U.S.-Mexico Transboundary Waters: Aquifers of the Upper San Pedro and Santa Cruz Basins, and the Colorado River Limitrophe and Delta

Aguas Transfronterizas México-EUA: Acuíferos de las Cuencas del San Pedro y Santa Cruz Río Arriba, y la Delta y el Limitrofe del Río Colorado

Southeast Arizona Citizens Forum
June 14, 2018
Bisbee, Arizona

James Callegary, Ph.D.
Lessons learned from the assessment of the Mexico-United States transboundary San Pedro and Santa Cruz aquifers

- Work conducted in two phases: (1) laying the groundwork and (2) implementation
  - Laying the groundwork
    - Binational meetings with stakeholders and key actors (agencies and individuals),
    - Developing an understanding of the physical, institutional, historical, and socio-political context
Lessons Learned

- Work conducted in two phases
  - Implementation
    - Agreement to proceed with the study of four “focus” aquifers and development of associated technical teams
The Arizona-Sonora Effort

- Data compilation and summary of existing studies
- Binational field visits and joint development of work plans
- Preparation of fact sheets in English and Spanish

El Esfuerzo Sonora-Arizona

- Recopilación de datos y resumén de estudios actuales
- Visitas de campo binacionales y desarrollo conjunto de planes de trabajo
- Elaboración de hojas informativas en español y inglés
The San Pedro-Santa Cruz effort includes

- Geophysical surveys
- Geologic mapping
- Identification of data gaps
- Binational data integration

El Esfuerzo San Pedrdo-Santa Cruz incluye

- Levantamientos geofísicos
- Mapeo geológico
- Identificación de carencias de datos
- Integración binacional de datos
Progress – Avances
San Pedro Basin – Cuenca San Pedro

- Runoff-recharge measurement and modeling in the Sierra Vista Subwatershed of the Upper San Pedro Basin
- Medición y modelación de aguas pluviales y la recarga en la Subcuenca Sierra Vista de la Cuenca Alta de San Pedro
Progress – Avances
San Pedro Basin – Cuenca San Pedro

- Network of 11 gages in ephemeral stream channels in Sierra Vista and the Fort Huachuca Military Installation.

- Rainfall-runoff model to estimate infiltration and recharge via soil and stream channels.

- Red de 11 fluviómetros en arroyos efímeros en Sierra Vista y la base militar de Fort Huachuca.

- Modelo de precipitación-escurrimiento para estimar la infiltración y la recarga a través del suelo y los cauces.
Progress Both Basins – **Avances Ambas Cuencas**

- Groundwater Vulnerability to Contamination: EPA DRASTIC model
- Vulnerabilidad de Aguas Subterráneas a la Contaminación: Modelo DRASTIC de la Agencia de Protección Ambiental (EPA).
Binational Landcover/Cobertura Vegetal Binacional – San Pedro
Binational Soils Map/Mapa Binacional de Suelos – San Pedro
Progress – Avances
Santa Cruz Basin – Cuenca Santa Cruz

- Geochemical Database
- Sampling surface and groundwater for compounds of emerging concern – pesticides, pharmaceutical and personal care products
- Preliminary transport modeling - nitrate
- Installation of a streamgage in Nogales Wash the main tributary to the Santa Cruz River which originates in the twin cities of Nogales

- Base de datos geoquímicos
- Muestreo de contaminantes emergentes – pesticidios, farmaceúticos, productos de cuidado personal
- Modelación preliminario – transporte de nitratos
- Instalación fluviómetro en el Arroyo Nogales, el tributario principal del Río Santa Cruz que fluye desde las ciudades de Ambos Nogales
Progress – Avances
Santa Cruz Basin – Cuenca Santa Cruz

- Initial work on hydrogeologic framework model for Upper Santa Cruz Basin (AZWSC, GMEG, UNISON)
- Development of wells database with geologic log information.
Selected Papers – Artículos Seleccionados

❖ Many jointly authored by U.S./Mexican TAAP participants
❖ Varios escritos por autores Mexicanos/EE.UU. Del TAAP


“Climate change and population growth impacts on the transboundary Santa Cruz aquifer” Scott, C.A., S. Megdal, L.A. Oroz, J. Callegary, P. Vandervoet, Climate Research. Accepted, October 2011 with minor revisions
Binational Reports – Informes Binacionales

- Reports – one for each basin. Written by binational team from US (USGS and UA) and Mexico (UNISON).
- Content:
  - Physical Geography
  - Surface-Water Hydrology and Hydrometeorology
  - Conceptual Geologic Model
  - Hydrogeology
  - Piezometry and Hydraulic Parameters
  - Hydrogeochemistry
  - Conceptual and Numerical Groundwater Models

- Reportes – uno para cada cuenca. Escritos por un equipo binacional de México (UNISON) y de los Estados Unidos (USGS y UA).
- Contenidos:
  - Geografía Física
  - Hidrología de Agua Superficial y Hidrometeorología
  - Modelo Conceptual Geológico
  - Hidrogeología
  - Piezometría y Parámetros Hidráulicos
  - Hidrogeoquímica
  - Modelos Conceptuales y Numéricos de Agua Subterránea
Binational Reports

- Santa Cruz Aquifer report is in review

Content:
- Physical Geography
- Surface-Water Hydrology and Hydrometeorology
- Conceptual Geologic Model
- Hydrogeology
- Piezometry and Hydraulic Parameters
- Hydrogeochemistry
- Conceptual and Numerical Groundwater Models
Lessons Learned – Why Did It Work?

- Laying the groundwork
  - Economic, historical, and socio-political setting
  - Legal framework, institutional setting
  - Identification of team members
  - Resources: technical and financial
  - Planning and decision-making
  - Communication: internal, stakeholder, scientific community
A Binational Partnership - Una Colaboración Binacional

- Mexican Government Agencies
  - Mexico’s National Water Commission (CONAGUA)
  - State of Sonora’s Water Commission (CEAS)
- University of Sonora – Geology

- Agencias Gubernamentales Mexicanos
  - Comisión Nacional del Agua (CONAGUA)
  - Comisión Estatal del Agua de Sonora
- Universidad de Sonora – Geología
A Binational Partnership - Una Asociación Binacional

- USGS and the University of Arizona Water Resources Research Center (WRRC) by U.S. law.
- Additional participants on the U.S. side
  - Government agencies at different levels
  - Non-governmental organizations
- International Boundary and Water Commission (IBWC) – U.S. Section and Mexican Section

- El Servicio Geológico de los Estados Unidos (USGS) y el Centro de Investigación del Recurso Agua (WRRC) conforme a la ley pública de los EE.UU.
- Participantes adicionales en los EE.UU.
  - Agencias gubermentales de varios niveles
  - Organizaciones No-Gubermentales (ONGs)
- La Comisión Internacional de Límites y Agua (CILA) – Sección Mexicana y Sección de los Estados Unidos

Signing of the “Joint Report of the Principal Engineers Regarding the Joint Cooperative Process United States-Mexico for the Transboundary Aquifer Assessment Program”, August 19, 2009
Lessons Learned – Why Did It Work?

- **Challenges**
  - Misunderstanding regarding the correct channels through which to carry out the binational work
  - Not being aware of the correct protocols to use
  - Words matter! differing interpretations of words
Lessons Learned – Why Did It Work?

♦ Solutions
  ♦ Think Social Science
  ♦ Adaptation-accommodation-perseverance: dealing with complexity and the unexpected
  ♦ Cultural and Socio-Political Sensitivity
  ♦ Time
Minuto 319 Río Colorado – Flujo Pulso
Minute 319 Colorado River Pulse Flow

- Minute 319, Interim International Cooperative Measures in the Colorado River Basin Through 2017 and Extension of Minute 318 Cooperative Measures to Address the Continued Effects of the April 2010 Earthquake in the Mexicali Valley, Baja California,
- Section III.6, Water for the Environment and ICMA/ICS Exchange Pilot Program (ICMA - Intentionally Created Mexican Allocation; ICS - Intentionally Created Surplus)

- The "pilot program will arrange for the means to create 158,088 acre-feet (195 mcm) of water for base flow and pulse flow for the Colorado River Limitrophe and its delta by means of the participation of the United States, Mexico, and non-governmental organizations"[T]he information developed through implementation of this Minute will be used to inform future decisions regarding binational cooperative efforts to address proactive actions in the Colorado River Delta."

- "The sources of water to implement this flow shall be from ICMA created or water deferred by Mexico under Section III.1. The Consultative Council and Environmental Work Group formed and tasked a binational Environmental Flows Team to develop the Delivery and Monitoring Plan..."
Flujo Pulso – Área de Estudio
Pulse Flow Study Area
Río Colorado – Flujo Pulso
Colorado River Pulse Flow

- Monitoring, Analysis, and Modeling:
  - Discharge
  - Vegetation changes
  - Effects on birds
  - Groundwater
  - Water quality/salinity
  - Sediment Transport
  - Geophysical investigations
  - Evapotranspiration
  - Groundwater/Surface Water Interactions

- Monitoreo, Análisis y Modelación:
  - Caudal
  - Cambio de vegetación
  - Efectos sobre pájaros
  - Agua subterránea
  - Calidad/Salinidad de Agua
  - Transporte de sedimentos
  - Investigaciones geofísicos
  - Evapotranspiración
  - Interacciones entre agua subterránea y superficial
Minute 319
Colorado River Limitrophe and Delta
Environmental Flows Monitoring
Interim Report
May 19, 2016

Minuto 319
Río Colorado Limítrofe y Delta
Monitoreo de Flujos Ambientales
Informe Interino
19 Mayo, 2016
Rodríguez Burgueño, J.E., 2016, Tesis: Efectos hidrológicos de los flujos pulso y base en la zona riparia del Delta del Río Colorado
Environmental Flows for the Colorado River Delta: Results of an Experimental Pulse Release from the US to Mexico

Edited by Edward Glenn, Karl Flessa, Eloise Kendy, Patrick B. Shafroth, Jorge Ramírez-Hernández, Martha Gomez-Sapiens, Pamela L. Nagler

Volume 106, Part B, Pages 629-808 (September 2017)
Minute 323 - Extension of Cooperative Measures and Adoption of a Binational Water Scarcity Contingency Plan in the Colorado River Basin

- Allows Mexico to defer delivery of a portion of its Colorado River allotment in the event of emergencies, or as a result of water conservation projects.
- Proactive basin operations during certain low elevation reservoir conditions at Lake Mead by applying water delivery reductions in order to deter more severe reductions in the future
- Implements measures to address salinity impacts stemming from the joint cooperative actions
- Provides water for the environment and funding for environmental monitoring and habitat restoration
- Provides greater U.S. investment in water infrastructure and environmental projects in Mexico
Minute 323 – Environmental Goals

- Use water to create habitat

- Monitor to verify that riparian and estuarine habitats are restored and maintained

- Understand relationships between restored habitat quality and restoration practice

Photos courtesy of Sonoran Institute
Minute 323 – Restoration Objectives

- Create and enhance habitat to support diverse wildlife species
- Promote additional recreational and economic opportunities for local communities in the Delta region
- Effectively utilize water resources to create sustainable, functional ecosystems
Minute 323 – Restoration Objectives

- Develop an integrated restoration approach to consider ecologic, abiotic, and public interactions.

- Incorporate ecological research and monitoring results into adaptive management decisions
Minute 323 – Water Deliveries

Restauremos El Colorado AC

- Non-for profit environmental organization, formerly Colorado River Delta Water Trust.
- Mission: secure instream flows for the Colorado River via permanent and temporary acquisitions and help restore critical riparian and wetland habitats in the Colorado River delta in Mexico.
Restauremos El Colorado AC
Delivery points – 2018 Online Platform
(only to share preliminary data)
Design: Yamilett Carrillo 2016

1. Presa Morelos
2. Miguel Alemán
3. Reforma-Km27
4. Barrote-Km18
5. Laguna Grande
6. Barrote-Km21
7. Cila 1
8. Cila 2
9. Sublateral 27-Ayala D.
10. Sublateral 22-Ayala D.
11. Chaussé
12. AlimentadorSur-Km31
13. Herradura
14. Cory
15. AlimentadorSur-Km37

* Approximate Location.

Minute 323 – Water Deliveries
Minute 323 – Monitoring and Research Activities

- Plans are in development
- Vegetation
- Hydrology
- Estuary
- Wildlife (Birds)
- Social and Economic Impacts
- Coordination
- Agreed upon protocols
- Data Management
Río Colorado - Modelación en 3D de Agua Subterránea y Superficial
3D Colorado River Ground- and Surface-Water Modeling
Gracias
Thank you

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