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Research article

Traditional and formal ecological knowledge to assess harvesting and conservation of a Mexican Tropical Dry Forest

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ABSTRACT

This research integrates Traditional and Formal Ecological Knowledge (TEK / FEK) of a Tropical Dry Forest in central Mexico, in order to assess harvesting and conservation of the non-timber forest species. We were interested in: knowing the structure and diversity of the forest community; identifying which are the tree resources of common interest to the users through participatory workshops. A further interest was to identify those resources which are important to local people in terms of preservation; explaining the relationship of the species with some environmental factors; and visualizing which management practices endanger or facilitate the conservation of species. Studied areas were defined and labelled on a map drawn by local informants, where they indicated those plant species of common interest for preservation. Ethnobotanical techniques were used to reveal the TEK and assess harvesting and conservation of the species. With the FEK through community and population ecology, we detected the importance of five environmental factors, obtained various ecological indicators of the vegetation, and studied the population structure of the relevant species. The FEK was analyzed using descriptive and multivariate statistics. As a result, low density and small basal area of trees were registered. Species richness and diversity index were similar to other natural protected areas in Mexico. Tree species harvested shown an asymmetric distribution of diameters. Harvesting, elevation, and accessibility were the most influential factors on tree density. FEK demonstrated that TEK is helpful for the assessment of forest harvesting. Ecological analysis complemented the local knowledge detecting that Lysiloma tergemina is a species non-identified for the people as interesting, although we discover that it is a threatened species by over-harvesting. Haematoxylum brasiletto was identified as important for conservation due to its scarcity and medicinal use. Our results advanced on how the traditional harvesting of tree community has contributed to preserve diversity, when comparing with protected areas. Discrepancies between both kinds of knowledge should be reconciled for contributing to the preservation of priority resources by the local society.

1. Introduction

Harvesting of non-timber forest species by local people and the change in land use have contributed to loss of the structure and diversity in the forests of the world (MEA, 2005; Newbold et al., 2015), as it is the case of Tropical Deciduous Forests (TDF) (Rendón-Carmona et al., 2009). This vegetation type in Mexico includes 45% of endemic flowering plants (Villaseñor and Ortiz, 2014), and provides most of the medicinal plants registered in this country (Argueta et al., 1994), which are of vital importance for local society welfare. Relevance of this kind of forest increases by over-harvesting and lack of conservation of its biological and cultural diversity, both situations influence negatively on the plant community, development and sustainability. Interaction with local stakeholders is an opportunity to link traditional ecological knowledge (TEK) with formal ecological knowledge (FEK), to assess the current status of the resources, understand the reasons for change, and derive the potential benefits that result from the

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synergy between knowledge and actions (Danielsen et al., 2014), in order to contribute to the sustainable management of natural resources. TEK-FEK must be linked to actions compatibles of co-management of natural resources, since any decision involves the presence of two or more political-social actors whose function is negotiate, define and guarantee sharing of the management purposes, entitlements and responsibilities, for a given territory and a set of natural resources (Borrini-Feyerabend et al., 2007). In according to these authors, multiplicity of options for the use of natural resources must be compatible with both, indigenous knowledge and scientific evidence, and be adaptive to the needs of conservation and development. Co-management is an approach effective (Costa et al., 2013) when the local users are motivated to participate in management of resources in order to solve human needs, and when there are recognized benefits for the government, in response to aspects of management conducted by communities at the local scale.

Participation of local actors and the integration of their TEK represent an opportunity to balance interests and values among scientist, politicians, indigenous people and farmers to conserve the environment and to promote social development; to preserve the biological and cultural diversity; to promote the sustainable use of resources and human well-being (Datta and Chatterjee, 2012; Ezebilo, 2011; Rahman et al., 2017). These objectives were matched in the Biological and Cultural Diversity Programme, launched in 2010 b y UNESCO, and the Convention on Biological Biodiversity (UNESCO and SCBD, 2010).

Traditional Ecological Knowledge based on a holistic view of the environment resulting from life experiences, is part of the biocultural heritage (Toledo and Barrera-Bassols, 2008). Formal Ecological Knowledge generates scientific information, including observation, logical reasoning and technological support to achieve further analysis of the results, which are transmitted openly by publishing the research (Usher, 2000). TEK is shared as a heritage among human generations, is the support of a subsistence economy, and operates with adaptive management of resources to preserve the diversity and multi-functionality in the biocultural landscape (Amici et al., 2015; Rotherham, 2015; Toledo and Barrera-Bassols, 2008). This kind of knowledge support the traditional use of natural resources, like food plants (Kuhnlein, 2014) or forest (Ford and Nigh, 2009) and the establishment and management of agroecosystems (Juárez-López et al., 2017) that underpin the survival of inhabitants in rural communities.

This research pretend to answer the following questions: Can the analysis TEK - FEK give a guideline on the harvesting, the impact on preferred species, and community solutions to forest management and conservation? Is it possible a synergy between TEK-FEK to carry out the co-management of forest resources?

This study assesses the harvesting and conservation of Tropical Deciduous Forest, integrating traditional and formal ecological knowledge (TEK/FEK) in Temimilcingo Morelos, Mexico.

We assume that the sum of traditional and scientific knowledge will help to explain the processes of resource use and management, to try in the future, the participatory co-management of natural resources.

Objectives are approached to describe the structure and diversity of tree communities, sources of the trees of common interest to be preserved by the inhabitants. Also, to relate species with some environmental factors and document which management practices endanger or facilitate conservation of species. Procedures of this research based on TEK-FEK are only to diagnose on the use and impact on preferred species by the local inhabitants, and register some actions as local management strategies to forest conservation.

2. Methods

2.1. Study site

Temimilcingo community (99° 09′ 41” N, 18° 43′ 42” W, elevation 1010 m above sea level-ASL) belongs to Sierra Monte Negro (SMN) Reserve, in Morelos State, Mexico. SMN comprises an area of 7328 ha lying on a limestone substrate since Cretaceous period (Ferrusquía-Villafranca, 1993). Climate is warm subhumid, mean summer precipitation reaches 954.4 mm and mean annual temperature, 23.5 °C (García, 2004). SMN is located in Balsas Basin, a centre of endemism to Fabaceae species (Sousa, 2010) and diversification area of genera *Bursera, Acacia, Euphorbia* and *Ipomoea* (Rzedowski, 1992). In Temimilcingo, Tropical Deciduous Forest (TDF) is the dominant vegetation, which include tree species like *Conzattia multiflora*, *Amphipterygium adstringens*, *Ipomoea wolcottiana*, *Lysiloma divaricatum*, *L. tergemina*, *Wimmeria serrulata,* and *Bursera copallifera* (Boyás, 1992; CEAMA, 2008).

There is archaeological evidence of occupation in SMN by Olmec culture (since 1500 BC) (Sánchez et al., 1998). At the time of Spanish Conquest, Temimilcingo was registered as a Nahuatl community tributing to Aztec Empire (Maldonado, 2010). By 1715, only 102 indigenous inhabitants were censed here. Later in 1850, the number of inhabitants increased to 320, all of them workers engaged by the landlords of Hacienda de Acamilpa (Guerra, 2004).

In Temimilcingo, currently there are 1349 inhabitants; only 33 are Nahuatl speakers, 11 are bilingual Nahuatl-Spanish and most, are mestizo population (COESPO, 2006); however, 35% of population recognized themselves as indigenous people (INEGI, 2015). Active economic population is working mainly in agriculture (40%), and services sector (40%), while others are engaged in plant nurseries. Up to 60% of these workers and their families survive with 2 USD or less per day, thus they live in conditions of marginality (COESPO, 2006). Due to their historical-cultural tradition, and also to their margination conditions, all inhabitants obtain environmental services (provision, regulation, support and cultural) from 182 ha of the SMN, but no economical valuation exists on the proportion of their income or subsistence, as product of their extraction activities from the forest. Only it has been estimated that 72% of wood extracted is destined to self-support (Boyas-Delgado et al., 2001).

2.2. TEK and sampling design of tree community

After explaining to the local government the objective of this work, 7 semi-structured interviews (Appendix) with adults of the community (farmers, homemakers, employees) and two, with traditional healers were conducted. Moreover, three workshops were implemented, the first one with four women and the rest with 34 adults, parents (32 of them women) of students from the elementary and junior high school. A questionnaire was delivered to the participants in the last workshop asking them to answer it in their homes, 22 were recovered. A modification of The REFLECT Basic Manual (Archer and Conttingham, 1997) regarding activities was used to prepare the workshops and interviews about the useful plants and their status of conservation. Using this participatory management approach (Gomotean et al., 2008), people identified species that they would like to keep for future generations.

In order to design the ecological sampling, a map of species distribution was prepared with the help of three male collectors and a herbalist, who knows and harvest plant resources in the forest (Fig. 1a). The information derived from this drawing was useful to select Piedra Grande (PG) and Camino Real (CR), two sampling areas of the tree community, because informants recognized these areas as locations of natural distribution of species, and