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Presenter Information

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Long-term socio-ecological research in the Biosphere Reserve in Mapimi, Mexico: a multidimensional participatory observatory of rangeland/pastoral systems

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Key words: Arid zones, conservation and protection of biodiversity; grassland and shrublands ecosystems, participatory research, transdisciplinary local incidence

Abstract

Since the creation of the UNESCO Biosphere Reserve Mapimi (BRM) in Mexico 45 years ago, pastoralism has undergone a series of transformations. Upon the arrival of the Spaniards, horse breeding flourished until 1900; thereafter extensive cattle production lasted for six decades. Only recently, farmers have adopted alternative management types for organic meat production. National and international efforts to achieve the Sustainable Development Goals (SDGs) require basic, applied, and participatory research efforts. In the socio-ecological pastoral system BRM, first halophytic ecosystems were examined for their ecohydrological role in rangeland productivity. In 1996, a long-term ecological research site was installed to monitor the effects of herbivores on the composition and biodiversity of desert communities. Shortly thereafter, the National Commission of Natural Protected Areas began a rigorous monitoring and conservation program to guarantee both the sustainable management of natural resources and the sustainable development of reserve dwellers. Soon international multisectoral institutions joined Mexican efforts to protect the natural, cultural, and social diversity of the BRM and to strengthen its socio-ecological resilience to climate change and land degradation. Hence, the BRM is currently a space of participatory monitoring and research, with emphasis on the health of this important socio-ecological pastoralist system. It is examined whether institutional programs promoting organic livestock farming are compatible with this desert system and how biological soil crust is developing as a fundamental indicator of soil functioning and the provision of ecosystem services and human wellbeing. The formation of multisectoral partnerships to foster dryland sustainability have led to the foundation of the International Network for Dryland Sustainability; it is currently coordinating a national network of participatory socio-ecological observatories (PSEOs) to promote the SDGs. Mapimi is one of the first PSEOs to promote local governance and social and ecological sustainable development in the drylands of Mexico and world-wide.

Introduction

In North America, the grassland biome extends from Alberta (Canada) (Figure 1), through a large part of central United States, to the vast central plateau of northern Mexico (Plateau) (CCA, 1999). Within these grassland areas, more than 55 protected areas have been decreed for the conservation of flora and fauna, including the “UNESCO man and biosphere reserves” with the mandate that resources use occurs in harmony with nature and in agreement with the locals and managers of the protected area; here we present the situation of the Mapimí biosphere reserve (RBM) (site 43 in Figure 1) (Halffter, 1988).

Methods

The dimensions and foci of research approaches in the Mapimí Biosphere Reserve socio-ecological system have evolved over time by increasingly strengthening integrated, interdisciplinary, inter-institutional conceptual frameworks and methodological strategies, coordinated by researchers in ecology, hydrology, vegetation, soil, and climate science and from the social sciences such as environmental and social anthropology, social geography, among others (Montaña, 1988; García Arevalo, 2002; Reyes et al., 2009). Originally, the main research interests were in basic conservation science; occasionally combined with applied approaches. In general terms, the interaction with local decision-makers was low or null; they participated in field work as wage laborers. However, the MBR gave many undergraduate and graduate students from different backgrounds (Biology, Ecology, Anthropology, Agriculture, Geography) the opportunity to collaborate in a multidisciplinary fashion. In the third and fourth decade, after the creation of the biosphere

reserve, public citizen consultation, action research, participatory inter-, and transdisciplinary research spearheaded long-term socio-ecological research targeting synergies among the interests of actors and sectors at the local, regional, national, and international level to support the SDGs and promote sustainable development in the participatory Observatory of the Mapimí Biosphere Reserve socio-ecological systems (Huber Sannwald et al. 2020).



Figure 1. Distribution of pastoral zones in North America, (adapted from CCA,1997)

Results and discussion

Origin of the Mexican modality of biosphere reserves

In the 1970s, UNESCO promoted worldwide the creation of protected natural areas within the framework of the Man and the Biosphere (MAP) program; Mexico was the first Latin America country to create two biosphere reserves in desert and temperate regions. The Mapimí Biosphere Reserve was decreed MAB as the scrub and grassland biomes of this region represent the habitat of the desert turtle, an important endemic species in danger of extinction. Each MAB has to be affiliated with a group of local and regional scientists committed to conserve and sustainably manage the natural resources and operates based on by-laws that define both the physical-biological extension to be conserved and the management plan to be adopted for the protected area (Halffter, 1984). In 1977, the MBR went through its first stage, when a group of ecologists, the Durango state government and several local actors agreed to manage the MBR area, which had originally been declared Forest Protection Zone by presidential decree (CONANP, 2006). On November 27, 2000, this area was officially declared the Mapimí Biosphere Reserve, covering land in the municipalities of Mapimí and Tlahualilo in the state of Durango; Jiménez in the state of Chihuahua, and Francisco I. Madero and Sierra Mojada in Coahuila, which together covered around 17,000 ha (Halffter, 1988).

From production and ecological research, combined with tourism, to conservation and management of the MBR socioecological system

Since the creation of the MBR, in 1977, the Institute of Ecology, A.C. (INECOL), promoted research in biophysical aspects, descriptive, taxonomic and functional ecology of fauna and flora, social geography, social anthropology, the monitoring of hydrological and edaphic processes, the use of natural resources including plant species of local interest (Mezquite, nopal, lechuguilla, cactus), potentially marketable species such as candelilla (wax), forage grasses, mining (salt and marble), among others. Research results advanced the understanding of the functioning of these diverse desert ecosystems, the reconstruction of the history of livestock production. Furthermore, clear shifts in the interest of knowledge generation were observed moving from disciplinary research to multidisciplinary, inter-institutional research agendas to protect, and conserve the natural resources with the support of local residents of the ejidos La Flor, Carrillo, La Soledad, Las Lilas. This period generated around 320 scientific and popular articles, student thesis, chapters and books (CONANP, 2006), as well as various newspaper notes, videos, television programs, among others.

Parallel to the creation of the MBR, agribusinesses of the Comarca Lagunera, a nearby urban area, implemented an exploitative tourist strategy, to promote (uncontrolled) visits of the MBR, through the aggressive dissemination of alleged events (legends, paranormal phenomena and encounters with Martians), mystical zone theory, known under the collective phenomenon of the "Zone of Silence" (in many occasions it is more popular than the MBR itself), epitomized by myths of high magnetism in the area, the appearance of

aliens, the fall of the Athena space capsule, megadroughts, the presence of plant species such as purple nopal (*Opuntia violacea*), caves, ferromagnesian minerals in the form of black concretions that visitors mistake for meteorites, capricious basaltic geofoms, and the presence of quartz and gypsum dunes, to mention the most important.

As of the year 2000, the Ministry of the Environment and Natural Resources (SEMARNAT), INECOL, various academic institutions, municipal governments and the political sector, defined by decree the National Commission for Protected Natural Areas (CONANP), responsible authority for the management of that socioecological MBR system. CONANP then developed the management plan of the MBR by citizen consultation which included the government, academia, producers, communal (ejidal) and private owners. This period CONANP underpinned the ordered and controlled management of natural resources to ensure sustainable development within the MBR by zoning the territory in a core zone, exploitation zone, buffer zone and zone of influence.

The MBR: a multifunctional participatory observatory in lands of pastoralism

The area of the MBR increased from 20,000 ha in 1978 to the current surface of 343,000 ha (since 2006). Land cover types within the polygon of the MBR have been reclassified. In the last two decades, an apparent shift in land cover and vegetation types has been detected by the National Institute of Statistics and Geography (INEGI) (Figure 2). Between 1993 and 2018 (see Series II and V of INEGI, in Figure 2 left and right, respectively) a shift occurred in that former secondary halophilic grassland vegetation was regrouped into secondary halophilic xerophilic shrub vegetation. The changes in land use and vegetation categorization identified between 25 years were mainly a reduction of halophilic grassland, and an increase in halophilic scrub; however this change is more related to a technical reclassification rather than to overgrazing or phenomena such as drought.

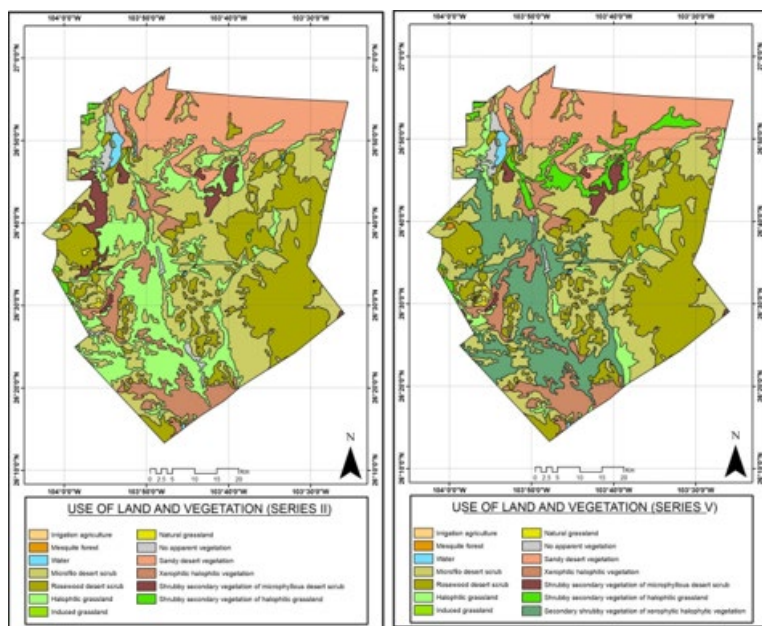


Figure 2. Cartography of land use and vegetation in the Mapimi Biosphere Reserve, Mexico used in the diagnosis of changes in surface area of grazing areas

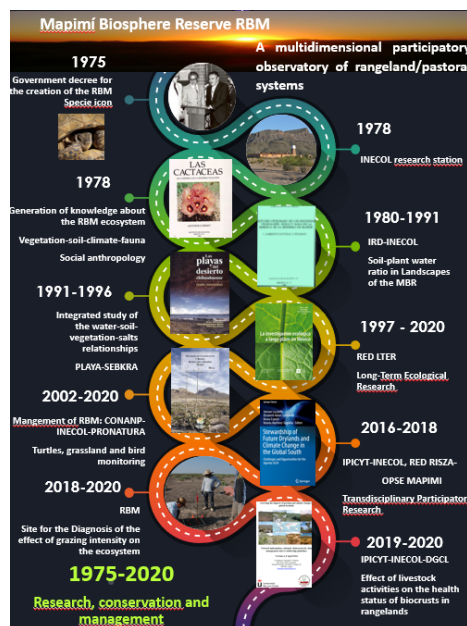


Figure 3. Time infogram representing the evolution and shifts in research approaches in the Mapimi Biosphere Reserve, Mexico between 1975 and 2020

Figure 3 depicts a temporal infogram of the development from disciplinary to multi- and interdisciplinary participatory research approaches in the MBR (Halffter, 1984; Montaña, 1988; Grünberger et al., 2005). Participation has been among various national and international academic scientific institutions, decision makers, government representatives, local actors such as landowners, ejidatarios, and non-governmental organizations (CONANP, 2006; Grünberger et al. 2005). The most recent investigations have generated close partnerships among actors. With the support of multidisciplinary research methodologies, since 1997 the MBR has been considered a subject area for long-term monitoring within the network framework of the Long-Term Ecological Research (LTER) project, through a surveillance model inspired by complementary LTER sites in the La

Jornada and Sevilleta in the United States of America (USA) (Jardel et al. 2014). Herbivore (native and domestic) exclosures were installed to examine their long-term effects on structural and functional changes of two representative vegetation communities of the Chihuahua desert, the microphilous desert scrub and halophilic grassland. The experimental design permitted to analyze the effect of both climate variability at long-term time scales (Reyes et al. 2009) herbivory by cattle, lagomorphs and rodents, the three most important groups of vertebrates of primary consumers in the food chain of these ecosystems. Through participatory action research, including a transdisciplinary multisectoral approach, the MBR installed a Participatory Observatory of Socio-ecological Systems (OPSE), through projects and research strategies developed by the International Network for the Sustainability of Arid Zones (RISZA). RISZA's conceptual philosophy seeks to promote sustainable development and contribute to achieving the Sustainable Development Goals (SDGs) (Huber-Sannwald et al., 2020). Between 2017 and 2020, other participatory research groups have also considered the MBR, as demonstrative sites and transdisciplinary research to co-generate knowledge in a participatory manner aligned to local, regional, national, and international interests of dryland development, such as the CrustNET project: A global research network devoted to a unified understanding of the "living skin" of the Earth (Bowker and Huber, 2018) and The BIODESERT project: Assessing the impacts of grazing and climate change in global drylands (Maestre, 2016). These international projects focus on generating integrated knowledge on physical (climate, structure and hydraulic properties of the soil) and biological variables (biocrusts, grassland and scrub vegetation structure and function) under the long-term influence of livestock grazing. These projects were installed with the intent to understand the function of the socio-ecological systems of the MBR in areas of interests of local communities including private owners, ejidatarios, and civil associations interested in the conservation of species of forage interest, hunting and for the protection of the cultural and natural biodiversity of socio-ecological systems of arid zones.

Conclusions

The Mapimí biosphere reserve has undergone a long process of transformations in the way of conceiving it as a site for research, conservation and management of natural resources in arid zones. First, as a natural biodiversity protection zone, with the main endemic species of care, the pocket turtle *Gopherus flavomarginatus*; later, as a meeting place of knowledge between ecological scientists from Mexico and the world, to describe the biophysical environment and the functioning of the desert ecosystem. In the second decade after the creation of the RBM, a multisectoral consortium is developed for the management plan of the Reserve and the execution of seven local strategies to conserve, manage and advance towards sustainable development in agreement with local communities. During the last six years, transdisciplinary research groups have emerged that through participatory research create strategies such as the participatory observatory of the socio-ecological system of the MBR, in order to build new strategies that are aimed at subjugating the Sustainable Development Goals raised at the summit of Paris.

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