PERMANENT FORUM OF BINATIONAL WATERS

SCIENCE TALK: Advances on the Water Systems Assessments at Binational Scale

March 20, 2023

Brief Summary

SPEAKERS

Enrique Prunes, Rio Grande Manager and Freshwater Lead Specialist at World Wildlife USA.
Jurgen Mahlknecht, Professor, TEC de Monterrey, Leader - Science and Technology Research Group.
Dr. Juan M. Huerta-Tolis, Director General of Juan M. Huerta Inc., of Sarasota.

Moderators: Samuel Sandoval Solis, Professor, UC Davis; Gabriela Rendon Herrera, Masters Candidate, UC Davis.

The Forum convened as an invited virtual event for World Water Week at the University of Texas at El Paso. Three questions were posed to each of the presenting scholars.

Enrique Prunes

What is the main objective and questions your research is trying to answer?

The Rio Grande/Rio Bravo Basin includes five terrestrial ecoregions and two global biodiversity hotspots and sustains 16 million people. It is unfortunately subject to complex and fragmented governance, heavily dammed and over-allocated mostly for agriculture that has resulted in the loss of 83% of historic natural flow. Our work in this is to create a Basin Health Report Card as a tool for policy makers.

The Report Card is a result of engagement with stakeholders, communicating the current state of the Basin and providing policy makers with guidance on interventions to achieve the best future scenario. The Card defines a quantitative baseline of the stocks and water flows, evaluates their vulnerability to climate change and a range of management strategies to help reduce vulnerability.

It is a seven-step process that includes steps to: Conceptualize; measure; grade; model; forecast; act; improve.

What are your results and therefore, the implications to the current conditions of your case study?

This was a three-year effort involving 100 stakeholders from 63 organizations in CO, NM and TX. The Final Report Card was released in November 2022. Grading was done on a scale from D to A based on assessment of 29 indicators, e.g., flow, groundwater, surface water, species diversity, air quality and many others. An overall grade of "C" was given to the Upper Rio Grande meaning that it is in "moderate" condition. Some indicators did better than others.

There were four report cards for each of four regions: URG Colorado; URG New Mexico; MRG and LRG. The first three were given a grade of C+ and the LRG (Las Cruces and south) a grade of C- in the assessment.

The Rio Grande Futures Model is a tool to model and forecast Report Card grades for policies executed under different climate scenarios. It addresses policies for basin hydrology, reservoir operation, agricultural water uses and performance measures and is an integration of several different regional models such as the SWIM Model at UTEP.

What are the future challenges according to your results and implications? Both at the scientific and policy level?

All models indicate an increase in temperature, less precipitation, declining satisfaction of irrigation demand and inflow to Elephant Butte Reservoir. These results were factored into an evaluation of management policy options that can be simulated in the model. These included: reducing irrigation losses; fallowing agricultural land; reducing municipal water demand; maintaining minimum ecological flows; and reservoir policies to reduce evaporation. The tradeoffs were pictured in a matrix of management options or policies against performance metric indicators. This produced a portfolio of options that can be seen in the final report at https://www.worldwildlife.org/publications/a-report-card-for-the-upper-rio-grande-basin.

Prof. Jurgen Mahlknecht

What is the main objective and questions your research is trying to answer?

This work focuses on how nitrate sources and the sulfphur cycle affect ground water, and how they reach groundwater. Sulphur doesn't have a maximum concentration limit in Mexico but it can affect health. Acid rain from fossil fuels in power plants and volcanoes are sulfphur sources. Nitrate sources include septic systems, animal waste, fertilizer, and atmospheric sources.

It is possible to develop methods to remove these contaminants or reduce them to meet regulatory limits. The objective of my research is to identify and quantify the relative contributions of nitrate and sulfate from different sources and processes in groundwater in the Monterrey area. A combination of isotopic tools and Bayesian analysis makes the difference with water isotope "fingerprints" determining the source.

What are your results and therefore, the implications to the current conditions of your case study?

From chemical and isotopic elements inside and outside Monterrey that experienced a 12% population growth, it was determined that soil and sewage are the largest contributors of nitrogen and that atmospheric rain, marine evaporites and sewage are the largest sources of sulfphur.

However, the concentrations of nitrate and sulphate were controlled by denitrification and sulfate reduction processes in the transition and discharge zones.

What are the future challenges according to your results and implications? Both at the scientific and policy level?

These involve both scientific and policy challenges. Science is needed to separate the sources of manure and sewage. Multidisciplinary approaches are needed to understand complex processes.

At the policy level there is a complex and dysfunctional framework for groundwater governance. The knowledge of groundwater quality has not yet yielded effective groundwater development and public health policy. There needs to be a recognition of a more sustainable use of groundwater resources for a healthier population.

Dr. Juan Huerta-Tolis

What is the main objective and questions your research is trying to answer?

In 2001, Mexico was behind in its delivery of water to the Rio Grande/Rio Bravo Basin by 1,314 Mm3, according to its obligations under the Bi-National Water Treaty of 1944. This resulted in tension between the governments of US President George W. Bush and Mexican President Vincente Fox. As a result, President Fox instructed his cabinet to find a solution that satisfied the terms of the Treaty and diminished the impact on Mexican agricultural producers.

Mexican water experts recommended an approach that would generate scenarios of the Basin that would determine the quantity of water Mexico could deliver to the USA and simultaneously mitigate the impact of irrigation reduction on Mexican producers.
The scope of the project from the Mexican side was from Fort Quitman to the Gulf of Mexico and the feeder streams in between such as the Rio Conchos, Arroyo La Vacas, Rio San Diego, Rio San Rodrigo, Rio Escondido and Rio Salado.

What are your results and therefore, the implications to the current conditions of your case study?

There are two possible approaches to build scenarios of the Basin. One is *Ex-post* in which statistical projections of the past are made into the future under the assumption that the past will repeat, something that is not happening now. The second is *Ex-ante* in which the future changes in the Basin are addressed using the knowledge of the Basin's system structure.

The *Ex-ante* approach was selected to include factors that determine water demand such as population dynamics of births and deaths accumulating as a state variable as a function of time, a differential equation. A dynamic holistic model of the Basin was created using this stock and flow structure for all the subsystems in the Basin, e.g., environment, demographics, industrial and agricultural production. The model provides a tool which shows how the Basin works and how it can be controlled to attain a desired outcome by generating numerical tracks of its variables.

The model is named MAUA® standing for *Modelo de Abasta y Uso del Agua*. It is the only model available that satisfies the requirements of the project. MAUA mimics the operations of the atmosphere as rain, temperature, and evaporation. Then the surface where there is water storage and runoff and man-made activities and the underground where there are aquifers. MAUA is implemented on the STELLA platform with 350 differential equations (now being ported to the VENSIM platform).

In formulating the Basin scenario, the span was from 1999 to 2005 executed one day at a time, rain assumed to be 40% under median for the region, and control variables being population births/deaths, daily per capita water use, industrial daily output, and crop surface in hectares by eight different crop types.

Iterations of MAUA accurately tracked historical deliveries and deficits of water under the Treaty for the periods simulated. In Scenario 0, it showed that the water debt under the Treaty has not been repaid with one third of the water produced by the streams in Mexico delivered to the US. Scenario 1 formulated a constant yearly delivery to the US of 431 Mm3 applied in the current cycle.

What are the future challenges according to your results and implications? Both at the scientific and policy level?

The Commission will establish a binational Rio Grande Hydrology Workgroup to enhance information exchange, develop a binational Rio Grande model as a tool to analyze water management scenarios related to future water conservation projects. Population growth in the Basin is a major driver of water demand. The model is proprietary and is not publicly available.

Q&A Discussion

As far as opinion is concerned regarding the Treaty, there is consensus that we need a more predictable and reliable method of deliveries.

What would the river or environment want to tell us that we have to do now? There needs to be a shared vision for the Basin, not necessarily a shared governance but a shared vision. Also, the river is in a dire situation, and it, too, is a user of its water deliveries from Mexico.

As for water treatment for nitrates and sulfates, reverse osmosis filtering such as is done in hospitals and households is doable but is slow and energy inefficient. The same is true for ion exchange systems that require a water softener. A third alternative is distillation. These options are not large-scale. A fourth alternative uses microorganisms. But the best approach is to look at the sources of contamination and there are several techniques to address this.

While the MAUA model is a tool, how does it function in the climate of political nationalism and isolationism? This depends on who is using it and the questions posed to the model, whether they are technical or national. The model gives numeric results that tell us what water we are using and for what purposes.