SERIOUS GAMES: HOW CAN WE PROLONG THE LIFE OF THE HUECO BOLSON THROUGH BINATIONAL COOPERATION?

Session 1. Establishing the Foundation: The Baseline Scenario and What Will Happen if We Do Nothing?

Session 1 Activities

Serious game activities will start with Session 1 meant to introduce the participants to each other, introduce the process of the workshop, describe the current situation and initiate the discussion. We will begin with introductions, a description of the workshop process, and a presentation of the current situation (referred to as the baseline scenario). The presentation will be followed by small group discussions of the scenario and impacts of depletion of the freshwater in the Hueco Bolson (HB). The questions for discussion in small groups are: a) Is the baseline scenario believable? and b) What will happen if we do nothing? Following the presentation, we will ask everyone to breakout into small groups for the first discussion. Participants will represent multiple sectors, including large and small municipal water supplies, industrial users (including both self-supplied users and municipal users), agricultural and rural users, and government representatives. Table A1 in Appendix A identifies some of the key stakeholders to be invited. The sectors will be mixed in each discussion group. All presentations and discussions will include simultaneous translation.

From Session 1, we should learn the following: 1) Is the scenario describing the current situation believable? 2) Is there agreement on the impact of "business as usual"? The participants will be asked to describe the potential impacts of depletion of the HB aquifer from their perspectives as water managers and users. These discussions will be the platform from which to launch the discussion of options for targets and potential solutions in Session 2.

The Current Situation: The Baseline Scenario

The HB aquifer (Fig. 1), shared by the US and Mexico, is a critical water resource for the cities of El Paso and Ciudad Juárez, as well as for irrigation districts and smaller municipalities on both sides of the border. Water managers on both sides of the border are assessing the future of the HB, but with limited binational collaboration.

It is well known that pumping rates for the HB far exceed recharge rates. For example, using the average pumping rate for the last five years of 188 thousand acre-feet per year (kAF/yr, Fig. 2), and an estimated annual recharge of 33 kAF/yr (see Table A2 in Appendix B), the current rate of depletion is estimated at 155 kAF/yr. This estimate is supported by decreases in published groundwater elevations over the past 100 years, which has also accelerated over the past 50 years (Figure A1 in Appendix B). According to Fig. 2, more than 6 million AF (MAF) were pumped from the HB from 1977 to 2013 by El Paso Water (EPW), Junta Municipal de Agua y Saneamiento de Ciudad Juárez (JMAS), plus other wells in Texas pumped by irrigation districts and small municipalities. In addition, agricultural wells in the Valle de Juárez irrigation district are estimated to pump 5 kAF/yr. We estimate that a total of more than 8 MAF have been removed from the HB through 2013.

While the focus of this Serious Game is extending the life of the HB aquifer, it is important to recognize that the two cities use other water sources in addition to the HB. Fig. 3 shows these other sources of water and recent average use for each of these sources. It is also important to note that there are other users of the HB beside the two major cities. The average pumping for the last five years for other Texas wells is 9 kAF/yr and for other Chihuahua wells is 5 kAF/yr.

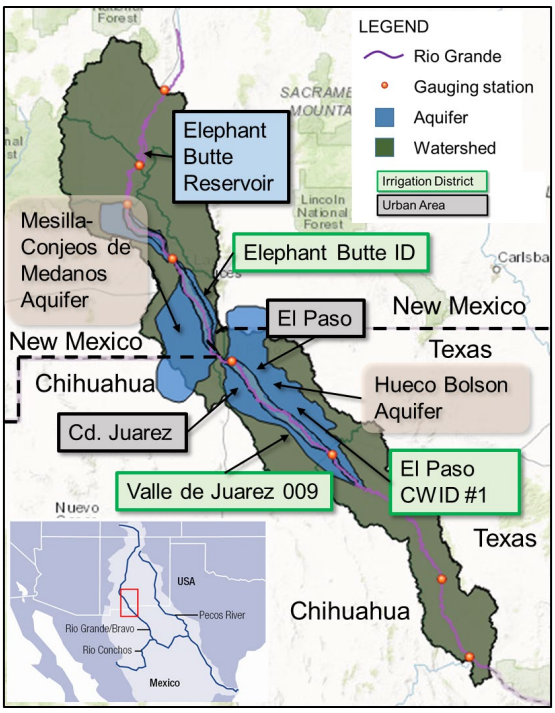

Figure 1. Location of HB, cities of Ciudad Juarez and El Paso, and irrigation districts.

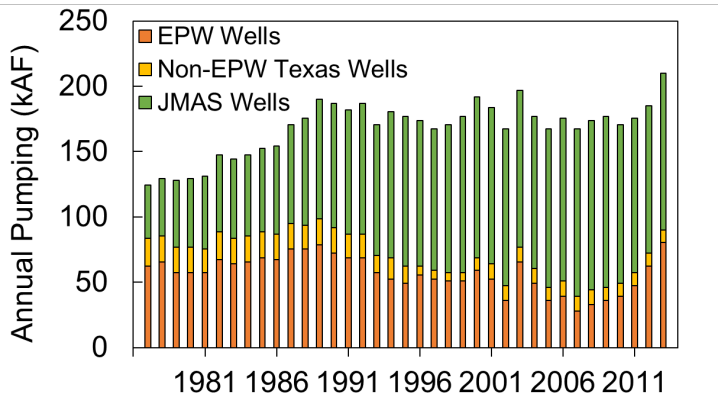

Figure 2. Pumping from the Hueco Bolson by El Paso Water (EPW), Junta Municipal de Agua y Saneamiento de Ciudad Juárez (JMAS), and other wells in Texas. Source EPW Montgomery & Associates Report, 2017.

Salinity in groundwater pumped from the HB varies from fresh (< 1,000 mg/L total dissolved solids, TDS) to brackish concentrations of up to 3,000 mg/L. Both cities have experienced increasing salinity because high pumping and depletion rates have caused brackish water intrusion into freshwater zones of the HB. For example, salinity increased from 750 mg/L TDS to 1,200 mg/L from 1979 to 1993 in an EPW monitoring well, a rate of increase of 30 mg/L per year.

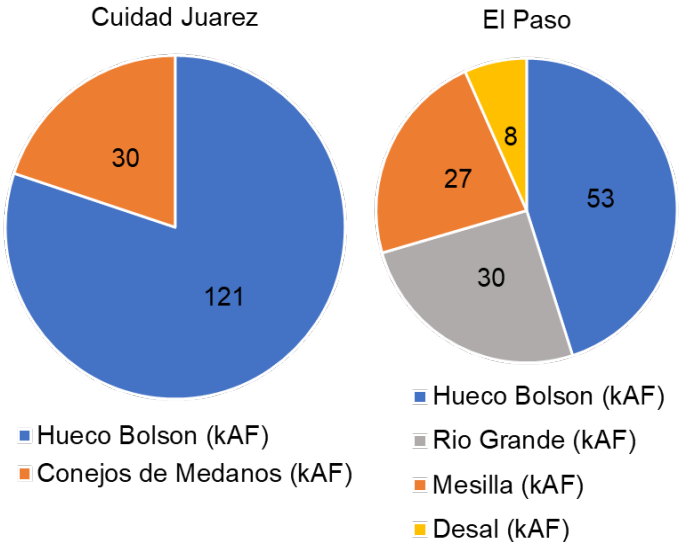

Figure 3. Water supplies used by EPW and JMAS and associated demands from most recent year statistics were

Estimated volumes of freshwater in the HB range widely from 7.5 MAF to 15 MAF and for brackish water, up to 20 MAF. For the purpose of the Serious Game, we use the Heywood and Yager (2003) estimate of recoverable freshwater volume of 9 MAF as of 2003. According to the pumping information in Fig. 2 and using the five-year average of 184 kAF/yr to extrapolate to 2020, approximately 2.5 MAF of groundwater have been depleted from the HB since 2003, leaving about 6.5 MAF of recoverable fresh groundwater**.** Of course, there is considerable uncertainty in these numbers, but we use our "best estimate" for the Serious Game. Using the current rate of depletion of 155 kAF/yr and the recoverable freshwater volume estimate of 6.5 MAF, **the recoverable freshwater will be completely depleted in approximately 42 years.** Meeting drinking and other household needs for water for millions of people on both sides of the border are compelling reasons for stakeholders to identify affordable and effective solutions to aquifer depletion. Because the aquifer is shared between the US and MX, the problem of depletion is also shared; thus, the responsibility for the solutions also must be shared.

The Future with "Business as Usual"

The baseline scenario is meant to set the stage for discussions by envisioning a future that assumes that urban populations and thus water demands will increase and there will be no significant change in policies that would slow depletion of the HB. Thus, it describes a future with "business as usual" (BAU). The BAU scenario spans a 50-year period (2020-2070) and is based on the following assumptions.

- Population will increase by 66% in Ciudad Juárez and 35% in El Paso, and per capita usage rates will remain the same, resulting in an average annual demand for Ciudad Juárez of 204 kAF/yr and El Paso of 141 kAF/yr over the 50-year period.

- Pumping from the HB will increase in proportion to the increase in total demand for the two cities.

- Water availability from Rio Grande-Rio Bravo for EPW will be reduced by 30% over the period due to climate change in the headwaters, resulting in a reduction of the availability from this source on the average, from 30,000 AF/yr to 21,000 AF/yr.

- Warmer temperatures will also impact water demand in cities, including a lengthening growing season by at least 4-6 weeks plus greater evapotranspiration (ET) from landscaping and outdoor green spaces due to higher temperatures, especially more days over 100 degrees F.

- Other users such as irrigators and rural residents who depend on domestic wells will use more groundwater for reasons mentioned above, plus to make up for reduced surface water supplies.

- Recharge from the river will also go down since flow in the river will go down and recharge from canals will go down as irrigation districts concrete line their ditches.

- Average salinity in groundwater pumped from the HB will increase from 500 mg/L to over 1,500 mg/L as TDS.

- Average groundwater levels in the HB will change at a rate equivalent to the depletion rate.

Sources of some of these assumptions and other sources of data for the baseline scenario are provided in Appendix C.

We estimate the average annual pumping from the HB over the next 50 years under the BAU scenario will be 242 kAF/yr (CJ 164 kAF/yr, EP 63 kAF/yr, and other users 14kAF/yr). Fig. 4 shows the resulting change in recoverable fresh groundwater in storage over time. The resulting average annual depletion rate for the BAU scenario is 209 kAF/yr (includes recharge of 33 kAF/yr on the average). Given this depletion rate and the recoverable freshwater volume estimate of 6.5 MAF, the recoverable freshwater would be completely depleted in 31 years.

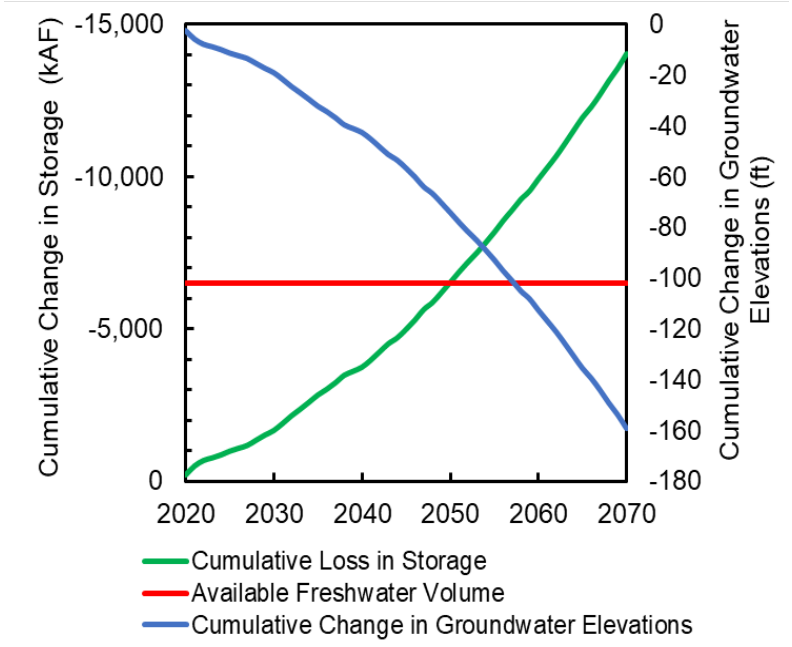

Figure 4. Change in recoverable freshwater in storage and cumulative change in average groundwater elevations since the base year of 2020.

Complete depletion of recoverable freshwater in the HB would mean that the aquifer can no longer support the water supply needs of users. Furthermore, the negative impacts of depletion could affect users well before complete depletion. Fig. 4 also shows the projected change in groundwater elevations over time, another 160 ft drop over the 50-yr period. Cones of depression around wells could increase faster than the average, resulting in depths to groundwater substantially greater than 160 ft. Changes in groundwater depths of this magnitude could result in water levels dropping below the well intake, necessitating either abandonment or drilling deeper wells. Regardless, pumping costs will grow substantially throughout the 50-yr period as a result of energy costs growing by as much as 50% over the same time period.

Session 2.
Brainstorming Solutions

Session 2 will occur five days after Session 1 to brainstorm: 1) What are possible targets for reducing the rate of depletion, and 2) What options can be identified for technologies, policies, and broader approaches that could be considered to meet those targets? The objective of this session is to brainstorm ideas, not to come up with a single solution. Session 2 will be carried out in small group discussions comprised of the same participants from Session 1. The results from these discussions will form the basis for the municipal and industrial (M&I) stakeholders to fine tune these into a binational strategy in Round 2, in early 2021.

APPENDIX

Appendix A. Workshop Participants

Table A1. Examples of invited participants by sector and country.

Sector	US	MX
Large municipal utilities	EPW	JMAS
Small municipal utilities	LVWD	Zaragoza
	Horizon	Praxidis G. Guerrero
	Fabens	Guadalupe
	Tornillo	
Industrial and/or large users	EPE	Electrolux
	Western Refining	CONCANACO
	Ft. Bliss	CMIC
	Borden/Eagle Brand	CANACINTRA
	UTEP	CANACO
	EPISD	
Agricultural and rural users	EP Irrigation District	Valle de Juarez #9
	Individual farmers	Individual farmers
	Domestic wells	Domestic wells
Government agencies	IBWC	CILA
	BoR	CONAGUA
	EPA	JCAS
	USGS	PROTECCION CIVIL
	TWDB	CFE
	TCEQ	

Appendix B. Supporting Information for the Baseline Scenario

Table A2. Recharge Components of the Hueco Bolson

Recharge Component	Annual Recharge (kAF)
Mountain front	9
Lateral inflow from Tularosa basin	0
Engineered artificial recharge	6
Seepage from Rio Grande channel	1
Leakage from irrigation & return flow canals	17
Total	33

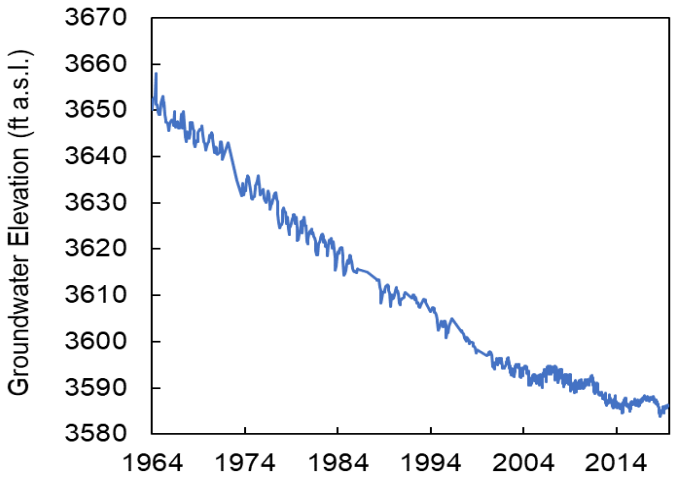

Figure A1. Groundwater elevations in feet above sea level (a.s.l.) in Texas Water Development Board State Well Number 4913301, located near Biggs Field, El Paso, TX.

Appendix C. Frequently Asked Questions about the Baseline Scenario

Q. What is the basis for the assumptions that Population will increase by 66% and 35% in Ciudad Juárez and El Paso, respectively?

A. Population increases are based on population projections from JMAS for Ciudad Juárez and from EPW for El Paso.

Q. What is the basis for the assumptions per capita usage rates for 2019 will remain the same?

A. This is the simplest assumption. Options for reducing per capita water usage are included in the discussion of water supply and demand reduction alternatives.

Q. What is the basis for water availability from Rio Grande-Rio Bravo for EPW being reduced by 30% over the period due to climate change in the headwaters, resulting in reducing the average availability of this source from 30,000 AF/yr to 21,000 AF/yr?

A. The reduction of water availability is based on calculations with a water balance model, using for a pessimistic, dry climate change scenario for water production from the headwaters of the Rio Grande-Rio Bravo[1].

Q. What is the basis for the assumption that average salinity in groundwater pumped from the HB will increase from 500 mg/L to over 1,500 mg/L as TDS?

A. Observed rates of salinity increased from 1979 to 1993 in an EPW monitoring well were 30 mg/L per year. We assume that this rate of increase will accelerate to 40 mg/L as the freshwater in the HB is depleted. The average increase over the 50-year planning period = 40 mg/L x [(50-0)/2] = 1,000 mg/L.

[1] Townsend, N.T. and Gutzler, D.S., 2020. Adaptation of Climate Model Projections of Streamflow to Account for Upstream Anthropogenic Impairments. JAWRA Journal of the American Water Resources Association. Paper No. JAWRA-19-0067-P.