

Water and Wetlands Outreach Project in the Sierra Gorda Biosphere Reserve, Mexico

Tatiana Lobato-de Magalhães¹, Marinus L. Otte², and Letícia Rocha Mier³

BACKGROUND

The development of sustainable water security strategies that preserve freshwater ecosystem functions and services to reduce water-related risks to humans and conserve biodiversity and abundance of biota is urgent. Nevertheless, wetland losses and degradation rates are alarmingly high, particularly in inland wetlands that face prolonged drought (Davidson 2014; Davidson et al. 2019). Through a Fulbright Specialist Project (FSP-P006854) with a multidisciplinary and multi-partner team, we worked in the Sierra Gorda Biosphere Reserve in the State of Querétaro, in collaboration with representatives of the government (Querétaro State Environmental Secretariat and Water Commission and others), rural communities (Cuatro Palos and El Éden in Pinal de Amoles, Tepozán in Arroyo Seco, and El Pocito and Carrizal de los Durán in Jalpan de Serra), Civil Societies and Non-Government Organizations, as well as with students, scientists, and practitioners of academic institutions: North Dakota State University (NDSU), Fargo, ND, USA and the Universidad Autónoma de Querétaro (UAQ), QRO, Mexico, the host institution. The 4-week consultation in September 2021 by the Fulbright Specialist in water and wetlands, Dr. Marinus L. Otte, was key to support and improve UAQ's ongoing efforts, particularly to develop strategies for sustainable management of water and wetlands, by improving rainwater harvesting and wastewater treatment and by creation of artificial ponds for improvements of ecology and biodiversity. Enabling capacity-building in wetland sciences is a crucial objective of our project, aligning with the Fulbright Program mission, and key for safeguarding water of good quality in a sustainable manner. The project focused on promoting and improving water and wetland management and conservation in the State of Querétaro through a three-pronged approach combining (1) aquatic science education, (2) wetland awareness, and (3) engagement of local stakeholders.

THE SIERRA GORDA BIOSPHERE RESERVE

The Sierra Gorda Biosphere Reserve, Querétaro State, Mexico, is situated in a predominantly semiarid environment with karstic geology at elevations from 350 to 3,160 m a.s.l. The main town in the area is Jalpan de Serra (21°13'05.2" N, 99°28'26.6" W, 760 m a.s.l.). The intermittent availability of water and the porous substrates complicate sustainable management of water (Mireles 2006). This region harbors many types of vegetation as high elevation pine-oak forests, lowland tropical forests, moist montane forests, and is home to a great diversity of cacti. The Sierra Gorda Biosphere Reserve is a very species-rich region, consisting of butterflies (800 species), birds (342), reptiles and amphibians (131), fungi (127), mammals (110), and fish (27), among others. It harbors the last remaining population of the *Ara militaris* (military macaw) in Mexico (Grupo Ecológico Sierra Gorda 2021). Surface water and wetlands



Figure 1. A) Santa María River with high sediment load due to the rainy season. B) Altered wetland (excavated) in Landa de Matamoras, Sierra Gorda Biosphere Reserve, Mexico. (Photos by Marinus Otte)

¹ FSP Project Director, Natural Sciences Faculty, Universidad Autónoma de Querétaro, Mexico; corresponding author: tatiana.lobato@uaq.mx

² Fulbright Specialist, North Dakota State University, USA.

³ Education and Communities Support Department, Universidad Autónoma de Querétaro, Mexico.



Figure 2. A concrete cistern, use for rainwater harvesting from the roofs of homes in El Éden, Sierra Gorda Biosphere Reserve, Mexico. This one was leaking a bit around the faucet, but the owners did not want to repair it yet, because the wasps living by their home used that spot for drinking. (Photo by Marinus Otte)



Figure 4. Teaching in the mountains: The Project Coordinator and Fulbright Specialist showing participants how to create new wetlands in high-altitude, steeply sloped lands. (Photo by José Gómez)



Figure 5. Sharing course materials with people from the Cuatro Palos community. (Photo by Marinus Otte)



Figure 3. The Fulbright Specialist Dr. Marinus Otte showing instructional materials. (Photo by Tatiana Lobato de Magalhães)

in this region are scarce and increasingly threatened by land-use transformation, urban and agricultural expansion, and invasive species (Figure 1). Groundwater extraction, pollution, and unsustainable agricultural practices such as flood and drip irrigation are major concerns. The problem is further magnified because the Sierra Gorda Biosphere Reserve is an economically marginal area from which inhabitants migrate to either larger cities or the United States (Arroyo-Quiroz and Perez-Gil 2007).

Scientific knowledge about how and where to restore and construct wetlands is essential to enhance sustainable management of water, and to secure ecological services and functions, such as suitable habitat for wildlife. This will also safeguard sustainable access to adequate quantities of

water of acceptable quality for human well-being and sustainable socio-economic development. In the Sierra Gorda Biosphere Reserve, four rural communities have about 100 rainwater harvesting systems as their principal water source (Cuatro Palos, El Éden, Tepozán, and El Pocito). They were constructed by the Autonomous University of Queretaro (UAQ) in collaboration with Cáritas de Querétaro I.A.P. and Peace Corps (Figure 2). In Cuatro Palos and Tepozán the rainwater harvesting complements the water they received by the pipe systems of the State Water Commission. However, these systems are interrupted very frequently. In Carrizal de los Durán the springs are the main source of water and they therefore do not have rainwater harvesting systems. Other communities of Landa de Matamoros municipality face severe water treatment issues and had specific questions about better and ecologically sound water management. Through the Linking Relations Department (Dirección de Vinculación) and the Education and Communities Support Department (Coordinación de Educación y Apoyo Comunitario, CEACOM), the UAQ already had a long-standing relationship with rural communities in the Sierra Gorda, a huge advantage that enabled us to achieve good results within the short period of the field visits.

TECHNICAL APPROACH

Eight-Day Expedition to the Sierra Gorda Biosphere Reserve

We carried out an eight-day expedition across the Sierra Gorda Biosphere Reserve (September 18-25, 2021), visiting four municipalities, interacting with at least 300 participants of communities, university, civil societies, and government. During this expedition we provided short courses and workshops on water and wetlands to five rural communities, visited several wetlands, water reserves, treatment systems, and water collection systems, organized two meetings with local representatives from government, university and civil society, visited two rural campuses of the UAQ, collected material for diagnostics (notes, surveys), took at least 4,000 photographs for a book, and filmed more than 14 hours of audiovisual material for a documentary, including 38 recorded interviews. In addition, one undergraduate and two graduate students (from Anthropology, Watershed Management, and Biological Sciences programs) supported the activities during the expedition, which, in turn, provided them with opportunities to connect directly with Dr. Otte and UAQ faculty members and learn from their experience and expertise.

Training and Instructional Materials

We organized one-day courses for at least five communities

within the Reserve. As part of the courses, local people, Dr. Otte, and UAQ faculty exchanged experiences relating to water and wetlands, focusing on the specific needs of each locality (e.g., water pollution and the potential use of constructed wetlands for water treatment, spring management and protection, habitat for wildlife, and education). All courses were open to undergraduate students from various rural campuses of UAQ located in the Sierra Gorda (Concá, Jalpan de Sierra, and Pinal de Amoles).

Due to a lack of infrastructure (e.g., energy and suitable space) and the need to be in outside areas due to the COVID-19 pandemic, we created nine bilingual pamphlets (in both Spanish and English; Figures 3 and 4) covering several topics on wetlands: What is a wetland? Why are wetlands important? What do wetland plants look like? Wetlands and mosquitos. Threats to wetlands. Constructed wetlands. How to construct wetlands? Holistic management of springs. Wetlands for water management in small dwellings. We shared the pamphlets with the participants during the interactive presentations and donated all pamphlet sets to the communities along with other instructional materials (e.g., boards, pencil, markers, and paper; Figure 5).

Finally, we invited participants to make drawings or written messages about the importance of water and wetlands. That activity was important to engage participants



Figure 6. A woman from the El Pocito community expressing her feelings about water and wetlands through drawings "For me water is life." (Photo by Emiliano Plata)



Figure 9. Interviewing a woman for the documentary. She lives in Cuatro Palos, the highest part of the watershed, and talked to us about the challenges she faced with water in the past and the rainwater harvesting systems that people currently use in this region. (Photo by Marinus Otte)

Scientific Lectures

Dr. Otte presented seminars based on his experience with projects in the USA, Asia, Europe and other regions, and his experience as Editor-in-Chief of WETLANDS, as follows: (1) “Sustainable solutions for environmental problems with water-loving plants” for the Botanical Society of Mexico audience (more than 2K views) as part of the monthly webinar program of the Botanical Society of Mexico on August 25, 2021, (2) “*Wetlands as solutions for environmental problems*” for faculty and students of the Natural Sciences, Biological Sciences and Watershed Management programs at UAQ (118 participants) on September 7, 2021, (3) “*Students vs Editors — or how to get your paper published*” for graduate students of the Natural Sciences, UAQ’ (30 participants) on September 14, 2021, and (4) “Wetlands” for undergraduate students of the rural campus of UAQ in Concá, Arroyo Seco (30 participants) on September 20, 2021.

Language Exchange

Language can be a challenge for international outreach projects, particularly when they involve local people. In this context, we planned courses molded in small parts with continuous translations for answers and questions, introductions, and technical comments. All of our instructional materials were presented in both languages, Spanish and English. We believe that we can promote further opportunities better by improving bilingual capabilities for stakeholders, not only via the direct participants, but also via the children who will benefit from the bilingual materials we offered to the local schools. In addition, the book and the

documentary arising from this project will be in both Spanish and English.

Outreach in Pandemic Time

Running a wetland education, society linkage, and awareness project during the pandemic was a challenge for us in terms of logistics and planning. We held many small workshops across the Sierra Gorda Biosphere Reserve and all activities were at outdoors locations, instead of large-scale indoor gatherings. Only a small number of participants were invited for all activities, to ensure groups remained small, while social-distancing and wearing masks. Challenging though this may have been, on the other hand this meant we were able to engage more directly with individuals, which we feel made the experience more productive for all.

OPPORTUNITIES FOR WATER AND WETLANDS MANAGEMENT IN THE SIERRA GORDA

We identified several opportunities for this region in terms of water and wetlands management, including:

Biodiversity Improvement and Restoration of ‘Bordos’

“Bordo” is a local name for a pond (usually used by cattle) that may be entirely artificial or constructed in existing natural wetlands. Most of the *bordos* in the State of Querétaro were temporary wetlands that were altered. Regardless, the *bordos* are important landscape elements that have huge potential for wetland restoration or to create new wetland zones to improve sustainable management of water and biodiversity.

Treatment Wetlands

Urban towns across the Sierra Gorda Biosphere Reserve would benefit greatly from incorporation of wetlands in wastewater treatment systems (at least for tertiary treatment) both in existing and future projects. Particularly in rural communities we suggest implementation of small wetlands for individual households for treatment of grey water and subsequent re-use for irrigation of flower and vegetable gardens at the property. This is crucial for sustainable water management at higher elevations of the Reserve (2000–3000 m) where water is scarce.

Conservation of Natural Springs

People in the region are well aware of the importance of conservation of natural springs, but knowledge about how to protect and conserve them is lacking. In a region with karstic geology, it is not so easy to assess what the watershed of the springs is and exactly where the water comes from. In addition, changes in land uses, such as deforesta-

tion and road construction, resulting in erosion and pollution, compromise essential water resources.

Promoting Well-being, Creating Awareness, and Citizen Science Projects

Wetlands are crucial for promotion of health and well-being anywhere in the world, but especially in this karstic region. Perhaps our most important role during the visits was to promote more awareness about sustainable water management and wetland conservation and protection. As in many regions, such efforts are complicated, because the majority of wetlands in the region were destroyed or severely altered in the past. The majority of the present population did not know what the term “wetland” means, nor did they have any memory of what used to be there (the problem of “shifting baselines”). Perhaps most surprising is that most of the people we encountered in the city of Jalpan, the largest city in the Sierra Gorda and its economic center, did not know that the reservoir near the town, La Presa de Jalpan, is also a Ramsar site. It is an internationally important stop-over and resting place for migratory birds. We observed lack of knowledge about the importance of wetlands not only in the rural communities but also among students and academics. Consequently there are many opportunities to raise awareness of wetlands and initiate dialogue about water and the environment in general.

CONCLUSIONS

This project aimed to advance knowledge of water and wetlands management, strengthen institutional linkages between academia, local communities, government and other stakeholders, and to support ongoing efforts to design innovative plans to harvest water, analyze water quality, and treat water using constructed wetlands. Several hundreds of people participated, and interest from rural as well as urban communities and stakeholders was very high. We plan to write a book to propose practices and techniques that people from this region could use to improve water management and wetland conservation and protection, to be published in 2022 by the UAQ.

This project was key to establish a “wetland dialogue” between people in the region. We achieved some outstanding results from the contact with the diverse groups. Most notable is the realization of the need for an ‘umbrella’ as-

sociation of stakeholders in water and wetland management in the region.

Finally, this Fulbright Specialist project was not a once-off exercise but was the starting point for continued collaboration on wetland outreach, teaching, and research among both institutions: Universidad Autónoma de Querétaro and North Dakota State University.

ACKNOWLEDGMENTS

We thank the Fulbright Specialist Program; Dr. Mahinda Martínez, Dr. José Gómez, Dr. Mónica Queijeiro (Natural Sciences Faculty), MSc. Sofia Rivas, MSc. Paulina Becerril, Psicóloga Janete Hoyo (Dirección de Vinculación), Dr. Teresa Gasca (Rector) from the Universidad Autónoma de Querétaro for their motivation and support with logistics and fundraising; Jackal Tanelorn for his support through the US-Mexico Commission (COMEXUS); the UAQ students Lizeth Harzbecher, Miguel Sarmiento, Emiliano Plato for their support to collect data during the expedition in the Sierra Gorda Biosphere Reserve, particularly Emiliano for the photography database with ~4,000 registers; and Christian Rodríguez (UAQ Audiovisual coordination) for his genuine dedication on collecting audiovisual data for our documentary.

This project was funded by the Developing Knowledge Fund (FONDEC-UAQ-2021), Fulbright Specialist Program (FSP-P006854), and Council on Science and Technology of the Querétaro State (CONCYTEQ-20101436).

REFERENCES

- Arroyo-Quiroz, I., and R. Perez-Gil. 2007. *Human-Wildlife Interactions in the Sierra Gorda Biosphere Reserve, Mexico*: Annual Report Y2. Rufford Foundation-Faunam, AC Ciudad de México, Mexico.
- Davidson, N.C. 2014. How much wetland has the world lost? Long-term and recent trends in global wetland area. *Marine and Freshwater Research* 65(10): 934-941.
- Davidson, N.C., A.A. Van Dam, C.M. Finlayson, and R.J. McInnes. 2019. Worth of wetlands: revised global monetary values of coastal and inland wetland ecosystem services. *Marine and Freshwater Research* 70(8): 1189-1194.
- Grupo Ecológico Sierra Gorda. 2021. Available in <https://sierragorda.net/reserva-de-la-biosfera-sierra-gorda/> Visited: Sep 2021.
- Mireles, M.V. 2006. El mundo de la Sierra Gorda. *Arqueología mexicana* 13(77): 28-37.