers of Focus

Colaboradores/ TAAP Partners



TAAP Background

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

El Paso, Texas
August 19, 2009

JOINT REPORT OF THE PRINCIPAL ENGINEERS
REGARDING THE JOINT COOPERATIVE PROCESS
UNITED STATES-MEXICO FOR THE TRANSBOUNDARY AQUIFER
ASSESSMENT PROGRAM

To the Honorable Commissioners,
International Boundary and Water Commission,
United States and Mexico,
El Paso, Texas and Ciudad Juarez, Chihuahua.

Sirs:

We respectfully submit for your consideration this Joint Report recommending the joint cooperative process between the United States and Mexico to implement an assessment program for the transboundary aquifers shared by both countries.

I. Background

Since the decade of the 1970s, there exists within the framework of the International Boundary and Water Commission (IBWC), a process for the exchange of information on groundwater along the border between the United States and Mexico. Any issues of data or studies have been addressed on a case by case basis through mutual consultation as established in Resolution 6 of IBWC Minute No. 242.

By way of example, on December 2, 1997, the IBWC issued the "Joint Report of Principal Engineers Regarding Information Exchange and Mathematical Modeling in the El Paso, Texas and Ciudad Juarez, Chihuahua Area Aquifer." The IBWC arranged for the exchange of groundwater data between both countries and the development of a bilingual publication that was produced jointly under this effort.

On December 22, 2006, United States Public Law 109-448, the "United States-Mexico Transboundary Aquifer Assessment Act" was passed, establishing a program to evaluate transboundary aquifers between the United States and Mexico, which included the possibility of applying United States funds for assessment activities in Mexico.

II. International Boundary and Water Commission's Position and Process Framework

The IBWC, United States and Mexican Sections, are aware of the interest on both sides of the border to preserve and understand the aquifers used by both countries, whereby it is considered necessary to develop a team of binational experts to assess transboundary aquifers, exchange data, and if needed, develop new datasets.

Initiatives that include transboundary water resources are traditionally coordinated through the IBWC using the customary binational cooperation process used by both

Signing of TAAP Agreement by US and Mexican Principle Engineers – August 2009

Firma del Acuerdo del TAAP por parte de los Ingenieros Principales de EUA y Méx. Agosto, 2009

COMISIÓN INTERNACIONAL DE LÍMITES Y AGUAS
ENTRE MEXICO Y LOS ESTADOS UNIDOS.

El Paso, Texas, 19 de agosto de 2009

INFORME COMÚN DE LOS INGENIEROS PRINCIPALES
REFERENTE AL PROCESO DE COOPERACIÓN CONJUNTA
MÉXICO – ESTADOS UNIDOS PARA EL PROGRAMA DE EVALUACIÓN DE
ACUÍFEROS TRANSFRONTERIZOS

A los Honorables Comisionados,
Comisión Internacional de Límites y Aguas entre
México y los Estados Unidos,
Ciudad Juárez, Chihuahua y El Paso, Texas.

Señores:

Respetuosamente sometemos a su consideración este Informe Común recomendando el proceso de cooperación conjunta entre México y Estados Unidos para la realización de un programa de evaluación de los acuíferos transfronterizos entre ambos países.

I. Antecedentes

Desde la década de los 1970's ha tenido lugar en el seno de la Comisión Internacional de Límites y Aguas (CILA) un proceso de intercambio de información sobre aguas subterráneas en diferentes zonas de la frontera entre México y Estados Unidos. Cualquier asunto de información o estudios sobre esta materia se ha atendido caso por caso sobre la base de la consulta recíproca establecida en la Resolución 6 del Acta 242 de la CILA.

Como ejemplo, el 2 de diciembre de 1997, la CILA emitió un *"Informe Común de los Ingenieros Principales relativo al Intercambio de Información y Modelo Matemático del acuífero en la zona de Ciudad Juárez, Chihuahua – El Paso, Texas"*, en el marco del cual, la CILA coordinó el intercambio de información de datos de aguas subterráneas entre los dos países, así como la elaboración y publicación bilingüe del documento conjunto generado como resultado de dicho informe.

El 22 de diciembre de 2006, se aprobó la Ley Pública de Estados Unidos 109-448, relativa al "Acta sobre Evaluación de Acuíferos Transfronterizos México-Estados Unidos", estableciendo un Programa de Evaluación de Acuíferos Transfronterizos entre México y Estados Unidos, el cual incluye la posibilidad de aplicar recursos estadounidenses para actividades de evaluación en México.

II. Marco de la Posición y Proceso de la Comisión Internacional de Límites y Aguas

Las Secciones mexicana y estadounidense de la CILA, están conscientes del interés en ambos lados de la frontera en entender y preservar los acuíferos compartidos por ambos países, para lo cual se considera necesario establecer un grupo de expertos binacionales para evaluar los acuíferos transfronterizos, intercambiar información y según se requiera, desarrollar nuevas series de datos.

Las iniciativas que incluyen recursos de aguas transfronterizas, tradicionalmente son coordinadas a través de la CILA aplicando el proceso acostumbrado de cooperación

Antecedentes del TAAP

Timeline/Línea de Tiempo

- U.S. Transboundary Aquifer Assessment Act signed into law (U.S. Public Law 109-448) — 12/22/2006
- Discussions on TAAP partnerships(US-MX) — 9/1/2007
- Signing of the the Joint Report of the Principal Engineers Regarding the Joint Cooperative Process US-Mex. for the TAAP — 8/19/2009
- Workshop in Tucson, AZ "Developing a Workplan for the Santa Cruz and San Pedro Aquifers" — 1/3/2009
- AZ-Son team members participated in the 2009 AGM Congress in San Carlos, Sonora. — 11/11/2009
- Meeting in Rio Rico, AZ. Agreement on first stage funding for assessment of Mexican basins — 5/18/2010
- Mex. study "Actividades Hidrogeológicas en el Acuifero Río San Pedro en el Estado de Sonora, 1ra Etapa" was released — 12/15/2011
- Mex. study "Actividades Hidrogeológicas en el Acuifero Río Santa Cruz en el Estado de Sonora 1ra Etapa" was released — 12/15/2011
- Development and signing of an MOU with IBWC for transfer of funding and data related — 1/6/2011
- The Binational Studies of the Transboundary Santa Cruz and San Pedro Aquifers begin — January, 2012
- The Binational Study of the Transboundary San Pedro Aquifer was released — December, 2016

Marco Cooperativo Conjunto TAAP
TAAP Joint Cooperative Framework

- IBWC is the Binational Coordinating Agency
- Focus is “to improve the knowledge base of transboundary aquifers between the United States and Mexico”
- Binational technical advisory committees will be established for each identified transboundary aquifer

The Cooperative Framework for the Transboundary Aquifer Assessment Program: A Model for Collaborative Transborder Studies

Sharon B. Megdal

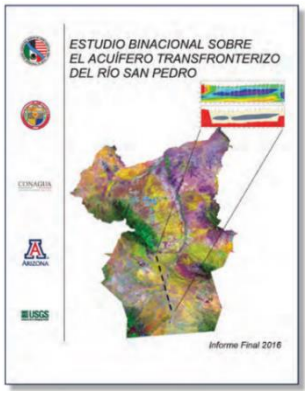
Being part of the team working on the Transboundary Aquifer Assessment Program (TAAP) continues to be gratifying. The International Boundary and Water Commission's (IBWC) recent publication of the *Binational Study of the Transboundary San Pedro Aquifer* (San Pedro Study) marked a milestone. This publication is noteworthy in that it is a first-ever binationally prepared, fully bilingual aquifer assessment, and because it was subject to peer review on both sides of the border. Also noteworthy is the

El Marco Cooperativo para el Programa de Evaluación de Acuíferos Transfronterizos: Un Modelo para Estudios Transfronterizos Colaborativos

Sharon B. Megdal

Traducido de la versión en inglés
por Elia M. Tapia Villaseñor

Formar parte del equipo que trabaja para el Programa de Evaluación de Acuíferos Transfronterizos (TAAP) continúa siendo gratificante. La reciente publicación del Estudio Binacional del Acuífero Transfronterizo San Pedro (Estudio San Pedro) por parte de la Comisión Internacional de Límites y Aguas CILA (International Boundary and Water Commission IBWC en Inglés) marcó una meta lograda. Esta publicación es notable por ser el primer estudio preparado de manera binacional, por presentar una evaluación acuífera bilingüe y porque fue sujeto a revisiones



- CILA es la Agencia Coordinadora Internacional
- El objetivo es “mejorar el conocimiento base de los acuíferos transfronterizos entre México y Estados Unidos”
- Se establecerán grupos técnicos binacionales para cada acuífero transfronterizo identificado

CILA pagina web: https://www.gob.mx/sre/acciones-y-programas/c-i-l-a-mex-eua
IBWC website: https://www.ibwc.gov/home.html
WRRC website: https://wrrc.arizona.edu/TAAP

Marco Cooperativo Conjunto TAAP
TAAP Joint Cooperative Framework

- IBWC responsible for:
  - Determining if aquifer studies are in the interest of both countries
  - Defining the scope of assessment
  - Being official repository of binational, bilingual project reports

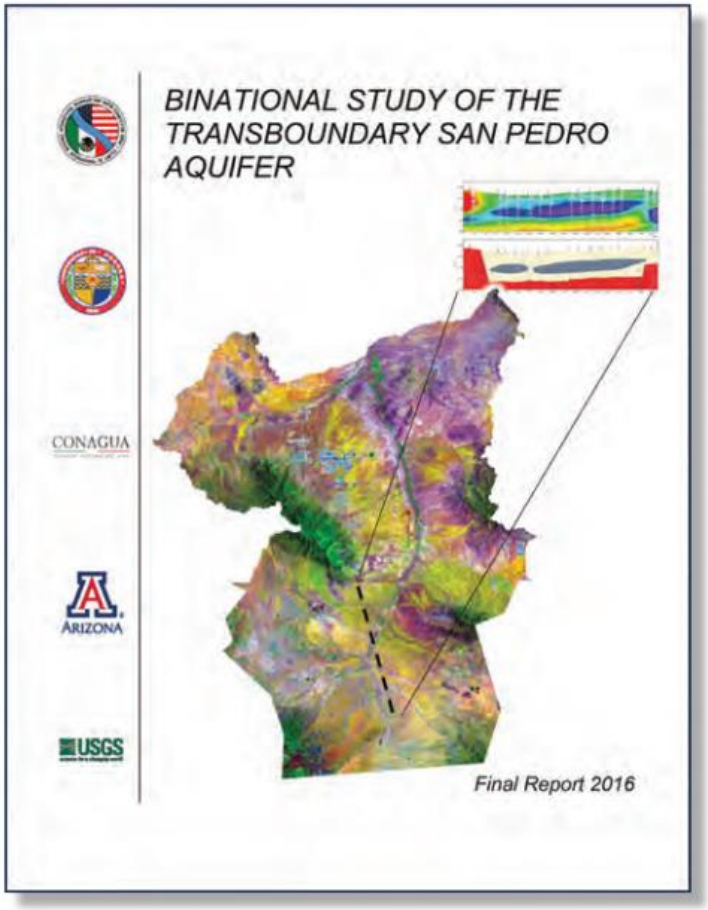
- La CILA es responsible de:
  - Determinar si los estudios de acuíferos son de interés para ambos países
  - Definir el alcance de la evaluación
  - Ser el repositorio oficial de los reportes binacionales bilingües

BINATIONAL COLLABORATION

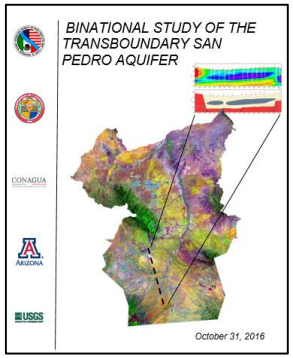
The San Pedro Report is the first-ever binational aquifer study prepared and released simultaneously in English and Spanish by the International Boundary and Water Commission.

COLABORACIÓN BINACIONAL

El Informe Binacional sobre el acuífero San Pedro es el primer estudio binacional sobre este acuífero preparado y publicado simultáneamente en inglés y español por la Comisión Internacional de Límites y Aguas.

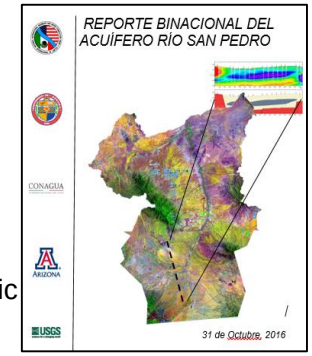


Chapters included



1. Introduction
2. Physical geography
3. Hydrography and hydrometeorology
4. Conceptual geologic model
5. Piezometry and hydraulic parameters
6. Hydrogeology
7. Hydrogeochemistry
8. Conceptual model of hydrodynamic behavior
9. Conclusions and recommendations
10. References

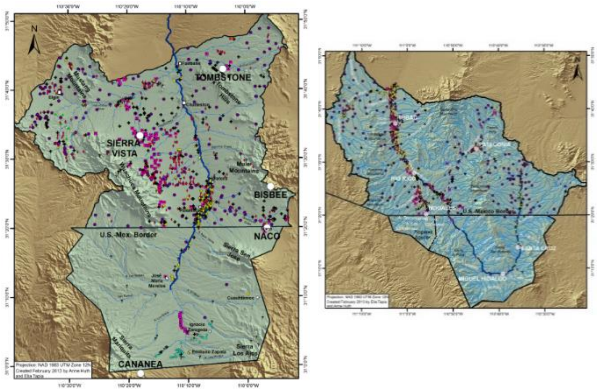
Capítulos Incluidos



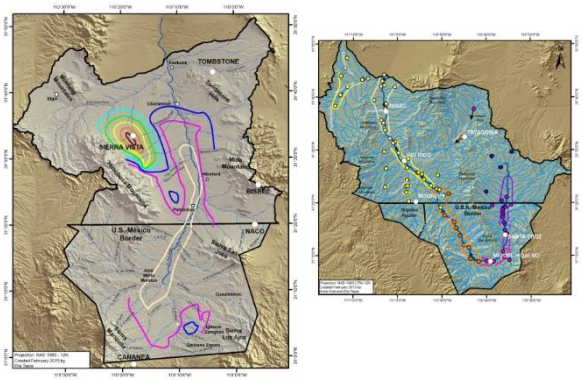
1. Introducción
2. Geografía Física
3. Hidrografía e Hidrometeorología
4. Modelo geológico regional
5. Piezometría y Parámetros Hidráulicos
6. Hidrogeología
7. Hidrogeoquímica
8. Modelo conceptal de comportamiento hidrodinámico
9. Conclusiones y recomendaciones
10. Referencias

Relevant Maps/Mapas Relevantes

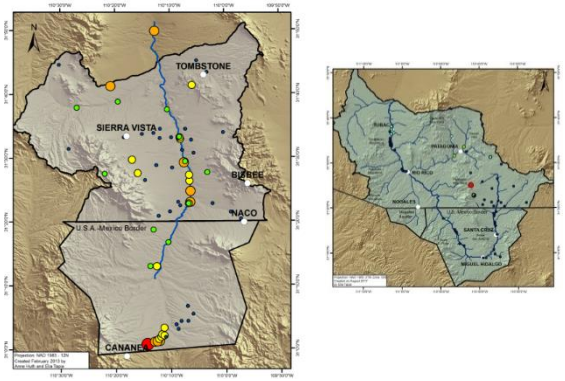
Water Uses/Usos de Agua



Static Water Level, 2011/ Nivel Estático de Agua, 2011



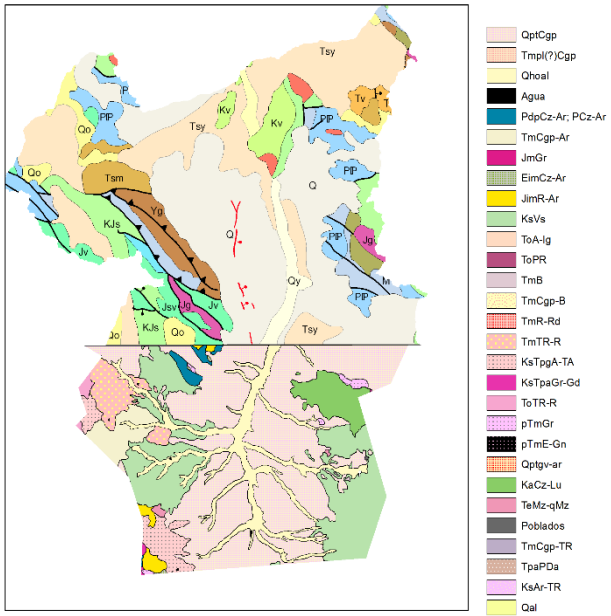
Water Quality/ Calidad de Agua (SO_4 Concentrations, Concentración de SO_4)



Harmonization Efforts/Esfuerzos de Armonización

Different classification systems for the same units.

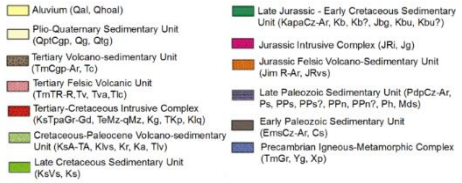
Geology Map/Mapa Geológico

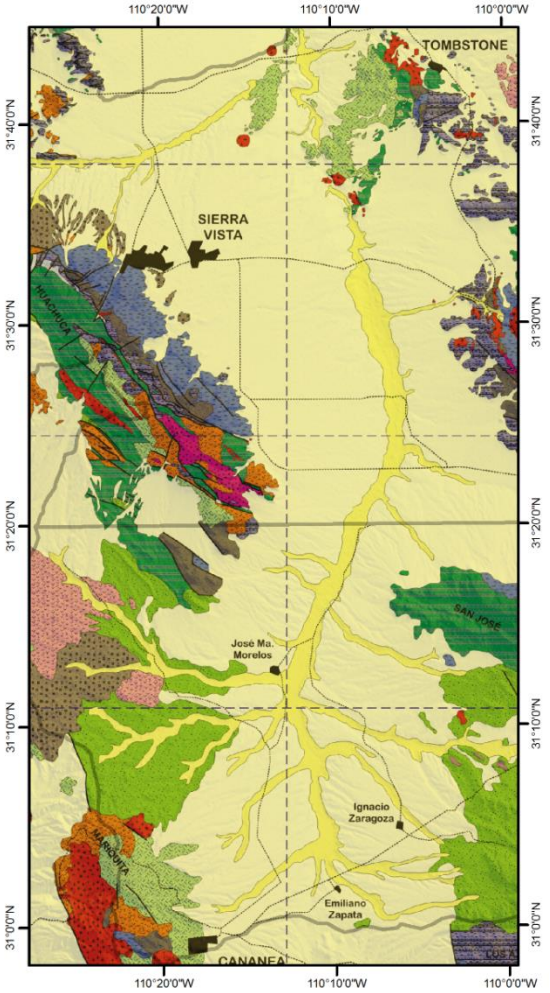


Diferentes sistemas de clasificación para las mismas unidades.

Final Product

Producto Final





THE BINATIONAL STUDY OF THE TRANSBOUNDARY SAN PEDRO AQUIFER

EL ESTUDIO BINACIONAL SOBRE EL ACUÍFERO 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 subsecuentes.

The San Pedro Aquifer

Acuífero del Río San Pedro

Full report:
https://ibwc.gov/EMD/reports_studies.htmleWQ_Reports

Informe completo:
www.cila.gob.mx/as/ebsatrsp2016.pdf

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

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

BINATIONAL INFORMATION

INFORMACIÓN BINACIONAL

Basin Information

Area: ~5,000 km² (1,930 mi²)
Length of River: ~106 km (66 mi)
Stream Order: 4 - 7
Terrain Slopes: 0 - 65°

Información de la Cuenca

Área: ~ 5,000 km² (1,930 mi²)
Longitud del Río : ~106 km (66 mi)
Orden de Corriente: 4 - 7
Pendiente de terreno: 0 - 65°

Hydrostratigraphic Units

Unit 1: Gravels and sand (sedimentary basin fill)
Unit 2: Fine sediments with low hydraulic conductivity
Unit 3: Units that could be lumped together as fractured rock aquifers

Unidades Hidroestratigráficas

Unidad 1: Gravas y arenas (relleno sedimentario de cuenca)
Unidad 2: Sedimentos finos con baja conductividad hidráulica
Unidad 3: Unidades que pueden agruparse como acuíferos de roca fracturada

Climatological Analysis

Annual Average Temperature: 12 - 18°C (54 - 64°F)
Annual Average Precipitation: 380 - 800 mm (15 - 31.5 in)
Annual Average Potential ET: 1.5 - 2 m (5 - 6.5 ft)

Análisis Climatológico

Temperatura Media Anual: 12 - 18°C (54 - 64°F)
Precipitación Media Anual: 380 - 800 mm (15 - 31.5 in)
ET Potencial Media Anual: 1.5 - 2 m (5 - 6.5 ft)

Geology

Description: Intrusive, metamorphic, volcanosedimentary, sedimentary, and volcanic rocks, ranging from Mesoproterozoic to Quaternary
Depth to Basement: 430 - 510 m (1,410 - 1,670 ft)

Geología

Descripción: Rocas instrusivas, metamórficas, volcano-sedimentarias, sedimentarias y volcánicas con edades que varían del Mesoproterozoico al Cuaternario
Profundidad al Basamento:
430 - 510 m (1,410 - 1,670 ft)

Piezometry and Hydraulic Parameters

Number of Wells:
5,000 +
Depth to Static Water Level (2011):
0 - 170 m (0 - 558 ft)
Static Water Level Elevation (2011):
1,150 m - 1,550 m (3,770 - 5,085 ft)
Hydraulic Conductivity (K):
0.0001 - 12.5 m/d (0.0003 - 41 ft/d)
Total Transmissivity:
0 - 3,000 m²/d (0 - 3,600 yd²/d)
Specific Storage (S_s):
1.0×10^{-6} m^{-1} - 6.7×10^{-6} m^{-1} (3.3×10^{-6} ft^{-1} - 2.2×10^{-5} ft^{-1})
Specific Yield (S_y):
0.001 - 0.3

Piezometría y Parámetros Hidráulicos

Número de Pozos:
5,000 +
Profundidad de Nivel Estático (2011):
0 - 170 m (0 - 558 ft)
Elevación de Nivel Estático (2011):
1,150 m - 1,550 m (3,770 - 5,085 ft)
Conductividad Hidráulica (K):
0.0001 - 12.5 m/d (0.0003 - 41 ft/d)
Transmisividad Total:
0 - 3,000 m²/d (0 - 3,600 yd²/d)
Almacenamiento Específico (S_s):
1.0×10^{-6} m^{-1} - 6.7×10^{-6} m^{-1} (3.3×10^{-6} ft^{-1} - 2.2×10^{-5} ft^{-1})
Rendimiento Específico (S_y):
0.001 - 0.3

Situación actual, Relación MEX-EUA en Aguas Subterráneas

- No treaty on groundwater between México and the U.S.
- Transboundary issues are taken care of within the IBWC framework on a case-by-case basis.
- Common interest in improving aquifer knowledge.
- Legislative differences between both countries.
- There are institutional differences between both countries (federal in MEX, not federal in the U.S.)

- No existe un tratado de aguas subterráneas entre México y EUA.
- Asuntos transfronterizos atendidos caso por caso en el marco de la CILA.
- Interés de ambos lados en mejorar conocimiento de los acuíferos.
- Diferencias de legislación entre ambos países.
- Diferencia de jurisdicción (federal en MEX, no federal en EUA).

Current U.S. - MEX relations regarding groundwater

TAAP Accomplishment Highlights

- Signing of a U.S.-Mexico binational agreement for scientific collaboration
- Over 50 binational meetings held
- Furthered development of Mesilla Valley Hydrologic Model (NM, TX, MX)
- Completion of the Binational Study of the Transboundary San Pedro Aquifer (AZ, MX)
- Funded research projects (AZ, NM, TX)
- Stakeholder engagement (AZ, MX)
- Climate change impact studies (AZ)
- Published articles related to TAAP and presentations at numerous conferences (AZ, NM, TX)
- Conducted extensive fieldwork on Mesilla, Hueco Bolson, and Santa Cruz aquifers (AZ, NM, TX, MX)

- Firma de un acuerdo binacional entre E.U.A.-México para colaboración científica
- Más de 50 reuniones binacionales
- Desarrollo de un Modelo Hidrológico para el Valle de la Mesilla (NM, TX, MX)
- Finalización del Estudio Binacional del Acuífero Transfronterizo San Pedro (AZ, MX)
- Fondos para proyectos de investigación (AZ, NM, TX)
- Compromiso de actores (AZ, MX)
- Estudios de impacto de cambio climático (AZ)
- Artículos publicados relacionados con el TAAP y presentaciones en numerosas conferencias (AZ, NM, TX)
- Trabajo de campo exhaustivo en los acuíferos La Mesilla, Bolsón del Hueco y Santa Cruz (AZ, NM, TX, MX)

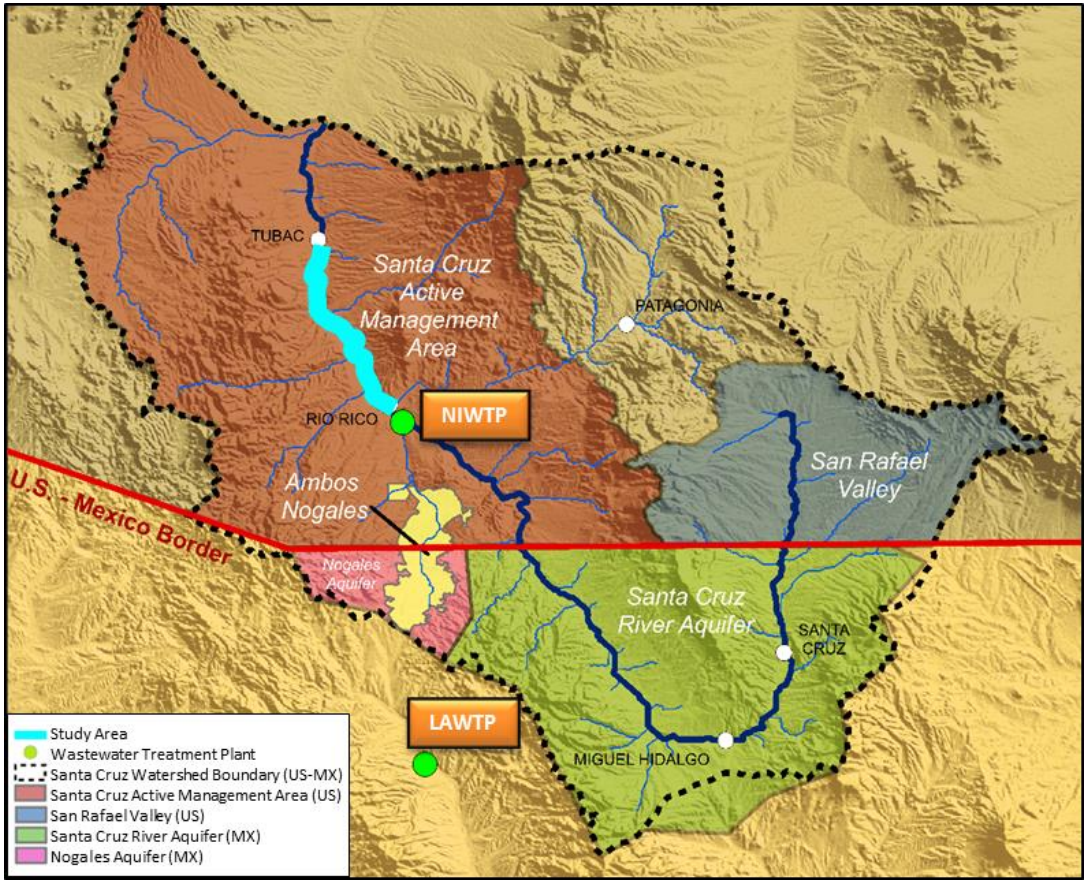
Recommendations from the Technical Team/Recomendaciones del Equipo Técnico

- Monitor water use and groundwater extractions.
- Measure piezometric levels.
- Measure surface flows.
- Expand climate observation network.
- Measure evapotranspiration and vegetation change.
- Monitor water quality and stable isotope sampling.
- Use of geophysical and remote sensing methods.
- Research drilling.
- Generate a binational soils map.
- Create a standarized database.
- Generate a numerical model for the area.

- Monitoreo de uso y extracción de agua subterránea
- Medir niveles piezométricos
- Medir el flujo superficial
- Expandir la red de observación climatológica
- Medir evapotranspiración y cambios de vegetación
- Muestreo de calidad del agua e isótopos estables
- Utilización de métodos geofísicos y de sensoría remota
- Perforación investigativa
- Generar una carta binacional de suelos
- Crear una base de datos estandarizada
- Generar un modelo numérico para el área

Current Work

- Assess the implications of variabilities of climate and effluent discharges on groundwater recharge downstream of the Nogales International Wastewater Treatment Plant in the Santa Cruz Aquifer



Current Work

- Stakeholder engagement
- TAAP programmatic activities

Published Article

Contents lists available at ScienceDirect

Journal of Hydrology: Regional Studies

journal homepage: 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

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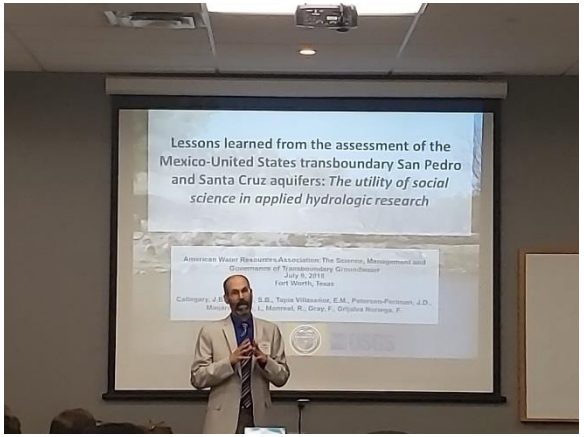
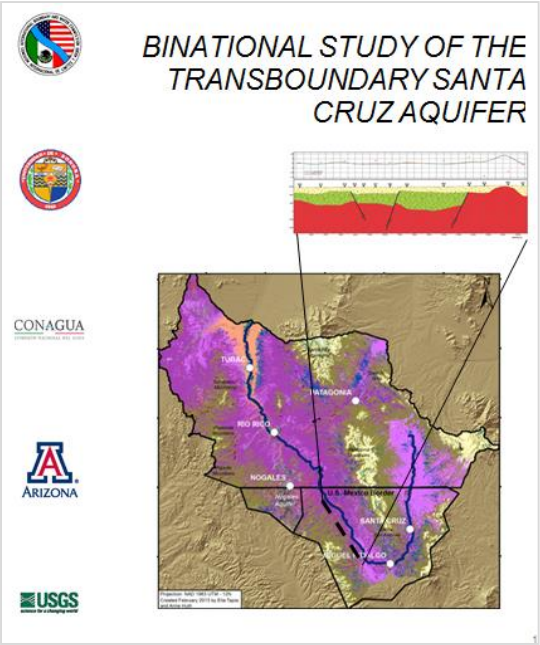
[a] USGS 520 N Park Ave, Tucson, AZ, 85719, USA
[b] University of Arizona, 350 N Campbell Ave, Tucson, AZ 85719, USA
[c] Universidad de Sonora, Calle Av. Rosales SN, Centro, 83000 Hermosillo, Son., Mexico

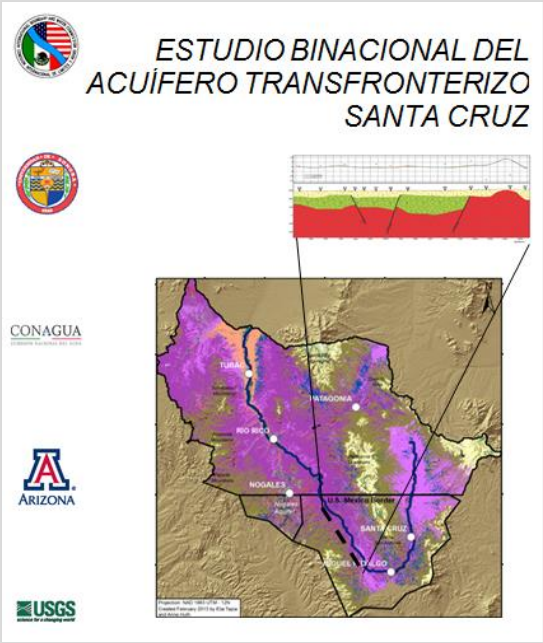
AWRA 2018 Summer Specialty Conference. The Science, Management and Governance of Transboundary Groundwater. Fort Worth, TX.



2018-2019 Task 1

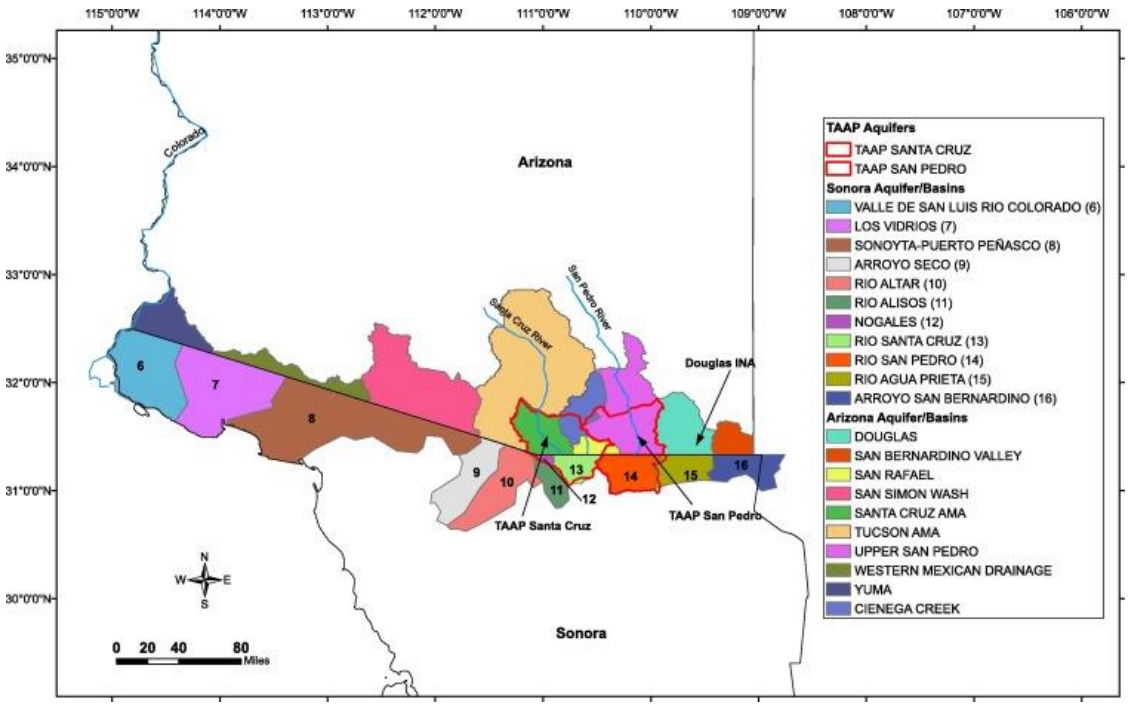
- Participate in the completion of the *Binational Study of the Transboundary Santa Cruz Aquifer*
- Collaborate with USGS, IBWC and others to coordinate efforts towards the development of binational groundwater modeling for the San Pedro and Santa Cruz aquifers





Task 2

- Reconnaissance work in other transboundary aquifers along the Arizona/Sonora border
- Focus on:
  - Jurisdictional responsibility
  - Available infrastructure
  - Ongoing projects
  - Stakeholder engagement



Source: Sanchez, R., Lopez, V., & Eckstein, G. (2016). Identifying and characterizing transboundary aquifers along the Mexico–US border: An initial assessment. *Journal of Hydrology*, *535*, 101-119.

Task 3

- Analysis of the TAAP Cooperative Framework and water management approaches in the TAAP priority aquifers and assess their applicability to other transboundary water efforts.

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

El Paso, Texas
August 19, 2009

JOINT REPORT OF THE PRINCIPAL ENGINEERS REGARDING THE JOINT COOPERATIVE PROCESS UNITED STATES-MEXICO FOR THE TRANSBOUNDARY AQUIFER ASSESSMENT PROGRAM

To the Honorable Commissioners,
International Boundary and Water Commission,
United States and Mexico,
El Paso, Texas and Ciudad Juarez, Chihuahua.

Sirs:

We respectfully submit for your consideration this Joint Report recommending the joint cooperative process between the United States and Mexico to implement an assessment program for the transboundary aquifers shared by both countries.

I. Background

Since the decade of the 1970s, there exists within the framework of the International Boundary and Water Commission (IBWC), a process for the exchange of information on groundwater along the border between the United States and Mexico. Any issues of data or studies have been addressed on a case by case basis through mutual consultation as established in Resolution 6 of IBWC Minute No. 242.

By way of example, on December 2, 1997, the IBWC issued the "Joint Report of Principal Engineers Regarding Information Exchange and Mathematical Modeling in the El Paso, Texas and Ciudad Juarez, Chihuahua Area Aquifer." The IBWC arranged for the exchange of groundwater data between both countries and the development of a bilingual publication that was produced jointly under this effort.

On December 22, 2006, United States Public Law 109-448, the "United States-Mexico Transboundary Aquifer Assessment Act" was passed, establishing a program to evaluate transboundary aquifers between the United States and Mexico, which included the possibility of applying United States funds for assessment activities in Mexico.

II. International Boundary and Water Commission's Position and Process Framework

The IBWC, United States and Mexican Sections, are aware of the interest on both sides of the border to preserve and understand the aquifers used by both countries, whereby it is considered necessary to develop a team of binational experts to assess transboundary aquifers, exchange data, and if needed, develop new datasets.

Initiatives that include transboundary water resources are traditionally coordinated through the IBWC using the customary binational cooperation process used by both

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¿Gracias – preguntas?
Thank you – questions?

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Visit http://www.wrrc.Arizona.edu/TAAP for more information