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Participatory forest conservation, restoration and sanitation in a resilient and resistant social-ecological system in Mexico

Elvira Duran-Medina, Guadalupe Pacheco-Aquino, José A. Hernández-Aguilar, Magdiel Y. Luis-Santiago and David B. Bray.

Instituto Politécnico Nacional, CIIDIR-Campus Oaxaca, Oaxaca, Mexico.
Contact e-mail: eduran3@hotmail.com, Potential presenter: Professor Elvira Duran]

Abstract

The world continues the search for effective mechanisms to protect the natural heritage of forested landscapes. Mexico is among the most important forested and mega-biodiverse countries, with some 60% (62.6 million ha) of forests owned by communities, which operate as common property forest social-ecological systems (SES). Mexican forests are under varying natural and anthropic threats, but community collective action around forest management is the most important response for facing them. Here, we document experiences of participatory-adaptive forest management for conservation, restoration and sanitation in community forests. Combined methods were used, included: document review, participatory mapping, forest cover analysis, community workshops, key actor interviews and participant observation. Participatory forest management strategies by varying communities commonly used community resources, labor, cultural values, local traditional knowledge and governance institutions, both with and without sustained government support. The hundreds of voluntary conservation areas demonstrate that nature and people can coexist. As well, thousands of participatory forest restorations are based on cultural motivations and concerns for environmental legacies. Also, despite the growing bark beetle threat in temperate forests, large-scale participatory sanitation logging illustrates the opportunities to maintain forest health at the community level. A better understanding of approaches that improve resistance and adaptive capacity in forest SES, may help to design public policies for government and non-governmental interventions oriented to support and strengthen grassroots initiatives in Mexico and beyond. Lessons from bottom-up collective action examples can help to build a more sustainable future in comparable inhabited forests.

Keywords: Adaptive and integrated management, habitat conservation, forest transition, climate change, local governance.

Introduction

A third of the terrestrial surface still presents forest cover (FAO 2020). Conventionally, forests were conceived as suppliers of timber and non-timber products. However, currently there is a wide awareness of their role in providing ecosystem services and other benefits from local to global scales (MEA 2005). This new perspective is accompanied by the recognition that the close relationship between forests and people calls for a consideration of them as forest social-ecological systems (SES; Kabala 2014; Fisher 2018). Although seventy-three percent of the world's forests are under public ownership (FAO 2020), commonly they are inhabited and exist as forest SES. This is particularly true since for at least three decades, there is a global trend towards shared forest management with indigenous and local communities. Thus, in these forests participatory or collaborative forest management may be practiced, i.e. "processes and mechanisms that enable those people who have a direct stake in forest resources to be part of decision making in some or all aspects of forest management, from managing resources to formulating and implementing institutional frameworks"

(Schreckenberg and Luttrell 2009). Forest SESs are also dynamic, subject to uncertainties, varying scenarios and may incorporate monitoring/evaluation and social learning. They are forms of participatory-adaptive forest management (PAFM), defined as a complex and dynamic process of forest management and oriented to meet the interests and different expectations of various stakeholders, while being open and flexible in the face of new or unexpected scenarios. Forests are the locus of a number of global environmental crises, including biodiversity loss, water crises, food security, soil loss, desertification and climate change (Bray 2020; Berkes 2021, FAO 2021; Hodgdon, 2021). Thus, forest health (structure, vigor, productivity and ecological functionality) is crucial as well as the participation of well-informed local communities empowered with technical capacity for sustainable forest management (Holvoet and Muys 2004; McDonald and Lane, 2004). However, reaching this ideal scenario implies that forest public policies are designed for maintenance of ecological-social stability in the forest SES and with the capacity to retain or return to structural and functionality after disturbances, i.e. resilience (Figure 1). As resilient systems they should not pass certain thresholds (transition points to alternate states) and display resistance (internal attributes that reduce response to pressures or factors of change) (Liu et al. 2007).

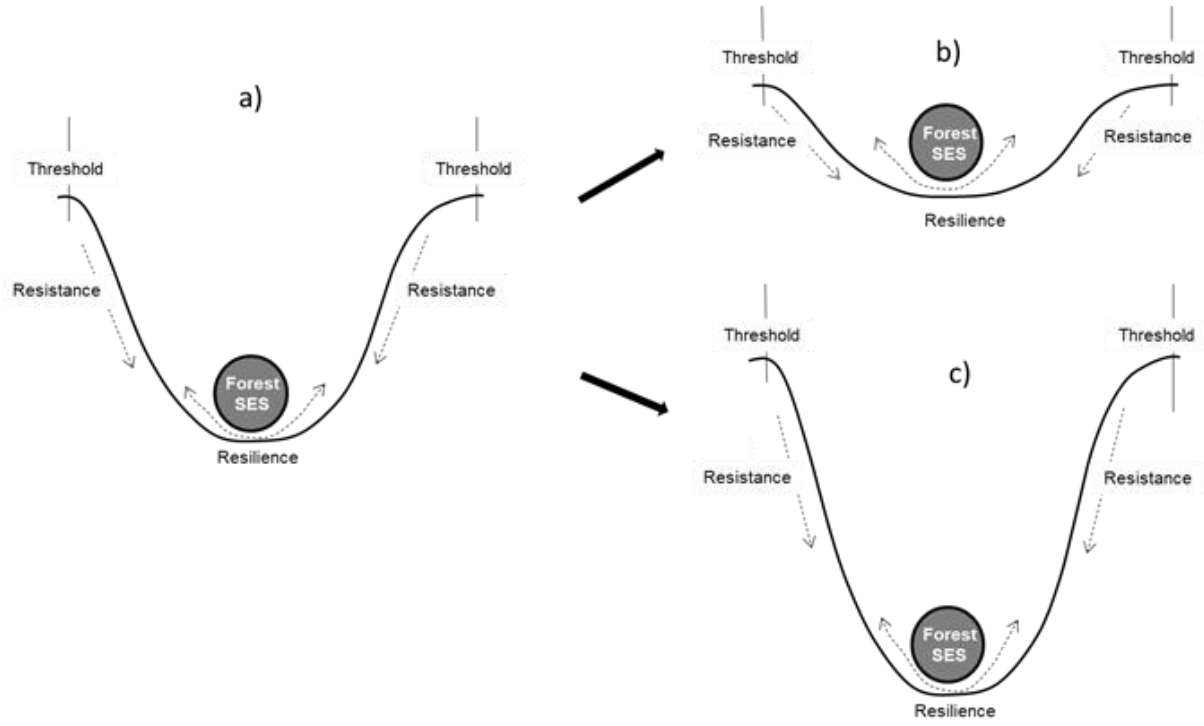

Fig. 1: Model that illustrate resilience and resistance of forest SES plus thresholds in: a) hypothetical current conditions, b) transition toward a less resilient future scenario and c) transition to a more resilient future scenario.

Although, strategies for PAFM are not a panacea that can provide solutions in all forest contexts (Ostrom et al. 2007), there is ample evidence globally that participatory forest management is an important option for forest conservation (Alden 2002; Nagendra 2007; Bray 2021; Hodgdon, 2021). Thus, in regions where local people have a key role in forest landscapes, policy makers need planned strategies to empower them and improve their collective action around forests (Macqueen et al. 2020). It is thus important to have a better understanding of the factors that are conducive to

successful PAFM. Here, we document three bottom-up experiences of PAFM in Mexican community forests: voluntary conservation areas, community-based forest transitions and participatory sanitation logging. All three are based on collective action processes, institutions (traditional or new), legal frameworks and community governance (Ostrom 1990; Bray 2020). They demonstrate opportunities for social-ecological resilience in forest landscapes, but also the many challenges for forest management in developing countries (RRI 2021).

Methodology

Study site

The study was focused at the national, regional and local levels. Mexico presents the second highest common property sector in the world, after Papua New Guinea (Bray 2020). It comprises at least 15,584 communities that own around 60 percent of the forests of Mexico (Bray 2013, CONAFOR 2019). In the community forests, decision-making is conducted by the community assembly although commonly other stakeholders (internal and external) may be involved (Figure 2). In the state of Oaxaca, forest management is commonly carried out through paid or unpaid obligatory community labor called *tequios* (Bray 2020).

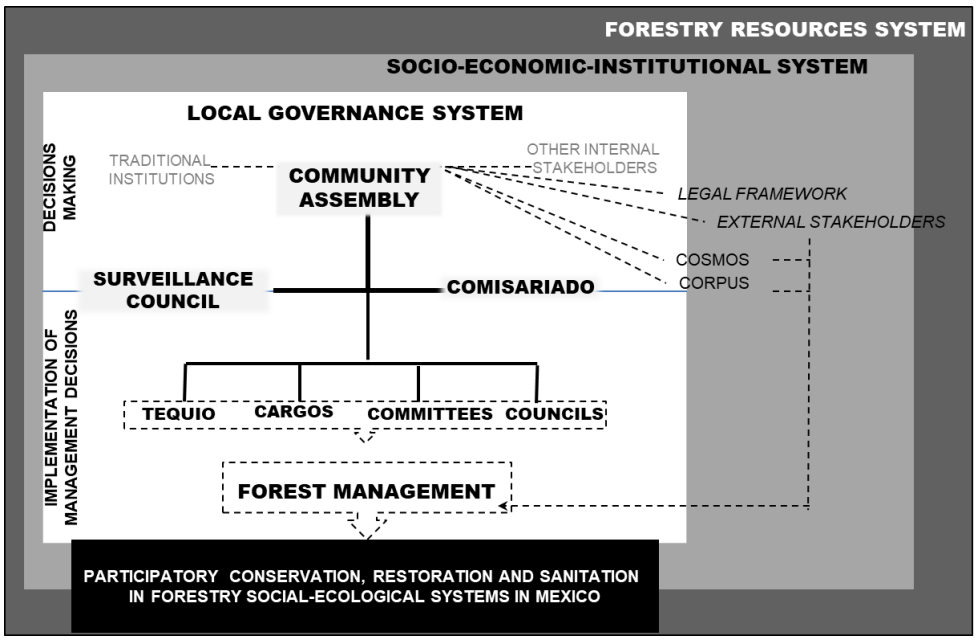

Fig. 2: General decision making framework at local level in Mexican community forests (Source: modified from Duran et al. 2018).

For decades, Mexican forest policy has promoted community forest management, principally for timber extraction. For biodiversity conservation in forest areas, a top-down strategy based on public protected areas was adopted, but since 2008, a policy of encouraging community conservation through certification of voluntary conservation areas (VCAs) was adopted. In the last decades of the 20th century, deforestation and forest degradation were high, and still today tropical forests have higher deforestation rates than temperate forests (Rosete-Verges et al. 2014). Forest recovery is also occurring through both passive and active processes (Velasco et al. 2014; Vaca et al. 2012) although there are spatial variations and some recovery is still incipient. On the other hand, forest

health is threatened due to unprecedented forest pests and diseases (Trumbore et al. 2015). In Mexico, bark beetles are the most important forest pest and currently represents the main biotic threat for temperate forests (CONAFOR 2020).

Methodological approach

The study was conducted from 2017-2020. For fieldwork in indigenous forest communities free, prior and informed consent was obtained and community authorities and local guides provided support. Initially, a review of academic literature and government documents and technical reports on community-based forest conservation and community-based restoration and participatory forest sanitation logging was conducted. Official data VCAs was compiled and opportunistic interviews with stakeholders from different levels were applied (under COVID-19 conditions, mostly video calls were used). Participant observation research also occurred in some VCAs in Oaxaca. Community workshops on participatory forest restoration were also held and included historical data and participatory mapping was carried out, including georeferenced data on reforestation and restored areas. A land/use forest cover change analysis was also conducted. For forest health, official data at the Oaxaca state level were reviewed and, at the community level, interviews with key local informants were applied to understand the decision-making processes followed by the communities for participatory forest sanitation logging. A total of 33 interviews with various stakeholders were conducted.

Table 1: Methods used for analyze participatory conservation, restoration and sanitation in community forest of Mexico.

Analyzed issues	Participatory mapping	Forest cover analysis	Field works	Community workshops	Key actors interviews	Participant observations
Conservation			X	X	X	X
Forest restoration	X	X	X	X	X	X
Forest sanitation		X	X		X	X

Results

Currently, thousands of Mexican community forests are implementing participatory and adaptive forest management for forest/habitat conservation, forest restoration and forest sanitation logging. As well, in a twelve-year period 366 voluntary conservation areas (VCAs) were certified, protecting 596,965 ha of forests of all types, from dry to humid. VCAs are mostly common properties where each community assembly makes the decision to apply to the government protected area agency, the Comisión Nacional de Areas Protegidas Naturales (CONANP) for recognition of an area it has decided to formally protect. VCAs are recognized in 25 of the 32 Mexican States, principally in indigenous lands composing 16 ethnic groups and some 89,000 inhabitants. This bottom-up conservation strategy has been expanding rapidly and has demonstrated success in preserving habitat and biodiversity, and is strongly connected with cultural values, traditional knowledge, and organizational and governance capacity in forest communities.

As an example, participatory wildlife camera-trap monitoring has been adopted in dozens of VCAs in Oaxaca and community bio-cultural festivals in mangrove, tropical deciduous and tropical perennial forests have been organized during the last decade, although interrupted by the COVID-19 pandemic. The interviews with external and internal key actors suggested four areas where the VCA

model needed improvement 1) Strengthening of the legal frameworks to make them more comparable with protected areas, with assigned annual budgets, staff, and basic infrastructure, 2) Establish an incentive and monetary compensation system, 3) Establish conservation goals linked to community development strategies and 4) A communications campaign to build awareness among the Mexican public about community contributions to forest conservation and environmental services (recharge of aquifers, carbon sequestration, biodiversity, etc.).

In the severely degraded landscapes of the Mixtec region in Oaxaca, participatory forest restoration efforts have been sustained for at least three decades. An analysis of this process in five community forests in the Mixteca showed that for the 1990-2018 period, forest cover increased by 71% (2,640 ha) with an annual rate of expansion of 2.73%, higher than tendencies for other regions. Participatory reforestation and collective care of natural regeneration were approved in community assemblies. Community members contributed with free labor (even women, elders, and children) through tequio institutions. Tools, trucks, lunches, sapling and fund came from migrants or government. There was also compliance with new community rules on restricting free grazing of goats. Forest restoration also depended on collective action, local leadership and social learning. Communities explicitly noted that their commitment to improve their forests was based on their desire to leave the forest in good condition to their descendants, a case of intergenerational value. The fact that these forests had been in decline for generations, but have now reversed course and are expanding, can be termed a new forest transition pathway, the local-community forest transition.

For forest health, official data for the 2010-2019 period reported 148,163 hectares as the annual average of forest affected by biotic threats in Mexico. Bark beetle was the most important pest, impacting pine trees in at least 760,820 ha of temperate forests. Mexican forest law establishes that forest owners are responsible for attending to forest threats. Thus, participatory forest sanitation is a common national practice, usually comprised of the felling of infested pines, debarking trunks and branches, and burning of bark debris. These practices are all done manually and is extremely labor demanding, complex, dangerous and expensive for communities. Government subsidies only amount to ~US$87 per hectare so are very insufficient. Temperate forests in Oaxaca are among the most affected by bark beetle in Mexico, and for the 2009-2019 period hundreds of participatory sanitation logging events occurred, removing 2.214 million m^3 of pine timber (SEMARNAT-CONAFOR, 2019). This practice requires a complex bureaucratic process for authorization followed by collective action on the part of the communities and their leaders and the use of *tequios* (Figure 2). Evaluation of sanitation logging commonly occur in the community assemblies, which provides opportunities for adaptation (learning by doing and correcting). In community assemblies two persistent questions are common: why our forests are being affected by bark beetle? And what we can do to prevent this problem? These questions show the need for educational campaigns and technical training for the communities, who are commonly poor and with low technical capacity. Despite these shortcomings, participatory sanitation logging still represents an effective forest management model and illustrates the opportunities for maintaining forest health at the community level.

Discussion

The three practical issues presented have had some success and meet some of the characteristics of Ostrom´s eight design principles for rules around common-pool resources (Ostrom 1990; Bray 2021), although in all cases collective action at the inter-community level is lacking. Because land tenure security is fundamental for conferring resistance, adaptive capacity and resilience in the forest SES analyzed, this factor is considered key to “conserve and restore the world’s land and forests” in order to face biodiversity loss and climate change (RRI 2020). These community examples also show the dynamic nature of forest SES, with permanent oscillation between certain thresholds (Figure 1),

driven importantly by secure land tenure and community collective action. The three different practices of community conservation, restoration and participatory sanitation logging all contribute to stability in the resistance and resilience of community forests (Table 2).

Table 2: Some resilience attributes in the Mexican forest socio-ecological systems that improve or reduce thresholds and resistance, for communities involved in forest conservation, restoration and sanitation logging.

Resilience attributes		Voluntary Conservation (Luis-Santiago & Duran 2020)	Forest restoration (Hernandez-Aguilar et al. 2021)	Forest sanitation logging (Pacheco-Aquino & Duran 2021)
Thresholds	improve	-Intergenerational perspective on environmental legacies -Local appropriation of conservation principles -Embrace of bio-cultural values	- Intergenerational perspective on forest restoration -Local concerns for scarcity of water -Outmigration that reduce pressures	-Culture for forest management - Local concerns for forest pest disturbance -Local concerns for scarcity of water
	reduce	-Internal conflicts -Lack of knowledge of the value of forests -lack of professional advice	-Centennial landscape degradation and soil erosion -Goat and sheep grazing culture -Outmigration (agriculture abandon that induce erosion)	-Climate disruptions (droughts) -Expansion of stands with pine host species -Lack of knowledge of forest pest management -Bureaucracy for forest sanitation logging
Resistance	improve	-Traditional local knowledge -Habitat integrity -Forest culture -Participatory wildlife monitoring	-Remnant of native forests -Agreement for annual reforestation - Official support for reforestation	-Prevalence of native and managed forests -Local concerns for forests health -Participatory forest sanitation logging
	reduce	-Rural poverty -Market forces for local products that impose pressure for unsustainable products -Low local technical capacity	-Extensive bare soil -Use of nonnative species for reforestation -Confluence of different degradation drivers	- Social conflicts (intra or intercommunity) -Low organizational capacity for forest sanitation -Lack of knowledge about forest pests

Currently these participatory practices are being inserted in the communities' work practices, including specific commitments, calendars and strategies for to look for resources. The practices have also generated positive feedbacks for the use of community resources and labor, cultural values, traditional knowledge and the local governance institutions (Hernandez Aguilar et al., 2021; Luis-Santiago, 2021). During the process, communities engaged in social learning, for example on the need to seek synergies with other stakeholders (governmental and non-governmental (Pacheco-Aquino 2021). However, more support is needed for standardized factors (Sansilvestri et al. 2019) and for communities to take advantage of proposals like the "Global Initiative for Community Forests" and others (Mohammed et al. 2017; Hodgdon, 2021), an effort to mobilize large new investments in community forest SES.

There is much evidence from the literature that resilient forest SES can maintain forest cover, reduce civil violence, generate rural income from timber extraction, as well as take advantage of new economic strategies like ecotourism and environmental service payments (Duran et al. 2011, Sims et al. 2014, Van Vleet et al. 2016, Bray 2021). Beyond Mexico, other countries with smallholder and community forests and where rights devolution and/or policies of PAFM and collaborative forest management are happening show successful results, as in China with incentives of distributing land to smallholders with commitments to restore degraded areas (He et al. 2014).

Conclusion

We propose that PAFM in Mexico has been successful for forest conservation, restoration and forest health. These participatory practices confer resistance and adaptive capacity to the community forests, and they may help to improve their resilience. The identification of forest SES attributes that improve or reduce their thresholds and resistance to transition towards less resilient future scenarios, or the opposite, may contribute to government and non-governmental policies and strategies for inhabited forests. Thus, smallholder and community participation should be supported to promote collective actions around soliciting funds, conflict resolution, and needs for information and to encourage concerns for environmental legacies for descendants. Lessons from bottom-up collective action examples here presented and from elsewhere show the potential at the local level to confront global environmental crises like climate change and their impacts in forest health. Participatory or collaborative forest management is a key strategy for building a more sustainable future in inhabited forests.

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