Hydrological Models for the Hueco Bolson: Water Storage Myth

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Outline

• Hueco bolson: shared & depleted
• History of hydrological modeling
• How much fresh water depleted?
• Compartmented water use & management
• Take home message
Hueco Bolson

- Shared transboundary aquifer (US/MX; TX/NM)
- Fresh water depleted
- Compartmented resources management
- Connected vs. disconnected with the Rio Grande
- Fresh water vs. brackish water co-exist

Sheng, 2013
History of hydrological models

• 1966 (Leggat and Davis) Electric analog model – GW drawdowns up to 1990

• 1976 (Meyer) 2-layer transient model (freshwater, TDS<1000 mg/L), alluvium and bolson; total vol. of fresh water in storage & GW decline (1973-1991)

• 1985, 1991 (Lee Wilson & Associates) 4-layer model (MODFLOW) with different thickness of water quality zones

• 1992 (Kernodle) used Wilson’s model to estimate additional elastic aquifer compaction (subsidence)

• 1994 (Groschen) 4-layer model (MODFLOW & HST3D to simulate the movement of saline water; leakage from the overlying alluvial aquifer
History of hydrological models (cont.)

• 2003 (Heywood & Yager) 10-layer transient (monthly) multiple node wells (no water quality component)
• 2004 (EPWU, Hutchison) convert USGS model to GAM (annual) regional water planning (drought scenarios)
• 2014 (Montgomery, EPW) 5-layer (MODFLOW and MT3D) assess effects of “trench”
• Current - (TAMU) SWAT-MF to assess future CC scenarios and Desired Future Conditions
SWAT-MF Model

Legend
- Weather Station
- Gauge Station
- Canal
- Waste Water
- Water Transfer

- Basin
- Sub-watersheds
- Rio Grande
- Irrigation Network (US)
- Irrigation Network (MX)
- Irrigation District
- Aquifer (Hueco Bolson)

Sheng, 2013
How much fresh water depleted?

\[ V_w = S A \Delta h \]

**Storativity S or Storage Coefficient**

\[ S = S_y + h S_s \quad (S_y: 0.02 \text{ to } 0.30); \text{ unconfined aquifer} \]

\[ S = b S_s \quad (\text{usually } \leq 0.005); \text{ confined aquifer} \]

**Specific storage** \( S_s (1/L) \):

\[ S_s = \rho_w g (\alpha + n \beta) \]

Historical Pumping in Hueco Bolson
Depleting Fresh Groundwater Reserve

\[ \sum Q_i^P = \sum Q_i^{in} - \sum Q_i^{out} - \Delta S \]
Deteriorating Groundwater Quality affects Natural Groundwater Reserve
Compartmented water uses and management

• Co-existing FW and BW
• Compartmented physical-chemically, though hydraulically connected
• Compartmented management

- Managed aquifer recharge
- Desalination of BW
- Lining canals
-Disconnected from the river

~18K AF
~35K AF
Next step

- Data exchange (USGS-TAAP, USDA-CAP) to better characterize the groundwater status (quantity and quality)
- SWAT-MF to assess future CC scenarios and Desired Future Conditions
- Implication of management of both brackish water and fresh water in the aquifer

Stay tuned: Two Nations One Water (April 24-25, 2019, Las Cruces, NM)

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