SCIENCE TALK: Drought and human induced stress in the Rio Conchos Basin

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Brief Summary

SPEAKERS

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Moderators: Gabriela Rendon Herrera, MS Candidate (UC Davis) and Saul Arciniega Esparza, Professor UNAM.

Topics for discussion included the Basin's current condition, how the work of the panelists contributes to improving its condition, and what remains to be done with transboundary challenges along the Rio Conchos?

What are the current conditions of the Rio Conchos Basin?

There is a growing problem with agricultural demand for water and high stress related to treaty obligations during a mega-drought. There needs to be a more comprehensive framework to coordinate conjunctive use of land and water that limits land use expansion and intensive water use. Additionally, the 1944 treaty needs to be updated to deal with the drought contingency planning and long-term restrictions.

72% of Mexico's territory is under water stress with Chihuahua being among the most stressed states. Climate variability in Chihuahua is the quasi-periodic variation in climate that lasts longer than the weather event and can span decades and even centuries. A mega-drought is a dry period spanning more than two decades. This type of climate change is amplified by human-induced demand for water and land use. This is where we are now with regional water deficits due to demand in agriculture and under the Treaty obligations.

Environmental issues include over-exploited aquifers, poor ground and surface water quality, low recharge of aquifers, soil degradation and desertification. Social issues in the Rio Conchos

Basin include increased users, poor schemes of environmental and water education, inadequate regulation of ground water, a deficit of information on water use, illegal wells, poor public policies and lack of consensus on decision making, and the fact that Treaty deliveries do not account for extended drought and climate variability. Economic issues include differences between ejido and private users, lack of payment schemes for hydrologic environmental services, inadequate technification systems for water irrigation, disaggregated land, and water management (conjunctive use), no water treatment/reuse/recycling, no governance over land use and development, increased agriculture intensity driven by higher value orchard crops, and the value of environmental flows not included in management schemes.

A comparison was made of the Rio Grande Basin (including the Conchos basin) between its natural state and its current regulated state. The natural state is based on how the Basin would look with no human impact and with alternating wet and dry periods. The regulated Basin state now has no alternating periods of wet and dry but persists in a perpetual dry state, an anthropogenic megadrought. This will be magnified by future water demand and climate change.

The 1944 Treaty is an overriding factor. Mexico is currently in deficit with respect to the Treaty. A key year is 1954 when the dams on the Rio Grande became operational. In Chihuahua almost 90% of water is for agriculture and deliveries over the years from 1996 to 2020 vary from less than 50% to 100% of Treaty obligations.

Population increases from 1960 to 2005 have affected water demand even though per-capita use has declined, but not sufficiently to overcome the impact of population growth. This phenomenon is happening globally, too, within the similar band of latitude of the Rio Conchos.

Geographically, the Rio Conchos Basin is large at approximately 68,800 square kilometers. The water volume of 2,400 million cubic meters is consumed 95% in agriculture, the remainder going to urban and industrial use. This is important to remember as a kind of “trinity” of factors to understand the Basin: agriculture; water; 1944 Treaty obligations.

How does the work and research of the panelists help to improve current conditions in the Rio Conchos Basin?

First, estimation of climate variability is needed to help frame and plan for management and governance of land and water sustainability over several timeframes: from annual, inter-annual, multi-decadal and multi-centuries. Analysis of tree-ring data correlated with climate variation events such as El Nino, along with monthly weather indices, were used for this study and even a solar luminosity cycle spanning over 1,400 years.

The results show an 8-year average dry period with fluctuating megadroughts such as the one we are in currently 2000 to 2020. The Treaty operates in five-year cycles, a mismatch to the less predictable cycles of nature embedded in the paleo climate data. The data show that these events literally end civilizations in the region over the span of centuries. The challenge, then, is to align the management/governance framework with the climate cycles.

Second, ongoing research updated the Orive 1944 flow estimation along with hydrologic extreme events, functional flow analysis and regime shift threshold analysis to identify tipping points in the sustainable carrying capacity of river basins. These integrate into a resiliency theory framework that shows the capacity of a system – the Basin – to absorb shocks like the current drought.

Third, the lens of "hydro politics" helps us to understand the internal competition for water between agriculture, industry, and urban use. This competition is exacerbated by illegal withdrawals in the Basin and by the structures in place for dialog to resolve these differences and legal matters. All could use improvement and overlying the whole system is the drought combined with the over-concessioning of water resources.

So, having a way to prioritize water use at appropriate scale with contingency plans in place for drought scenarios is a way forward in hydro politics. This is complicated by the number of agencies having various roles, some overlapping, at the national, state and Basin level. Cooperation or the lack of it is at the heart of the problem.

Fourth, models as a management tool. There is the matter of the time scale granularity of models and can they be tuned to be used as a management tool. For example, a model that predicts on a monthly cycle might be insufficient for daily operational decisions and analysis. The current model includes 80% of the hydraulic infrastructure of the entire basin. This includes all the important sub-basins, irrigation canals and diversions from the surface to the irrigation districts.

1981 was used as the calibration year for the model, a year in which there was constant information. It was also a hurricane year. Subsequent model iterations revealed a close approximation of modeled versus actual observed flows for the Upper and Middle basins of the Rio Conchos and to Ojinaga in the Lower basin. The same model was run for drought years 1992 to 2001, also with close results. The model team is attempting to develop water security indices for key areas of the Basin.

What is left to do, what are the risks and remaining challenges, and transboundary implications?

The biggest problem is that the 1944 Treaty for surface water deliveries to the USA is not in alignment with the reality of climate variability, long term drought, and drought contingency planning. The solution would be a new Treaty Minute that would include drought contingency and longer delivery periods for the Mexican tributaries. Also, an integrated approach to monitoring (SCADA) and modeling (One-Water) so that the watersheds, climate/boundary conditions, governance and infrastructure, land use and water demand are part of a holistic, Smart self-updating system with dynamic allocation based on climate cycles rather than fixed time periods.

This integrated approach represents "Whole Basin Thinking." That is managing for connectivity, adaptation, polycentricity, participation, diversity and redundancy, and slow variables such as aquifer recharge. The perceptual lens shifts to see water as a common shared resource. These river systems extend far beyond the Rio Conchos into Texas, Coahuila, and Nuevo Leon.

Unfortunately, there is a low level of trust among the various governing institutions of the Basin and this is a huge impediment to coordinated management, in addition to disconnects between the Upper and Lower Basins. As a result, problems are detected but not acted upon and participation is more symbolic than real, resulting in over-concessioning.

The solution recommendation is for coordinated action at three levels: local, regional and state. At the local level there could be water exchanges between different uses of water, a multiple-use approach and obtaining water contributions from additional users. At the regional level, a commitment to annual delivery quotas preferably and more in wet years; include considerations for the San Juan and Alamo rivers and make the commitment bi-national. At the state level there needs to be contingency plans that involve all water resources and overall reduction percentage if needed.

Recommendations extend, too, to the Federal and bi-national levels. The Federal level has a role to play in emphasizing user participation in problem solving to avoid conflicts, creating incentives to cooperate and a national fund for contingencies like the current drought. The bi-national level can help to improve information flow and communication channels with transboundary water users in Mexico. Future research could analyze the organizational characteristics of the Basin actors to identify points of conflict and cooperation.

There is a perfect storm of events coinciding now with climate variability, less precipitation, regional growth and the fixed demands of Treaty deliveries. We need good water management but at the end of the day, Mexico still must deliver water to the USA. There is a good, calibrated model available for anyone who wants to use it but there needs to be better collection of

hydrometric data and the information in the riverbeds. CONAGUA has been talking about investing in hydrometric stations, but it has not yet happened.

It would be a great step forward if we were able to model the Basin accurately based on good hydrometric data and then integrate the model results dynamically into the governing and management processes. What if a hurricane occurred? Could we measure and integrate that event and its hydrological significance into our basin management with the model? Or a drought like 1992 to 2001?

Q&A - The Forum discussed the panelists' comments with questions and observations.

These included how are the models simulating the natural flows of the river? This is done with water balance accounting and flows. It is highly variable and there are five or six eco-regions that are involved, too.

There is the issue of how to attain fair agreements between all the parties involved in the Rio Conchos. The sense is that what is discussed in the local irrigation committees never makes it to the decision makers. There needs to be open spaces for these discussions that hear all voices and evaluate if proposed solutions are actually viable. There is a water model from 2007-2008 that is still not agreed upon to determine who gets water each year.

How can we make the cultural changes that involve values and habits? Climate change itself is the biggest driver here and especially the variability of drought phases. If temperature increases, even if we have normal precipitation there is going to be stress. Especially because of the intensity of agriculture activities and its demand on water that include illegal withdrawals of groundwater by wells. Running a model doesn't give one the authority to govern by it. Our adaptations need to be communal decisions.

Has the Rio Conchos model been shared successfully with government and water managers? The COVID pandemic put a halt to this and we have not yet presented it to the government as a tool for decision making. There is a complete model calibrated to 2020 for the San Juan Basin. Perhaps this all will change in the next few months?

What are the issues for water equity, especially among poor farmers and indigenous peoples? Minority peoples are far more likely to be affected by climate change and it is basically a problem of environmental justice. This will require managing for demand and conservation practices that lead to resilience. This is a particularly interesting topic in Mexico where we are in a stratification and are not asking about the needs of marginalized groups. Technology, too, is contributing the stratification depending on which farmers have access to it.

Water unites us.