Local approaches to biodiversity conservation: lessons from Oaxaca, southern Mexico

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Abstract: Large areas of Oaxaca, southern Mexico, exhibit high biodiversity in the absence of official protected areas. This paper discusses some of the key mechanisms and practices employed by local communities to help conserve their forest resources. The findings suggest that learning from local resource management systems should become an important component of future conservation planning in Mexico. This will require conservationists and the wider public to consider local communities to be a necessary part of territorial and ecological processes and, in some instances, to give them a greater role in biodiversity conservation and stewardship of the country's forest commons. However, such a shift in thinking is unlikely to occur until more research is carried out to determine the specific impacts of these land-use systems on biodiversity and ecological integrity.

Keywords: biodiversity; conservation planning; institutions; Mexico; multifunctional landscapes; Oaxaca; resource practices.

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1 Introduction

In their book, *Protecting Beyond the Protected*, O'Riordan and Stoll-Kleemann (2002) argue that biodiversity is both an ecological and a social phenomenon and, as a concept, should embrace a mosaic of objectives and management strategies. Despite this, the dominant approach to biodiversity conservation has been based on the establishment of national parks or other protected areas (PAs), the (typical) relocation of local people and the banning or restriction of most, if not all, productive and extractive activities taking

place within park boundaries. As a number of scholars have reported, such protectionist attitudes and policies have become a major source of rural tension across developing countries (Ghimire and Pimbert, 1997; McShane and Wells, 2004).

In response to these concerns, much of the recent literature has focussed on the merits of local participation in conservation activities. Terms such as community-based conservation, integrated conservation development projects (ICDPs), collaborative, joint and co-management all imply a simultaneous interest in the welfare of people and nature. Common to all is an attempt to link the conservation of biodiversity in protected areas with local economic and social development (Berkes, 2004; Ghimire and Pimbert, 1997; Wells and Brandon, 1992). However, successful examples of ICDPs and active local participation in conservation schemes have often been conspicuous by their absence (IIED, 1994; McShane and Wells, 2004; O'Riordan and Stoll-Kleemann, 2002; Pimbert and Pretty, 1997). This has led to the subsequent revival of the traditional conservationist approach or, what Hutton et al. (2005) have called, the 'back to the barriers' movement. Seemingly, we are no closer to reaching agreement on how best to conserve the world's remaining biodiversity.

While the right mix of policy options are considered, recent empirical work is helping to support an alternative approach to biodiversity conservation that sits outside the realm of most previously conceived models. This work focusses on the way local people interact with their resource base and shape local territories into multi-functional, cultural landscapes, where biodiversity is maintained and renewed without the need for the establishment of formal protected areas (Berkes and Davidson-Hunt, 2006; McNeely and Scherr, 2003).

This paper discusses whether such local approaches can offer an alternative to formal protected areas or externally driven community-based conservation projects. It does so by looking at local and indigenous conservation strategies in the state of Oaxaca, southern Mexico, where extensive tracts of well-conserved temperate and tropical forest remain under community control (Sarukhan and Larson, 2001). Given that large areas of Oaxaca display high levels of biodiversity in the absence of official protected areas, the paper responds to two main questions. Firstly, what are some of the mechanisms and practices that help local and indigenous communities conserve their forest biodiversity? Secondly, what are the implications of these findings for future conservation policy in Mexico? This last question is of particular relevance due to the current push by the national and international conservation lobby to expand the country's National Protected Area System (SINAP) (Mittermeier et al., 2005; Nagal Egea, 2003).

While not a primary objective, the main findings of the paper also form the beginnings of a conceptual framework that could help guide future research looking at many of these issues in greater detail.

2 Country and regional context

Mexico straddles two of the world's major biogeographic regions and it is this factor, combined with a varied topography, that has led the country to exhibit very high species diversity, high genetic diversity and very high endemism for certain taxonomic groups (Ceballos et al., 2002; Mittermeier et al., 2005). Six major areas of natural habitat can be identified which are classified principally by temperature and humidity:

- tropical rainforest
- tropical dry forest
- cloud forest
- temperate pine-oak forest
- deserts
- grasslands.

The National Protected Area System (SINAP) is the main policy instrument charged with meeting conservation goals in Mexico (Conanp, 2008). The SINAP currently includes 161 protected areas, split into six different categories according to size, type and level of protection:

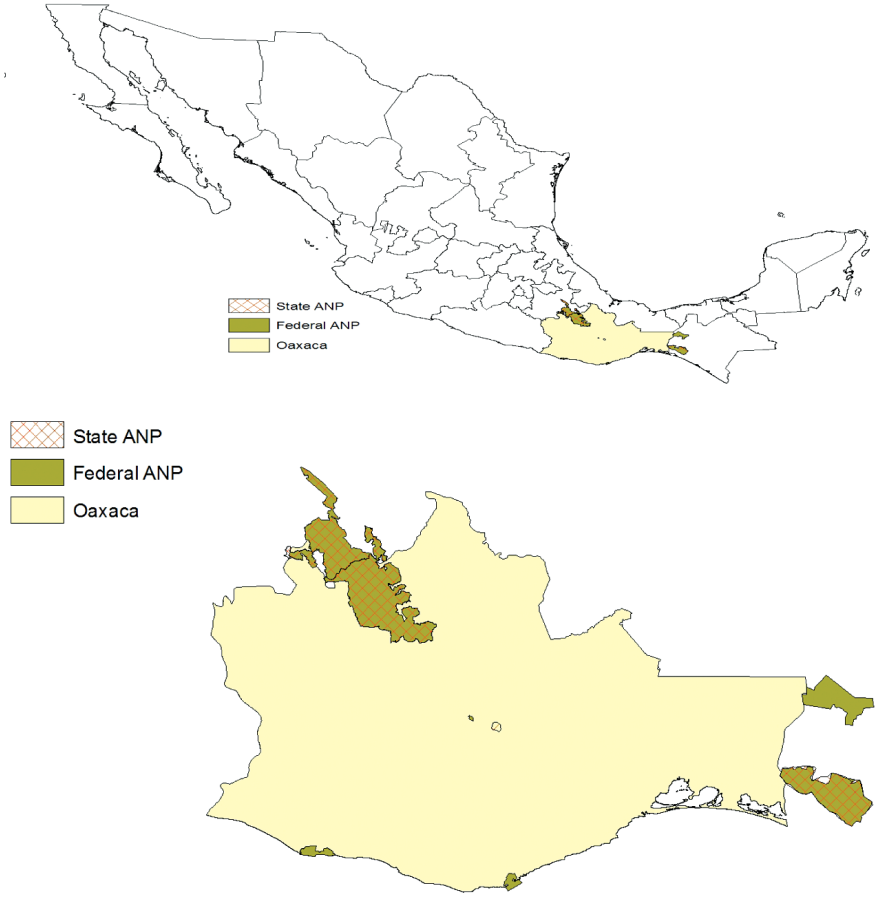
- biosphere reserves
- national parks
- natural monuments
- natural resource protection areas
- flora and fauna protection areas
- wildlife sanctuaries.

Together, these areas account for 196,437.5 km^2 or 11.56% of national territory (Conanp, 2008).

The SINAP, however, is not distributed evenly across the country. Oaxaca, in southern Mexico, offers a prime example. Figure 1 shows that, while PAs in Oaxaca cover approximately 12% of state territory, most of this (11.3%) is taken up by the large Tehuacán-Cuicatlán Biosphere Reserve in the state's northwest. Combined, the other three national parks comprise only 0.3% of the remaining territory (Illoldi-Rangel et al., 2006). Despite poor PA coverage, Oaxaca is home to some of the country's most biologically diverse areas of tropical and temperate forest (Challenger, 1998). The state's Sierra Norte (Northern Sierra) and Sierra Sur (Southern Sierra) regions are of particular ecological importance. The Sierra Norte, which marks the point where the eastern and western Sierra Madre mountain chains meet, forms part of the Madrean Woodland Biodiversity Hotspot (Conservation International, 2008), an ecoregion where both pine and oak reach their highest global diversity (Mittermeier et al., 2005). The temperate and tropical forests of the Sierra Sur, meanwhile, are home to a unique assemblage of species, many of them endemic (Challenger, 1998).

These same areas exhibit an important human presence. Indeed, it is estimated that up to 80% of Oaxaca's forests and so the vast majority of its biodiversity, is under the management and control of approximately 1400 indigenous communities and ejidos[1] (Moguel and Toledo, 1999; Sarukhan and Larson, 2001). Although exact data are difficult to come by, the majority (more than 75%) of these 1400 local communities are indigenous communities, with far fewer (less than 25%) *ejidos* of mixed ethnic background (Atlas Agrario del Estado de Oaxaca, 2002).

Figure 1 Location and extension of natural protected areas (ANPs) in the state of Oaxaca, in southern Mexico (source: Bezaury-Creel et al., 2007; Conanp-Conabio, 2005)



3 Land use strategies in rural Oaxaca

Although Oaxaca is famed for its rich biodiversity, it is not clear the degree to which this is tied to local communities' resource management and conservation strategies. While a growing body of work has documented the wealth of dynamic and innovative local practices and institutions found in the region (Alcorn and Toledo, 1998; Chapela, 2005; Merino Pérez, 2004), there has been little attempt to draw these findings together to look at how community land-use systems may function as a catalytic force for the conservation and sustainable use of local biodiversity.

In response to this, the current paper looks at the respective roles that play in local conservation in Oaxaca:

- multi-functional land use
- environmental practices
- institutional arrangements.

While using examples from other parts of Mexico, much of the discussion is informed by two Oaxacan community-based land-use experiments. The first is the *Union de Comunidades Zapoteco-Chinanteca* (UZACHI), an organisation of three Zapotec communities and one Chinantec community located in the Sierra Norte. The second is the *Sistema Comunitario para la Biodiversidad* (SICOBI), the joint work of five indigenous communities from the Sierra Sur and a local environmental NGO – *Grupo Autónomo para la Investigación Ambiental* (GAIA A.C.). Both regional bodies were created to support community forest management strategies and face problems collectively.

Table 1 provides summary information for these two inter-community organisations. Table 2 provides the latest species data[2] collected from the geographical localities that correspond to UZACHI and SICOBI community territories. These communities' forests are particularly rich in angiosperms, mammals, reptiles, amphibians and fish. A relatively high number of species from these groups are either endangered or endemic.

Table 1 Summary information on UZACHI and SICOBI community-based land use strategies

Community organisation	*Location*	*Forest type*	*Land-use/env. practices*
UZACHI	Sierra Norte, Northern Oaxaca	Pine-oak forest, cloud forest	Forestry, mushrooms, medicinal plants, maize
SICOBI	Sierra Sur, Southern Oaxaca	Pine-oak forest, tropical humid forest, tropical dry forest	Forestry, shade coffee, native gardens, beans, maize

Table 2 Species data collected from UZACHI and SICOBI community territories

Taxonomic group	*Individuals recorded*	*Species recorded*	*Infra-species*	*Endangered species*	*Endemic species*
Alga	147	53	5	0	0
Angiosperms	4848	1731	130	38	8
Arthropods	6350	799	371	2	0
Birds	8	3	2	1	1
Crustaceans	263	87	4	1	0
Gymnosperms	23	9	5	4	0
Reptiles and amphibians	442	150	47	62	45
Fungus	16	10	0	0	0
Mammals	3023	118	96	20	7
Invertebrates	27	12	2	0	0
Fish	43	27	0	1	1
Ferns	349	170	5	12	0

Source: Conabio, (2007).

3.1 Multi-functional land use

Across upland areas, a complexity of site factors such as altitude, slope direction, soil type, temperature and rainfall are all driving forces behind the traditional diversification of agricultural and resource practices. From the Andes to the Himalayas, this has often resulted in an organically interlinked system of land-based activities based on farming, forestry and animal husbandry (Bebbington, 1990; Stevens, 1993). In Oaxaca, it is a similar variation in environmental conditions that has impeded the use of a single model to manage the land. Instead, through what Chapela (2005) terms 'cultural evolution', communities have developed a set of techniques and practices to adapt to such diversity. This involves multi-crop production for subsistence, pasturelands for grazing, forestlands dedicated to logging (of differing intensities), the protection of ecosystem services, wildlife refuges and the harvesting of non-timber forest products (NTFPs). In maintaining the social, cultural and ecological elements of a community's territory, these systems have been referred to as 'multi-functional, cultural landscapes' (Berkes and Davidson-Hunt, 2006).

Chapela (2005) describes how multi-functional land use planning has led to the integrated management of nearly 29,000 hectares of territory among the four UZACHI communities. This area is large enough to talk about management at a regional scale and covers habitat for viable populations of both flora and fauna. Chapela (2005) contends that, without this system of communal management, it is likely that the forest would have become fragmented among the 1000 families that make up the UZACHI communities. Instead, there are forest areas that extend for more than 12 kilometres without interruption.

A similar pattern can be found among the SICOBI communities, whose combined territory covers 78,000 hectares and is home to approximately 23,000 people. Territorial planning here has been conditioned by the region's large altitudinal range and diverse vegetation and soil types. Land-use plans combine agroforestry, coffee cultivation, subsistence agriculture, biodiversity protection, forest restoration and community-based forestry. Community forestry areas are found in the higher, temperate forests, while shade coffee is cultivated at lower altitudes, where high-biodiversity tropical forests are found. At the lowest altitudes, close to the coast, dry tropical forest is found. This area covers some 20,000 hectares and consists of a mosaic of land uses: subsistence agriculture (corn and beans) mixed with shrubby forest and urban settlements.

3.2 Environmental practices

Multifunctional landscapes, such as those described above, typically employ a diversity of resource and environmental practices. These can range from the use of small-scale disturbances, such as fire, through to biodiversity-friendly agricultural and forestry systems and the harvesting of non-timber forest products (NTFPs). It has been argued that such practices can create new habitats, maintain patterns of resource use and facilitate the continued renewal of ecosystems (Berkes and Davidson-Hunt, 2006).

SICOBI's agroforestry programme, which began in 2001, includes more than 350 producers from the Huatulco-Copalita watershed and covers some 2000 hectares. Agroforestry, which involves the integration of trees and other large woody perennials into farming systems, is a natural resource management practice that looks to increase social, economic and environmental benefits while influencing microclimate, matter and energy

cycles and biotic processes (ICRAF, 2000). In SICOBI, it is coffee (a shade-tolerant crop) that has been established under an open canopy of remnant trees to form an agroforest.

As well as agroforestry, other practices used by indigenous groups in Mexico have been shown to contribute to ecological functioning and biodiversity in managed landscapes. In the Sierra Tarahumara, in the State of Chihuahua, the Rarámuri people use fire to open up aging oak groves for ecological succession (Davidson-Hunt and Berkes, 2003b). In the Yucatan Peninsula, the Maya have a tremendous wealth of knowledge about their biotic environment and their ability to manage resources, collectively, over the long term. Beekeeping, for example, has a long and rich tradition (Faust, 2001), which requires the presence of a large variety of native trees, shrubs and liana species to provide a long flowering period. In this way, honey production has helped to conserve local plant diversity and the continued provision of important ecosystem services. These are examples of what McNeely and Scherr (2003, p.91) refer to as land-use practices managed for both "agricultural and resource production and the conservation of wild biodiversity".

Returning to Oaxaca, UZACHI provides an interesting case involving a non-timber forest product (NTFP). With technical assistance from an Oaxacan NGO[3], UZACHI began a project to safeguard and utilise local knowledge of wild mushroom ecology and uses. As a result, a number of mushroom harvesting and cultivation initiatives began in the region and wild mushrooms are now commonplace in local marketplaces. Forest areas not used for logging have now gained new economic, cultural and conservation value as wild mushroom production areas (Chapela, 2005).

The above example highlights how important local ecological knowledge is in promoting sustainable resource practice. Through the identification of community members as carriers of critical social memory about resource and ecosystem dynamics, an important environmental practice was able to re-emerge. Knowledge alone, however, is not sufficient to build such adaptive capacity; the right social and institutional framework also needs to be in place for it to develop.

3.3 Institutional arrangements

Institutions are the formal rules and informal norms that help to shape and govern human interaction and behaviour by defining the set of choices available to groups or individuals (North, 1990). Institutions help to reduce uncertainty by providing a structure or framework to any social, political, environmental or economic activity. Only recently have institutions come to be recognised as important for biodiversity conservation and management (Berkes, 2004; O'Riordan and Stoll-Kleeman, 2002).

Institutions can be split into local-level institutions that govern the internal workings and activities of the community and cross-level institutions that connect the community to the government, external actors and the outside world (Young, 2002). Local-level institutions determine when, how and where resources are used and who uses them. At the household level, these may take the form of informal rules to determine crop and livestock selection and the timing of agricultural activities and NTFP extraction, while at the user group and community level, it is typically a mix of formal and informal institutions that govern the management and use of the community's territory and forest resources. Additional rules are required to ensure compliance (Ostrom, 1990).

Local environmental knowledge and cultural values provide the basis for the development of many of these rules, while it is generally through the participation of

community members that rules are accepted and management responsibilities defined. When rules are not in place and collective action is not possible, conventional resource theory dictates that an open-access regime ensues, with the resource quickly depleted (after Hardin, 1968). There is strong evidence to suggest that community-based conservation depends on how these institutions are established, monitored and enforced (Agrawal, 2001; Berkes, 2004; Merino Pérez, 2004).

In Mexico, communal land property systems dominate the rural landscape, with agrarian (indigenous) communities and *ejidos* being the two models of communal organisation in existence. Through extensive work in central and southern regions of Mexico, Merino Pérez (2004) has shown that successful cases of community-based forest management have been dependent on the following institutional arrangements:

- the participation of resource users in the formulation of rules that regulate use
- the participative monitoring of forest conditions
- transparency in resource management decision-making
- spaces for discussing and resolving problems (conflict resolution)
- strong social capital within the community and past experience and knowledge (social memory).

In Oaxaca, such arrangements are exhibited by many of the indigenous communities that dominate the state's forest landscape, including the member villages of UZACHI and SICOBI (Chapela, 2005; Merino Pérez, 2004).

The paper now moves on to discuss how these communities' multi-functional resource strategies, including the role played by local institutions and systems of governance, may help to maintain and even enhance forest biodiversity.

4 Discussion

4.1 Multi-functional land use and biodiversity conservation

As Ryszkowski (2002) explains, with increasing recognition of a landscape's basic processes, such as energy fluxes, organic matter cycling and other mechanisms, there is a growing conviction that it is the way in which natural resources are used, not the fact that they are used, that leads to either their degradation or protection. From a conservation perspective, this suggests that all areas of the landscape should be considered important for the potential role they play in maintaining biodiversity.

In Oaxaca, high biodiversity is found within working landscapes that integrate logging, agricultural and conservation areas. In the case of UZACHI and SICOBI, territorial planning is based on a mix of land uses and practices to form dynamic, *multi-functional* resource systems. Multifunctionality is an emerging concept in the landscape sciences and concerns how the physical, chemical and biological processes that form the natural basis for landscape function are interwoven with the economic, social, cultural and political spheres of human activities (Brandt and Vejre, 2004).

By focusing on all aspects of the landscape, including those areas under intensive management and use by local people, the multifunctional approach differs from other,

more established landscape ecology models. Land use strategies in Oaxaca, for example, tend to fit poorly with the models proposed by Forman (1995) and MacArthur and Wilson (1967). MacArthur and Wilson's theory of 'island biogeography', in which a lot of landscape ecology thinking is rooted, is based on the notion that the area in between patches of habitat (the 'matrix') is totally unsuitable for resident biota. Forman's more recent 'patch-corridor-matrix' model, which does consider the matrix a functional component of the larger landscape, still obscures the richness of these areas, which themselves are a source of different patch types and land uses. A number of ecologists have suggested that a 'mosaic' landscape model is a better way of describing the contemporary resource systems found in most tropical countries, including Mexico (Gutzwiller, 2002; Wiens and Moss, 2005).

Berkes and Davidson-Hunt (2006) argue that the practices taking place within these mosaic landscapes can help conserve biodiversity via four main mechanisms:

- the maintenance of successional stages
- the creation of patches and gaps
- the creation of edges
- the conservation and enhancement of vertical diversity.

Recent empirical work on resource systems that are managed to increase food production and farmer incomes and conserve biodiversity and other ecosystem services supports this view. In Asia, research has shown the biodiversity benefits of systems that 'mimic' the structure of natural forest ecosystems. Millions of hectares of multi-strata agroforests in Indonesia produce commercial rubber, fruits, spices and timber, often in a mosaic with rice fields and rice fallows (Leakey, 1999). The number of wild plant and animal species in these agroforests are often nearly as high as in natural forest (Schroth et al., 2004). Similar findings have been made in the Western Ghats, India, where the diversity of trees, birds and macro fungi is as high in managed landscapes as it is in formal protected areas (Bhagwat et al., 2005). In Mexico, the Lacandon Maya practice a form of agroforestry that maintains soil fertility and reduces deforestation by improving fallow in agricultural areas (Diemont et al., 2006). In Veracruz, studies have highlighted the biodiversity benefits of shaded coffee plantations. Solis-Montero et al. (2005) show that plantations with high levels of structural diversity provide refuge for forest-dependent biota such as birds and insects. Pineda et al. (2005) found similar results for frogs, bats and beetles.

For the UZACHI and SICOBI communities, a mix of land use strategies and environmental practices can be identified. These range from logging for both commercial and domestic end-uses, to the harvesting of NTFPs and medicinal plants, through to agricultural systems for shade coffee, native gardens and *milpa* (where maize, beans and squash are grown together). Forestry, in particular, is an increasingly important land use in these areas. Timber management practices, however, are not normally considered compatible with a functional level of biodiversity. While this is often the case, it is also true that disturbances, including logging, can produce a shifting mosaic of successional habitats that has spatial and temporal dynamics to which ecological communities respond (Schroth et al., 2005). UZACHI has incorporated this line of thinking into its forest management plan and cutting cycles (Chapela, 2005). Indeed, the UZACHI communities have modified their forest management to move away from the single species focus

favoured by previous logging operations, to an ecosystem approach that seeks to protect natural forest processes and functions. This shift appears to have had a positive effect, with forest area in 2000 greater than it was in the early 1980s and increased forest biomass volumes recorded in the communities of Capulalpam de Mendez and La Trinidad (CCMSS, 2002).

Despite improvements in forest management, it is less clear how other aspects of communities' multifunctional land use systems may be affecting biodiversity, both at a local and a regional scale. This lack of knowledge and certainty has led to some confusion with regards to the perceived and actual conservation value of these areas.

4.1.1 The scientific challenge

Many of the above studies, from both Mexico and further a field, suggest that agroecosystems and ecologically-sensitive forest management can help to connect natural habitat fragments with other landscape habitats and, thus, represent a functional resource for biodiversity that serves as a complement to natural ecosystems in a modified mosaic landscape. Such thinking has led McNeely and Scherr (2003) to argue that mosaic, multifunctional land use systems should be given a far more prominent role to play in biodiversity conservation efforts.

Yet the positive biodiversity impacts of UZACHI's and SICOBI's land use systems and practices still tend to be largely assumed rather than substantiated through empirical study. For example, there is a lack of data to justify claims that SICOBI's shade coffee system and native gardens are good for local biodiversity. Although work has shown that coffee-based agroforestry systems can be beneficial for species diversity among certain taxonomic groups (Perfecto and Vandermeer, 2002; Pineda et al., 2005; Solis-Montero et al., 2005), it is also clear that not all shade-coffee plantations include much planned diversity (Potvin et al., 2005). In many cases, coffee agroecosystems essentially consist of just one crop and a single shade tree species (Schroth et al. 2005).

More work is, therefore, needed to determine how the spatial configuration and functional dynamics of these landscape mosaics in Oaxaca influence species predation, dispersal, population dynamics, nutrient distribution or disturbance spread, among other factors. No matter the type of landscape model followed, conservation still requires that landscapes provide the right habitat quality, amount and configuration for species persistence over the long-term. This is why Sarukhan and Larson (2001) noted that communal land use systems in Mexico do not constitute, by themselves, a model of rational and ecologically-sound resource use. Only through a much better understanding of the composition (elements and patches that make up the mosaic), structure (physical configuration) and processes (flows of materials, organisms and disturbances through the mosaic) of these land use systems can we move beyond making recommendations based on assumption rather than empirical truth.

4.2 The role of local institutions and governance

Institutions play a critical mediating role in facilitating the interactions between people and natural resources. In such an environment, the formal and informal rules and the type and effectiveness of enforcement will determine the form of interaction occurring between the social and ecological components of the land use system and lead to the sustainability or unsustainability of any given management practice. Scholars now largely agree on the

set of institutional variables that enhance the likelihood of resource users organising themselves to avoid the losses associated with open-access resources (Baland and Platteau, 1996; Ostrom, 1990, 2005). This body of work provides some of the best arguments in favour of local resource management and shows how communities can craft viable forms of 'environmental government' (Agrawal, 2005).

In Oaxaca, forest communities have designed and maintained complex sets of social institutions to govern the use and management of their common-pool resources (CPRs) (Chapela, 2005; Merino Pérez, 2004). Among the UZACHI and SICOBI communities, local institutional arrangements meet a number of the criteria laid out as being important for resource conservation:

- local officials are elected
- communities can self-evaluate their actions
- member communities are able to network with each other
- communities have appropriate institutions to manage and regulate natural resource use
- community institutions are recognised and authorised by the municipal, regional and national authorities.

Such context-specific arrangements take their place alongside the presence of other, more general institutional arrangements identified by Merino Pérez (2004) and previously mentioned in this paper.

Many of these institutions are supportive of system resilience through the development of locally adapted management practices, which are based on ecological knowledge and understanding. As Davidson-Hunt and Berkes (2003b) explain, the concept of resilience places the focus firmly on processes and so shifts the analysis from simple models of cause and effect to complex systems and nonlinear relationships. While some institutions may appear stable over a long period, by changing the scale of analysis, specific rules may have altered considerably during a single season. From Merino Pérez's work in Oaxaca, this seems true of a number of communities and supports the view that local-level institutions are often capable of responding to environmental feedback faster than centralized agencies (Merino Pérez, 2004). As Ostrom (2005) has noted, such organisational and institutional flexibility is important as it helps individuals to learn from their experiences to build knowledge and skills, modify existing or construct new institutions.

In Oaxaca, the governance structure within which these institutions are embedded is especially important. Governance provides the conditions that allow for ordered rule and collective action, including how decisions are made and power is shared. In the Sierra Norte and Sierra Sur, governance revolves around family, community and regional organisations, forming a system in which these three levels of organisation mutually depend upon each other in what may be thought of as 'circles of interdependence' (Chapela, 2005). This provides an example of good institutional fit, where institutions are created at levels appropriate to the different ecological scales to which they correspond (Folke et al., 1997).

In addition, there are a couple of features that distinguish communities in Oaxaca from those in other parts of the country. Firstly, most municipalities are relatively small, often consisting of just one or two localities/communities. While this so-called

mini-municipalismo can cause problems for state and federal administration, in terms of local governance it does allow for an important closeness to form between civil government and the local population. This has been identified as an aid to communal resource management among the UZACHI communities in particular (Chapela, 2005; Merino Pérez, 2004). Secondly, the majority of municipalities and communities (73% according to Velásquez (2000)) are governed under a traditional system known as *usos and costumbres* (uses and customs), which is legally recognised under the 'Rights of the Indigenous Peoples and Communities of the State of Oaxaca' (a law brought into force in 1998). This system considers the assemblies (municipal and communal) as holding the maximum authority within their jurisdiction. Elected posts are accountable to the assembly rather than state or federal government and the assemblies are free to devise and approve norms to govern life in these small municipalities, including activities related to the use and conservation of common resources.

These systems exhibit many of the characteristics of 'polycentric governance' (Ostrom, 2005), where each decision-making unit has considerable autonomy to experiment with rules for using a particular resource. In experimenting with rule combinations, users have access to local knowledge, obtain rapid feedback from their own policy changes and can learn from the experience of other units.

4.3 Drivers of change and future challenges

Discussions so far have suggested that it is a model based on multi-functional land use, community ownership, flexible and appropriate institutional arrangements and high levels of social organisation that has led to successful forest conservation in biodiversity-rich areas of Oaxaca. However, a question mark remains as to how these experiences are being challenged and affected by external pressures that can alter the social, political, cultural and economic context within which communities are situated or embedded (after McCay, 2002).

A quick look at the history of forest use in Oaxaca shows how both state and federal governments have frequently intervened in resource matters through participation in logging activities, the concession of forest user rights and the implementation of externally-driven conservation policies. While communities in Oaxaca retain an important degree of control over management decisions, the federal government can still exercise substantial control over local forest resources (Merino Pérez and Segura-Warnholtz, 2005). Ostrom and Schlager (1996) have stated that rights may not be effective without power. What this essentially means is that people cannot exercise their rights without political power and institutions can only succeed when given the political space to do so (Agrawal, 2001). In the Sierra Norte of Oaxaca, *mini-municipalismo* and a governance system based on the traditional system of *usos y costumbres* provides local communities with real political capital. However, can these local systems of governance survive in an increasingly changing world?

At the local level, there are clearly sources of tension created by the institutional system employed in rural Oaxaca. In particular, conflicts between the obligations of the communal governance system and the private needs and interests of community members have been reported (Merino Pérez, 2004). These may be exacerbated by some of the changes that communities across the region are currently experiencing. In particular, demographic and cultural change through out-migration has been poorly studied in terms

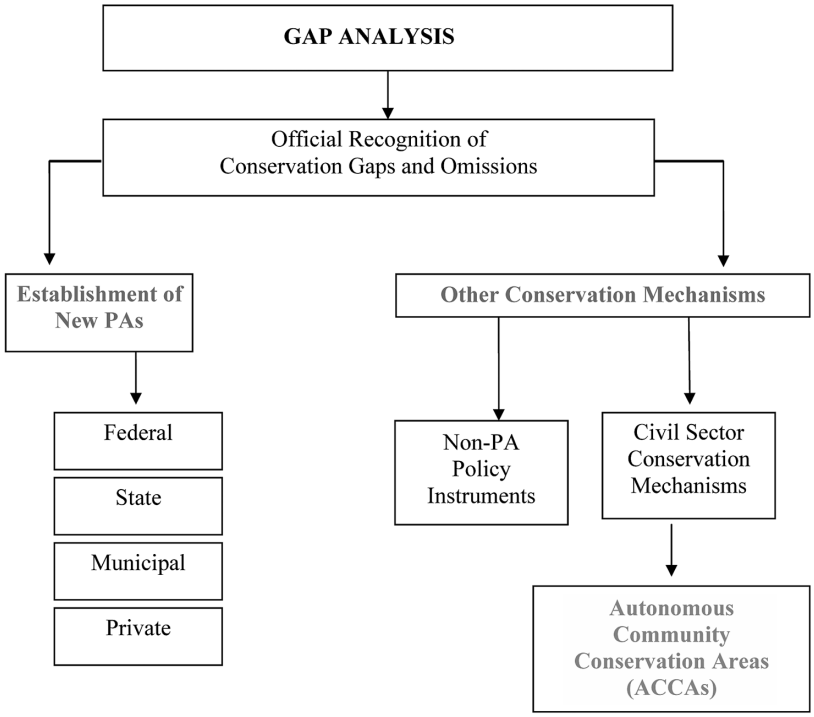
of the impacts it may have on resource management institutions and practices, through lowering participation, a changing community demographic and the emergence of new cultural attitudes.

How communities are responding and adapting to change and external stress is clearly an important research area and one that needs to be looked at in much greater detail if local land use systems are to be promoted for biodiversity conservation.

5 Lessons and implications for Mexican conservation policy

In compliance with its commitments to the Convention on Biological Diversity (CBD), the National Commission for the Use and Knowledge of Biodiversity (CONABIO) and the National Commission for Protected Areas (CONANP) have coordinated a 'Gap Analysis'[4] of Mexico. The purpose of this work has been to identify priority ecoregions and key sites to identify 'gaps' in the existing national protected area system. Most of the field studies and data analysis have now been completed and preliminary results are emerging (Patricia Koleff, personal communication, April 2007). What are some of the likely consequences of this work? Of most relevance to this paper, Figure 2 provides a simplified flow diagram showing the major policy options likely to come out of the Gap Analysis process. In particular, the identification of gaps in the SINAP may well lead to calls for the establishment of a new generation of parks and reserves.

Figure 2 Mexican gap analysis project: policy implications



Source: modified from Conabio (2007)

Although formal, government-run PAs will remain a fundamental component of conservation policy in Mexico, it is doubtful whether they are sufficient to meet key conservation goals (i.e. a representative national PA system) and the current biodiversity crisis on their own. Many are already islands within a sea of other land uses. It has been calculated that 30–50% of species may be lost worldwide because isolated PAs do not contain large enough populations to remain viable (McNeely and Scherr, 2003). While the kind of 'systematic planning' (after Margules and Pressey, 2000) being undertaken at present is an excellent way of targeting areas for policy, conservation goals are complicated by the realities of limited government funding, community rights, politics and the amount and spatial extent of remaining habitat. Given that the greater part of its forests and, thus, terrestrial biodiversity, is found in areas of agrarian community and *ejido* land tenure systems, conservation planning in Mexico must look for alternatives to the PA model.

Oaxaca provides an excellent example of this conservation dilemma. While the National Protected Area System (SINAP) claims that 12% of Oaxaca is (officially) protected, it is clear that a far greater proportion of the state's territory is home to large contingent blocks of well-conserved temperate and tropical forests. The majority of these forests, along with all the plant and animal species for which they provide habitat, are community-owned and form part of working, productive landscapes. How can these landscapes figure as part of national conservation planning, despite their location outside the current federal protected area system? To legally recognise 'autonomous community conservation areas' (ACCAs) as contributing to biodiversity protection will be enormously challenging.

First and foremost, there is the philosophical challenge of integrating arenas of resource management – biodiversity conservation, forestry and agriculture – that have traditionally held very different agendas. Biodiversity protection based on a multifunctional landscape model would require a new set of perspectives to emerge from within the ecological and conservation sciences (Berkes, 2004; Robinson, 2006). In particular, managed landscapes would have to be re-conceptualised as systems that can provide key ecosystem services and act as potential habitat for both flora and fauna species. With so much evidence pointing to the vulnerability of biodiversity to agricultural expansion and intensification, this will be a major undertaking. Despite a large number of species residing in or being affected by managed landscapes, most conservationists still pay little attention to the interface between natural and productive systems.

Secondly, to have a more meaningful impact on biodiversity conservation at a national or regional scale, this landscape model would need to be replicated and promoted across larger areas. Policies would have to be modified to encourage these new approaches and it is questionable whether such changes are feasible. While this paper has provided examples of small- to medium-scale agroecosystems and managed forest landscapes that appear beneficial to biodiversity and ecological integrity, it is not clear if such systems could be easily replicated in other settings. Scaling-up would not only require neighbouring communities to adopt and adapt practices that are compatible with the conservation of biodiversity but also fitting and cumulating these operations into larger spatial units so that more biodiversity is conserved.

Thirdly, for grassroots conservation to work, the rights and local governance systems of communities would have to be fully recognised and supported. Institutions, in particular, are key since they intertwine with the multifunctional land use model to play a

fundamental role in regulating resource practice and, thereby, act as critical capital for securing conservation in populated, rural settings. In a study of thirteen developing countries, Hayes (2006) found that, rather than official designation of protection, it is the rules adopted by local people that most influence forest protection. Where appropriate, conservation policy would need to empower local institutions for natural resource management and conservation. It would need to recognise that, contrary to the assumptions of many conservationists, local resource users are able to craft institutions appropriate to the environment and encourage sustainable resource use that integrates ecosystem management with human well being.

Despite these difficulties and potential pitfalls, the promotion of local strategies does offer Mexican conservation planners an important opportunity to safeguard areas of high biodiversity value – especially in regions of the country where the establishment of new PAs may prove politically, socially and financially unworkable. From a research perspective, what is called for is the development of a coherent conceptual framework to better understand the conservation value of local land use systems, to help determine what works and how and then to discuss how well such a model could function in different settings and contexts. While this paper does not explicitly provide such a framework, it does form the beginnings of one.

6 Conclusion

Tilman (2000) has argued that any future for biodiversity will be the outcome of human choice. His message is that biodiversity can be created as much as it is destroyed by the correct application of knowledge and management. As this paper has shown, in some areas of Oaxaca, biodiversity is being maintained within working, productive landscapes. This finding sits uneasily with the preservationist view that agriculture, forestry and other forms of resource use leads to the degradation or destruction of natural landscapes and the loss of biodiversity (Gutzwiller, 2002; Wiens, 2002).

While PAs in Mexico are important and may need to be expanded, they will only be successful if surrounded by production systems of high environmental value. One essential strategy will be to convert resource management systems that are destructive of biodiversity into more ecologically friendly versions. UZACHI and SICOBI in Oaxaca are examples of land-use systems managed to produce food, timber and other resources while protecting biodiversity and other critical ecosystem services. Although rural communities can be one of the main threats to biodiversity, through integrated resource management and multifunctional land use, there are communities in Mexico that are contributing to biodiversity conservation over the long term. Conservation policy needs to better reflect this reality.

In this sense, the country finds itself at a crossroads. The recent emergence of community-based strategies as an alternative conservation mechanism is an important step in the right direction. This changing attitude is reflected in the recent creation of government programmes such as COINBIO, MIE and the *Corredor Mesoamericano*[5], which are all working with communities towards promoting local conservation efforts. However, despite a number of successes, these programmes are working in different regions of the country and each doing so under a different set of objectives and priorities. Whilst some focus on social development, others are strongly conservationist in tone. Currently, a lack of integration and synergy exists between them. In addition, these are not

'autonomous' community conservation initiatives but rather co-management programmes where participating government agencies maintain an important say and degree of control.

This paper has argued for a different approach, one where communities are recognised for their conservation value as self-governed units, without the need for external government intervention. Among forest communities in the Sierra Norte and Sierra Sur regions of Oaxaca, conservation gains appear to be based upon the existence of a multifunctional land use strategy that combines areas of resource production and protection with ecologically friendly practices, a strong cultural base and high levels of social organisation. However, while a mosaic landscape structure, the adoption of certain resource practices and good forest management may be key factors counteracting biodiversity decline in some areas, there is a lack of empirical data to fully support this claim.

A 'science' of biodiversity in multi-functional landscapes is therefore needed to test this hypothesis. This will need to include studies that look at the composition, structure and processes of contemporary mosaic landscapes and shed light on the actual potential of forestry and other practices to increase the conservation value of habitat fragments. In addition to more ecologically based studies, any future research agenda must also investigate the social, cultural and political aspects of these systems, with a particular focus on how key local institutions are responding to changing realities as communities are touched by globalisation and further integration into mainstream Mexican society. At the same time, government needs to show greater support, with the adoption of agricultural and environmental policies at state and federal levels that aid rather than hinder local resource planning and governance.

It is only through such an enabling political, institutional and scientific context that sustainable community landscapes can be promoted as an integral component of future conservation policy in Mexico.

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Notes

[1] In Oaxaca, the vast majority of forest communities are agrarian (indigenous) communities, with a much smaller number of 'mestizo' or mixed origin *ejidos*. Agrarian communities refer to the ancestral territories of indigenous groups or other peasant communities that pre-date the Mexican Revolution. As part of the agrarian reform process, the Mexican government restored to these communities lands that had been dispossessed during the colonial period. Formally guaranteed in Article 27 of the 1917 Constitution, *ejidos* form a system of inheritable communal lands assigned by the federal government to landless campesinos of varying ethnicities.

[2] Data was provided by CONABIO's National Biodiversity Information System (SNIB). The National Commission for the Knowledge and Use of Biodiversity (CONABIO) is an inter-ministerial agency of the Government of Mexico.

[3] *Estudios Rurales y Asesoría Campesina* (ERA) is an Oaxacan-based NGO that provides technical support to rural communities in order to promote sustainable natural resource management across the region.

[4] *Gap analysis* is a scientific means for assessing the extent to which native animal and plant species are being protected and is carried out at a local, regional or national level. The goal is to identify those species and plant communities that are not adequately represented on existing conservation lands. In this way it provides policy makers with information to help identify future priority areas for conservation (www.gapanalysis.nbii.gov).

[5] COINBIO (Biodiversity Conservation by Indigenous Groups and Communities) is a programme of the National Forestry Commission (CONAFOR). MIE (Integrated Ecosystem Management) is a programme of the UNDP in Mexico. The 'Corredor Mesoamericano' (Mesoamerican Corridor) is a programme of the National Commission for the Use and Knowledge of Biodiversity (CONABIO).