



San Pedro Transboundary Aquifer Report is posted: Spanish version also complete; Santa Cruz Report under review

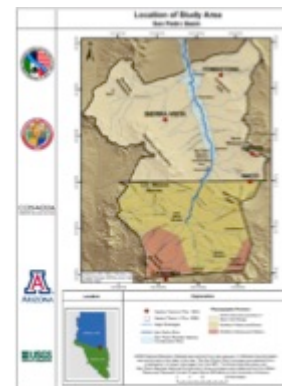
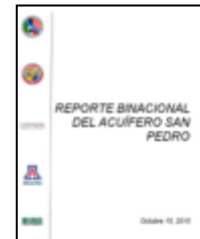
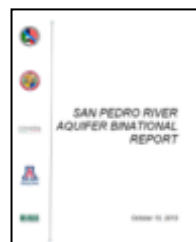


CONAGUA
Comisión Nacional del Agua



The screenshot shows the homepage of the International Boundary & Water Commission (IBWC) website. The header includes the IBWC logo and the text "International Boundary & Water Commission United States and Mexico United States Section Est. 1859". The main content area is divided into several sections:

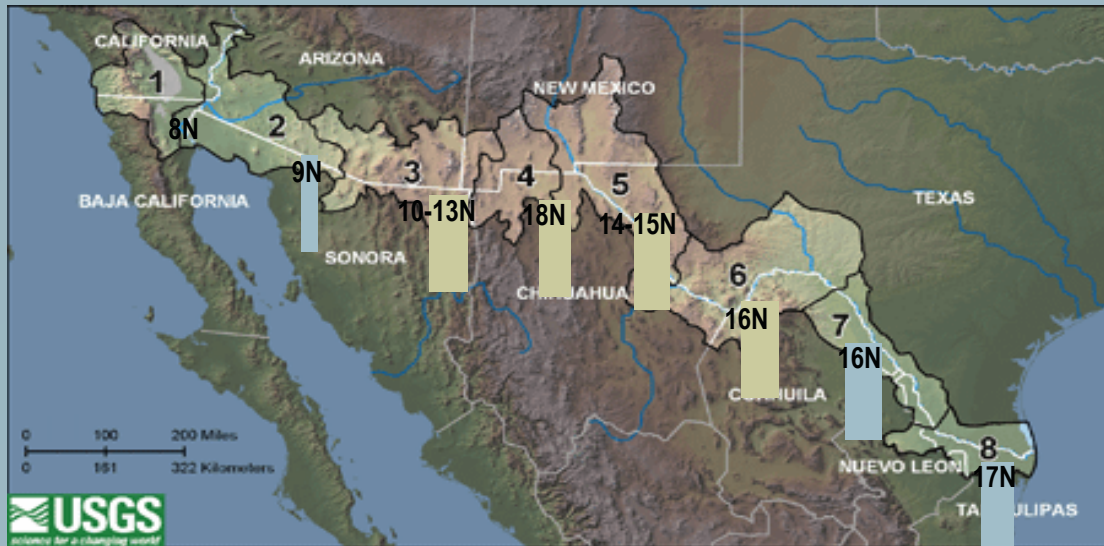
- RECOVERY.gov**: A banner for the Recovery.gov portal.
- Welcome**: A message stating the mission is to provide binational solutions to issues that arise during the application of United States - Mexico treaties regarding boundary demarcation, national ownership of waters, sanitation, water quality, and road control in the border region.
- About Us**: Information about the U.S. Section of the IBWC, led by Commissioner Edward Strata, a federal government agency and the U.S. component of the International Boundary and Water Commission (IBWC).
- IBWC News & Press Releases**: A list of recent news items, with the entry "01/13/2016 In accordance with Resolution 4 of Minute 242, the USBWC has published the San Pedro River Aquifer Binational Report" highlighted in a red box.
- Navigation Menu**: A vertical list of links including HOME, About Us, Employment Opportunities, Organization, Mission Operations, Treaties / Minutes, Permits / Licenses, Water Data, GIS / Maps, News / Publications, Citizens Forums, Reports / Studies, Links, and Contact Us.
- Footer**: Links for "No FEAR Act Data", "Freedom of Information Act", "Flood Warning Notices", "Rio Grande Water Flow", "Suspected Fraud", and "Mexican Section of the IBWC".



Download the English version at http://ibwc.gov/Files/San_Pedro_River_Binational_Report_013116.pdf

Contributions to UNESCO-ISARM transboundary aquifer analysis and examples of ISARM Americas from the Mexico-United States Border

Randall Hanson, Research Hyd., U.S. Geological Survey,
San Diego, California, USA (rthanson@usgs.gov)



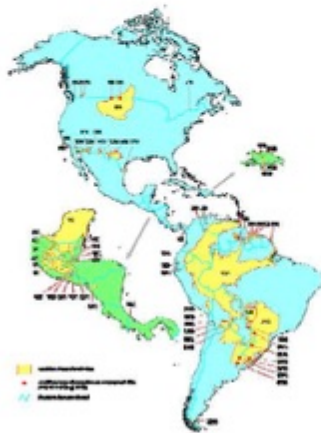
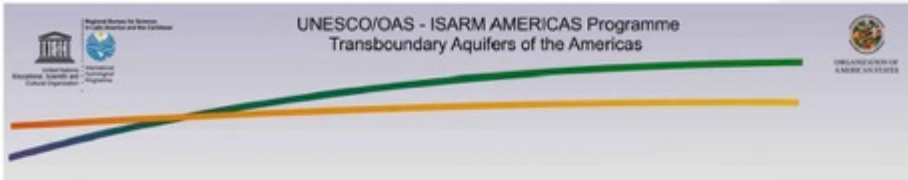
Arizona WRII – Brown Bag Seminar
Tucson, Arizona, February 25, 2016





TODAY'S TALK:

- ***Highlights*** → ***ISARM Americas Book IV***
- **Ongoing Studies** → **Rio Grande, San Pedro, Tijuana**
- **Needed Studies/Related Activities** → **Mexicali/Imperial, Colorado**

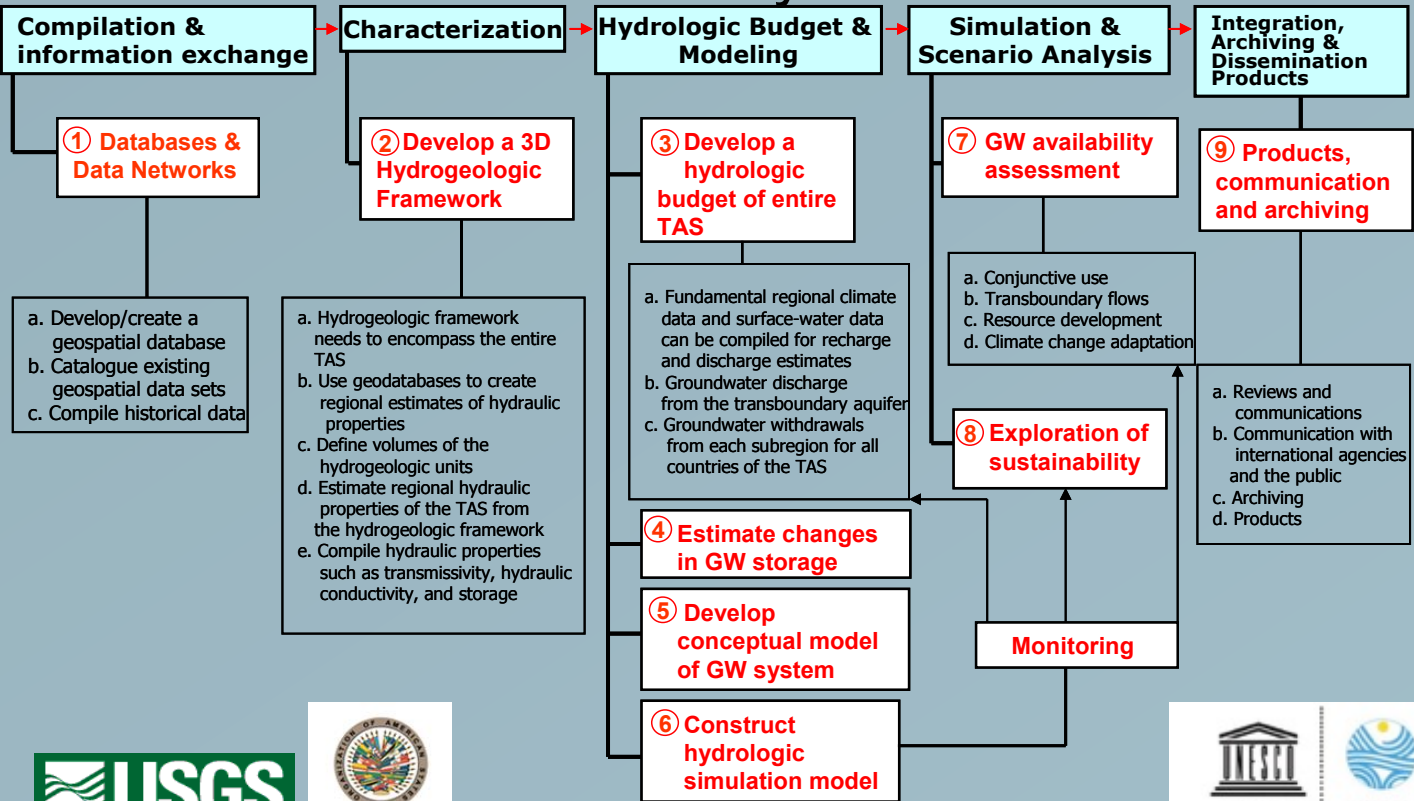


**Estrategia Regional
para la Gestión de los
Sistemas de Acuíferos
Transfronterizos (SAT)
en las Américas**

UNESCO ISARM-AMERICAS

**UNESCO-IHP
ISARM-Americas
technical committee
has developed a
regional strategy
for the assessment
and management of
transboundary
aquifer systems in
the Americas as
part of their
ongoing cooperative
assistance to help
neighboring
countries sustain
water resources and
reduce potential
conflict.**

Groundwater availability flowchart for TAS



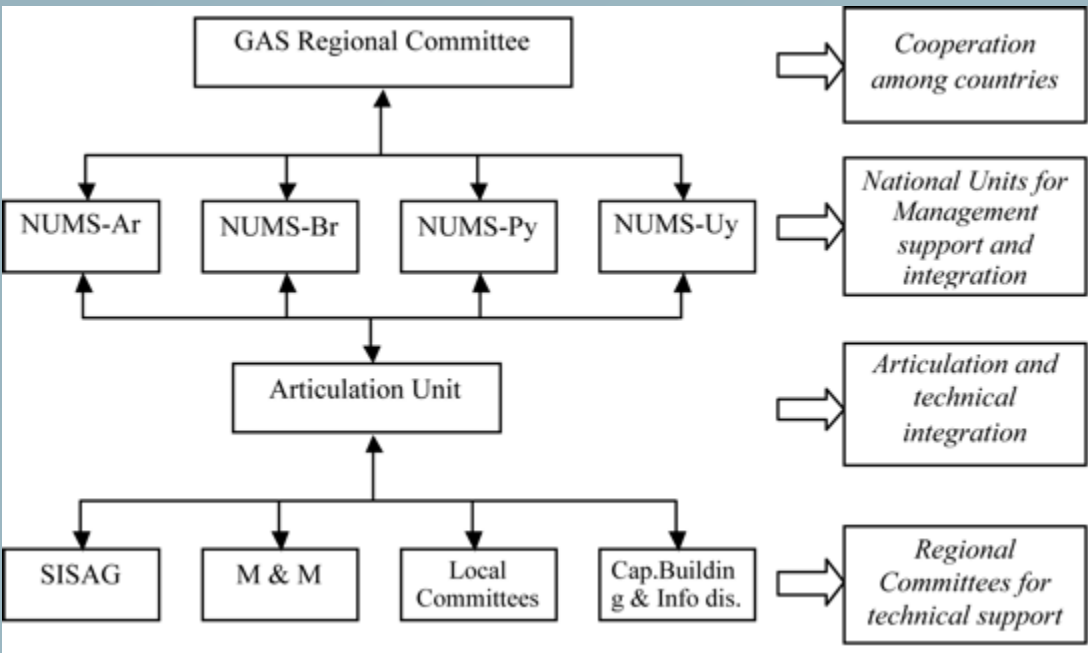
Regional cooperation framework

U.S.-Mexico
Agreements

IBWC/CILA:

- Minute 242
- Minute 319
- Minute 320?? (TJ/Sweetwater)
- Minute 321?? (Colorado River)
- TAAP Data Sharing TX/NM/AZ

Bi-National Studies:
Rio Grande/Conejos-Medanos Model
San Pedro Valley
Upper Santa Cruz
Colorado River Pulse Study
San Diego/TJ Model



⇒ *Cooperation among countries*

⇒ *National Units for Management support and integration*

⇒ *Articulation and technical integration*

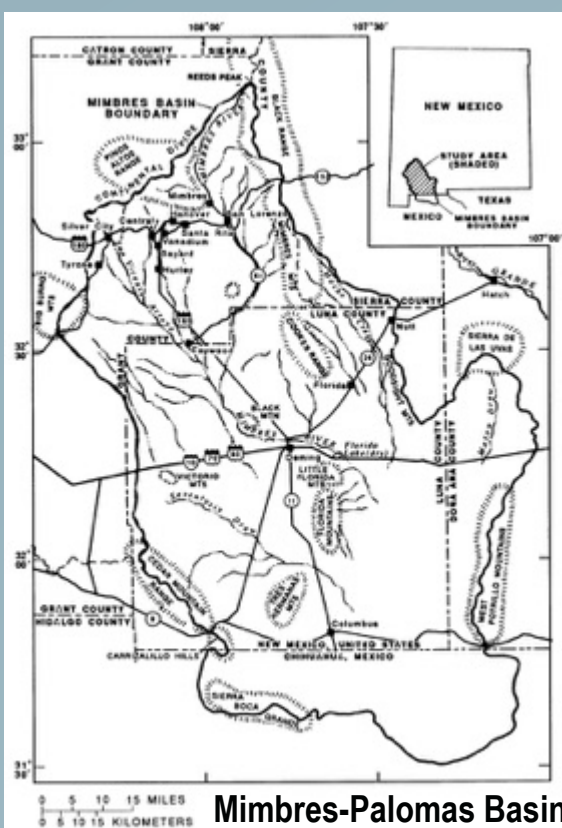
⇒ *Regional Committees for technical support*





TODAY'S TALK:

- Highlights → ISARM Americas Book IV
- **Ongoing Studies** → Rio Grande, San Pedro, Tijuana
- **Needed Studies** → Mexicali/Imperial, Colorado



One of the first Transboundary aquifer groundwater models along the US-MX border. ~5,000 mi² of SW NM, USA and northern Chihuahua, MX

“Closed Basin” since 1976 to additional water rights at time of study



Hanson et al., 1994, U.S.G.S. Water-Resources Investigation Report 94-4011 (<http://pubs.er.usgs.gov/usgspubs/wri/wri944011>)



U.S. Environmental Protection Agency

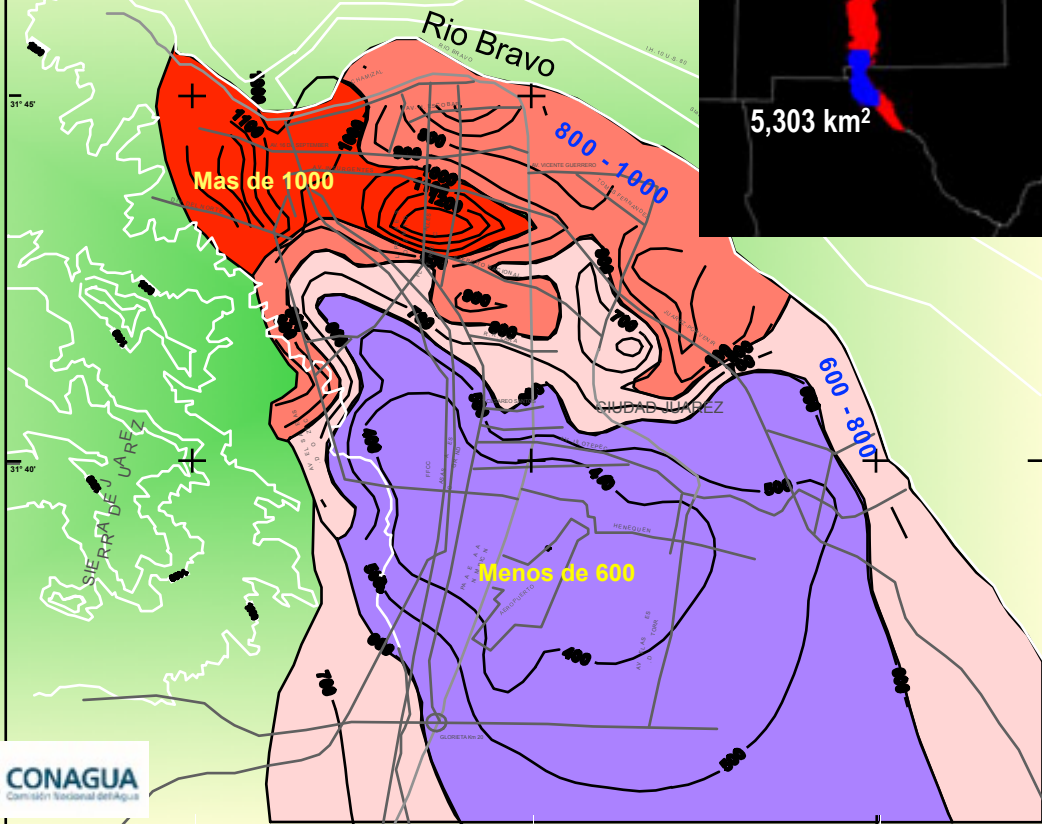
OF THE ENVIRONMENT
AND NATURAL RESOURCES
WASHINGTON, D.C. 20460

Transboundary Conjunctive Use for Agriculture & Urban Supply

ESTADOS UNIDOS DE AMERICA

Tularosa - Hueco Basin

5,303 km²



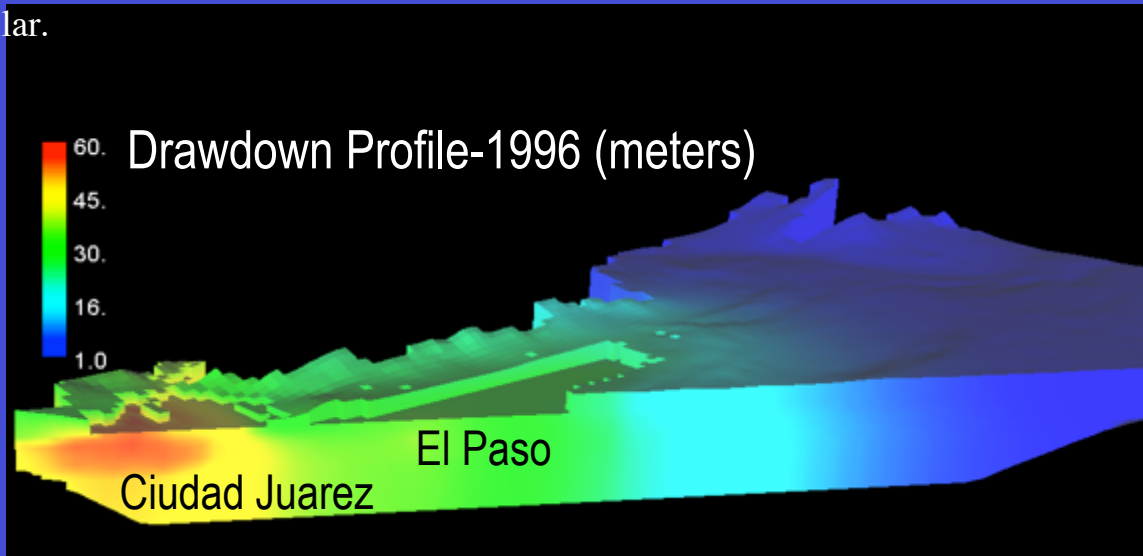
Previous Study
3: Hueco Bolson
Water Supply &
Quality Problems in
Mexico & USA
Regional (USGS) &
Mexico subregional
(JMAS) models

WATER QUALITY →
(Total Dissolved Solids)
(ppm), 1998



Lessons Learned from Hueco Bolson Transboundary Model:

- USGS and JMAS steady-state-flow models agree OK.
- Use geologic/hydrologic boundaries when possible.
- Difficult to reconcile Regional-USGS and Local-JMAS transient-flow models because of pumping near JMAS model boundaries but when JMAS subregional model was provided boundary fluxes computed from USGS regional-flow model, computed heads were similar.



Transboundary Aquifer Assessment Act 2009-2016



**MEXICO-EUA
(Sonora-Arizona)**

1. Nogales-Santa & Cruz-San Pedro

**MEXICO-EUA
(Chihuahua-Nuevo México-Texas)**

**2. Conejos Médanos- Bolsón Mesilla
3. Huevo Bolsón**

Ongoing/Future Studies (USBR Funded): Current Geologic & Hydrologic Model for USA-Mexico Border for Conjunctive Use and Project Operations Analysis for Rincon Valley-Mesilla Bolson/ Conejos-Medanos NM-TX/Chihuahua →

Quantify Hydrogeology (Geologic Model), Geochemistry, and Conjunctive Use (Hydrologic model) to jointly assess Water Supply & Water Quality Issues. Rio Grande Transboundary Integrated Hydrologic Model (RGTIHM) using MODFLOW-OWHM to estimate Surface-Water Deliveries, Pumpage, Recharge, Impact on Rio Grande

Ongoing Studies:

Project operations of Surface-Water Operations subject to Climate Change Analysis → USBR EIS with RGTIHM

Conjunctive Use Effects on Rio Grande Streamflow-Pumpage-Land Subsidence Relations → USGS/USBR with RGTIHM

Potential Future Studies:

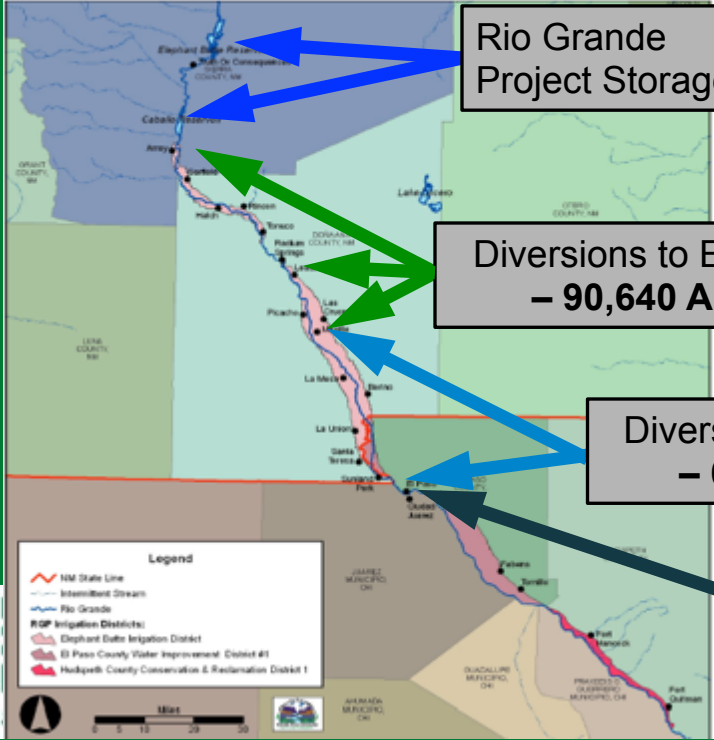
Storm-Water Runoff Capture → Unappropriated Storm Water in USA → BCM/RGTIHM

Water-Quality Transport & Salinity Management



Case Study:

Rio Grande Project



Rio Grande Project Storage

Diversions to EBID (NM)
- 90,640 Acres -

Diversions to EP#1 (TX)
- 69,010 Acres -

Delivery to Mexico

Legend

- NM State Line
- Intermittent Stream
- Rio Grande
- RIP Irrigation Districts
- Elephant Butte Irrigation District
- El Paso County Water Improvement District #1
- Hudspeth County Conservation & Reclamation District 1



Stages of RGTIHM Model Upgrades & Development

US Rincon/Mesilla – Groundwater Model of Office of State Engineer (OSE)
March 1940 – October 2004 (Completed in 2007)

US Rincon/Mesilla – **FIRST STAGE**: Farm Process “mimicking” OSE Model but with
Estimated Irrigation Pumping and Estimated Recharge

Completed

US Rincon/Mesilla – **SECOND STAGE**: Farm Process with Uptake from Groundwater
Based on Digital Elevation Model and SSURGO Soil Type Distribution
THIRD STAGE: Extended Period: March 1940 – October 2009

2009-11
TAAP
Funding

US Rincon-Mesilla – **REFINED MODEL**:

- ❑ Additional Simulation Features: Agriculture, Wellfields (Canutillo, Santa Teresa, Conejos-Médanos),
- ❑ Additional Observations → Streamflows, Pumpage, Remote-Sensed ET, & Water-level Networks
- ❑ Refined Inflows & Outflows → Service Areas & Land Use/Cropping, Runoff
- ❑ Extended Period: March 1940 – December 2015

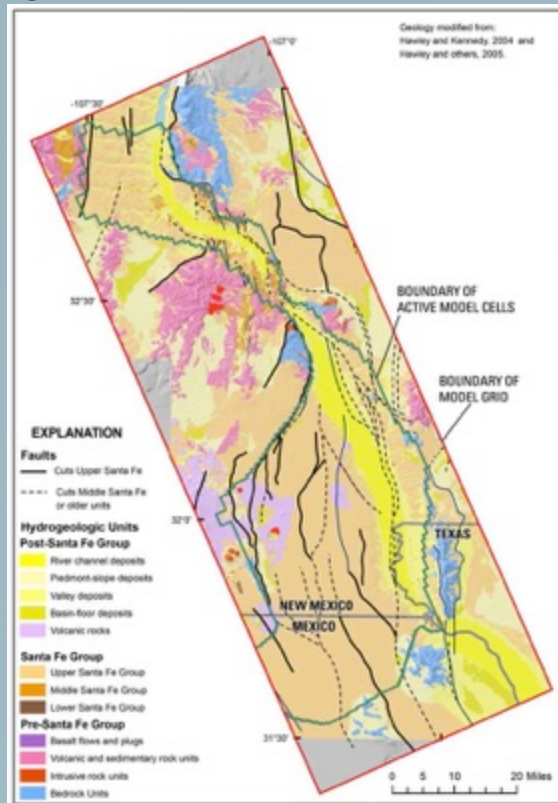
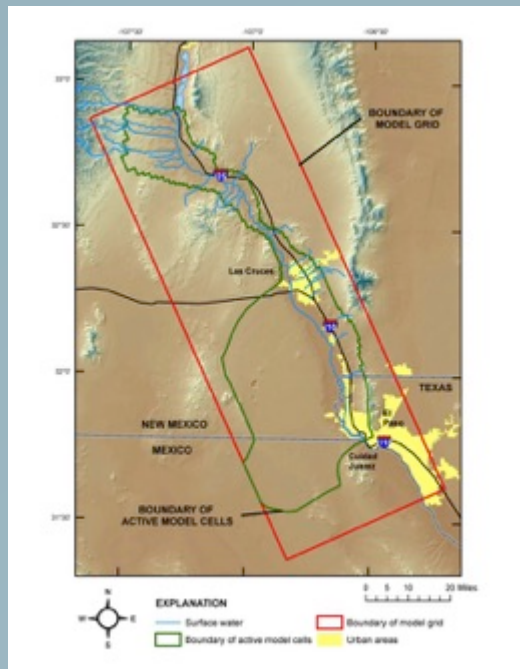
Now

**One Regional Transboundary
Model (MX/US) -- RGTIHM**
Rincon-Mesilla & Conejos-Médanos
together

Two separate but simultaneously
developed US Rincon-Mesilla & MX
Conejos-Médanos Models

Join or dynamically link models to a
Regional Transboundary US/MX
Model

Transboundary Aquifer systems & Conjunctive use requires analysis of all water with new Geologic Framework



Farm Process – Coupling between Demand and Supply

Problem: Conjunctive use of groundwater and surface water results in flows affecting each other

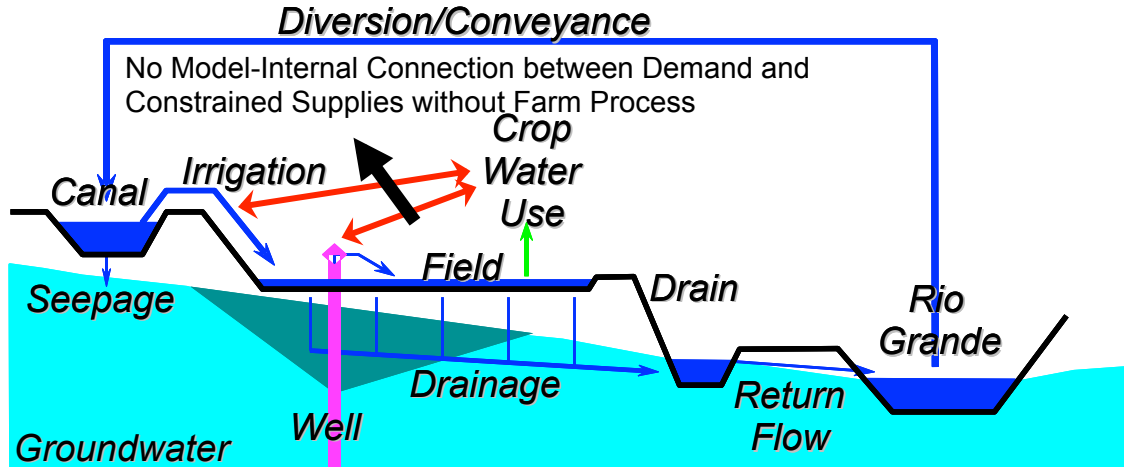


Diagram from Phil King, 2011

New Tool for New Questions – One Water Hydrologic Flow Model

Previous Models don't address new questions:

Conjunctive Use:

- Estimate Surface-Water Deliveries
- Estimate Pumpage
- Estimate Recharge
- Effects on Canal/Streamflows
- Capture Runoff
- Effects of changing Land Use

Sustainability: Water Conflicts

Future Issues:

- Water Quality & Salinity
- Land Subsidence
- Effects of Climate Change
- Future Development

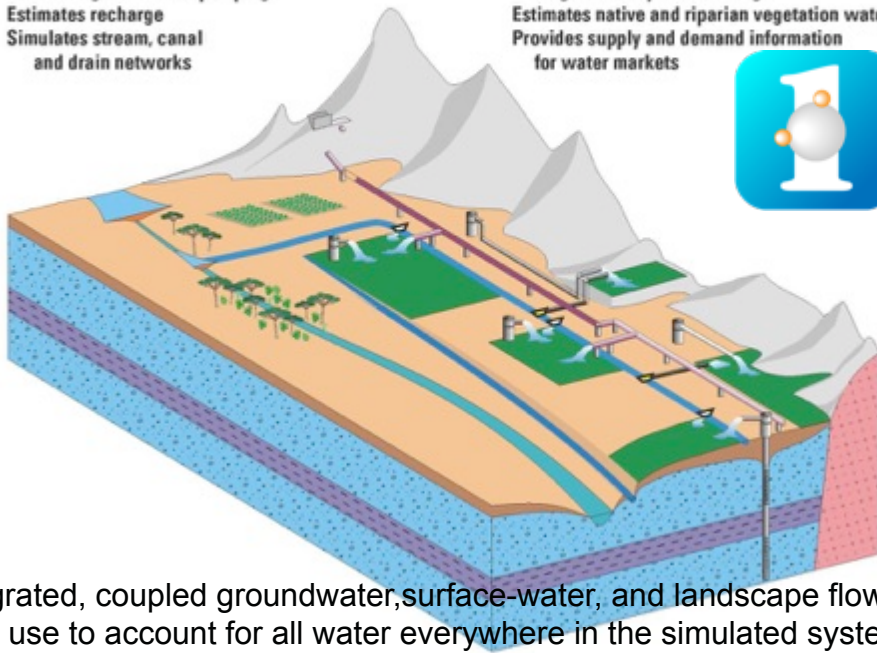
USGS MODFLOW-OWHM-- FARM PROCESS: Water-Supply and -Demand Analysis

FEATURES

- Estimates irrigation needs
- Simulates water transfers
- Simulates surface water deliveries to farms
- Estimates groundwater pumping
- Estimates recharge
- Simulates stream, canal and drain networks

CAPABILITIES

- Estimates supply - Natural and Artificial Recharge
- Analyzes Water Use and movement
- Simulates a broad range of water uses from irrigated to dry land farming
- Estimates native and riparian vegetation water use
- Provides supply and demand information for water markets



Fully integrated, coupled groundwater, surface-water, and landscape flow, and water use to account for all water everywhere in the simulated system

Approach: MF-OWHM with Reservoir Linkage

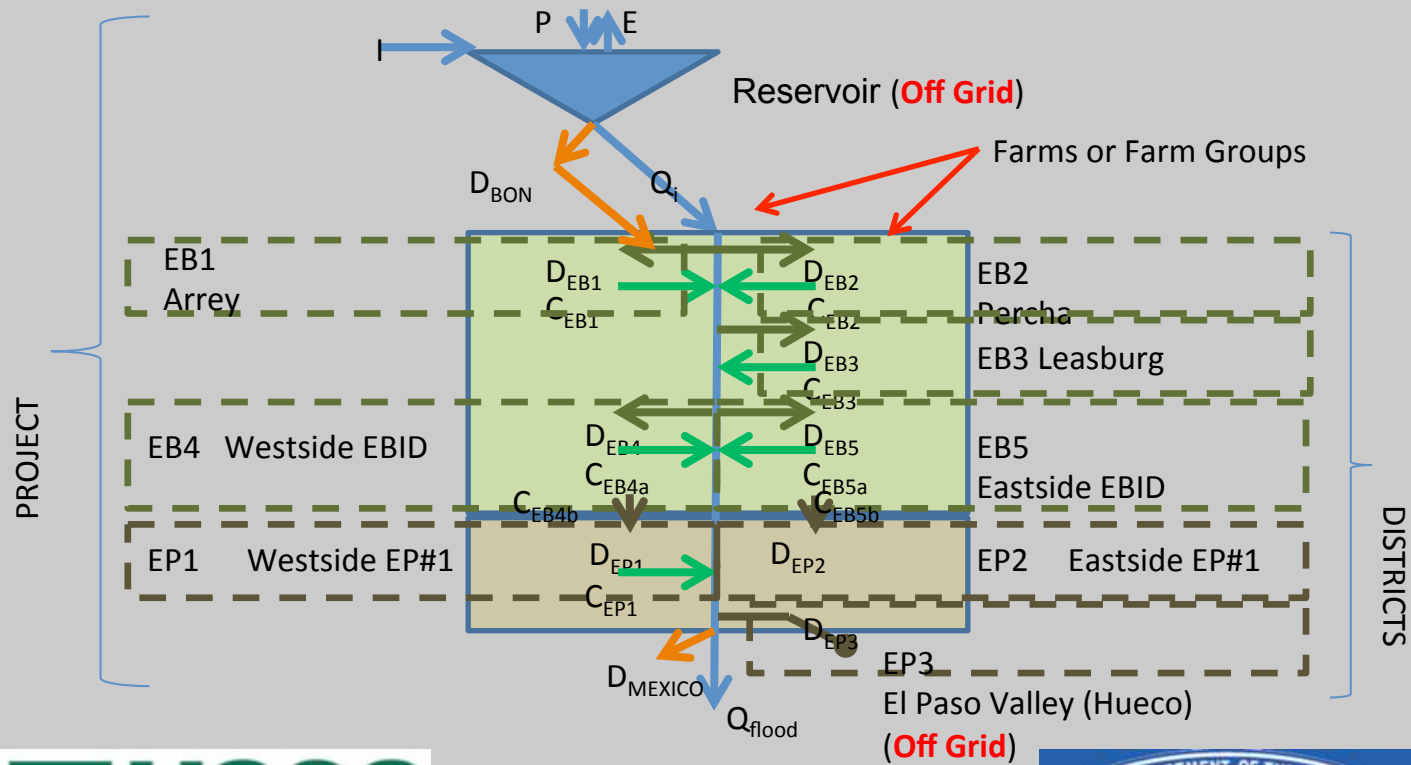
Surface-WaterOps: General Solution Outline

- Obtain farm delivery requirement from FMP; read non-farm delivery requirement from input
- Compute project storage, diversion allocation to districts, and delivery allotment to farms/auxiliaries
- Computes delivery orders for farms, auxiliary demands

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- Ca

All steps updated at each solver iteration for full integration of
Water management (allocation, release, diversion, delivery)
and
Physical hydrology (surface water and groundwater flows)

Example: OVERVIEW SCHEMATIC for RIO GRANDE PROJECT



Reservoir Connection New Structure → Grid-Mapped Identifiers

Current FMP: Water Accounting Supply-and-Demand Units)

- Farm

Expanded FMP w/ WATEROPS Subroutine: (Simulates/Analyzes Multi-Level Accounting)

- Project → Irrigated lands with common SW supply
- District → Irrigated lands with common SW allocation
- Unit → Irrigated lands with common point(s) of diversion, charge, and credit
(NOTE: Unit = Service Area)
- Farm → Irrigated lands with common set of SW and GW deliveries

Currently supports supply-and-demand linkage for “agricultural” water-supply.

Case Study:

Rio Grande Project

- Effects of On-Farm-Efficiency on Project operations:
 - MODFLOW-OWHM allows for fully-integrated simulation of conjunctive use at *farm scale* coupled with the Farm Process (FMP)
 - New WaterOps features allow for fully-integrated simulation of conjunctive use at *regional to basin scale*, including reservoir operations

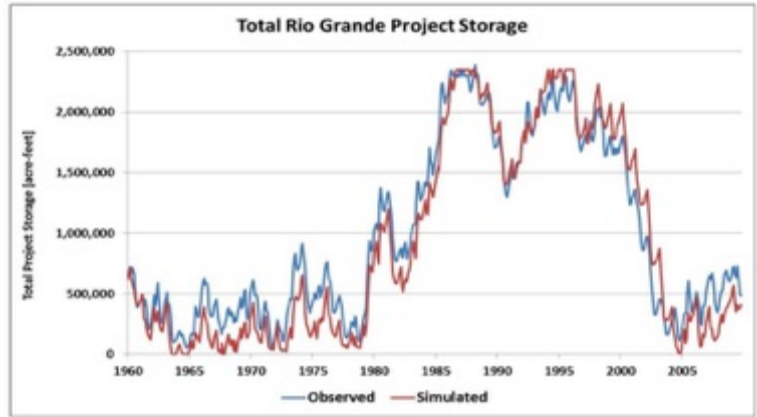


Figure 2: Observed and simulated monthly total Rio Grande Project storage in Elephant Butte and Caballo reservoirs (acre-feet) for the period 1960-2010.

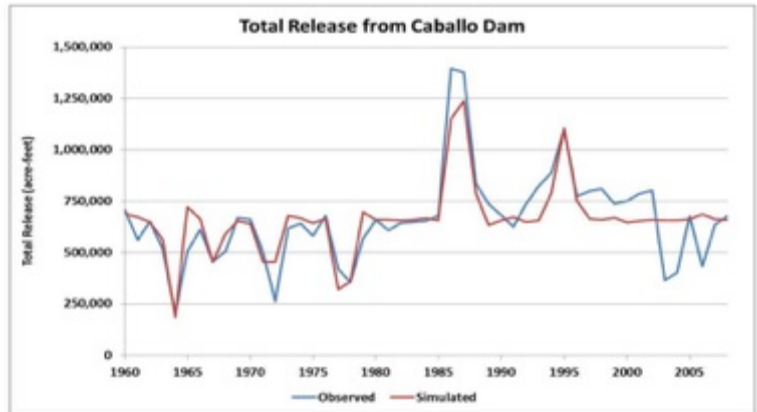
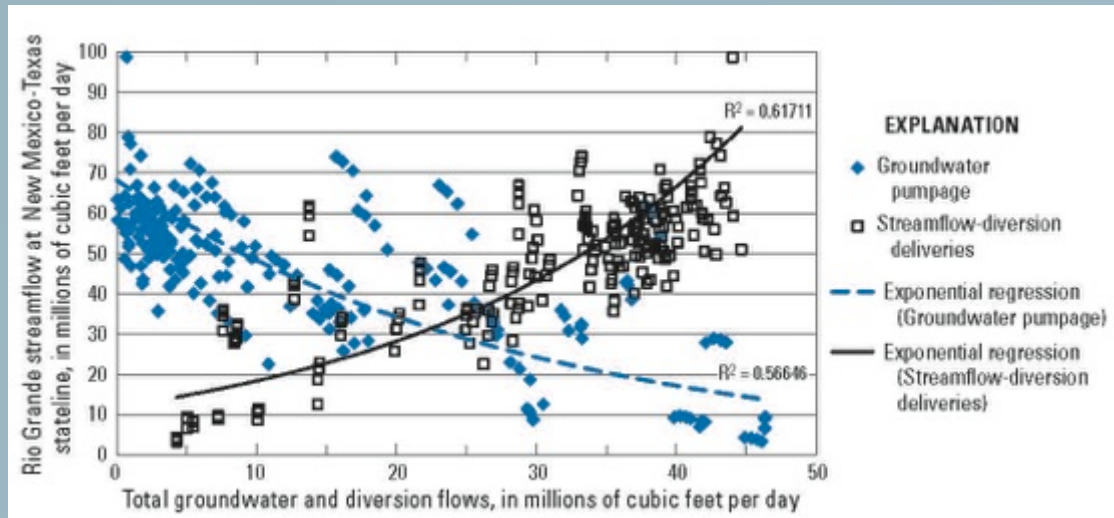


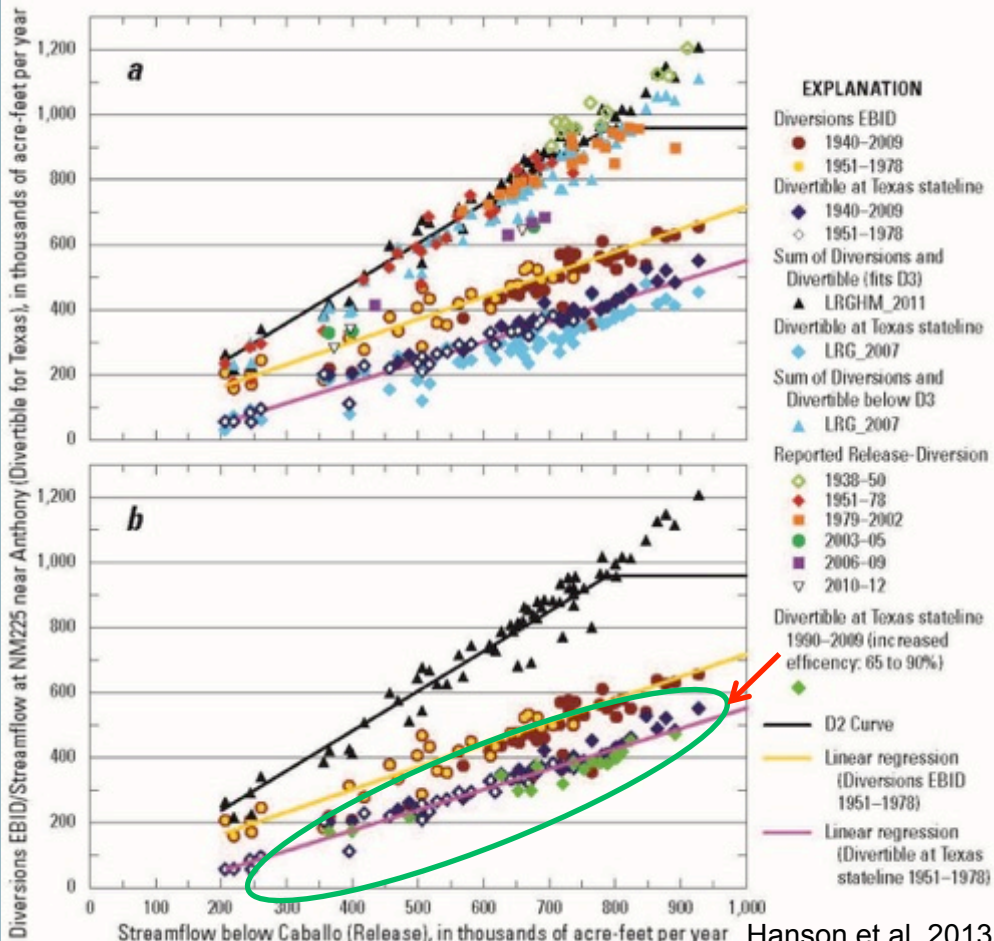
Figure 3: Observed and simulated annual release from Cabal Dam (acre-feet) for the period 1960-2010.

Transboundary Aquifer Assessment Program

First Phase of Conjunctive Use Analysis with enhanced MF-FMP Hydrologic Model for USA-Mexico Border: Nonlinear relation between streamflow, diversions, and pumpage → Conjunctive use requires analysis of all water



Treaties and operating agreements as well as adaptation and new projects require analysis of all water → Flow dependent flows simulated with Integrated Hydrologic Model MF-OWHM



Transboundary Aquifer Assessment Program

Current Geologic & Hydrologic Model for USA-Mexico Border

Upper Santa Cruz & Upper San Pedro – AZ (US)/Sonora (MX) →

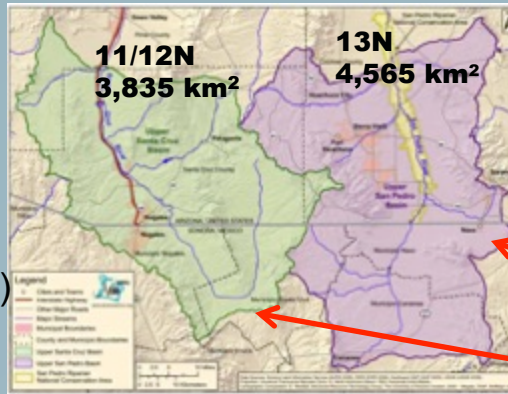
Characterize Hydrogeology and Geochemistry, Identify aquifer vulnerability, and Develop Institutional Assessment Mechanisms

New Data:

Water Quality
Geophysics (TEM, Gravity)
Geologic Mapping

New Models

Rainfall-Runoff Model
Integrated Hydrologic Model



Upper San Pedro River Watershed – AZ (US)/Sonora (MX)

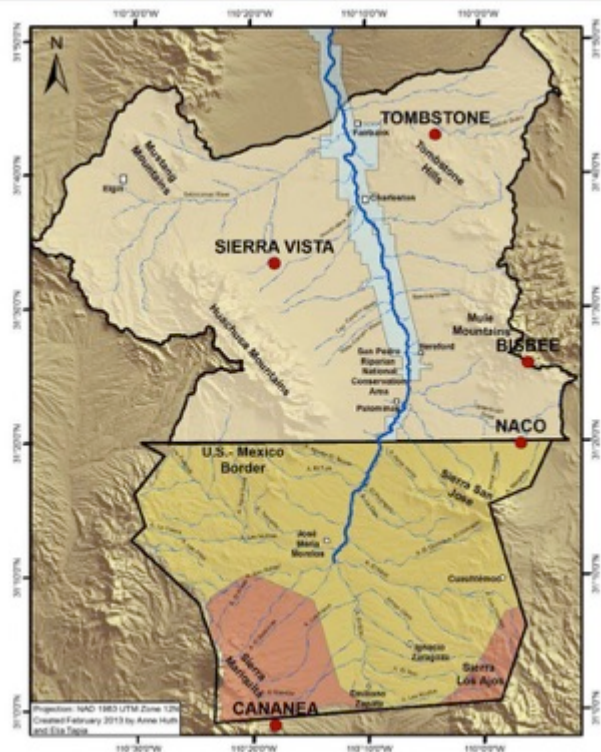


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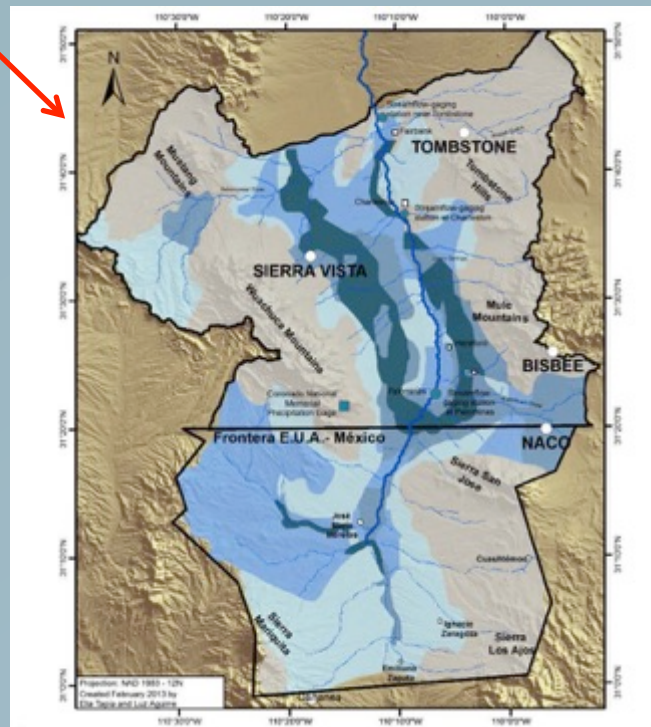
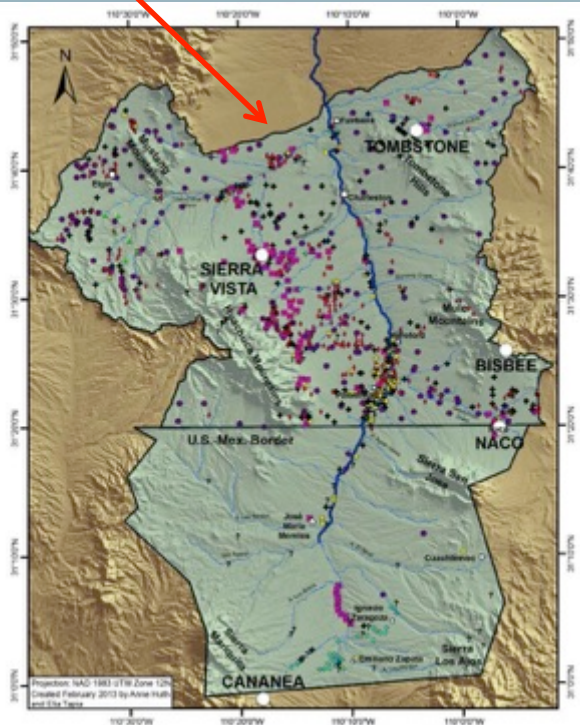
SAN PEDRO RIVER AQUIFER BINATIONAL REPORT

January 31, 2016



Upper San Pedro River Watershed – AZ (US)/Sonora (MX)

Well and Transmissivity Distributions

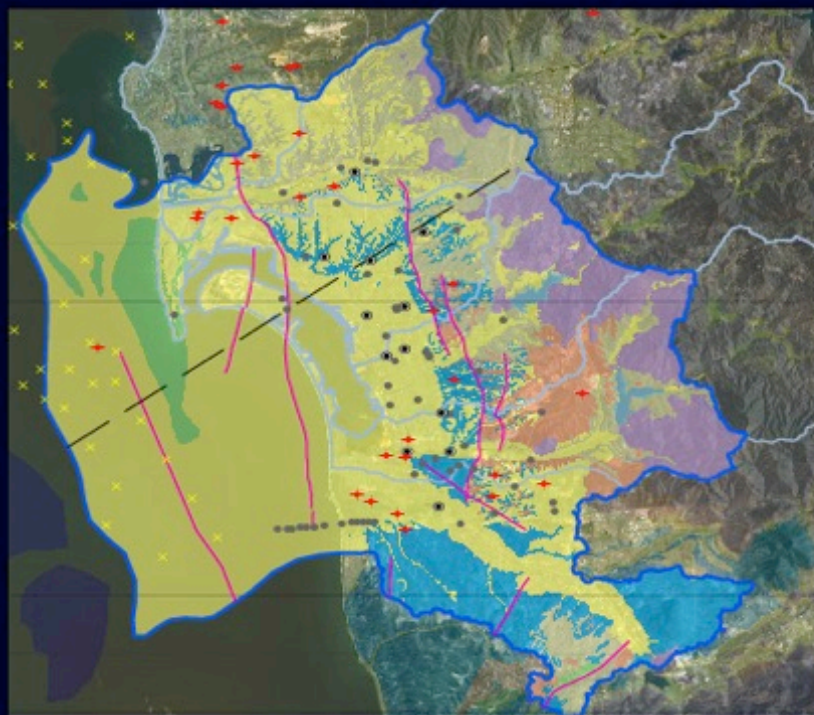




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- Highlights → ISARM Americas Book IV
- *Ongoing Studies* → Rio Grande, San Pedro, *Tijuana*
- **Needed Studies** → Mexicali/Imperial, Colorado

Geologic framework model covers the coastal area







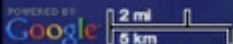
Real Time

Graph

• [Weekly Graph](#) (click to enlarge)



Example



Imagery ©2008 TerraMetrics, Map data ©2008 LeadDog Conso

Potential Collaboration with Mexico



Planned:
Mission Beach
SDMB

Planned:
Tijuana River
SDTR

Completed

- | | |
|------------------------------|------------------------------------|
| SDSY Santa Ysabel | SDSW Sweetwater |
| SDAQ Aqua Culture | SDMC Mile of Cars |
| SDCP Chollas Park | SDCC San Diego Country Club |
| SDHF Home and Federal | |
| SDBP Balboa Park | SDOT Otay Trolley |
| SDEP El Toyon Park | SDOR Otay River |
| SDNB Naval base | SDBW Boundary Waters |

- Planned**
- SDSS** Silver Strand
 - SDMB** Mission Beach
 - SDTE** Tijuana Estuary (U.S.)
 - SDTR** Tijuana River (Mexico)

Transboundary San Diego Project

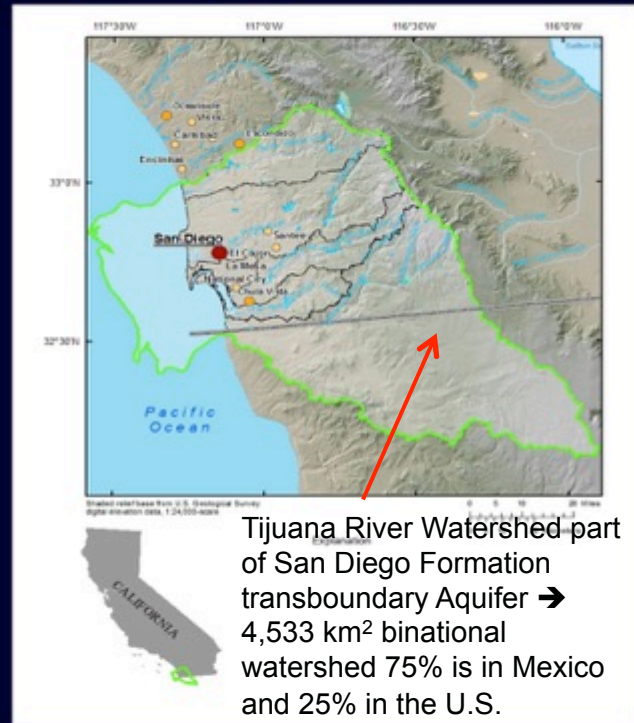
Objectives

- Identify additional ground-water resources, including brackish
- Facilitate multi-agency water management

Work Elements

- Extensive data collection
- Modeling: geologic, ground-water, management
- Realtime website

FUNDING → City of San Diego, Sweetwater, USGS
Ongoing Development of Minute 320 for 1944 Treaty



Hydrologic model areas

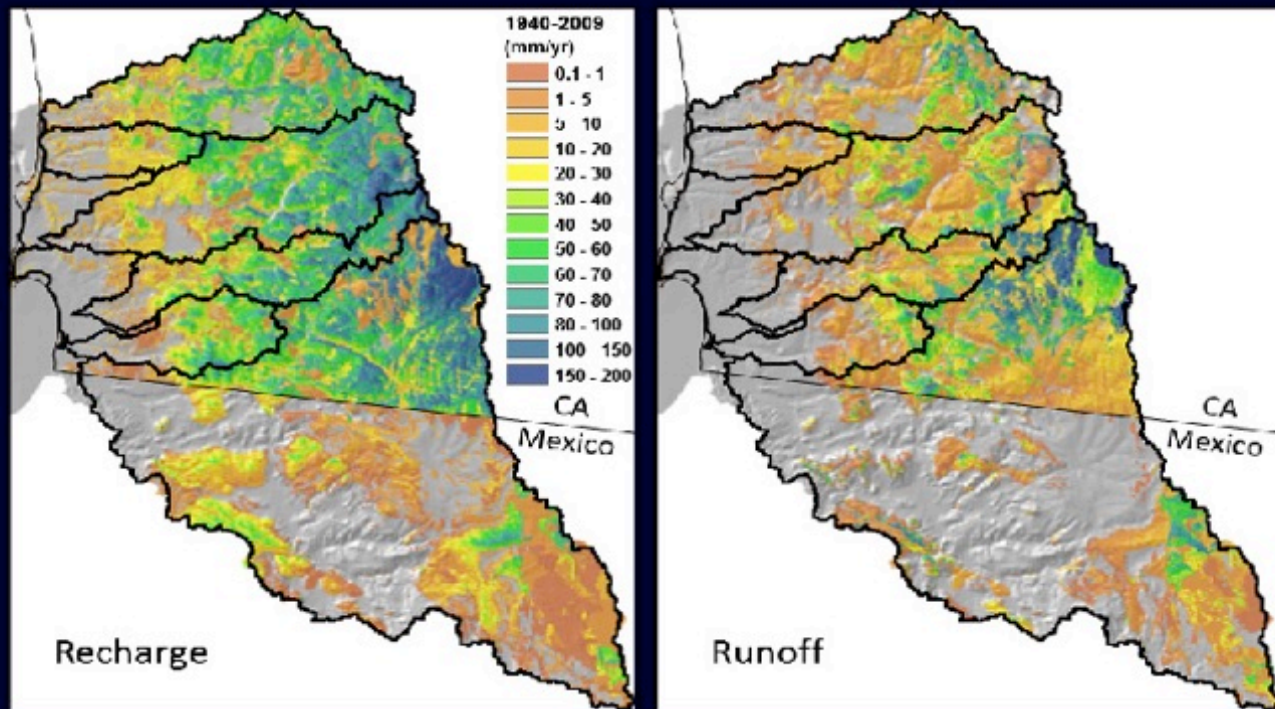


Precipitation-Runoff/Recharge Model
Basin Characterization Model (BCM)

Surface-water/Groundwater Model
MODFLOW model

Potential SE extension
of Regional
MODFLOW model to
include Rodriguez
Reservoir flows and
Ciudad Tijuana use

Recharge and runoff occur mostly from precipitation in the east county





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- Highlights → ISARM Americas Book IV
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COLORADO RIVER BASIN

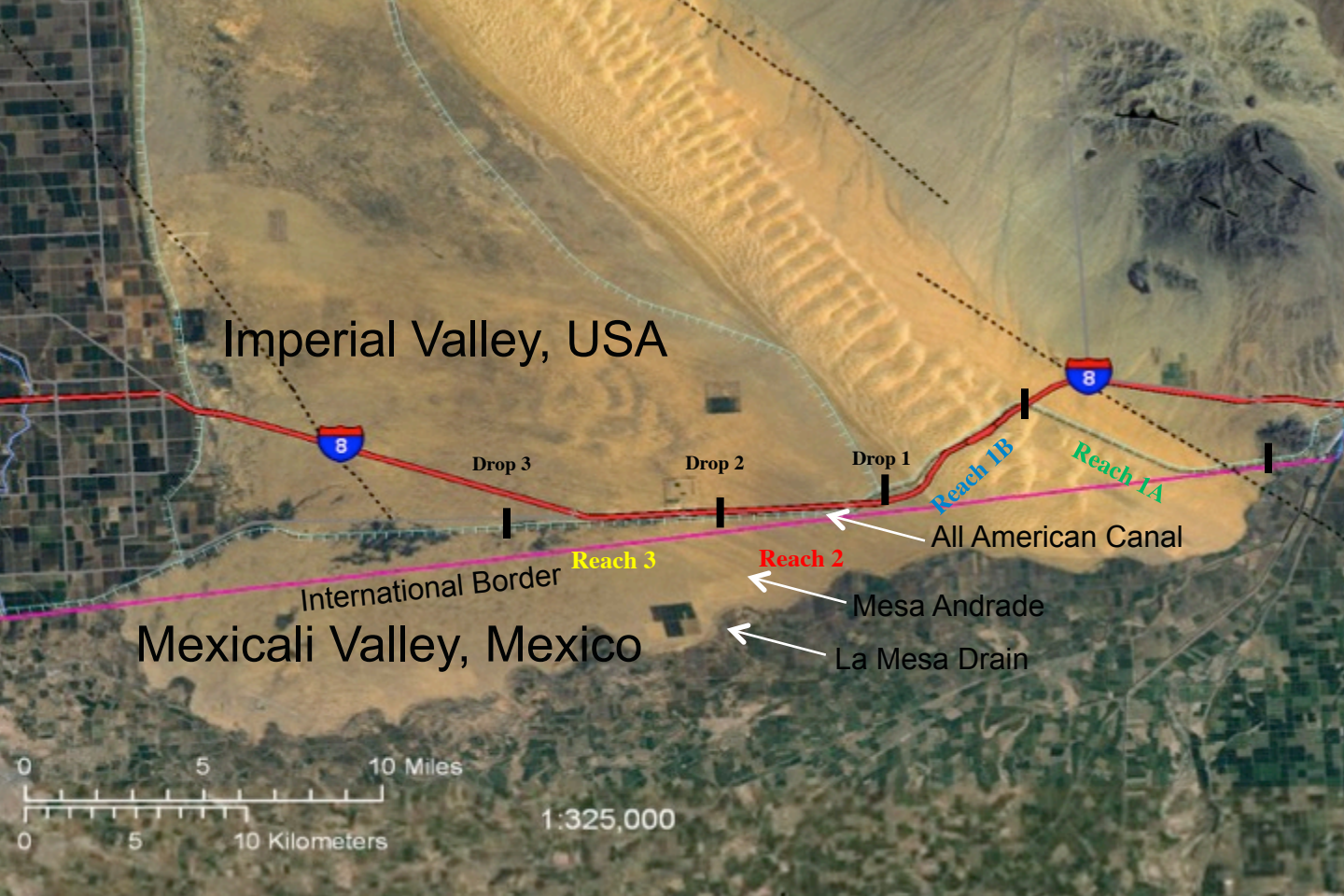


Total area: 655.000 km²
(<1% in Mexican territorio)
Length: 2,300 km
Median Runoff: 22,400 Mm³/a
Allocation to Mexico: 1,850 Mm³ / a

© 2010 NGA
© 2010 Europa's Technologies
© 2010 Google
Google USA Farm Service Agency

Google





Imperial Valley, USA

Mexicali Valley, Mexico

International Border

All American Canal

Reach 3

Reach 2

Mesa Andrade

La Mesa Drain

Reach 1B

Reach 1A

Drop 3

Drop 2

Drop 1

8

8



1:325,000

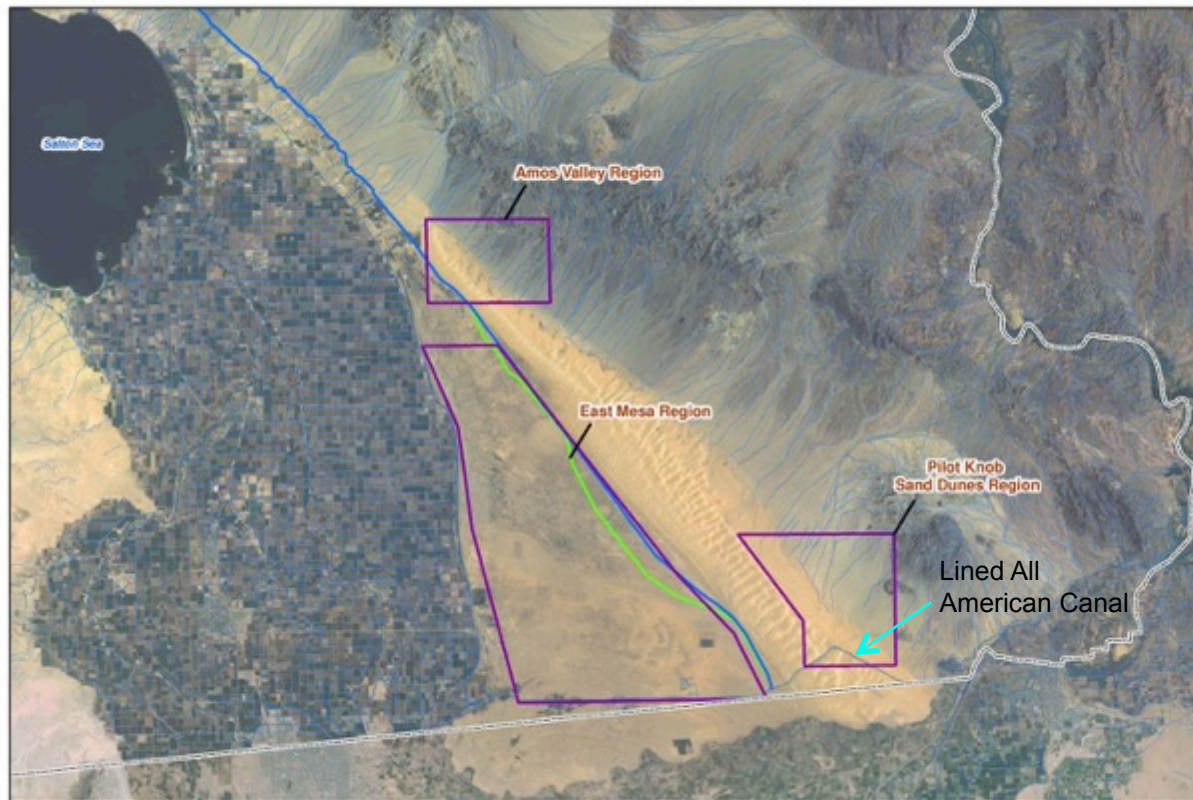
Artificial Recharge Project Locations

INDEPENDENT ANALYSIS OF THE EAST MESA REGION FOR GROUND WATER STORAGE - UNIFIED SUMMARY REPORT

GENERAL PROJECT LOCATION

EXPLANATION

- Coachella Canal
- Old Coachella Canal
- ID Study Area
- County Boundary



4-May-12

Prepared by: OWR, Map Projection: UTM 12N, Zone 11

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USGS
science for a changing world

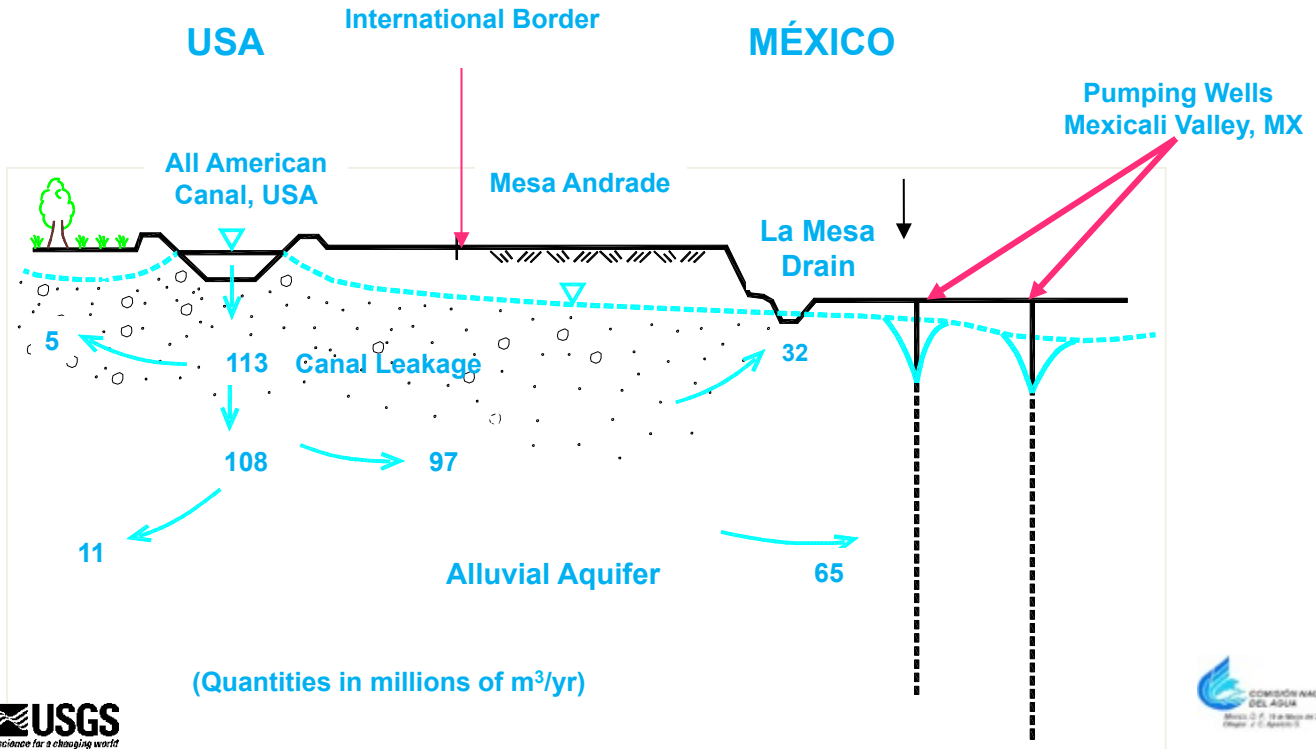
DRAFT

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Figure 1

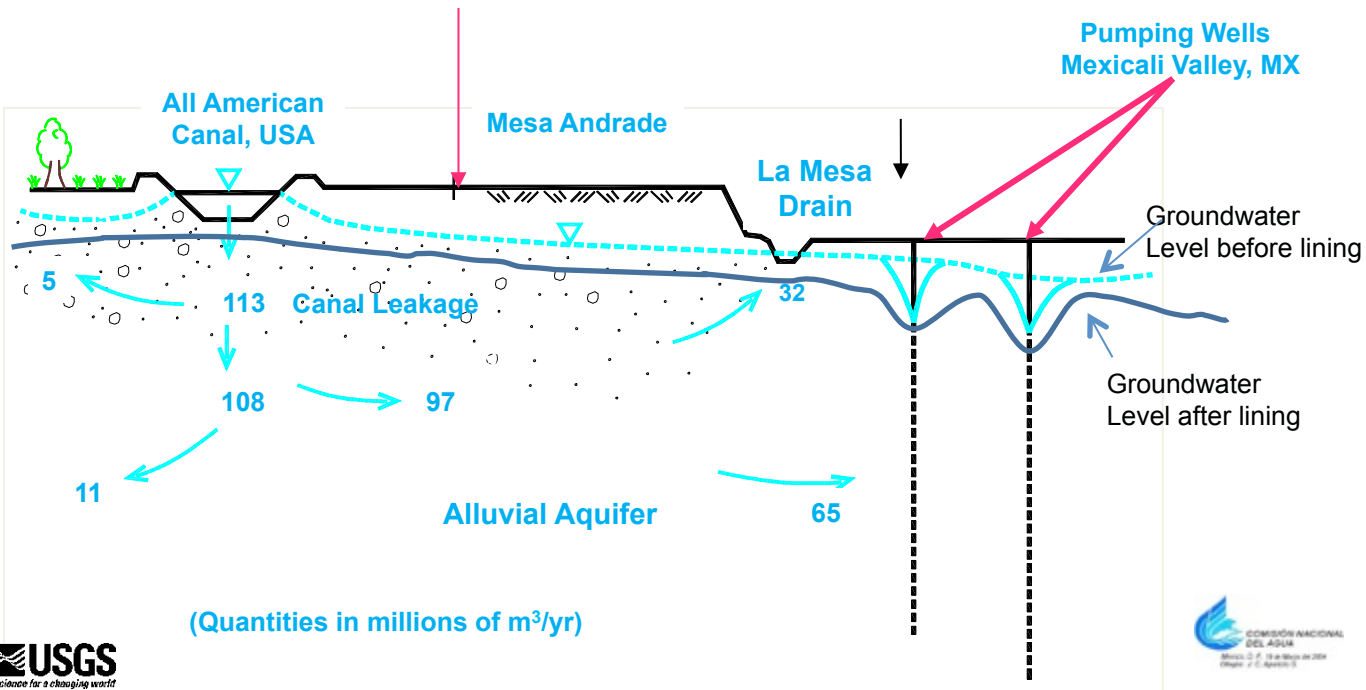
Estimated Distribution of Groundwater Infiltration



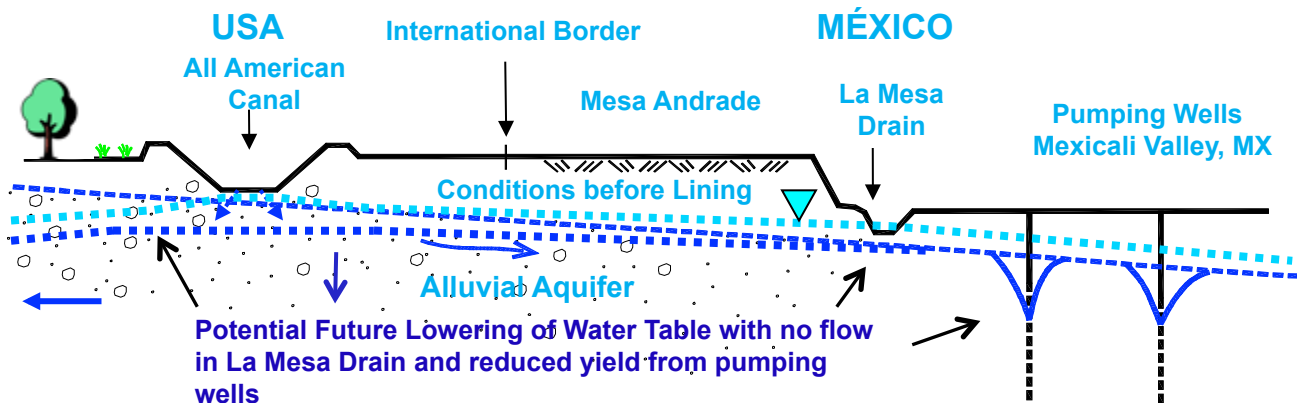
USA

International Border

MÉXICO



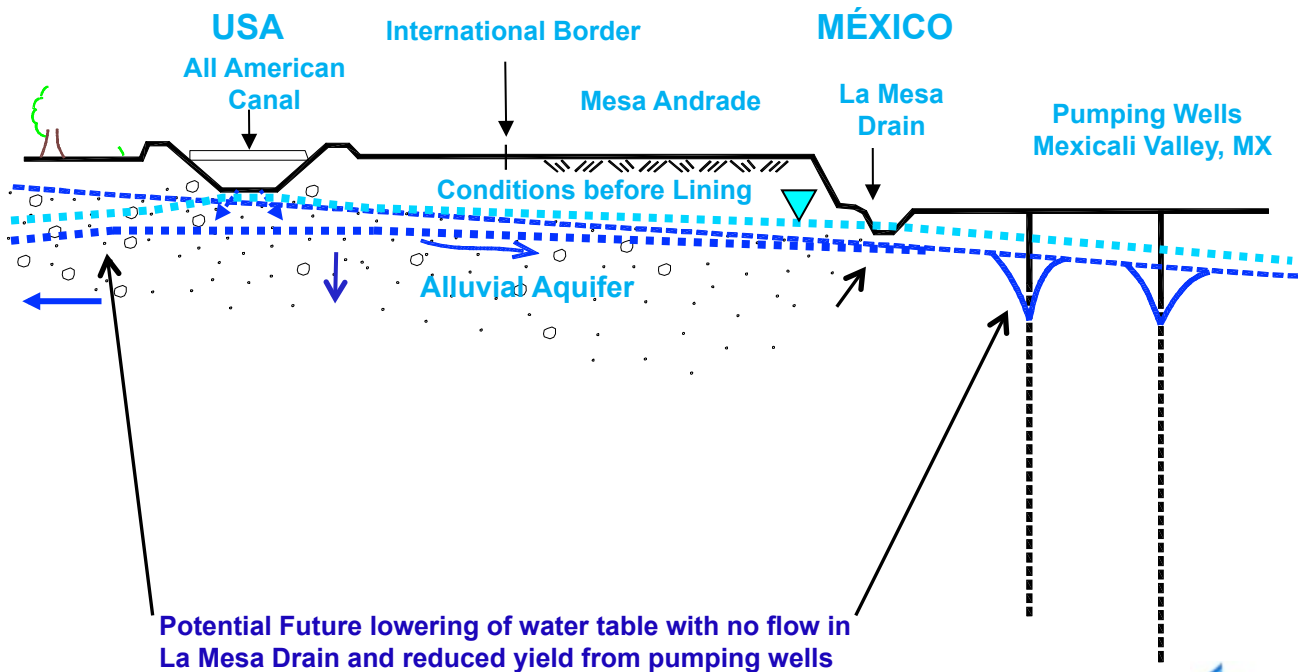
Potential Effect of Canal Lining on Decline of Water Table



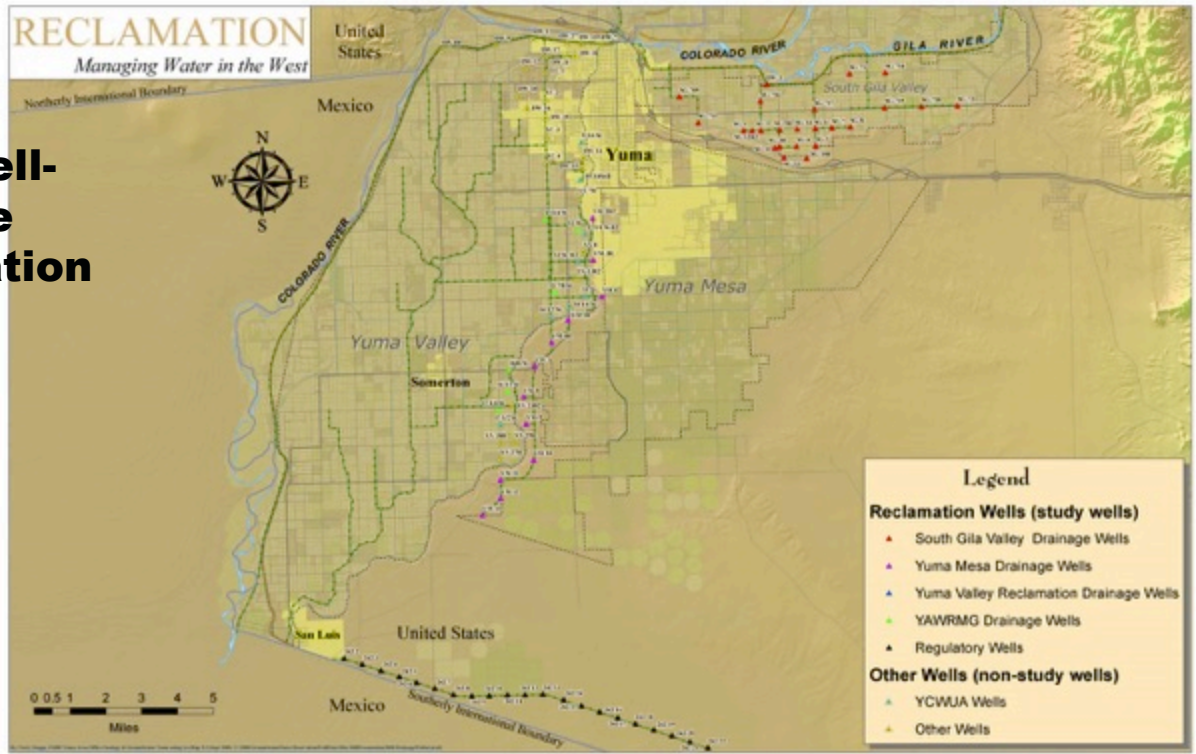
a.) - Canal Leakage was source of recharge that from the beginning of its operation has contributed to the Mexicali Valley aquifer feeding of about 90-100 hm³/yr

b.) - Canal lining of unlined segments reduced leakage by 75% which is comparable to the subterranean flow of groundwater to Mexico, resulting in increased groundwater salinity, about 1,000 lps less flow in La Mesa Drain, reduced well yields, and impaired wetlands on Mesa Andrade.

c.) - Decay of groundwater mound in the water table formed from leakage along its course, will result in lower groundwater levels in Mexico and USA. Over the next 10 to 15 years from the operation of the new channel, these drawdowns will have values decreasing from north to south, with a maximum value of about 12 m south of the international border.



USBR Well-Pumpage Optimization Analysis



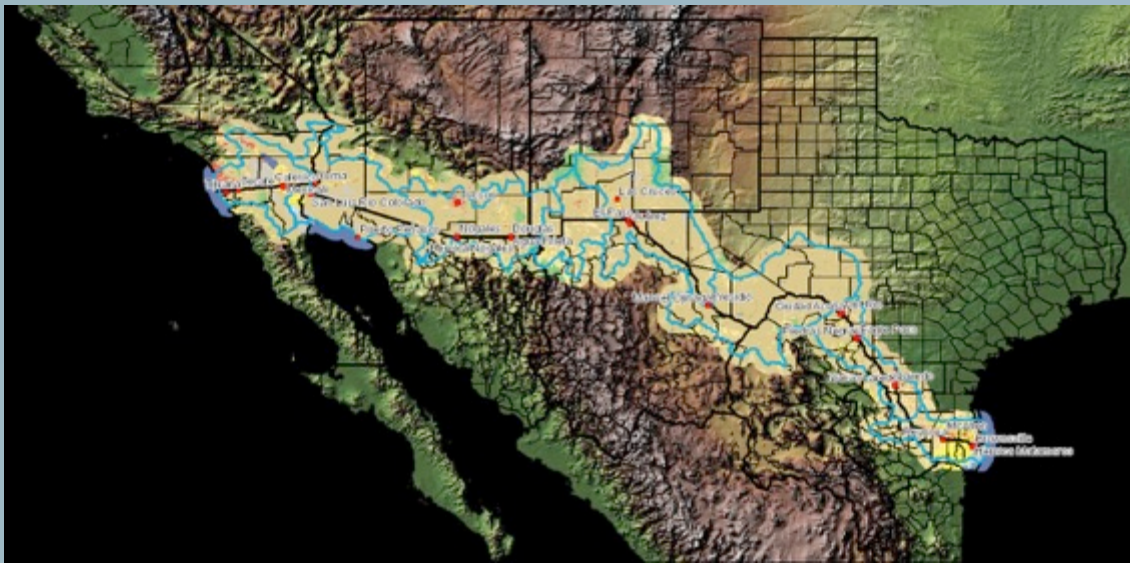
Conjunctive-Use Analysis subject to US-Mexico Treaty delivery requirements for Flow, Salinity, & Differential Salinity



Conclusions

- Past Studies have helped with Transboundary Aquifer Development and Resource Management → Provide a systematic platform for resource analysis
- Present Studies are helping to jointly explore sustainable resources along the border but commonly need additional funding from neutral sources, and
- Future Combined US-Mexico Studies with help from UNESCO (?) may help with other areas where the stewarding of sustainable water resources will require joint investigation and management.
- Multiple TWAP

Candidates along
US-Mexico Border



Thank You !



09/15/2004 20:10



One-Water Class



California Water and Environment Modeling Forum

Promoting Excellence and Consensus in Water and Environment Modeling

P.O. Box 22529, Sacramento, CA 95822 916-833-6557 cwemf@cwemf.org www.cwemf.org

Technical Workshop

“MODFLOW – One Water Hydrologic Flow Model” Workshop



In cooperation with the
United States Geological Survey
(California Water Science Center)



Tuesday May 31 through Friday June 3, 2016 (4-days) 9:00 to 4:30pm

***New
Location***

Wildland Fire Training & Conference Center

3237 Peacekeeper Way, Room W120

McClellan, CA 95652

[Directions](#)

Workshop Fee: \$200 for CWEMF members, \$300 for non-members, and \$50 for students

Pre-registration is required. Refreshments included. Lunch not included.

Please email elaine.archibald@comcast.net to reserve your spot.

