

Interactions between community traditions and geospatial technology in natural resource management: case studies from common property regimes in rural southern Mexico

Jose Manuel Canto-Vergara

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Abstract

Issues related to improving community participation and the effectiveness of green economy instruments are central to current debates regarding progress towards sustainable development. Information technology, such as Geographic Information Systems, may be able to play an important role in addressing these challenges. In this study an experiment with introducing geospatial technology was conducted with four rural communities at different levels of engagement with institutional frameworks of payments for ecosystem services in Chiapas, Mexico. The purpose was to examine the impacts of such an intervention and evaluate whether it had the potential to enhance collective understanding of natural resource management practices, lead to better shared decisions and enhance community social capital. By exploring the outcomes it was also possible to assess the conditions that enable or constrain such implementation processes. Five key themes (i.e. social structure, IT skills, participation in development, external relations and power structures) were identified in an evaluation framework informed by actor-network theory concepts, and these guided the collection of evidence and data analysis. The results indicated that all of these factors had some influence over the success of geospatial technology analysis transfer, with community political decision-making processes and previous involvement of external agents in local natural resource management activities being of particular importance.

I would like to dedicate this thesis to my beloved parents, Rita Vergara and Manuel Canto

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1. INTRODUCTION

1.1 Sustainability in the 21st century

There is a growing consensus that sustainable development must be achieved at the local level if it is ever to succeed on a global basis. The meaning of the sustainability paradigm has been updated and adapted because of social and technological change. It has evolved from an ambiguous vision of not compromising the abilities of future generations to meet their needs (United Nations, 1986); to a focalised notion of livelihood improvement and the protection of the environment. However, lessons from implementing climate change adaptation strategies highlight the difficulties of achieving a more sustained world; poverty eradication being one of the pending challenges limiting sustainability in the 21st century (Toulmin and Lines, 2013).

In response to these challenges, interactions between nature, society, technology and the economy, have seen the founding of numerous international public-private partnerships. Integrating the environmental, economic and social agendas by combining green economy instruments of innovation and poverty eradication, with a growing citizen framework of people working for other people, has provided successful examples towards global sustainability. A distinctive element in contemporary international discourse is the issue of participation, as the involvement of civil society is conceived as having great potential to provide support for norms on sustainable development and environmental protection (United Nations Environment Programme, 2012).

Of particular interest is the involvement of local communities with profitable ecosystem services assets, seeking to benefit from interaction with international ecosystem services markets. Such schemes have been most successful when they have simultaneously created incentives for local communities to make management decisions consistent with the objectives of wider environmental and sustainability programmes (United Nations Environment Programme, 2012; Corbera and Schroeder, 2011; Phelps *et al.*, 2010; Moran, 2010).

Along with citizen participation in ecosystem services markets, it is necessary to enhance the technical capacities of local communities for them to capture the benefits of these initiatives. As a result, this thesis focuses on the need for better natural resource management and the potential role of technology. The ultimate goal is to contribute to a situation under which local communities are able to conduct their negotiations with public institutions and private organisations as well as coordinate and evaluate their own decisions (United Nations Environment Programme, 2012).

In this context, the role of geospatial technology (e.g. geographic information systems, GIS) and especially of Public Participation GIS (PPGIS), to support and inform local management decisions is of special interest given the spatial element of ecosystem services markets, and the traditional land management practises of local groups. Currently, the ecosystem services sector has a great demand for geo-referenced information and tools that facilitate making well informed decisions, assist in monitoring and reporting their direct results and indirect implications, and provide a strong basis for subsequent actions. However, the implementation of information technology and spatial analysis concepts has profound implications for people and communities everywhere, particularly for those individuals who are unlikely to have used them before (Ramasubramanian, 1999).

Although the adoption of geospatial technology is not meant to guarantee more just and equitable opportunities for local development, it is possible to contemplate the potential of these sorts of initiatives to focus on the socialisation of skills rather than just technology transfer. The challenge is to generate frameworks which contribute to the wider adoption of certain skills, which might also enable citizens to make more informed decisions (Wright *et al.*, 2009; Wood, 2005; Weiner and Harris, 2002; Jankowski and Nyerges, 2001).

1.2 Challenges in natural resource management

As a result of increased awareness on the value of nature to human activities, and social acknowledgement on the importance of their preservation to deal with environmental change, recent decades have witnessed major transformations in natural resource management activities. Wider understanding of natural resources pools, which have an often unaccounted economic value, have emphasised the need to revise natural resource management practices, regulate their exploitation, implement fair and equitable trading procedures and explore innovative instruments to profit from natural resource management under green schemes (World Bank, 2011; Newell and Bulkeley, 2010).

The goal of the Millennium Ecosystem Assessment was to establish the scientific basis for actions needed to enhance the contribution of ecosystems to well-being, without undermining their long-term productivity (Millennium Ecosystem Assessment, 2005). As recognition of the dynamic interaction between people and ecosystems, the report acknowledges the actions taken by local communities, NGOs, governments, business and industry, public and private bodies, to conserve biodiversity, mitigate its loss, and support its sustainable use.

The forest sector has been of significant interest in relation to the implementation of actions towards reduction of greenhouse gas emissions from deforestation and forest degradation. Evidence from forest management experiences shows that the process of influencing actors within the sustainable natural resources management sector is often the product of long trajectories and well established networks of collaboration (Innes, 2009; Schoeneberger, 2009; Bray *et al.*, 2006; Humphreys, 2006; Klooster, 2006; Cashore *et al.*, 2004).

Overall, it has been estimated that terrestrial ecosystems absorb approximately 60% of the carbon emitted to the atmosphere from human activities (United Nations Environment Programme, 2012; Kollmuss *et al.*, 2010; Sarukhan *et al.*, 2009), but the diversity of services provided by the forests on the planet (i.e., net primary production, forest products, livelihood provision and ecosystem services) also offer opportunities to tackle social issues and provide benefits to society (Schoeneberger, 2009; Shvidenko *et al.*, 2005).

In recent decades, use and administration of forest resources by local communities has received especial interest across intergovernmental partnerships of environmental governance (i.e., the United Nations programme on reducing emissions from deforestation and forest degradation in developing countries, REDD+). Among the incentive-based instruments within forest management are payments for ecosystem services, which pay forest landowners for providing carbon storage, watershed protection and biodiversity protection (Tacconi *et al.*, 2010; Schoeneberger, 2009).

Payments for ecosystem services, as a strategy for the integrated management of forests, land, water, and biodiversity, has the potential to promote conservation and sustainability in an equitable way. However, the possibility to capture global benefits and create redistribution mechanisms, which are able to compensate local communities and improve their livelihoods, remains as a challenge within current green forestry innovation mechanisms (United Nations Environment Programme, 2012).

Among the criticisms of natural resource management initiatives promoted by intergovernmental schemes such as payments for ecosystem services, are that such schemes interfere with control over local economic activities, limiting local governance autonomy due to contractual and financial constraints (Corbera and Schroeder, 2011; Corbera and Brown, 2010; Enciso, 2010; Goldtooth, 2010). Similarly, it has been reported that network cohesion can be limited when trade-offs between national, sub-national and local benefits emerge because the initiatives fail to address the structural causes of problems like poverty (Millennium Ecosystem Assessment, 2005).

Among the advantages reported with payments and markets for ecosystems services, evidence suggests that because of local governance structures, and local natural resource management practices, the loss of biodiversity has slowed while community-level benefit has become a central objective for sustainable natural resource management initiatives at local, regional and international scales (World Bank, 2011; Kolmuss *et al.*, 2010; Boege, 2009; Spaargaren *et al.*, 2009; Newton, 2007).

Evidence on the social and economic impacts of payments for ecosystem services suggests a varied situation. On the one hand, the extent to which the poorest groups participate in the schemes and the extent of livelihood benefits for those who do, has been reported as fairly positive (Engle *et al.*, 2008). However, non-financial long-term benefits such as capacity building activities, strengthening of land and resource tenure, and social cohesion resulting from payments for ecosystem services schemes depend on individual programme design and implementation (Tacconi *et al.*, 2010).

1.3 Research context and guiding premises

Among other natural resources, forests are of strategic importance for Mexico, both in relation to current green economy mechanisms to tackle global environmental issues, and to traditional land tenure systems, as part of the wider political and economic activities of rural landscape management. However, the absence of national public policies to strengthen social development, economic opportunities and environmental innovation, has deepened inequality and created difficult conditions in rural Mexico. As a result, extreme poverty has spread across the culturally rich and environmentally diverse rural territories in the country (Boege, 2009; Anta Fonseca *et al.*, 2006; Arreola, 2006; Chapela, 2006; Bojorquez-Tapia *et al.*, 2004; Klooster, 2003; Bray and Merino, 2002; Toledo *et al.*, 2001).

In my view, effective technological change can only be accomplished if accompanied by social capital assets. As a result, I suggest that local organisation schemes in rural Mexico offer an opportunity to explore and assess the implications of technological innovation for natural resource management in rural settings. In this context, if such forest resources and their legal owners are to be incorporated into national and international efforts to alleviate global environmental issues such as greenhouse gases emissions, as well as extreme poverty conditions, validated strategies are necessary to lead the successful implementation of such schemes.

As a result of the literature review, particularly of studies focusing on transferability of geographic information technology for natural resource management, I identified many studies reporting on single case studies (see Section 2.2.2); lacking an evaluation framework to assess and compare PPGIS and PGIS pilot initiatives. As a result this thesis aims to fill these knowledge gaps, by contributing to the development of an evaluative framework to document and assess PPGIS and PGIS pilot schemes in rural lower income settings.

The evaluation framework approach presented in this thesis proposes a categorisation of the main elements and interactions involved in these sort of initiatives, hence allowing a better understanding and comparison of the conditions that enable or constrain geographic information technology transfer. The latter may open opportunities to improve local capacities for natural resources governance, strengthening local governance for land management within social property regimes.

1.4 Aim and research goals

In order to exemplify and understand how nature, society, technology and the economy interact in a particular context, the overall aim of this investigation was to evaluate under what conditions local communities in southern rural Mexico could make effective use of geospatial technology for natural resource and land management.

The research goals of the investigation were therefore as follows:

- a) Identify key concepts and guiding principles from relevant literature, to focus on a series of conditions to set up comparative community case studies (see Chapter Two, Section 2.4 for the set of guiding questions resulting from the literature review).
- b) Document and present the social, political, economic and environmental conditions inherent to the context of intervention.
- c) Develop a research design to inform, implement, systematize and compare pilot experiences, based on significant thematic and analytic characteristics.

- d) Examine and compare the results derived from the processes studied during pilot implementations.
- e) Assess the enabling conditions across the community case studies to explain the findings in terms of factors influencing outcomes.
- f) Identify the preconditions of success for this sort of initiative in rural Mexico by answering the original guiding questions presented in Chapter Two, and discuss future research priorities.

As a consequence, this investigation developed a multi-case study approach to examine the impacts of such an intervention and evaluate whether it had the potential to enhance collective understanding of natural resource management practices, inform decision-making processes, lead to better shared decisions and enhance social capital within a wider rural sustainable development scope.

Results derived from this research can help us not only to explore and understand how, and in what situations geospatial technology can be successfully integrated in locally-based land-use planning initiatives for natural resource management, but also to identify effective implementation methods to suit local participation protocols in rural common property regimes. The following chapters on this thesis have been structured following the research goals logic.

1.5 Thesis structure

The thesis has been divided in eight chapters. This chapter has introduced the general context for the research, by presenting a scenario under which nature, society, technology and the economy, interact with green economy instruments aiming to share examples towards global sustainability. To conclude the initial Chapter, I presented a statement of aims and research goals.

Chapter Two introduces key concepts and sets the guiding principles for the empirical study. It begins with a review of planning frameworks and the evolution of citizen participation, focusing on environmental decision-making and the implications for contemporary natural resource management. In addition, the evolving role of GIS and associated technologies is discussed, introducing the concept of Public Participation GIS. A final section sets the discussion on the selection of key themes to design an evaluation framework informed by actor-network theory concepts.

The context of the study is presented in Chapter Three under four broad thematic strands: traditions and diversity within natural resources management; power relations in Mexico; local knowledge and the impact of land and resources tenure; and environmental NGOs and payments for ecosystem services. The chapter concludes with an explanation of the case study selection process and a description of the study areas, providing elements to explain a number of relations on the results.

Next, Chapter Four outlines the rationale behind the research design and describes the research process; providing details about implementation procedures, data collection techniques and qualitative analysis choices. The final section offers a reflection on the selected research approach and methodology.

A narrative of the events and outcomes in each community case study is presented in Chapter Five. This presentation is structured under a set of standard headings for each community. Subsequent discussion in Chapter Six uses the analytical categories of the evaluation framework to present a comparative exploration of findings across the case studies. This leads to a series of potential future scenarios for each community case study.

Chapter Seven elaborates on the discussion of the outcomes of the thesis and provides a comparison of findings with the evidence suggested by recent literature, while Chapter Eight presents the key conclusions by answering the original guiding questions and sharing some personal reflections derived from the study, particularly concerning the limitations and strengths of the investigation.

2. LITERATURE REVIEW

Chapter Two aims to examine the main concepts, issues and debates of relevance to this investigation, to provide the study's justification, and to set out the guiding principles for the empirical study. Section 2.1 provides an account of the recent history of planning frameworks, as well as the evolution of the concept of citizen participation, particularly regarding environmental decision-making and its connection to natural resource management approaches as part of the green economy discourse.

By examining concepts of GIS and Society, and the relationship between planning support systems and the development of Public Participation GIS, Section 2.2 explores the role that GIS and associated technologies can play within specific socio-cultural - including socio-political - conditions, as well as relationships and practices affecting the introduction of PPGIS as a tool for local natural resource management.

Finally, Section 2.3 outlines analytical techniques by reviewing ideas from recent literature on PPGIS methods, as well as a series of principles from actor-network theory to propose the basis of an evaluation framework that can inform the collection and analysis of evidence during the empirical stage of the investigation.

2.1 Planning frameworks and participation

The process of considering and discussing the available options to solve a problem, by those who share interests and responsibilities in a situation, and taking action towards its solution, is known as decision-making. The group of participants who are involved in a decision-making process can vary significantly, depending on the decision context, scale and resources allocated (i.e., time, information, money, technology).

The process of making decisions is based on available information and the knowledge of the decision-making group. If such information is evidence-based, and the knowledge is shared, then decisions tend to be more effective. Nevertheless, information is not constrained to those who have a stake in the process. Support for decision-making requires prior knowledge and understanding of problems, processes and activities leading to a decision (Kersten, 2002).

2.1.1 Environmental decision-making in the planning process

Traditionally, environmental decision-making, as part of the planning process, was conceived as tokenism rather than a necessity. The high degree of expertise involved, and associated political and economic power, generated a technocratic and elitist top-down structure, characteristic of the planning process era driven by economic needs. The planning process was committed to particular policy choices and coordination of different agencies was rare as conflicting goals emerged (Cullingworth and Nadin, 2006).

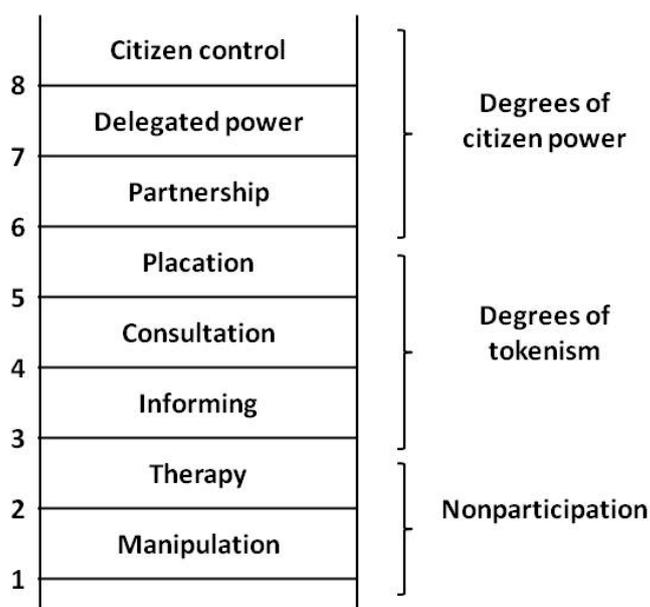
As decisions were taken considering specific interests, the exclusion of certain actors, including the general public, was justifiable. Under this scenario, a typical way of deliberating potential solutions considers the costs and benefits of the decisions to be made. However, a major disadvantage of the cost-benefit analysis approach is the frequent conflict associated with the spatial distribution of the costs and benefits of a given solution (Bishop, 2008).

As the paradigm of development experienced a transition, from the post-war capitalist vision of economic efficiency, to incorporating the protection of the environment and poverty alleviation, growing number of citizens became critical about environmental quality and the protection of nature. Policy-driven land-use changes, natural resources degradation and NIMBY (Not In My Back Yard) conflicts generated claims about ineffective placed-based decision-making, evidencing the failure of the specialists working for the public and private sectors to respond to the challenging needs of modern planning goals (Jankowski and Nyerges, 2001).

While increasing numbers of citizen representatives, such as community groups and non-governmental organisations, sought opportunities to contribute in the decisions about their future, and claimed involvement in planning strategies, so planners became aware of the responsibility to recognize and increase citizen participation in a more inclusive form of planning (Healey, 1997). With environmental decision-making moving from an expert-based approach towards citizen involvement in a collaborative model, the challenge of providing support for making optimal decisions, and understanding the consequences of their implementation, required specific tools, procedures and skills to structure and inform the process (Bishop, 2008).

However, during the late 1960s the idea of participation was often little more than political rhetoric. A major development in ideas about citizen participation was the typology proposed by Sherry Arnstein (1969), represented by a ladder which became a reference to effectively diagnose the different degrees of citizen power redistribution among the have-not citizens in political processes (see Figure 2.1).

Figure 2.1 Arnstein’s ladder of citizen participation. The ladder diagram shows a participation typology divided across eight levels, from which the lower two correspond to expressions of non-participation, the middle three to tokenism, and the upper three to citizen power.



Source: Arnstein (1969) p. 217.

Although the intention of the eight rung ladder was to illustrate that there were different degrees of citizen participation, a questionable characteristic was the inclusion of some levels of non-participation as part of the typology. Also controversial was the labelling of ‘informing’ and ‘consultation’ as degrees of tokenism (see Figure 2.1). What becomes clear from Arnstein’s representation is that during the late 1960s the idea of citizen participation was so vague that was partially defined in opposition to degrees of non-participation and tokenism, without considering the connection between the different stages of the public policy agenda.

At the same time, the ladder of citizen participation was an indicator of the political transformations of the time. In environmental planning, the green discontent was characterised by a critique of the content of political decision-making and the processes by which such decisions were made (Van Tatenhove and Leroy, 2003). In this sense, Healey (1997) explains how from the early 1970s planning

practice gradually transformed into a communicative approach, responding to the pressure for more active citizen involvement in planning strategies and their implementation. Equally, she argues that as part of the communicative turn in planning theory, the value of society and social interaction gained recognition as part of the construction and communication of all forms of knowledge, used for collaborative consensus building, leading to effective and accountable territorial decisions.

During the late 1970s and early 1980s, as environmental planning gained increased experience at involving citizens, there was a need to counterbalance the technical capabilities of the decision-making groups constituted by expert planners and citizens, if effective participation and real influence in decisions were expected. In this context, the adoption of information technology for spatial planning (i.e., GIS) aims at supporting group decision-making by engaging a greater number of participants with diverse information and knowledge backgrounds. The purpose is to facilitate the communication, exploration and negotiation of the problem, by reducing the cognitive workload and potential bias from individual preferences, resulting from integrating the variety of perspectives. The ultimate goal is to enable collaboration and consensus building to improve the spatial character of decision problems (Jankowski and Nyerges, 2001).

As the procedures to structure and inform collaborative planning processes evolved, spatial decision-making gained importance as a mechanism for group selection of land uses, as it aims to address conflicts over land, and ultimately avoid adding pressure on social relationships. According to Cullingworth and Nadin (2006), land use planning is essentially a political process due to its conflict and dispute character; and because of the variety of levels at which the planning process takes place, the diversity of actors involved, and the economic and cultural elements influencing national policies, land ownership systems are of particular importance for the implementation of land-use planning tools.

Among the different systems of land tenure, the case of common property is of special interest, as access to land and use of resources occur according to known and mutually accepted rules, and the level of social interaction offers an advantage to build social networks, in which information, relationships and trust are articulated, enabling a greater potential to deal with complex dilemmas (Ostrom, 1990). In this context, increasing participation in environmental planning decisions of citizens and communities affected by the use of natural resources gains further relevance, as they provide greater opportunities for protecting natural capital under locally evolved social arrangements (Ostrom 1990 in Moran, 2010); and because of the growing involvement of various agents promoting initiatives which require local decision-making (Jankowski and Nyerges, 2008).

As a summary of the initial steps towards the configuration of a public participation approach, Rydin and Pennington (2000) examine the advantages for social capital of citizen involvement in decision-making under different approaches to local environmental planning (see Table 2.1).

Table 2.1 Alternative approaches to public participation in environmental planning.

Type of environmental planning	Environmental management	Environmental governance	Collaborative environmental planning
Rationalisation of participation	Policy delivery	Policy delivery	Democratic right
Goal of public participation	Limitation of policy process as government	Effective policy delivery	Democratic governance
(Means or end?)	Means	Means	End
Collective action problem	Severe	Less severe	Irrelevant
Role of the state	Active management	Institutional redesign	Opening up policy process
(Ostrom's terms)	Controller	Facilitative	----
Role of individual	Consultee	Active in implementation	Active in formulation
Conceptualisation of social capital	Contained within the state	Embedding incentives	Quantum and distribution of trust
Potential for failure	State failure; state unable to solve problems	CAP persists; insufficient co-operation among public	Lack of consensus of lack of implementation
Policy example	Air quality management, development planning	Nature conservation, recycling initiatives, many specific Local Agenda 21 initiatives	Overall strategy work for Local Agenda 21

Source: adapted from Rydin and Pennington (2000) p. 165.

A significant element of the description presented in Table 2.1 is the appropriateness of collaborative environmental planning in common property regimes, where potentially, information technology can contribute to enhance access to spatial information to meet the needs of global strategies for poverty alleviation and the protection of the environment as is the case in Agenda 21 (i.e., broadening citizen involvement in rural communities to combat poverty throughout land-use planning and natural resource management). Nevertheless, the autonomy of land tenure arrangements and local institutions in common property regimes are at risk as a consequence of the intervention of market forces in the world economy.

A report on the global importance of land tenure for development (Kirk *et al.*, 1998), identifies two main problems that common property regimes faces worldwide: the effect of government intervention to promote the individualisation of property rights, as a global trend of modern agrarian reforms, adding pressure to land use change and generating adverse conditions for natural resources exploitation; and the crisis within rural societies representing the end of land as a means of social security for agrarian populations, having as a consequence social tensions which cause fragmentation and commercialisation of landholdings. The ultimate effect of both conflicts adds pressure regarding resources and society because of the growth in numbers of landless people.

Due to the political nature of land-use planning, and because of the need to enable collaboration and consensus building to improve the spatial character of decision problems, the use of technology has the potential to facilitate the participation of local actors to enhance equity and transparency in the planning process. In the following section an explanation of participation as a concept, and its role within the decision-making process is presented.

2.1.2 Participation within the decision-making process

Contemporary states, seen as modern democracies, are the result of a recent historic global transition. The last four decades of the twentieth century witnessed a crisis of social representation and political credibility. The rise of global market forces on the one hand, and the increasing amount of available information as well as access to technology on the other, inspired a more critical judgement on what is accepted or not by society. As a result, the state as a central political object experienced a decrease of decision capacity, and its relation with markets and civil society had to be re-negotiated.

The current re-negotiation of such relations has taken place within the political domain of society, understood as *'the setting in which different agencies and organisations (from state, markets and civil society) produce and distribute resources (power and domination) and meanings (discourses) to shape public life'* (Van Tatenhove and Leroy, 2003, p. 158). However, the idea of participation has been controversial and the subject of political rhetoric, populist discourses and confusing conceptualisations.

In order to establish the evolution of participation, as well as an initial definition, I present Hickey and Mohan's (2004) historical review of participation in development theory, placing emphasis on its different political influences, the conception of citizenship and the unit and level of engagement (see Table 2.2). Despite the lack of reference to planning theory, the purpose of the review is to describe the evolution of the approaches and political perspectives influencing citizen participation. Participation can be conceptualised in two ways, as an evolution of approaches, but also as individual tendencies. In any case, it is not possible to characterise by generalising, as every experience is the result of the context and evolution of each political regime. As suggested in the last three rows of Table 2.2, modern participation can be explained as a result of at least three different approaches.

The populist form of participation in development is a misconception of participation in democracy (see Table 2.2). This approach refers to a series of practices and organisational arrangements oriented to support and facilitate the implementation of local projects by development agencies. As a result, the wider interactions between the state, civil society and markets are not recognised, failing to address the promotion of citizenship as part of the state's governmental responsibilities. In this approach, participation is understood as a tool to meet practical project needs, and not as a process of citizen involvement in the structures and institutions of society (Cleaver, 1999).

The social capital approach (see Table 2.2) proposes participation as a practice in which civic associations are the unit of social engagement. However, institutional interventionism that leads and regulates the creation of civic associations releases the state of its responsibility to promote instruments for citizen involvement in the process of government. In this sense, the role of the state becomes critical, as it can be a facilitator state or a controller one (Ostrom, 1990); but in the end, its role is to allow different degrees of assistance and autonomy rather than opening up the possibility for a society to auto-regulate in terms of its organisation. A major contradiction is the idea of participation as a right and as an obligation of citizenship, as it denies the obligation of the state to provide citizenship rights.

Table 2.2 Participation in development theory and practice, presents a description on the evolution of approaches and political perspectives influencing citizen participation.

Era	Approach	Institutional influences	Approach to citizenship	Locus / level of engagement
1940s-1950s	Community development (colonial)	United Kingdom Colonial Office 1944 Report on Mass Education in Africa	Participation as an obligation of citizenship; citizenship formed in homogeneous communities	Community
1960s-1970s	Community development (post-colonial)	Post-Colonial governments (social welfare or specialised departments)		
1960s	Political participation	North American political science	Participation (e.g. voting, campaigning, political party membership) as a right and an obligation of citizenship	Political systems and constituent parts; citizens
1960s-1970s	Emancipatory participation	Radical 'southern' researchers / educationalists	Participation as a right of citizenship; participatory citizenship as a means of challenging subordination and marginalisation	Economic and civic spheres; communities; citizens
	Liberation theology	2 nd Vatican Council, Latin American Catholic priests		
1970s-1990s	'Alternative development'	Dag Hammarskjöld Conference 1974	Participation as a right of citizenship; citizenship as a key objective of alternative development, to be realized in multi-level political communities	Initially focused on communities and civic society, latterly the state through 'inclusive governance'
1980s-Present	Populist / Participation in development	Development professionals, NGOs, World Bank Participation Learning Group, UN Agencies	Focus on participation in projects rather than in broader political communities	Development professionals and agencies; local participants
Mid-1990s-Present	Social capital	World Bank Social Capital and Civil Society Working Group	Participation as a right and obligation of citizenship	Civic associations
Late 1990s-present	Participatory governance and citizenship participation	Institute for Development Studies, Brighton (Participation Group)	Participation as primarily a right of citizenship	Citizens, civil society, state agencies and institutions

Source: adapted from Hickey and Mohan (2004) p. 6-8.

The last and most recent approach presented in Table 2.2, participatory governance and citizen participation, a result of historical manifestations of different influences, reflects the sense of contemporary citizen participation. This approach recognises democracy, and in particular participatory democracy, as a necessary condition to participation, acknowledging citizenship as the social rights of citizens to organise for political purposes aside of political party representations, and their capacity to interact with state agencies and institutions for administrative and regulatory purposes in the form of civil society organisations (Giddens, 1999). As citizen rights are at the same time state obligations, citizen participation must then be understood as a right of citizenship, in the same way that it is an obligation of the state; in which the *'state and civil society should act in partnership, each to facilitate, but also to act as a control, upon the other'* (Giddens, 1999, p. 79).

The above review of participation in development theory has served to introduce the evolution of contemporary approaches to participation, and to initially describe modern citizen participation. Although contemporary states are characterised by economic or political similarities which tend to create strategic alliances (i.e., European Union, North American Free Trade Agreement, Southern Common Market, Association of Southeast Asian Nations) or to categorise them in terms of wealth and power (i.e., developed and developing countries, higher-income and lower-income countries, North-South), citizen participation as a political process breaks throughout such categorizations, as its manifestation depends on the evolution and the context of each political regime.

When talking about participation in environmental planning, the literature often refers to it as public participation (i.e., Parkins and Mitchell, 2005; Beierle and Cayford, 2002; Webler *et al.*, 2001; Rydin and Pennington, 2000; Davidson, 1998; Wiedemann and Femers, 1993) with some exceptions referring to it as stakeholder participation (Reed, 2008; Karl, 2000), or as public involvement (Hampton, 2009; Jackson, 2001). However, the public, understood as people in general, has a distinct connotation of referring to those members of the society, in a particular country or town, who have rights as part of citizenship. For this reason I will refer to citizens rather than the public. Accordingly, I will use the term *public* to refer to the state and its institutions, keeping clear that social organisations and individuals are private.

As discussed in Section 2.1.1, collaborative planning, as a political process, seeks to enhance social interaction and enable collaboration for consensus building to improve the spatial character of decision problems. As a result, citizen participation should be seen as an act of governance

involvement by different actors, consisting of problem-solving or decision-making at different levels (International Association for Public Participation, 2011).

For citizen participation to be able to redistribute power, it must follow a framework of reference to assess the degree of decision power and its influence on the outcomes of a process. Back in the 1960s, the idea of citizen participation consisted of electoral voting for the majority of people. Since then, civil society has accumulated recognition under different regional circumstances across Eastern and Western Europe, North and Latin America; and participation itself has evolved in practice, and also in the ways of perceiving its levels of impact. In environmental planning, this can be seen in the different levels of participation considered in the adaptations of Arnstein's ladder of citizen participation.

Two decades after the ladder of citizen participation appeared, Wiedemann and Femers (1993) presented an updated version of a ladder for risk-related decision-making in which the levels of non-participation had been removed, integrating the public right to know and informing the public as degrees of participation, but also the higher levels of delegated power and citizen control were simplified (see Figure 2.2).

Figure 2.2 Results of a study focusing on public participation for waste management in Germany presented evidence in the evolution of citizen involvement in environmental decision-making. The study presented a revised version of the public participation ladder, modified to be adopted within the practices of 1990s European waste management context.

Public partnership in the final decision
Public participation in assessing risk and recommending solutions
Public participation in defining interests and determining the agenda
Public right to object
Informing the public
Public right to know

Source: Wiedemann and Femers (1993) p. 357, (After Arnstein 1969).

On the one hand, the results acknowledged democracy as the cornerstone of citizen involvement in decision-making. However, it was emphasized that its diverse manifestations produced a difference between public officials making decision based on public mandate, or citizen involvement as a democratic right to meet society's needs, and against decision processes dominated by expert elitism. On the other hand, the conflicts associated with public participation such as power distribution and their potential to reproduce inequality were presented as a warning, disregarding the myth of participation as necessary, and opening up the discussion about how participation was viewed; as a process or as a final product; participation as the goal, or participation as a means.

In relation to participation in environmental issues, within a context of relationship re-negotiation between state, markets and civil society, resulting from the decreased decision capacity of the state, Van Tatenhove and Leroy (2003) emphasise the inextricable connection between participation and environmental issues. They also discuss the implications of the environmental policy domain in political participation by providing an updated analysis of three phases of political modernisation, and its relation to environmental policy in Europe since the late 1960s (see Table 2.3 for a summary).

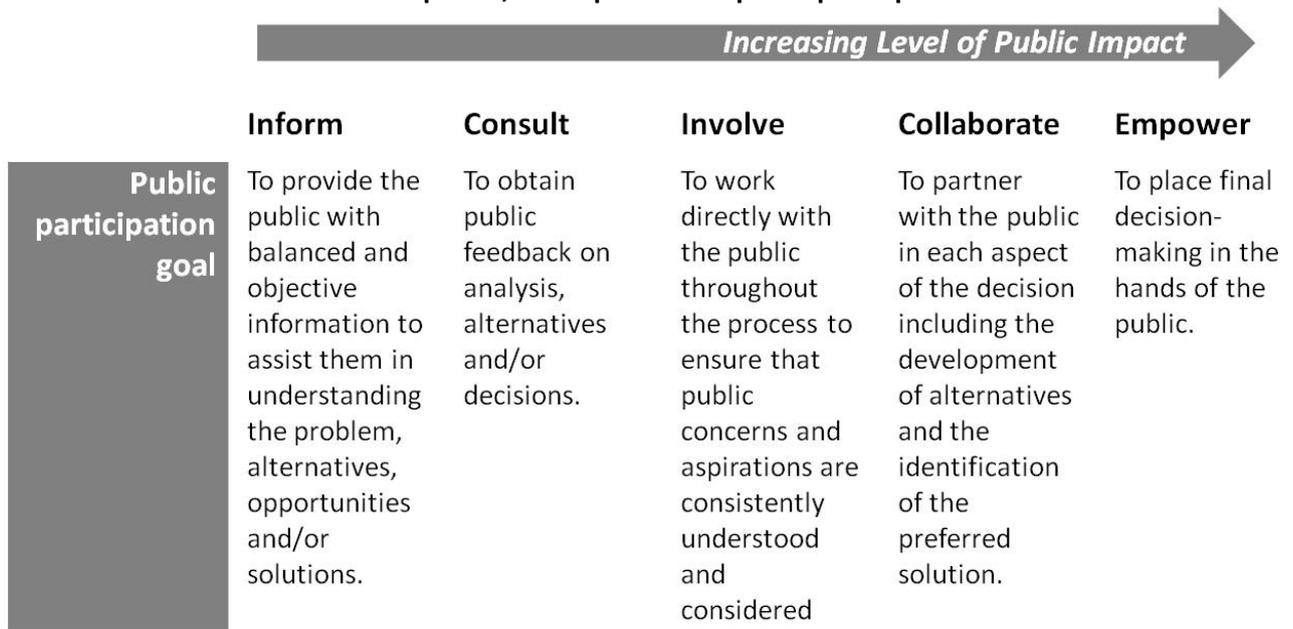
As described by Van Tatenhove and Leroy (2003), the meaning of contemporary participation as a political process is the result of historical developments and recent lessons from the transformation of institutions in various democratic contexts. In this sense, the traditional forms of political participation are inadequate, having to be redefined in the form of participation mechanisms and opportunities in accordance with a mixture of political features present in modern environmental politics.

Recognising the value of the reviewed literature to clarify and contribute to the debate on participation for environmental planning, also demands the actualisation of the parameters by which political changes have re-arranged the way in which citizen participation is proposed, dealt with and debated. A recent typology is the Spectrum of Public Participation proposed by the International Association of Public Participation (2011). A significant difference with previous typologies is the modification of the conception of participation itself, as it is no longer presented in a ladder form, and recognises the fact that citizen participation has changed from being considered as horizontal levels of citizen empowerment, into a vertical process in which participation increases progressively, and all stages are seen as necessary and equally important for the evolution of the process (see Figure 2.3).

Table 2.3 Resulting phases from the evolution of the political modernisation process and social participation.

	Early modernisation	Anti-modernisation	Late modernisation
Relation state, market and civil society	Presumed loyalty from market and civil society	Criticism of elitist and technocratic rationality	Decreased centrality of the state as a political actor; increasing encroachment and interference
Governance discourse	Rational policy making and comprehensive planning	Opposition to state-market coalition and the oppressing role of the state	Pivot in governance as a consequence of modernisation 'global risks', within and beyond the nation-state
Predominant policy practices	State initiated and taking scientifically deduced standard goals	Policy making in relation to participation	Common formulation of the problem and the design of solution strategies
Type of democracy	Representative; political rights, selection of representatives who make political decisions	Direct and participatory; new linkages between state and civil society	Deliberative and sub-politics
Form of political participation	Constitutionally institutionalised; insulated, each sphere functioning according to its own rationalities: bureaucracy, competition and solidarity	Supplementary and corrective; state-civil society interfaces, direct participation of citizens in key institutions of society, participation instruments	Sub-politicisation of society; new coalitions of actors, as politics is no longer a privilege of the institutions of the nation-state, participation turns to deliberation; strong influence of media and technology

Figure 2.3 Recent typology on public participation levels proposed by the International Association of Public Participation, IAP2 Spectrum of public participation.



Source: International Association of Public Participation (2011) <http://www.iap2.org>

The objectives of this section were to present and clarify the concept of participation, and offer a description of how environmental decision-making and citizen participation are interrelated. The following section will discuss the ways in which collective decision-making on natural resource management takes place at present, and based on the ideas presented in this section, an explanation of particular strategies for citizen participation in natural resource management will be given.

2.1.3 Natural resource management

In the 21st century, natural resources management is translated into multiple practises ruled by the interests of the green economy, and to some extent under certain circumstances, by environmental management. The environmental impact from the transformation of the nation-state economic model, into the current world-system of market economies, has represented an increase in natural resources consumption and environmental degradation. In this sense, the attempt to reduce environmental damage has gradually become an essential part of the global economic process (Jacobs, 2001).

The political evolution of modern democracy, which advocates new arrangements for governance between the state, markets and civil society; in addition to the influence of science and technology on our relationship to nature, are re-shaping social and institutional paradigms related to the

environment and natural resources. However, modern society has been characterised by polarisation and inequality; and perhaps the co-existence of different democratic visions associated with particular political contexts, combined with natural resources interactions between lower and higher-income countries, is the ultimate representation of it.

Although international consensus to tackle the environmental crisis is already in progress, it still does not possess a truly global influence to deal with the situation. For example, on the one hand, technological innovation to produce and use renewable energy is simultaneously incentivised along with the continuing expansion of fossil fuel combustion. On the other, a proportion of national institutional discourses associated with the original ideas of sustainable development fail to address the environmental consequences from the diversity of trends within society and economy as a major cause of the environmental crisis, resulting in conflicting programmes on natural resources administration.

Among contemporary environmental social science schools of thought, ecological modernisation provides a descriptive analytical theory approaching the environment as a political subject. It emphasises the role of government policies, sustainable citizenship and market-based instruments to promote policy making, and implementing social and institutional arrangements, to address problems related to the environment, natural resources and climate change worldwide (Spaargaren *et al.*, 2009; Giddens, 1999).

A distinctive element of ecological modernisation is the acknowledgement of contemporary societies' needs and roles of consumption as part of the solution, and therefore, the central field of policy is not the environment per se, but the economy and industry (Jacobs, 2001). However, *'the environmental state remains an important institution in safeguarding environmental quality, it needs to be restructured: moving from a bureaucratic, hierarchical, reactive, command-and-control state, towards a more flexible, decentralised, and preventive institution that creates networks with other societal actors and applies a variety of approaches and instruments to guide society into directions of sustainability'* (Mol and Jänicke 2009, p. 19).

In this context, Van Tatenhove and Leroy (2003) propose the societalisation and marketisation of environmental politics as innovative expressions of policy making, governance and participation arrangements between environmental authorities and regulation modes representing the state, civil society networks of organisations and the diversity of market actors and mechanisms. The

societalisation of environmental politics is seen as governance and policy arrangements between civil society and the state. From civil society's perspective, the change in patterns of governance between the network of civil organisations and state institutions represent rule-altering arrangements. Similarly, the design and implementation of instruments to communicate, formulate views of problems and influence policy correspond to rule-directed innovations on behalf of the state (e.g. participatory budgeting processes involving citizens in making decisions on the spending and allocation of public resources).

From the perspective of the state, the marketisation of environmental politics proposes a shift from institutional regulation schemes to economic instruments, as well as innovative types of governance between state and market actors. From the perspective of the market, policy arrangements consist of covenants, voluntary agreements between state and market, and co-operation between civil society organisations and market agencies, in which flexible instruments of auto-regulation as well as the adoption of standards and targets are incentivised under the guidance of the state. Although based on collaborative deliberation for the formulation of problems and design of strategies, the potential range of interactions between agencies, and the degree of participation given societalisation and marketisation arrangements depends on the character of governance mechanisms between the actors.

To some extent, recent natural resource management strategies have been influenced by trends closely associated with the concept of marketisation, and to a lesser degree that of societalisation of environmental politics. However, such instruments have developed under conflicting and unclear circumstances. For example, as a result of the failure to reach agreement on a global forest convention during the 1992 United Nations Conference on Environment and Development, the international community and the forest management sector focused on non-state market-driven governance systems to deal with the problems associated with environmental degradation and its effect on climate, as well as the consequences for the forestry social sector (Bray *et al.*, 2006; Shvidenko *et al.*, 2005; Cashore *et al.*, 2004).

In this sense, due to their role as a central component on Earth's biogeochemical systems, and as a source of ecosystem services (Shvidenko *et al.*, 2005), forests have been the subject of a series of innovative instruments, influenced by international co-ordination and oriented to regulate global interactions in forest management. Examples of these instruments involving state institutions, citizens

and market bodies are certification systems for forest products and carbon offset programmes (i.e., international offset mechanisms, mandatory cap-and-trade systems and voluntary standards); and they seek to tackle problems like carbon dioxide emissions associated with land use and land cover change, illegal logging and corruption, the impact of bureaucratic governmental institutions on forest governance, and conflicting property regimes of forestry resources.

Although forest certification programmes evolved quickly during the 1990s, they failed to reach global coverage, as the regions of the world in which they succeeded were those with better organisation in terms of business, environmental and social networks (Humphreys, 2006). Subsequently, certification procedures have failed to provide equitable access and benefits for small-scale participants and local communities in comparison to large enterprises and business corporations, limiting social rights, forest governance and potential environmental benefits in some regions (Klooster, 2006, Cashore *et al.*, 2004).

As for carbon sequestration, although controversial, recent interest has increased as it is considered to be a key mechanism to tackle global greenhouse gas emissions. An ongoing example is the international policy to reduce emissions from deforestation and forest degradation and to promote the conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries, REDD+. According to a review of the current offset markets and standards (Kollmuss *et al.*, 2010), issues surrounding such programmes can pose a risk to environmental integrity if they are not adequately addressed.

Evidence on governance issues due to conflicting interests between national forest policies and social outcomes (Corbera and Schroeder, 2011), suggests that implementation of successful carbon forestry requires a transition of government institutions to give local communities and forest dwellers a stake in their environment, while international legal instruments have to be designed in accordance to national policies and the diversity of sectors and impacts on the economy.

The experiences from international partnerships between public and private actors in the forestry sector have shown that public administration of forests limits social and environmental benefits (Shvidenko *et al.*, 2005; White and Martin, 2002). In this sense, an initial assessment of the cases which offer potential advantages of innovation in the forestry sector is expected to come from countries with knowledge and practice of private regimes. To indicate the international status of forest resources,

Table 2.4 provides a summary of official ownership regimes in the twenty most forested countries in the world.

The cases of the United States of North America, China, Mexico, Argentina, Papua New Guinea, Sweden and Japan may offer interesting experiences from their forestry sectors as private regimes hold the majority of forest resources. However, for my interest on common property regimes, the cases of China, Mexico and Papua New Guinea (highlighted in Table 2.4) are of particular importance as common forest ownership dominates all other private ownership forms. Current practice in the use and administration of forest resources in these countries could offer an outlook on the alternatives to balance current marketisation initiatives, with the less experimented societalisation mechanisms of natural resources, and their impact on environmental management.

Table 2.4 Official figures on forest ownership in the top 20 forested countries.

Country (by descending area of forest cover as identified by the U.N. Food and Agriculture Organisation in 2001)	Area in million hectares (percentage of country total)							
	Public				Private			
	Administered by government		Reserved for community and indigenous groups		Community/indigenous		Individual/firm	
Russian Federation	886.5	(100)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Brazil	423.7	(77.0)	74.5	(13.0)	0.0	(0.0)	57.3	(10.0)
Canada	388.9	(93.2)	1.4	(0.3)	0.0	(0.0)	27.2	(6.5)
United States	110.0	(37.8)	17.1	(5.9)	0.0	(0.0)	164.1	(56.3)
China	58.2	(45.0)	0.0	(0.0)	70.3	(55.0)	0.0	(0.0)
Australia	410.3	(70.9)	0.0	(0.0)	53.5	(9.3)	114.6	(19.8)
D. Republic of Congo	109.2	(100)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Indonesia	104.0	(99.4)	0.6	(0.6)	0.0	(0.0)	0.0	(0.0)
Peru	no data	--	8.4	(1.2)	22.5	(33.0)	no data	--
India	53.6	(76.1)	11.6	(16.5)	0.0	(0.0)	5.2	(7.4)
Sudan	40.6	(98.0)	0.8	(2.0)	0.0	(0.0)	0.0	(0.0)
Mexico	2.75	(5.0)	0.0	(0.0)	44.0	(80.0)	8.3	(15.0)
Bolivia	28.2	(53.2)	16.6	(31.3)	2.8	(5.3)	5.4	(10.2)
Colombia	no data	--	no data	--	24.5	(46.0)	no data	--
Tanzania	38.5	(99.1)	0.4	(0.9)	0.0	(0.0)	0.0	(0.0)
Argentina	5.7	(20.5)	0.0	(0.0)	0.0	(0.0)	22.5	(79.5)
Burma	27.1	(100)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Papua New Guinea	0.8	(3.0)	0.0	(0.0)	25.9	(97.0)	0.0	(0.0)
Sweden	6.1	(20.2)	0.0	(0.0)	0.0	(0.0)	24.1	(79.8)
Japan	10.5	(41.8)	0.0	(0.0)	0.0	(0.0)	14.6	(58.2)
Total	2704.65	--	131.4	--	243.5	--	443.0	--

Source: adapted from White and Martin (2002) p. 5.

Although issues exist around the early development of forest certification systems and carbon offset programmes, they have also incentivised the use of fast moving technological innovation. As forest management decisions are often based on long-range projections of future forest conditions, the use of IT gains particular relevance.

The application of computer tools for collaborative decision-making (Stock *et al.*, 2009), visual simulation methods in forest land management (Cavens *et al.*, 2005; Meitner *et al.*, 2005), and GIS-based data support infrastructures for carbon offset mechanisms (Minang *et al.*, 2008) are among the contexts in which geographic information technologies have been used in the forestry sector. In this sense, it is necessary to investigate if the use of geographic information technologies can contribute as technical support to describe, implement and monitor local initiatives for natural resource management, and if so, how to manage their use for possible benefits among the actors involved.

Adapting the principles of ecological modernisation can offer an alternative to approach the problems faced by common property regimes in their natural resources management initiatives, by re-considering the role of local communities, government institutions and business corporations in forest governance. Understanding the linkage between traditional community management systems and innovative instruments of participation in natural resource initiatives could contribute to adapt and improve management practices over long periods of time. Also, the recognition of local communities' land ownership rights presents an opportunity for new governance arrangements to contribute to improve the livelihoods of millions of forest inhabitants around the world.

One element of ecosystem services marketing considers forests ecosystem services, such as carbon sequestration, in which property regimes and property rights play a determinant role in defining the rules and mechanisms of operation. However, it is necessary to examine the degree of adaptability and functionality of such principles, according to the structure of the forest sector and public policy approaches in each particular context (Corbera and Brown, 2010; Innes, 2009; Schoeneberger, 2009), as well as the regional conditions and potential local benefits coming from the adoption of geographic information and IT for local community management.

An investigational approach to the challenges presented by instruments for innovation within payment for ecosystem services schemes, considering the inclusion of geospatial technology tools, can be based on the lessons and experiences derived from collaborative and participatory approaches to spatial

planning (Bishop, 2008; Batty, 2007; Cullingworth and Nadin, 2006; Geertman and Stillwell, 2004; Healey, 1997).

2.2 The role of geospatial technologies

In this section the aim is to provide an overview of the role geospatial technologies could play in collaborative decision-making for natural resource management. The concept of Public Participation Geographic Information Systems (PPGIS) is introduced by referring to its origins and history, while presenting current practice by reviewing different contexts in which PPGIS case studies have been implemented in relation to citizen participation and collaborative decision-making for natural resource management. This section concludes with a brief discussion in relation to current codes of practice and their relation to how negotiation between the technology and users takes place at present.

2.2.1 Geographic information systems as planning support systems

As decision-making within the planning process moved from rigid professionalism to collective negotiation, the appearance of new methods sought to communicate information and disseminate ideas as well as generating solutions to planning problems (Batty, 2007; Geertman and Stillwell, 2003). As a result, the available set of geographic information technology tools used to inform the planning process became known as Planning Support Systems (PSSs).

As Batty (1995, p.6) defines them, *'planning support systems are a subset of these geographic information technologies dedicated to aid those in planning to explore, represent, analyse, visualise, predict, prescribe, design, implement, monitor, and discuss issues associated with the need to plan'*. In addition to this definition, Geertman and Stillwell (2004) point out that one explicit aim of this re-developed set of tools was to facilitate group interaction and discussion as part of the planning process.

One of the most significant achievements of PSSs has been the development of new techniques for communicating information, in which interactions between the computer and users gain relevance through visualisation techniques, displacing the orthodox computer - computer interaction processes commonly developed during the 1990s boom of GIS approaches for planning. In this sense, the idea of a varied suite of components that planners can utilise to explore and manage their particular activities

(Geertman and Stillwell, 2004) is of significant relevance when considering PSSs as a transitional stage or experimental field in which alternative uses of GIS have been incentivised.

Of particular importance is to remember that PSSs came to the planning scene as a result of a public demand for adequate ways to communicate the technical basis of potential solutions to planning problems between citizen groups and government agencies. The similarities with the emergence of Public Participation GIS practice coincide, as one of the aims of the Public Participation practice within GIS was to facilitate analysis and deliberation in a group decision setting (Jankowski and Nyerges, 2001).

2.2.2 Public Participation Geographic Information Systems

During the early 1990s geographic information systems (GIS) were suggested as a useful source of information in group decision-making, with the potential to facilitate public involvement in understanding of spatial problems (Jankowski and Nyerges, 2001; Klosterman, 1995). Similarly, the idea of GIS and related spatial technologies playing a role in natural resource management in lower-income countries was recurrent in the ongoing GIS debates. Among the major obstacles was the lack of infrastructure and expertise with information technology, similar to wider discussions about use of computer-based tools for regional planning in developing countries (Mannheim, 1987).

Discussions about the appropriateness of GIS and related technologies in lower-income settings were the subject of a series of publications (i.e., Rambaldi *et al.*, 1998; Bocco and Toledo, 1997; Dunn *et al.*, 1997; Openshaw, 1997; Harris *et al.*, 1995; Klosterman, 1995) highlighting the potential contribution if issues such as data availability and technology transfer were solved. However, some of these authors presented a discouraging perspective on the obstacles, rather than a reflection oriented to create a framework for implementation, use and evaluation of GIS initiatives and related technologies in the developing world. Some of the ideas presented in those debates, proposing critical questions about the viability of GIS for development, set out the agenda for the wider discussion of what became a new GIS paradigm known as 'GIS and Society' or 'Critical GIS'.

The idea of a critical GIS paradigm was discussed by John Pickles (1995) in his '*Ground Truth*' compilation about the social implications of geographic information systems. One of the key arguments referred to the limited range of critical frameworks about the use of the technology, and

the impacts of its products in the reconfiguration of cultural patterns as well as economic and political relations (Pickles, 1995). Under this reading, GIS was strongly criticised as an instrument of surveillance and corporative control, emphasising the nature of its use by corporations, public agencies and governments, and to some extent, contrary to the desired contribution of geography in society (Taylor and Johnston, 1995).

As a response to technocratic criticisms and debates about the role of GIS in society, members of the National Centre for Geographic Information and Analysis (NCGIA) expressed their concern and highlighted the need to revise the GIS paradigm, and allow a new generation of GIS in which the voices of the disempowered and unprivileged were taken into consideration (Obermeyer, 1998).

Public Participation GIS opened up a new debate area in relation to the use of geographic information technologies by non-scientists and disadvantaged sectors of society. Before explaining what Public Participation Geographic Information Systems proposes, is important to explain a phenomenon that has taken place since the commencement of its practice. Although scholars, practitioners and researchers involved in the wider GIS and Society debate have made the effort to characterize the particularities of their work, in the case of Public Participation Geographic Information Systems, the *label* put to different applications and uses has been inconsistent (Schlossberg and Shuford, 2005); ranging from Bottom-Up GIS, Community-integrated GIS, Community-based and Collaborative GIS, Participatory GIS, Public Participation GIS and SoftGIS among others.

Despite the absence of a common thread, the most frequent terms the approach has received remain '*Public Participation GIS*' and '*Participatory GIS*'; and regardless of the sometimes questionable nature of the terminology to characterize applications and uses, some differences can be identified, depending on the epistemological affiliation of the proponents (Schuurman 2009; Wilson 2009), the degree of citizen involvement and ownership of the initiative, as well as the purpose and regional context in which the study develops. In addition, due to the circumstance in which the Public Participation GIS concept originated, at the meetings sponsored by the NCGIA between 1993 and 1998 (Jankowski and Nyerges, 2008, Obermeyer, 1998), Participatory GIS had almost inevitably to exist as an alternative to existing perspectives as a result of the variety of conceptual approaches taken into account.

Weiner *et al.*, (2002, p. 8) describe Public Participation GIS '*as a broad tent with multiple meanings and a global reach*' and because of the hybrid nature of representations, analytical interventions and

conceptual engagements associated with Public Participation GIS practice, identifying a distinctive definition would fail to consider the flexibility and adaptability of the approach (Elwood and Cope, 2009). In consequence, this sub-section aims to describe what Public Participation GIS is about, and refers to a selection of Public Participation GIS case studies to compare the different kinds of practices. Then, I make use those examples as materials to exemplify the analytical techniques section of the present literature review.

Since the earliest use, the concept of Public Participation GIS has been described as a political process (Harris *et al.*, 1995) rather than in terms of the methods or technologies employed. Regardless of the terminology adopted to characterize different studies, Public Participation GIS has been conceived as an attempt to transfer geographic information systems and technologies for the use of non-expert groups, to facilitate their involvement, and inform them about alternatives they face, in relation to interventions with a spatial decision-making element (Abbot *et al.*, 1998).

In this sense, the role of technology is to augment and support the dialogue between the actors involved, emphasising the participation of the public, as an element of increased accountability (Carver, 2003). However, as Dunn (2007, p. 616) points out, *'these newer approaches are context- and issue-driven rather than technology-led and seek to emphasize community involvement in the production and/or use of geographical information'*.

At the same time, Public Participation GIS has been placed as a research field in Geographic Information Science (Elwood, 2006) and been oriented *'to investigate the use and value of GIS by marginalised peoples and communities engaged in social change'* (Sieber, 2003 p, 50), as it *'explicitly situates GIS within participatory research and planning and, as a result, local knowledge is incorporated into GIS production and use'* (Weiner *et al.*, 2002, p. 4). As a research approach, it also offers a potential response to those criticisms related to the social and technical role of GIS in society, as it combines expert and traditional representations of knowledge, in combination with theoretical frameworks and approaches (Williams and Dunn, 2003), as well as having been applied in a diversity of contexts.

Case studies on Public Participation GIS initiated in higher-income settings included use of visualization tools to promote resident participation in multi-cultural U.S. communities (Al-Kodmany, 1999), and the Great Britain 'Planning for Real' Slaitwaite exercise (Kingston *et al.*, 2000). It also included examples of neighbourhood improvement activities in U.S. urban areas (Ghose, 2001; Elwood, 2006) and the

issues encountered by environmental non-profits in getting access to government spatial data in California (Sieber 2007; 2002).

Other developments consisted of desktop GIS tools for community participation, such as the Scotland countryside conservation participatory mapping tool (Wood, 2005) and using an envisioning system to support decision on land-use planning in rural Australia (Stock *et al.*, 2007). Recent examples are the 'Community Action GIS' for tourism research in northern Canada (Stewart *et al.*, 2008) and a European counterpart focusing on the regional impacts of a web-based GIS tool for tourist information in rural Germany (Herrmann and Neumeier, 2008). An interesting example is a case in which a Public Participation GIS reflects the bottom-up approach, as a means to express the mobility needs of different user groups in a higher education facility in England (Castle and Jarvis, 2008).

Alongside the previous examples from richer nations, other proponents have provided valuable lessons from Public Participation GIS implementation and use in lower and middle-income settings. For example, Bernard *et al.*, (2011) provide a series of recommendations related to Participatory GIS and the designation of conservation areas in the context of under-funded government agencies in a case from the Brazilian Amazon; and Moore (2009) and Butler (2006) detail Google's Outreach Programme experience in providing mapping tools to support local development projects for emissions reductions in the Bolivian and Brazilian Amazon. In other Latin-American examples, Peters and McCall (2010) report on the use of handheld computers for mapping and visualizing community forest management in the context of a potential REDD scheme in central Mexico, while Jardinet (2006) shares her experience about communitarian land demarcation for natural resource management in Nicaragua.

In the Asian context, Rambaldi *et al.*, (2006) implemented a participatory 3D modelling strategy for collaborative natural resource management on the Fiji Islands; and Williams and Dunn (2003) examined GIS in participatory research for landmine impact assessment in Cambodia. Experiences from Africa include McCall and Minang (2005) on a participatory GIS approach for forest governance in Cameroon; and Kyem's (2002) discussion of how Public Participation GIS was implemented for dialogue support in southern Ghana forest management; while Weiner and Harris (2003) present the results of the community-integrated GIS for land reform in post-apartheid South Africa.

The varieties of settings and contributions offer interesting findings and challenging questions; as Wright *et al.*, (2009, p. 260) propose, *'the abiding issues of power-knowledge relations bear remarkable similarities and produce some universal concepts that fluidly cross development stage*

boundaries'. However, recent papers by academics involved in this research area suggest that there has been little systematic comparison between Public Participation GIS implementation case studies (Jankowski, 2009; Elwood, 2006; Sieber, 2006; Joerin and Nembrini, 2005; Schlossberg and Shuford, 2005; Carver 2003; Craglia and Onsrud 2003; Jankowski and Nyerges 2003; Laituri 2003).

Despite the remarkable diffusion that Public Participation GIS practice has had during recent years among traditionally underrepresented GIS users, the adoption and use by those groups has not been studied in sufficient detail by the GIS research community, especially in poorer nations and within indigenous and local communities (Sieber, 2003; Ramasubramanian, 1999); This does not seem to have changed since Jankowski and Nyerges (2001, p.5) wrote *'currently research about Participatory GIS and collaborative decision-making for geographically oriented, public policy problems continues to gain momentum. Unfortunately, most of the research concerning collaborative spatial decision-making has been about GIS development rather than about GIS use, without a strong theoretical link between the two'*.

As participatory research, Public Participation GIS has been described as highly political because it attempts to empower historically marginalized peoples and communities (Barndt, 2002). Of major significance are the issues of political power and power relations in Public Participation GIS implementation and usage: who decides and what counts in Public Participation GIS. As Harris and Weiner (2002, p. 248) remind us with an example of their experience in South Africa, *'efforts to hear the voices of 'ordinary' people and 'capture local knowledge' are well intentioned, but in many instances these are forms of participation for publication, in which academics undertake research to produce books and journal articles while leaving the subject communities with little (if any) tangible benefits'*.

Notwithstanding the previous warnings and observations, not all efforts in Public Participation GIS research have had a positive conclusion. The *Mexico Indigena* case arose from a research project in which the American Geographical Society (AGS) funded the Bowman Expedition programme to carry out a participatory research mapping initiative in indigenous communities in the Sierra Juarez region within the Mexican state of Oaxaca. The purpose was to use remote sensing and IT to map indigenous land tenure and natural resources. The justification of the project is encapsulated in a fragment of an article describing its focus by the leader of the programme, Peter Herlihy (2008, p. 402):

'Our focus was on the geography of indigenous land tenure in Mexico. The nation has one of the largest indigenous populations in the Americas whose homelands coincide with the globally important biological diversity. Indigenous lands include significant resource areas of forest, minerals, hydroelectric dams, and reservoirs. They house cultural heritage and attract ecotourist dollars, but they are also where rebellions are fomented, drugs are produced, resource pirates traffic, and conditions of poverty encourage out migration.'

The expedition was funded by the United States Army's Foreign Military Studies Office and its objective was to build a GIS database of property rights in Mexico. The controversy surrounding the project began when the indigenous representation of the communities involved accused the expedition's leaders of misconduct, as they failed to fully inform the General Assembly of Santa Cruz Yagavila about the source of their funding (Cruz, 2010). The latter resulted in a dispute over the lack of informed consent and violations of ethical norms to be expected in a research project organised by the AGS (Agnew, 2010). The representatives and authorities of the community ended up releasing a statement denouncing abuses and illegal data collection by the Kansas University, the academic institution representing the research project.

This type of case generated a series of debates and publications about codes of ethics within GIS and participatory mapping practice, also considered as Public Participation GIS. In this respect, several proponents and practitioners have made contributions in the particularities of ethics in GIS practice (i.e., URISA, 2003; Crampton, 1995; Craig, 1993), in Critical GIS (i.e., Miller, 1995; Onsrud, 1995); as well as in Participatory GIS (i.e., Rambaldi *et al.*, 2006; McCall, 2003), and measuring transparency in Public Participation GIS (i.e., Drew, 2003).

A recent example of a development in this area is the 'Training Kit on Participatory Spatial Information Management and Communication'. The compilation aims *'to support the spread of good practise in generating, managing, analysing and communicating community spatial information'* (CTA, 2010). A key characteristic of this tool is the variety of materials which aim to enable groups and organisations to carry out geographic information strategies within a guided set of themes and exercises.

Although the use of available tools to bring support to non-expert users of geospatial technology is a positive action towards wider education about Public Participation GIS practice and conflicts, the need to document adoption protocols and the impacts of such interaction with traditional governance protocols remains an outstanding issue. It is still not clear if there are identifiably boundaries within

which Public Participation GIS practise has the potential to enable wider understanding of spatial problems by facilitating public involvement (Jankowski and Nyerges, 2001).

2.3 Analytical approach

As discussed in previous sections of this chapter, the involvement of non-experts in planning and decision-making processes has enhanced, and gradually re-defined, the role of citizens in environmental governance arrangements. In this sense, the use of geospatial technology for natural resource management has been proposed as a mechanism to increase citizen participation in local initiatives, and as a way to socialise instruments that contribute into local social capital assets.

However, the adoption of these sorts of initiatives has the potential to trigger events closely associated with the political conditions inherent to every negotiation process, as its ultimate aim is to provide support for local groups making decisions and engaging with a diversity of stakeholders. In this sense, and given the objectives of the investigation, this situation represents a valuable opportunity to investigate and document the responses of the object of the study.

Vedung (1997, p. 18) argues that creating a framework for evaluation requires *'careful retrospective assessment of the merit, worth and value of administration, output and outcome of the Public Participation GIS pilot interventions, which are intended to play a role in practical action situations'*. With this in mind, I followed a rationale which suggested running iterative processes for the evaluation framework design as well as for the documentation and analytical stages. As a result, in my attempt to design a framework to document and collect data, actor-network theory ideas helped to continuously re-shape the focus of the evaluation, by elaborating on a set of indicators to provide a mechanism to document the impact of the interventions.

Initially related to the work of Michael Callon, Bruno Latour and John Law, actor-network theory's roots are related to the General Systems Theory (see von Bertalanffy, 1968). Emerging in the field of Science and Technology Studies during the early 1980s, actor-network theory originates from the need to understand and explain the interaction between technology and society. With this in mind, actor-network theory is conceptualised by Bruno Latour (1997) as a method to describe associations and connections between heterogeneous entities (i.e., all elements of the network).

Examples of an actor-network are the conditions under which rural communities agree to implement natural resource management initiatives with external actors. In this situation, actions and activities are reciprocally granted status by the interaction of nature, people, public institutions, private organisations, local values and traditions, texts, payments for ecosystem services and technology among others.

In building its network, the actor-network enrolls other players (actants), giving each an identity, a role to play, a course of action to follow, and projects to carry out (Callon *et al.*, 1986). In actor-network theory the notion of power plays a significant role as actants gain power by enrolling - translating - the interests of other entities into their own (Morris, 2004); entities are actors with power to act. *'In actor-network theory power is a property of a network not an individual (human) actor'* (Perillo, 2008 p. 195).

Actants in actor-network theory are disconnected from the ideas of scale, boundaries, proximity and hierarchy and as a result form heterogeneous associations (Allen 2011; Latour, 1997; Law, 1991). The latter characteristic enables actor-network theory to provide a uniform framework, regardless of the unit of analysis (Rhodes, 2009). The apparent chaos within the potential for endless associations, in addition to the principle of symmetry between humans and non-humans, are the pillars of the main criticisms.

However, the response to those critics is that actor-network theory offers the possibility to prioritize actants' relations over their characteristics, setting a place for non-humans in sociological analysis (Cerulo, 2009). From Latour's perspective, actor-network theory widens its object of study by including non-humans within a sociological perspective to relationships, aiming to flag controversies inherent in the object of study and it is most useful in the early development of a particular field (Pachucki and Breiger, 2010).

As an analytical approach, actor-network theory can be used to track patterns and ordering in the relations between such heterogeneous entities by describing how network effects are generated as a consequence of their locations (Perillo, 2008). Latour (1997) described actor-network theory as a network-tracing activity employed to explain what moves and how this movement interacts. As he argues, *'The key point is that every entity, including the self, society, nature, every relation, every action, can be understood as choices or selection of finer and finer embranchments going from abstract structure - actants - to concrete ones - actors -'* (Latour, 1997 p. 1).

In relation to the present investigation, I decided to adapt some of the principles of actor-network theory to help create an evaluation framework that would inform the collection of evidence on the outcomes of the interventions. To do so, the first step was to delineate a set of key ideas derived from actor-network theory:

- Identify interactions between society and technology by assuming that technology is only relevant if its usage occurs within local protocols.
- Bring out the infrastructure of rural communities technological innovation by describing the way in which local traditional systems work within their networks of action.
- Acknowledge the heterogeneous nature of actors in terms of their connections, limitations and advantages.
- Weight power relations by deducing actors' roles in relation to community protocols in an attempt to translate the understanding of such roles of power as a property of the 'systems'.

According to Rhodes (2009, p. 53), actor-network theory can contribute *'to encapsulate and address the issues that deal with how the technology will be embedded in the evolving social process of modernisation in developing countries'*. The purpose of adopting actor-network theory ideas was to understand the interactions involved between communities and technology as a result of the PPGIS implementation process, across and within several case studies. In this sense, actor-network theory concepts offered the possibility to prioritize actants' relations over their characteristics.

Once the ideas adopted from actor-network theory had been identified, the next step was to translate them into a series of key themes that could be further developed into analytical categories (see Table 2.5).

Table 2.5 Key actor-network theory concepts translated into themes for an evaluation framework design.

Key idea	Theme
Interactions between society and technology	Social structure IT skills
Bring out the infrastructure of rural technological innovation	Participation in development
Heterogeneous nature of interactions	External relations
Power relations	Power structures

In this sense, the contribution of actor-network theory to the exploration of the case studies was to enable a description, and to build an explanation, about the way in which technology usage is shaped by different levels of organisation within the context of natural resource management in rural communities (i.e., local participation mechanisms and the degree of external relations); and how each case study responded to the intervention represented by the pilot PPGIS implementation strategies, taking in consideration the different levels of social and political organisation, as well as previous exposure to technology within each community.

2.4 Guiding questions

Derived from the literature review presented in this chapter, I propose a series of questions to guide the investigation and answer in the Conclusions (Chapter Eight).

- Is the experience of other studies where public participation GIS (PPGIS) has been used for natural resource management in rural lower-income settings borne out in Mexico?
- What insights can actor-network theory provide into the interpretation of community case studies results?
- How important are pre-existing IT skills for the adoption of PPGIS schemes?
- How important are local power structures for PPGIS implementation?
- What other factors facilitate the adoption of PPGIS initiatives?
- Does PPGIS change the way of working in local communities?
- To what extent can geospatial technology usage by local groups effectively support social participation mechanisms for natural resource management global initiatives?
- What is the future of geospatial technology usage in common property regimes of rural lower-income settings?

3. RESEARCH CONTEXT

The purpose of this chapter is to describe the elements that constitute the context to the case studies on Public Participation GIS pilot implementation. The review focuses on four broad strands: traditions and diversity within natural resources management; recent political changes in Mexico; local knowledge and the impact of land and resources tenure; and environmental NGOs and payments for ecosystem services. To consider these elements the chapter has been divided in five sections.

Firstly, in Section 3.1 I describe Mexico's history in terms of the evolution of land tenure structures, pointing out the development of peasantry, and the inheritance of pre-Hispanic land administration forms and socio-political colonial structures, as the main features that have shaped the territorial organisation and rural identity of the nation.

Next, Section 3.2 refers to the political characteristics of modern Mexico as a private-corporation nation state. An explanation is given to illustrate the impacts of government discourses and interests on the consolidation of citizen presence and representativeness within the political sector.

In Section 3.3 I illustrate the relationship between local governance, the search for recognition of collective land tenure, and its effect on current strategies of natural resources management and conservation. Based on agreements between the members of the community, emphasis is given to the transformation of paradigms and the dislocation of authoritarian traditions represented by the community-based land-use planning framework.

Section 3.4 highlights the importance of socio-political boundaries within collective land tenure, and their relevance when planning and implementing mechanisms of cooperation and policy making. Under this topic, I discuss the activities of environmental NGOs within payment for ecosystems services schemes, and the implications of interactions between NGOs procedures, government policies and local community roles. As part of efforts to strength the position of rural communities, I anticipate the issues associated with government intervention in current payments for ecosystem services initiatives and recognize the potential conflict of a REDD+ (or REDD plus) national strategy.

Finally, Section 3.5 offers a description of the case study areas characteristics, outlining a series of variables with the potential to influence the results of technological interventions. Finally, Section 3.6 aims to summarise the ideas presented in the chapter, highlighting some key features which need to be kept in mind during interpretation of the case studies discussed in later chapters.

3.1 The *ejido* and its historical ancestry

As an initial reference regarding the general characteristics of Mexican history which are relevant to the study context, I propose a chronological review of the processes that have influenced rural land tenure systems. I give especial attention to the role that collective land tenure forms have played within events that have shaped the evolution of the country (Table 3.1 summarizes the characteristics of land tenure and land-use systems in Mexico's history).

Table 3.1 Characteristics of land tenure in Mexico from the Pre-Hispanic period to current time.

Historical period	Land organisation and tenure structures	Land-use systems	Natural resources administration
Pre-Hispanic	Altepeme-Calpulli	Subsistence crops	Traditional uses
Spanish colonization (1512)	<i>Encomienda</i> to Spanish soldiers	Introduction of cattle and 'new' European crops	
	Indigenous territories	Tribute goods and subsistence crops	
Viceroyalty (1520-1810)	<i>Haciendas</i> for Spanish farmers	Cattle, cotton, fruits among others	Extraction
	Concentration of indigenous population for doctrinal purposes		
	Isolated land for the use of indigenous population	Agriculture land protected from cattle	
Independence (1810-1817)	Continuation of the <i>Hacienda</i> model	Cattle and textiles	
Porfirio Diaz regime (1876-1911)	Privatization of communal land	Cattle and export goods	Build-up infrastructure
Revolution (1910-1920)	Agrarian reform: expropriation and re-distribution of land	Subsistence crops	
Cardenas presidency (1934-1940)	Community-based land tenure	Subsistence and commercial crops	Forestry and natural parks
	Private land tenure	Extensive cattle ranching and commercial crops	
Neoliberal reforms (1992)	Privately oriented tenure regime policy	Support to commercial crops (export oriented)	Conservation

The current community-based land tenure form in rural Mexico was the outcome of landless and deposed peasant farmer's demand for '*land and freedom*' that inspired the armed rebellion of 1910, known as the Mexican Revolution. The post-revolutionary *ejido* is an expanse of land, restored or

granted by the government to a community of beneficiaries. Under this land tenure form, the nation retains direct ownership of the territory, while villagers either in common or individually have the right to use it (Randall, 1996).

As a result of the agrarian reform and subsequent land distribution, Mexico's territory has been divided into 31,518 *ejidos* (INEGI, 2007). With an estimated 9,047 *ejidos* and indigenous communities holding some 50 percent of the croplands and up to 80 percent of the forest in the country, the *ejido* sector has vast implications for Mexico's rural environment (Bray *et al.*, 2006; Wexler and Bray, 1996). Therefore, this form of land tenancy has become a significant system of possession and safeguard of natural resources by rural communities.

The historical roots of the *ejido* can be traced to the *Altepeme-Calpulli*, a pre-Hispanic form of land administration in which social organisation was determined by small territorial units with independent government (Bernal, 2008). However, the Spanish conquest of Mexico interrupted the social and productive traditional relations of some indigenous groups, by entrusting Spaniards with a number of natives in order to promote the Catholic religion and get benefit from their work via taxation. The system known as *Encomienda* replaced the *Altepetl* government, giving power to the conquerors over the traditional productive system of the controlled indigenous territories.

Nevertheless, the coexistence of two territorial systems characterised the colonisation period: on the one side were the Spaniards who ruled entrusted holdings and progressively changed the traditional system into productive units, most of which were in the form of *haciendas* (large agricultural properties originating during the Colonial period). On the other side, and as a result of land displacement or territorial isolation, were indigenous territories that had managed to maintain their own social and productive organisation, while bound to the Spanish Crown through tribute exacted from them (Esteva, 1983). Together, indigenous territories as communities, and entrusted settings, the *haciendas*, formed the basis for the development and maintenance of the political ruling elite in the New Spain settlement.

The internal situation within communities and *haciendas* developed into a structure which became a significant element for the preservation of the cultural tradition of land usage and administration. The transformation of pre-Hispanic farmer-soldiers into rural workers, with different kinds of serfdom in between, constituted the basis for the uprising of the agricultural workers in a peasant movement (Esteva, 1983). This contrasting productive and social organisation between community and *hacienda*,

that characterized the development of peasantry, lasted beyond the Colonial period and was also associated with the omnipresence of the largest landowning institution in Mexico, the Catholic Church.

During the years of the Viceroyalty (1520-1810) a peculiar phenomenon among the ruling elite took place. Two new racial categories, strongly associated with power and authority, brought a new configuration into the administration and governance of the *hacienda* productive structure. The emergence of *criollos*, people born in the American continent, having both European-born parents; and *mestizos*, those who had one European-born parent and one who was native American, introduced a phenomena that diversified the power among the ruling elite and allowed a degree of diversity within the different productive and social practices of the time.

After the long period of Spanish hegemony during the Viceroyalty, and as a result of the diversification of leadership among productive structures, there was a move towards independence which took place in 1810. However the different degrees of domination experienced during the Viceroyalty allowed the indigenous communities to safeguard for their own benefit about 18 million hectares of land. At the same time, many of the workers on some ten thousand ranches covering more than 70 million hectares (35 percent of the territory) maintained community organisation among themselves (Esteva, 1983). The confirmation of the social rural organisation established during the Spanish occupation was a main element of support for the independence movement during the early 19th century.

In the fifty years following independence, Mexico experienced a prolonged failure of its inherited social and political structures, which maintained the operation of a class domination system typical of the Colonial period. The economic structure based on the exploitation of peasantry within the *hacienda* production model collapsed, and the absence of '*control*' over rural communities resulted in a certain degree of autonomy, though there was neither stability nor development. Countless uprisings characterised the constant struggle of the rural population against the power structures represented by the *hacienda*, which remained as the major productive structure (Esteva, 1983).

After years of instability and foreign intervention in Mexico, the establishment of the '*New Republic*' took place in 1876 under Porfirio Diaz, a retired member of the army, ex-president and *hacienda* landlord. However, the regime was characterised by electoral manipulation to support federation rule with practically no social policy implementation. During the thirty-four years of the Porfirio Diaz presidency, 90 percent of indigenous communities were deprived of their land in favour of private farming enterprises (Otero, 1989), while the *hacienda* sector received complete support from the

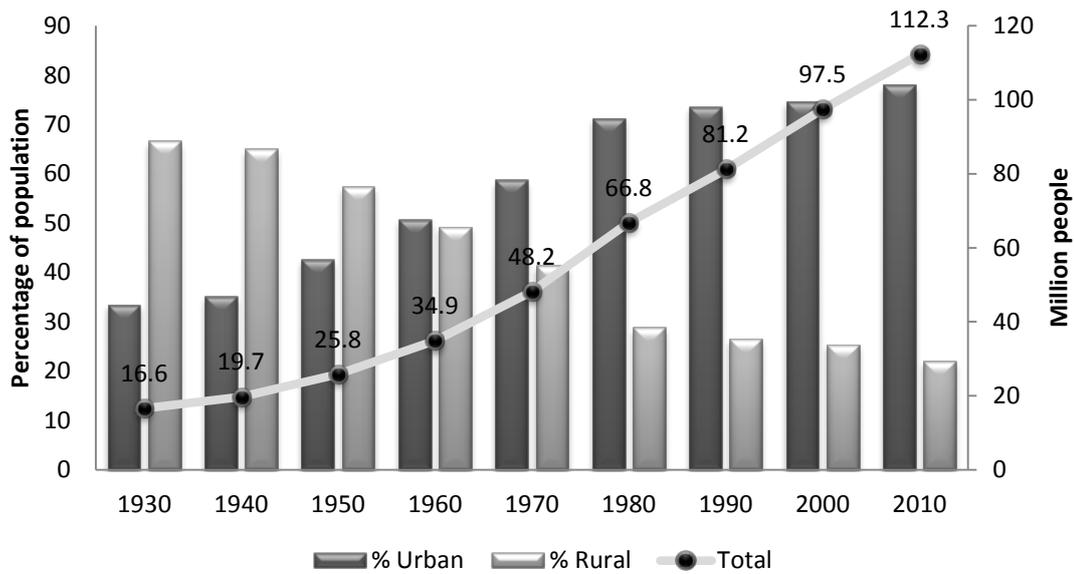
regime. As a result of the continuous land dispossession in favour of *haciendas*, and the effects of extended poverty across the country, peasant farmers and rural workers began to organise and elect village representatives to lead the rebellion against the inequity of the dictatorial regime. In addition, stimulated by an undelivered promise to call for elections in 1908, the political sector began to oppose the presidential designation of state governors and ministers.

By 1910, 97 percent of the land was owned by ranchers and *hacienda* landlords, 2 percent was designated as '*small properties*' and the other 1 percent belonged to peasant villages and indigenous communities (Toledo, 1996). Under this scenario the Mexican Revolution began and developed as an eleven year civil war. During the rebellion, peasant farmers and agricultural workers supported by the political opposition became members of territorial armies whose objective was to sabotage the interests of the economic beneficiaries of the regime.

Some political scientists conceptualise the Mexican Revolution as a political rather than a social revolution because it did away with a highly exclusionary political regime, one in which political power was based on landownership (Otero, 1989). Others describe the revolution as a territorial conflict in which the peasantry organised a rebellion to defend the right to maintain their own traditions within their towns and villages (Womack, 1969). Independent of the interpretation of the conflict, the Mexican Revolution and the Constitution Act of 1917, allowed the expropriation of large landholdings for re-distribution among landless peasants, giving origin to three types of property: small private property, communal property (indigenous land), and *ejidal* property. Additionally, it prohibited religious institutions from possessing any land unrelated to their functions.

Between the revolution (1910-20) and the Cardenas presidency (1934-40), a limited re-distribution of land took place and only 6 percent of the area ultimately affected by land reform was allocated (Thiesenhusen, 1996). During the Cardenas presidential period, the largest grants of *ejido* land took place, about 10 percent of Mexico's territory was expropriated from *haciendas* and redistributed to landless peasant farmers (Katz, 1996). The nationalisation of oil and rail infrastructures characterised the creation of the modern social fabric: labour unions, peasant grassroots organisations, and the consolidation of the post-revolutionary political ruling elite. In addition, a demographic shift took place as a result of internal migration from rural to urban areas, influencing the configuration of what today is an urban industrialised economy (Figure 3.1 shows the proportion of urban and rural inhabitants in Mexico as well as population growth between 1930 and 2010).

Figure 3.1 Representation of urban and rural population behaviour in Mexico between 1930 and 2010.



Data source: General Census of Population and Housing 2000 and 2010 (INEGI 2011; 2001).

However, with the reactivation of the rural sector, serious social and environmental repercussions occurred. On the one side, the custodians of the natural capital did not receive direct benefits from its appropriation, while an explosion of land-use and land cover change processes took place in areas of high environmental value due to the inability of the nation to achieve minimums of social wellbeing for the rural population. On the other, public policies and subsidies encouraged the deforestation of remote and undisputed areas for agricultural activities, and the subsequent land use transformation of natural ecosystems, resulting in the separation of community-based forestry and local natural resources management policies from the economic priorities of the country (Sarukhan et al., 2009).

After seventy years of an institutionalised land distribution process of more than one hundred million hectares of land (equivalent to twice the area of Spain; half the land area of Mexico), in 1991 the most extensive legal modifications to the agrarian system took place since its creation during the Constitution Act of 1917. The presidential reforms to Article 27 and then in 1992 to the Agrarian Legislation, put an end to the distribution of land and introduced the possibility to privatise rural social property and the natural resources included on it (Whiteford and Bernal, 1996). The agrarian reforms, along with the elimination of a grain pricing policy and the privatization of rural state enterprises, laid the basis for the signing of the North American Free-Trade Agreement (NAFTA) between Canada, the United States of America and Mexico (Grammont and Mackinlay, 2009).

Alongside the 1992 neoliberal reforms, an important negative effect has been the increasing loss of control over the use and occupancy of *ejido* land. Trading processes have emerged in the rental and sale of land for purposes other than farming, having as a consequence further fragmentation of rural communities (Barnes, 2009). A prime example of the convergence between deteriorating trends in biodiversity and the weakening of the *ejido* is the fragmentation of areas of common use, mainly the forests and woodland belonging to village communal landholdings located in southern Mexico (Sarukhan *et al.*, 2009).

The multiple roles the *ejido* has played within Mexico's transformation are complex and often ignored. Its cultural importance stems not only from the historically rooted mechanism of land administration, but also in the ideals of social equity stated by the armed rebellion of 1910. Additionally, what the *ejido* represents in theory introduces the possibility of allowing the protection and management of natural resources by local communities, and the subsequent conception of a natural resources administration system in the hands, and for the benefit of, the legal owners of the natural capital.

Although as a land tenure system, the *ejido* provides a local governance structure for organising political and economic activity (Newton, 2007), in rural communities this has been used as a political mechanism of control and an electoral tool. From this perspective, the 1992 modification to the agrarian law not only was, and is, an anti-peasant mechanism and a stimulus of social conflicts, such as the indigenous uprising of 1994 in Chiapas (Harvey, 1996; Randall, 1996) but also a central cause of new and more extensive environmental and natural resource depletion (Toledo, 1996). For all of these reasons, I employ the *ejido* as a means of explanation and interpretation of the impact that land and resources tenure plays within the social and environmental structures of the country.

3.2 Recent political changes in Mexico

In addition to land reform, and as a result of the struggle against government authoritarianism, during the last thirty years a group of social actors has emerged with a set of citizen claims which have forced the transformation of government practises. In Mexico, civil society was born as a result of inequalities which had a historical heritage, but were also the consequence of the political dictatorship by the ruling state party, and consequently, unlike the experience in Eastern Europe, in Latin America the term civil society is defined in terms of opposition to the state but also against the market economy.

As a result of the 1960s political and military repression in Mexico, during the 1970s *'dirty war'*, union leaders and students persecuted by the state, sought refuge in rural communities of southern mountainous regions. In that period they participated in the creation of community-based social organisations oriented to educate and disperse left-wing ideology among rural and peasant grassroots organisations. Despite systematic persecution by state secret police and paramilitary groups, community-based groups became established and managed to constitute an alternative ideological model for the grassroots sector of the civil society organisation movement.

By the end of the 1980s, the political positioning of civil society groups had been further defined by three major events. In February 1982, the Mexican peso suffered a substantial devaluation against the U.S. dollar, and in combination with the collapse of crude oil prices, public debt increased. The consequences were reflected in increased unemployment and the creation of the northern border manufacturing sector which lowered the working rights and salaries of the Mexican population. Both events marked the beginning of the application of an aggressive neoliberal model by the Mexican government and resistance to its policies by civil society groups.

In September 1985 a series of earthquakes hit Mexico City causing the death of at least ten thousand people (there are no official figures) and because of the federal government failure to help the victims of the disaster, a major divide in terms of social organisation and representation took place in which the economic and political centre-left witnessed a massive increase in NGOs. By the end of the decade, and following the digital electoral fraud of 1988, NGOs coalitions had also become organised as networks of citizen observers on electoral processes. At this stage, the NGO sector also experienced a major transformation as it began to modify its internal structure from a majority of grassroots activists and academics to a new configuration including a ordinary citizens and intellectuals (Reygadas, 1998).

After the organisational challenges and learning experiences during the 1980s, by the 1990s Mexican civil society had more than two decades of active and continuous organisation. On the international scene, new challenges brought further developments. As a result of the NAFTA negotiations with Canada and the United States of America, public protests took place and social movements formed national and international coalitions between academics, grassroots movement leaders, trade unions and peasant farmers. A strong network of NGOs was created; its objective was to force re-negotiation of the free-trade agreement on issues like immigration policy, labour markets, the energy sector, environmental protection, law enforcement, access to information, and to include social and human rights in the agreement.

A key year in the further development of civil society organisations was 1994. On the first of January, an indigenous armed movement, the Zapatista Army of National Liberation (EZLN) declared war on the federal government in opposition to the neoliberal policies adopted in the NAFTA; the uprising had the support of other guerrilla groups established in various states. In March and September respectively, the ruling Institutional Revolutionary Party, the presidential candidate and his general secretary were murdered due to political differences with president Carlos Salinas. By December, the Mexican peso lost half of its purchasing power against the U.S. dollar resulting in a further increase of public debt.

As a consequence of the social destabilization due to events in 1994, citizen movements sought the need to confront the political and economic power structures by establishing new forms of citizen participation. The aim was to stop the violation of human rights of the EZLN's social base (rural indigenous people from southeast Chiapas), as well as to put an end to the secrecy surrounding political negotiations, privatization of state-owned industries and international trading agreements. The trajectory of two decades of social organisation saw its consolidation during the late 1990s when local, small-scale civil society organisations began to formulate new ways of interaction and coordination as social actors, looking for a more relevant impact on regional and national public affairs (Reygadas, 1998).

After the highly criticised '*democratic election*' process of 2000, in which the ruling political party lost its hegemony after more than seven decades in power, the elected right wing government continued with the same pattern of civic violations, hidden economic negotiations and neoliberal policy implementation characteristic of bureaucratic authoritarian industrialising regimes. However, under the '*democratic transition*' social groups demonstrated growing discontent against the governmental-driven policy to weaken and dissolve different union sectors in the country. Additionally, new cases of human rights violations emerged with unprecedented examples of federal government negligence regarding gender violence and human rights in northern border towns (Tijuana and Ciudad Juarez are among the most notorious cases).

In 2006, Mexico's current president assumed power with less than 0.56 percent margin over the left-wing candidate, despite the opposition of three political parties, civil society observer groups and intellectual leaders due to serious concerns about irregularities during the voting process. Since then, Mexico's authoritarian right wing regime has pursued a major militarization of the country, accompanied by systematic human rights' violations from government armed forces against civilians. In the almost six years since the '*war on drugs*' began, there have been more than 60,000 '*war-related*'

fatalities (Presidencia de la Republica, 2011; Semanario ZETA, 2011) and an estimated 220,000 displaced citizens (Internal Displacement Monitoring Centre and Norwegian Refugee Council, 2011; Parametria, 2011) as a result of this strategy to deal with drugs and weapons trafficking in the country.

During the last three decades, the governance of the country has seen major changes in power relations. In the last ten years, Mexico has fully turned into a private-corporation nation state ruled by economic interests favouring privatisation of national strategic areas (i.e. energy, telecommunications and transport infrastructure sectors), while in 2002 50.6 percent of the population lived below the national poverty line (World Bank, 2011). After the collapse of the PRI ruling elite in the year 2000, and a failure to tackle administrative reforms by the authoritarian government, the country has descended into a situation of increasing corruption and violence.

Although the current state of the country reflects the collapse of the federal government leadership and operational structure, civil society organisations have consolidated their presence and role within the political system and their achievements have left a series of lessons and implications. Discussions within the civil society sector in Latin America suggest the need to establish a new paradigm, in which international NGOs and cooperation agencies explicitly see citizenship as the only meaningful foundation for development and participation (Grugel, 2000), in opposition to the traditional and paternalist behaviour of supporting the creation of an unlimited number of NGOs for specifically driven problems.

According to evaluations conducted by citizens and academics, the Mexican experience suggests that when there is a strong tradition of government control, the social demand for democratization tends to be located in independent sectors, marginal to the system; and that government offers of participation are not only limited, but tend to rework such tools with control mechanisms, accentuating tensions which alienate progress.

Despite the changes and achievements of Mexican civil society during the past four decades, the economic and political structures in the country have continued to operate under the same authoritarian and exclusionary way. In addition, the configuration of the country as a federation has clear repercussions for the availability of information and the ability to build regional civil society networks. The later has particular implications for rural communities, especially those located in remote areas, as the possibility for networked civil society organisation has tended to be limited depending on the basis of individual NGO initiatives.

3.3 Local communities and natural resource management

So far, the present review has focused on those historic and national events that triggered agrarian reform, as well as shaping the relationship between the government and citizens. The purpose of this section is to introduce the situation in which local communities operate and their position within wider power relations in Mexico.

While the vast majority of rural communities are excluded from the government's minimum instruments to incentivise local development, those communities with forest resources are renowned for the strong association between cultural traditions and natural resources management. The latter is largely attributed to the practical expertise obtained as a result of the interaction between traditional knowledge, or what can be recognised as Geographical Knowledge Systems '*GKS*' under Taylor's (1990) '*contemporary parlance*', and the social cohesion resulting from collective land tenure. However, this does not mean that the majority of such communities effectively execute their collective organisation, have long term land-use planning or have specific norms for access, use and management of the natural resources in their territories (Chapela, 2006).

In order to contextualize the problematic surrounding rural communities' territories and resources, I open this section by defining the connection between community and *ejido* as I refer to the internal governance structure. Next I outline some regional characteristics of *ejidos* in Chiapas, and conclude with a review of the conditions by which collective *ejidos* make use of their natural resources within the community-based land-use planning framework.

3.3.1 Internal governance of the *ejido* and regional attributes in Chiapas

A community, within the context of the present study, can be defined as a set of social groups with a common history, a territory with specific environmental conditions, particular practices that define its culture, and a form of social organisation within certain political and economic structures (Arreola, 2006). Each community has a particular attitude towards change and a perspective on struggle, resistance and vindication. In rural Mexico, a community finds its cohesion and territorial identity under the legal administrative form of the *ejido*.

In some *ejidos* land property is collectively owned and, generally speaking, there are three different land tenure regimes within: a zone with individual house lots; the arable land which is divided into individual agricultural parcels; and areas of collective use such as water bodies, grassland and woodland. Collective areas function as the *ejido* reserve, by offering *ejido* members mechanisms to diversify their sources of income, or protection against unexpected events. Complementary activities like firewood and timber supplies, food collection, as well as hunting and ecotourism, are directed at local consumption and play an important social role.

The number of *ejido* members (beneficiary landowners) is set in the original *ejido* title and members may only cede or will their land to a single individual. Internal governance in the *ejido* is responsibility of three elements which are renewed every three years (see Table 3.2). Other stakeholders in the *ejido* include community residents and land possessors, who may be working the land through a formal or informal agreement with a member. Even though these land possessors and residents live and work in the *ejido*, they have no voting rights and are not legally regarded as members of the *ejido*.

Table 3.2 Schematic description of governance structures in the ejido system.

General Assembly	Ejido Assembly Commission	Supervisory Council
<p><i>The ultimate authority</i></p> <p>Comprised of all <i>ejido</i> members and decisions are made by majority vote</p>	<p><i>General administration</i></p> <p>Responsible for implementing agreements made by the General Assembly</p>	<p><i>The ejido watchdog</i></p> <p>Ensures that General Assembly decisions comply with Mexican law and internal regulations</p>

According to the Agrarian Law of 1915, it was the responsibility of each state to expropriate, divide and distribute large *haciendas* among landless peasants or former plantation and ranch workers, as well as to determine the maximum area any individual could own (Womack, 1969). In Chiapas, however, both of these principles were successfully resisted by the dominant families, and instead of redistributing property, and as a strategy to avoid social conflict, the federal government promoted the colonisation of remote forested regions (Harvey, 1996).

In contrast to the local governance structure in collective *ejidos*, and as a result of the collusion between private interests and state power, there is an absence of legal structure on land ownership

and local political power in other rural areas, which is expressed in continuous confrontations between politically divided territories and grassroots organisations in Chiapas.

3.3.2 Community-based land-use planning: a framework for collective interest

The current relationship of indigenous and peasant communities with their territories through land-use planning, and the subsequent rationalisation of natural resources management, has been the outcome of historic influences, limitations and requirements. With the implementation of the agrarian reform, the *ejido* unlocked the opportunity to restore historical traditions of collective organisation, long term land-use planning and design of specific norms for access, use and management of the natural resources.

However, despite the legal landownership and entitlement for natural resources administration that land distribution opened for collective *ejidos* and indigenous territories, since the Cardenas presidency (1934-40) the federal government has granted private concessions to foreign companies in order to control and extract forestry resources intended for the paper industry (Bocco *et al.*, 2001a; Bray and Merino, 2002). After four decades of external exploitation of local forest resources in the early 1980s collective *ejidos* dispossessed of their forestry assets regrouped themselves as grassroots peasant organisations, and claimed their land and resources rights to generate profits from the protection and use of their natural capital.

As a result of these grassroots efforts against the private concessions made to paper companies, Mexico's community-based forestry sector has developed remarkable examples of local management of its natural capital. These examples combined environmental conservation and economic viability, in a context of community-based land-use planning for natural resources management, driven in large part by the communities themselves, as owners and custodians of the natural capital (e.g. Purepecha groups in Nuevo San Juan, Michoacan; Zapotec communities in the Sierra de Juarez, Oaxaca; Maya villages of Quintana Roo managing the *Plan Piloto Forestal*; and many other community-based rural organisations across the states of Chihuahua, Durango and Chiapas).

In this context, a collective *ejido* has to fulfil several requirements to ensure the wealth of its citizens. In relation to the use and management of forests, pastures, water and communal land, the community-based land-use planning framework consists of rules which define who has access to such

resources, the restrictions on and characteristics of use, and the criteria for distributing the resulting benefits. In contrast to public resources, the benefits of common resources, which are neither public nor individual property, are distributed in relation to the effort and work invested by each *ejido* member (Chapela, 2006).

The requirements to carry out a community-based land-use planning procedure represent a transformative paradigm, due to the dislocation of authoritarian traditions which go back to the Colonial period. Instead of the priest, the *hacienda* landlord, the supreme government or the specialist sent by a politician, the decision of what to do with the community's territory and natural resources is established by a framework agreed between the members of the community (Chapela, 2006).

When operating alongside collective community-based land-use planning practise, the application of a governmental conservation programme on natural resources administration has often resulted in territorial administration conflicts. Natural protected areas have faced jurisdictional problems when they include *ejidos* partially or totally within their boundaries (Wexler and Bray, 1996). In some cases, such as in La Sepultura and Montes Azules biosphere reserves in Chiapas, the *ejidos* were there before the protected area decree.

According to some critics, the schemes for protected areas and management units for wildlife conservation, along with sustainable forest management and ecotourism, which came about as a result of the restructuring of the Ministry of Environment in 2000 have brought about more conflicts than solutions, in opposition to the official perspective which acknowledges them as '*economically viable*' and '*environmentally sound*' (Sarukhan *et al.*, 2009). In addition, social and natural capital, cultural perceptions, traditional knowledge and common property rights within indigenous and peasant communities constitute key components of the wider territorial diversity which have not been fully recognized by the institutions of the state (Klooster, 2003).

In contrast to the conflicts originating from the conservationist paradigm, the community-based land-use planning framework has been acknowledged as an effective local planning instrument for programmes aimed at strategies for social development and natural resources management and conservation (Arreola, 2006; Bocco *et al.*, 2001; Boege, 2009; Bray *et al.*, 2006; Chapela, 2006; Klooster, 2003; Toledo *et al.*, 2001). These programmes have also been instrumental in the design of economic tools, such as fees for access rights to natural protected areas, certification of '*sustainably managed*' forests and payments for ecosystem services (Cervantes *et al.*, 2008).

The initial work carried out on payments for ecosystem services (PES) schemes has been conducted by environmental NGOs due to the conception of an alternative paradigm for natural resources policy implementation, and because of the mistrust by local communities, and the historical ineffectiveness of government agencies in addressing and conducting environmental problems within the wider social and politic development context. Paradoxically, the major critique of NGOs programmes to offset CO₂ emissions is that they limit the autonomy of local governance to assess the financial mechanisms within ecosystems services schemes of community participation (Corbera and Brown, 2010; Corbera *et al.*, 2010).

The economic opportunities within ecosystem services schemes facilitate the interactions between NGOs and producers while buyers enjoy the benefits derived from such investments. At the same level, such initiatives have been subject to government intervention (e.g. to institutionalise practises oriented to a national REDD+ strategy), resulting in a struggle for the recognition of local powers and environmental governance traditions to dispose of natural resources and assets (De Ita, 2010; Enciso, 2010; Goldtooth, 2010; Phelps, *et al.*, 2010; Ribeiro, 2010).

3.4 Environmental NGOs and markets for ecosystem services

During the last decade efforts to offset greenhouse gas emissions have resulted in programmes to bring together international initiatives to mitigate such problems with NGO-supported cooperative management and conservation of natural resources associated with rural development (e.g. PES schemes). However, the impact of such activities in rural Mexico has been limited because of the disparity between local authority roles on one side, and government and NGOs structures on the other: the problem of power relations in the Mexican context.

This is not to suggest that initiatives for PES in general are misconceived. In order to analyse the evolution of local governance and its role within PES initiatives, I present a brief account of the development and evolution of the environmental NGO sector. Next, and as an attempt to understand the challenges and associated problematic surrounding the different actors involved, I present an example of the more general activities in which a Mexican NGO is involved as part of a PES initiative with local rural communities in Chiapas.

After the 2009 United Nations Climate Change Conference, the scope for private investor participation in programmes for reduction of greenhouse gas emissions from deforestation and forest degradation (REDD+) was severely constrained (Corbera *et al.*, 2010). As a result, REDD+ activities are likely to be coordinated and led by governments, with sub-national activities being developed in cooperation with government agencies, promoted by local private or public sectors (Corbera and Schroeder, 2011).

In the Mexican case, environmental NGOs can take advantage of the different degrees of social organisation and territorial configuration of local communities in order to adopt and integrate local practices from the community-based land-use planning framework into the PES scheme (i.e. *Plan Vivo*). However, the intervention of government officials into relations between environmental NGOs and local communities is a major concern due to the role that the different actors may play within the imminent execution of a REDD+ national strategy. If it is to be efficient and inclusive, REDD+ will have to address corruption and authoritarian practices within Mexican government, as well as the problem of reconciling control mechanisms with access to the regional networks of civil society organisations.

3.4.1 Origin and development of environmental NGOs in Mexico

It was during the 1990s that environmental NGOs were recognized as key actors in shaping policies throughout Latin America, particularly after the 1992 United Nations Conference on Environment and Development. Following the Rio Summit, a series of cutting-edge NGOs began to appear in Mexico. These organisations focused on two major issues: the anti-pollution and anti-nuclear power movement, and those involved in sustainable rural development work with peasant grassroots organisations (Fox, 1994). At this stage, some of the social movements initiated by politically and military persecuted citizens who sought refuge in rural areas during the early 1970s saw the possibility of emerging from their anonymity, under a period of tolerance and relative freedom due to the role played by international activists in Mexico.

Chiapas, as with other politically and socially vulnerable states in Mexico, witnessed the transformation of different grassroots movements into the first generation of NGOs during the 1970s. Their purpose was to contribute to the improvement of living conditions for rural and indigenous sectors by promoting local development projects. During that initial phase, the first local NGOs coordinated with some civil society organisations, including Catholic Church community-based rural organisations, and sought to engage with peasant and indigenous communities on a diversity of issues

like community health, gender projects, rural technology, education and human rights (Reygadas, 1998). Despite the close relationship with the communities any further NGO promotion was limited by the authoritarian and repressive actions of federal and local governments in the region.

During the political transition between the 1970s and 1980s, local NGOs in southeast Mexico began to rely more on the network of civil organisations due to the requirements of dealing with more than a quarter of a million Central American refugees. At this stage, the liberation theology sector of the Catholic Church joined NGO efforts and established a partnership which served as a strong basis for the appearance of the civil society movement in the 1990s. At the same time, the need to generate a political voice by people concerned about environmental issues stimulated locally-based environmental NGOs.

During the 1980s, environmental NGOs working closely with community-based organisations were involved in the creation of rural development programmes with peasant organisations in regions of intense biodiversity (e.g. organic coffee producers in the Highlands region of Chiapas) or in areas vulnerable to industrial and toxic waste management (e.g. Laguna Verde nuclear power research facility on the Gulf of Mexico coast). By the 1990s, environmental NGOs began to shift approach from traditional conservation, which tended to exclude community participation, to more responsive sustainable resource management programs in regions of political and social conflict (Fox, 1994); and as a result these groups started to work in a more participative way, including community leaders, government agencies, and international promoters: the wider civil society.

After some decades of experience with environmental NGOs, the community-based sector has learned what Price (1994) identifies as their limitations. Although NGOs deliver mechanisms of cooperation in crucial areas, they are not a replacement for sound policies and enforceable laws (Klooster, 2006); independent of their nature, NGOs are private organisations and it is therefore difficult to know how well these organisations represent popular concerns. Finally and most important, there is the question of whose voice is being heard and whose environmental needs are being addressed (Chambers, 2006; Rambaldi *et al.*, 2006).

3.5 Regional context

The aim of implementing a comparative PPGIS experiment in rural *ejido* regimes arose from my interest in the growing level of exposure to technology, green innovation initiatives and government programmes which local communities with collective governance protocols have experienced in recent years. In this sense, the scoping process of this investigation consisted of establishing contact with rural organisations involved in forestry resources management in southern Mexico, as in those regions there are a number of communities with relevant social organisation and common property regimes.

However, the outcomes of the initial contacts during 2007 were not successful due to the reluctance of the forestry cooperatives to participate in the implementation of the PPGIS schemes. Limited contacts and communication gaps were particular obstacles. In one specific case, there was initial interest in the PPGIS pilot initiative. However, by the time of scheduling a visit to present the project to the communities, no clear agreement could be reached.

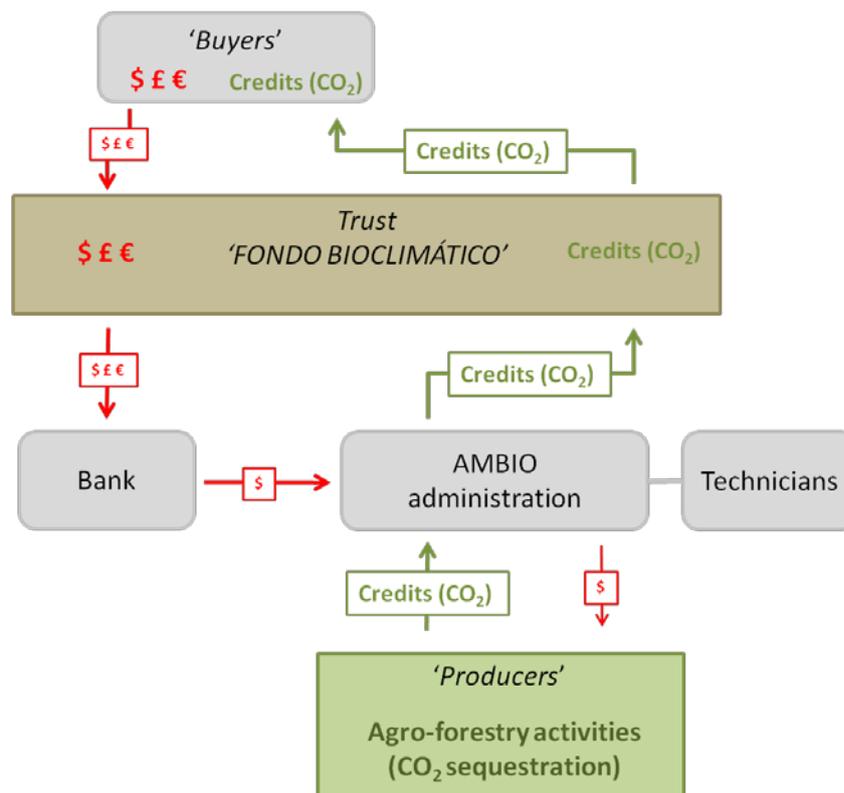
After assessing the strategy involved in this first approach, a renewed effort consisted of establishing contact with intermediary civil society organisations. In March 2008, a response from FORO A.C. (Forum for Sustainable Development), a civil society organisation engaged with sustainable management of natural resources by indigenous and peasant groups in Chiapas, included an invitation to visit their organisation and present the PPGIS project to generate initial contact with a group of local environmental NGOs in San Cristobal de las Casas. FORO's support and feedback on the PPGIS implementation protocol facilitated the approach to local NGOs, which generally speaking, offer support services that rural communities increasingly require, especially in the areas of credits, marketing, and technical assistance.

Following initial interviews and presentations of the PPGIS project to different civil society organisations, dedicated to promote cooperative management and natural resource management initiatives among peasant and indigenous communities in Chiapas, the establishment of a collaboration agreement with a Mexican NGO took place. Ambio administers the Plan Vivo programme, a carbon-forestry project related to voluntary carbon markets (Corbera and Brown, 2010).

3.5.1 The Plan Vivo carbon programme

In 1994, a research project funded by the United Kingdom Department for International Development (DFID) culminated in what today is known as the *Plan Vivo* system, which is a carbon management framework for community-based land-use projects in developing countries (Kollmuss *et al.*, 2010). By 1996, the initial research had led to the development of a pilot project in Chiapas. The pilot developed into the *Scolec-Te - Plan Vivo* regional project, for which a non-profit trust fund was created in 1997. The *Fondo Bioclimático* trust is the international body in charge of administering *Plan Vivo* initiatives in a group of developing countries, and Ambio is the non-profit organisation created for its coordination in Mexico (see Figure 3.2 for general overview of the *Scolec-Te - Plan Vivo* organisational structure).

Figure 3.2 Description of the *Scolec-Te - Plan Vivo* regional project for which the non-profit organisation Ambio was created to administrate local projects in Chiapas Mexico.



Within the *Fondo Bioclimático* trust, Ambio's role is to recruit producers (project participants) and coordinate the training involved in the *Plan Vivo* system. Simultaneously, the NGO oversees project administration, technical monitoring, negotiation of purchase contracts with carbon credit buyers, and coordination of agreements with producers, including the distribution of carbon payments.

On the other side of the *Plan Vivo* structure, producers are small-scale peasant farmers, forest dwellers and other land users with recognised land tenure rights. The idea of the project is that producers get paid for planting and maintaining trees to offset greenhouse gas emissions. The *Plan Vivo* system requires the producers to design land management plans called '*living plans*' by combining existing land-use configurations and agricultural activities with agroforestry initiatives, including the protection of primary forest and woodland.

3.5.1.1 Ambio

Ambio is a Mexican NGO dedicated to administration of a carbon-forestry project. This is linked to voluntary carbon offset markets for the exchange of standardized Verified Emissions Reductions (VERs) where individuals and companies reduce emissions over and above the mitigation goals set by regulations with an interest in becoming more environmentally friendly (Corbera and Brown, 2010). Ambio is a relatively small organisation and consists of three parties: researchers working as scientific advisors from Edinburgh University; researchers designing methodologies and selecting areas of interest from a Mexican research centre, ECOSUR; and the operative personnel.

Ambio develops the *Plan Vivo* system in collaboration with peasant farmers holding *ejido* membership and communities. The carbon monitoring strategy has a procedure in which skills are transferred gradually to selected community leaders and some other participants known as community technicians. The verification of the reported conditions is conducted by Ambio and occasionally contracted externally.

Additionally, the NGO administers the capital flows between buyers and producers. The communities receive 60 per cent of expected carbon revenues during a 10 years period, while the remaining 40 per cent is used by the NGO to cover management costs. As a cooperative structure, Ambio re-invest the profits from its administration fees.

The reputation and experience gained as a result of pioneering a carbon finance system in Mexico has opened up the possibility for the NGO to share experiences for a REDD+ national readiness strategy, coordinated by the Ministry of Environment (SEMARNAT) and several of its associated institutes and agencies. Ambio has collaborated with government agencies in the design of carbon offsetting programmes, one example being the National Forestry Commission (CONAFOR) programme on PES.

3.5.2 The community case studies

In relation to the unit of analysis, the main interest consisted of implementing and examining the pilot Public Participation GIS implementation processes, while understanding the perspective of those directly involved in the safeguard and administration of natural resources at a local scale. For this purpose, the PPGIS experiment sought to engage and observe local groups responsible for conducting such natural resource management activities. Accordingly, and following the comparative emphasis of the research design, the agreement with Ambio focused on getting access to four communities, initially taking into account two main factors.

On the one hand, the degree of involvement in payments for ecosystems services programme (in this instance previous experience within the Plan Vivo carbon sequestration initiative), selecting two villages with various years of existing experience, and two more considered as potential participants of the carbon sequestration programme. The other factor considered in the comparative design was the actual degree of local experience with natural resource management activities, these being a direct result of productive diversification of economic activities derived from a natural resources management initiative, namely the way in which each community structured their local development projects.

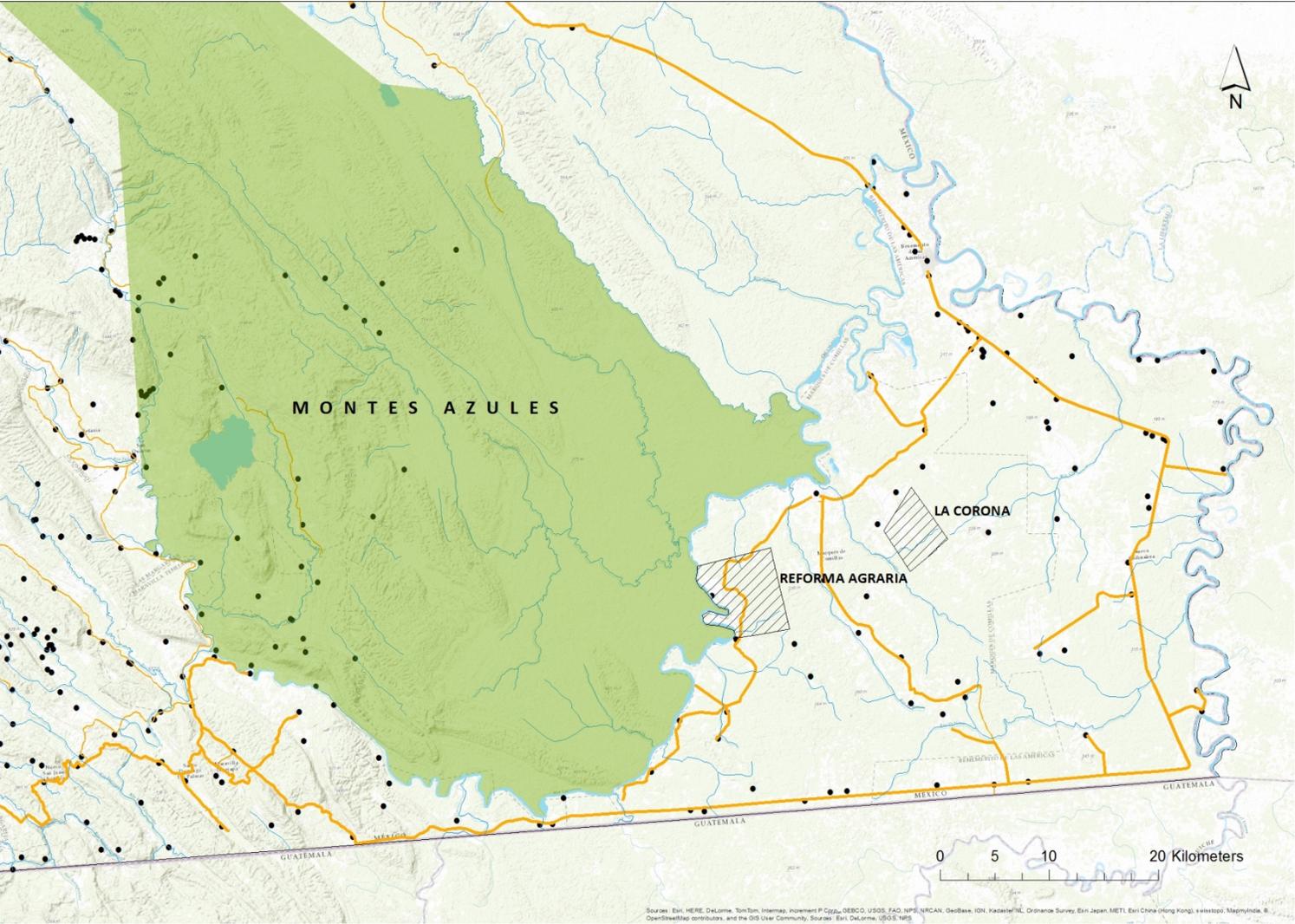
After considering Ambio's opinion and suggestions regarding the participating community case studies, an initial agreement was reached. Due to the interest in getting the support of the NGO, and to guarantee the duration of the implementation processes, it was important to make a concession in relation to the communities which were already participating with the carbon sequestration initiative. Similarly, the NGO aspired to include in this experiment two of their most successful cases, also filling a quota within the organisation's internal interests.

As a result of the negotiations in relation to the selection of the participating communities, Ambio proposed two communities. La Corona and Reforma Agraria, in the Marques de Comillas Region, located next to the Montes Azules Biosphere Reserve. Similarly, Sierra Morena and Tres Picos were selected from among several options, mainly because their potential as participants of the carbon sequestration programme, and because of their location inside of La Sepultura Biosphere Reserve, contributing to the analysis with a different territorial organisational model, in comparison with the first two communities proposed by the NGO. Figure 3.3 gives an overview of the study areas, while Figures 3.4 and 3.5 provide more detail.

Figure 3.3 Overview of the study areas in Chiapas, Mexico. On the left hand side it is possible to see the location of Tres Picos and Sierra Morena, inside La Sepultura Biosphere Reserve. On the Right hand side, it is possible to appreciate the location of La Corona and Reforma Agraria, next to the Montes Azules Biosphere Reserve.



Figure 3.4 Location of La Corona (2,265 hectares) and Reforma Agraria (4,755 hectares), community case study areas located next to the Montes Azules Biosphere Reserve, decreed in 1978 with an area of 331,200 hectares. The biosphere reserve is surrounded by 1,300 settlements with an approximate total of 500,000 inhabitants.



3.5.3 Study areas description

The colonisation of Chiapas State in southern Mexico, and resulting rapid population increase due to government induced immigration, generated large areas of previously non-disturbed forest being cleared, mainly for extensive cattle grazing. Government policies during the 1970s and 1980s encouraged the settlement of farmers to alleviate population pressure on other parts of the country (Castillo et al., 2007). Due to its geographical location and diverse topography with a variety of climatic conditions, Chiapas has a natural base an abundant reservoir of forests, water and biodiversity, resulting on a unique ecological richness (Nelson & de Jong, 2003).

In contrast to its ecological abundance, Chiapas is considered as one of the poorest states in Mexico (World Bank, 1995). Subsistence agriculture and cattle ranching are the most widespread economical activities, traditionally involving a system of shifting cultivation, in which forest is cleared both legally and illegally, to grow maize and beans in a labour-intensive rain-feed system, which subsequently is transformed in grasslands. However the ecological richness, I suggest social exclusion as the main driver for environmental degradation in Chiapas. Between 1975 and 1994, net forest loss was estimated at an average rate of 37,000 hectares per year, accounting for almost 10% of Chiapas territory (Carabias *et al.*, 1999).

Although socio-economic and political conditions vary widely across Chiapas State, the purpose of this section is to distinguish between the two regions in which the present investigation took place: La Sepultura Biosphere Reserve and Marques de Comillas Municipality (see Table 3.3 for a summary of the key elements considered for the selection of the community case studies).

Table 3.3 Comparative elements within community case studies: proximity to a biosphere reserve, local economic activities and Plan Vivo project status.

		Proximity to a biosphere reserve	
		Next to a biosphere reserve	Inside a biosphere reserve
Economic activities	Traditional activities	La Corona	Tres Picos
	Alternative projects	Reforma Agraria	Sierra Morena
		Ongoing participants	Potential participants
Plan Vivo project status			

3.5.3.1 La Sepultura Biosphere Reserve

La Sepultura Biosphere Reserve covers an area of 167,309 hectares, with an altitudinal gradient going from 60 meters above sea level in the Pacific Ocean slope, to 2,550 meters above sea level in the highest peak in the region located in the ejido Tres Picos. Tropical humid and sub-humid climates, including temperate sub-humid climates are characteristic of La Sepultura (see Figure 3.6 for a climatic map of the biosphere reserve).

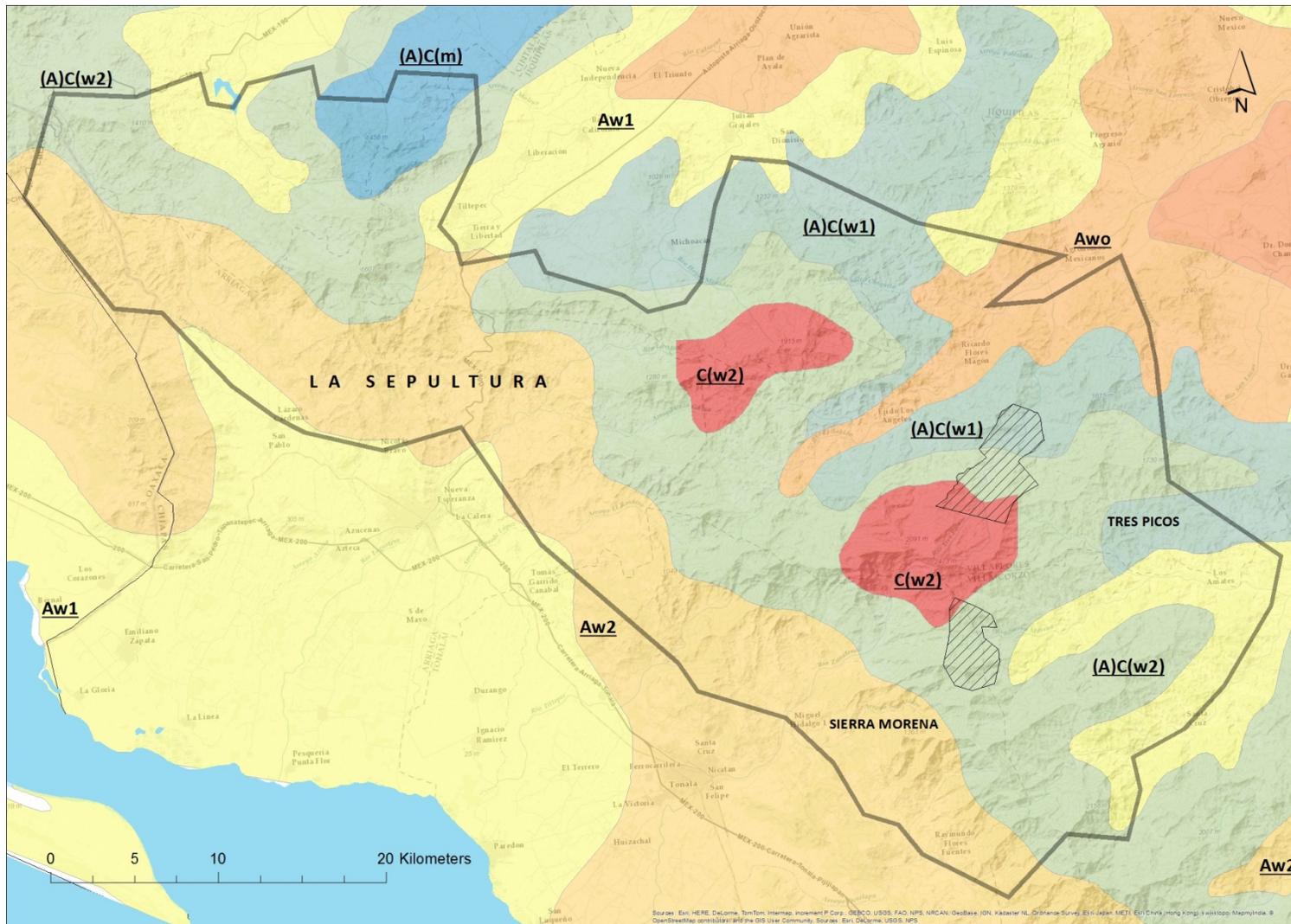
According to Miranda and Hernandez (1963), La Sepultura contains at least 9 out of 18 types of primary vegetation in Chiapas; being pine-oak forest, evergreen cloud forest, tropical deciduous forest, medium semi-evergreen and semi-deciduous rainforest, foggy chaparral, and savannah, the most important forest types in the area (see Figure 3.7 for a vegetation map of the area).

Although the predominant land use in La Sepultura is classified as forest (90% of the area), net forest lost can be seen in the last 15 years. Previous large forested areas covered by old-growth forest, are now characterised by a landscape of cultivated land, perturbed and open forests (Castro et al., 2003). A significant feature of La Sepultura Biosphere Reserve is that 95% of its territory is communal and private property, a key reason why local citizen participation is relevant to conservation strategies in the reserve (Carabias *et al.*, 1999).

The 1995 General Population Census Review reported that 24,000 people inhabit La Sepultura's territory, of which 51.3% were males and 48.7% females (INEGI, 2011). There are no specific updated figures as the Census report for La Sepultura Biosphere Reserve took place before its creation in 1996, and subsequent census considered the six municipalities sharing some extent of their territory with the biosphere reserve. An interesting statistic shows that Chiapas reports the highest illiteracy rate within the 32 Mexican States, and for the case of the population in the biosphere reserve, only 16% had primary school educational levels (Carabias et al., 1999). Similarly, it was reported that in the area covered by the biosphere reserve, approximately 25% of the population received regular income derived mainly from agriculture and cattle ranching activities (INEGI, 2011).

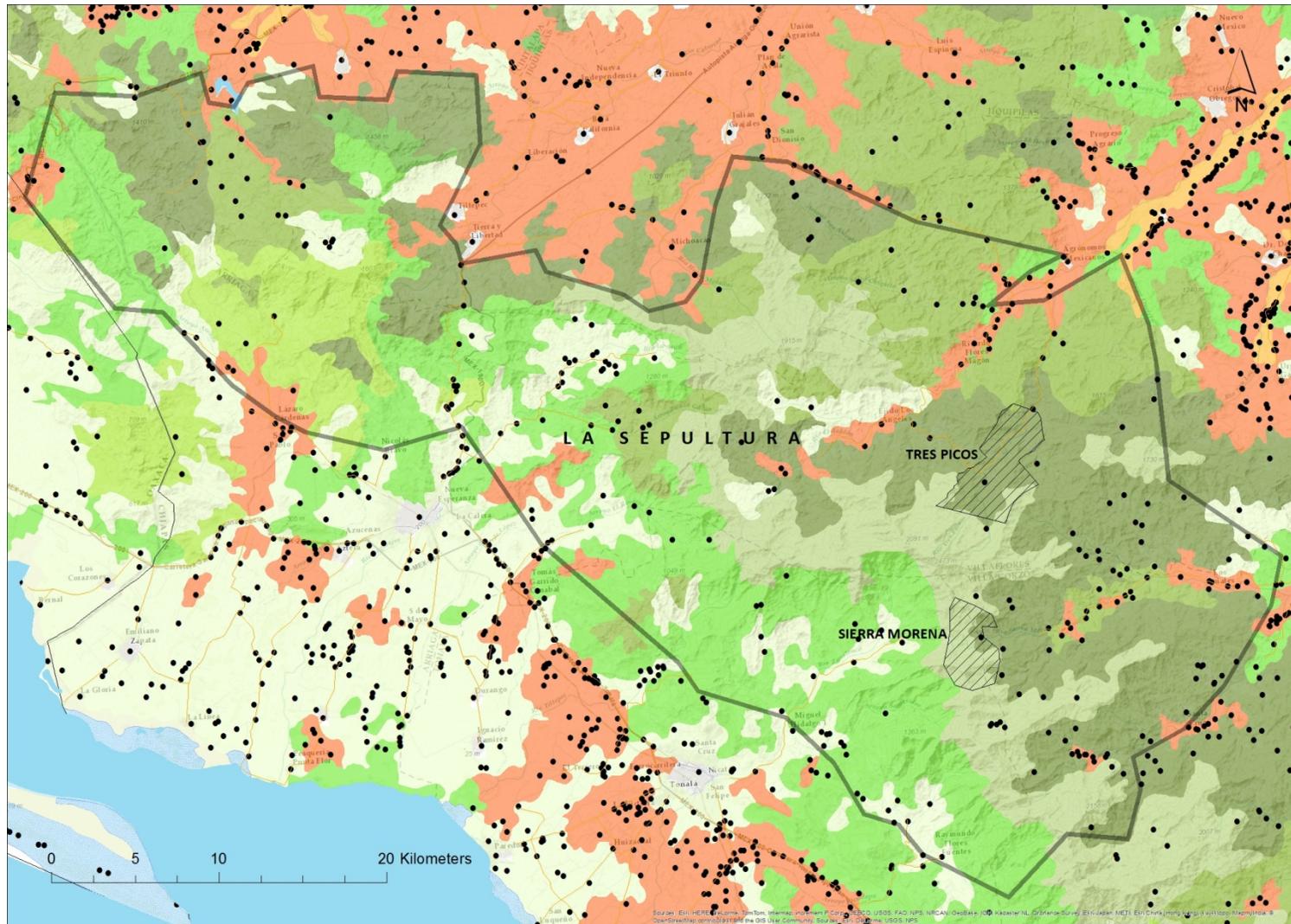
A particular problem in terms of natural resources management and conservation activities in La Sepultura is that almost 70% of the population reside in villages with less than 100 people (INEGI, 2011). This situation has serious implications as a result of the commercialisation of small rural properties which are a major driver for land use change and water resources availability.

Figure 3.6 Climatic conditions in Sierra Morena and Tres Picos inside La Sepultura Biosphere Reserve. Köppen climate classification system adapted by Garcia (1964)



- | | | | |
|---|---------------------------------------|---|--|
|  | (A)C(m) - Tropical wet (Summer rains) |  | Aw1 - Tropical wet (lowest rain levels during winter) |
|  | (A)C(w2) - Tropical wet (dry Winter) |  | Aw2 - Tropical wet (Summer rains) |
|  | Awo - Tropical wet-dry (Summer rains) |  | C(w2) - Temperate sub humid (annual rain below 250 mm) |

Figure 3.7 Vegetation types in Sierra Morena and Tres Picos inside La Sepultura Biosphere Reserve.



3.5.3.2 Marques de Comillas Municipality

The Marques de Comillas Municipality is located over a karstic lowland plain area of approximately one million hectares, representing 1.2% of Chiapas. Most representative soils are thin and in chromic phase, with some fine and medium-sized organic soils mixed in. The region is part of the Mayan Tropical Forest, the largest area of tropical humid forest in Central America (Medellin, 1994).

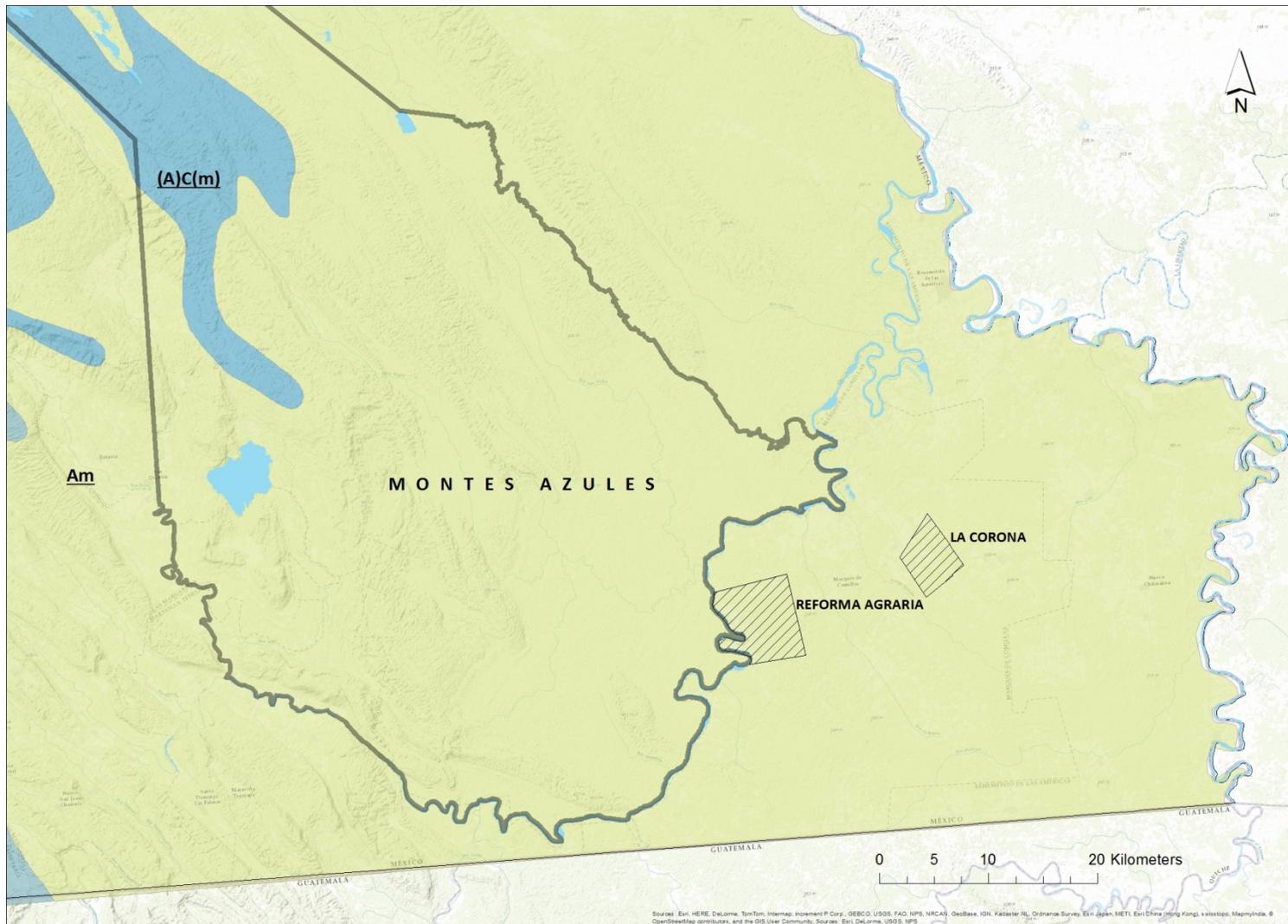
Figures 3.3 and 3.4 show a unique characteristic of the Marques de Comillas region, as this corner of Mexico is almost surrounded by the country's largest Biosphere Reserve of Montes Azules and the Mexican southern border with Guatemala. The Montes Azules Biosphere Reserve represents the northern limit for most of species inhabiting the Mayan Tropical Forest, which means that the region is an important corridor for Neotropical species.

The characteristic tropical sub-humid and sub humid climates show little variability due to topographic gradients (see Figure 3.8 for a climatic map of the area). The most representative forest types are evergreen and semi-ever green lowland rainforest (Miranda and Hernandez, 1963). Although the Montes Azules Biosphere Reserve is one of the most densely forested areas in southern Mexico, Marques de Comillas is characterised by a fragmented landscape of induced grasslands and seasonal crops in a once tropical broadleaf evergreen primary forest (see Figure 3.9 for a land cover map).

According to the 2010 General Population Census (2011), the Marques de Comillas Municipality registered 9,856 inhabitants, of which 4,993 were males and 4,863 females. Out of the 9,856 people living in Marques de Comillas, only 2,768 are considered as having a permanent job, and from this, only 8.31% correspond to females. Poverty levels in the region are the highest in Mexico, classified as extreme poverty; and 24.39% of the population more than 15 years old are illiterate.

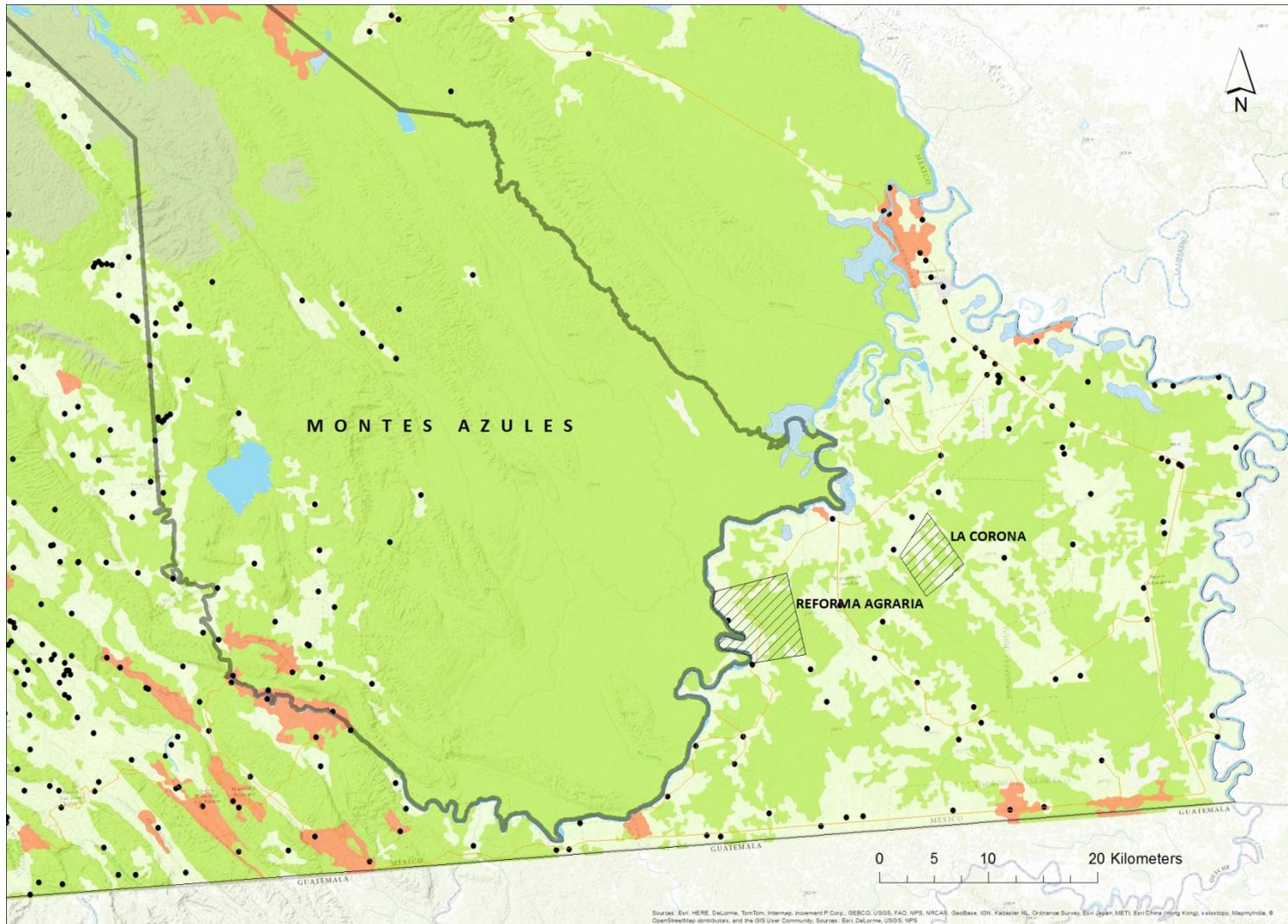
Extreme poverty levels and limited economic alternatives in the region were the result of a complex situation in which government policies ignored the environmental impacts of populating a fragile ecosystem region with limited infrastructure. During the late 1990s, access provided by the construction of a highway, and resulting provision of electricity, created initial conditions for economic development and population growth in the communities. However, these measures also enhanced pre-existing problems related to land ownership, land invasions, forest fires, deforestation, land use changes, and wildlife trafficking.

Figure 3.8 Climatic conditions in La Corona and Reforma Agraria next to Montes Azules Biosphere Reserve. Köppen climate classification system adapted by Garcia (1964)



- (A)C(m) - Tropical wet (Summer rains)
- Am - Tropical wet (Summer rains feed by tropical cyclones; Winters show the lowest rain levels)

Figure 3.9 Vegetation types in La Corona and Reforma Agraria next to Montes Azules Biosphere Reserve.



Forests exploitation in communal lands has been more conservative over the past 20 years, contradicting theories that common resources are more likely to be degraded through the lack of control mechanisms (e.g. Hardin, 1968). However, it is also possible that deforestation in communal lands has been lower because communities lack financial resources to invest in other land uses such as cattle ranching (Castillo *et al.*, 2007) or mechanised agriculture.

According to Castillo *et al.*, (2007) the Marques de Comillas showed a 2.1% annual deforestation rate between 1975 and 1996; while in La Sepultura most of the deforestation occurred already in disturbed forests, so it is not feasible to estimate a net deforestation rate. In addition, deforestation between 1975 and 1996 was generally higher in private property, compared to communal agrarian settlements in Marques de Comillas (private property 62.5%; communal land 36.3%).

Between 1990 and 2006, the Marques de Comillas region showed the highest forest loss within Chiapas, while La Sepultura Biosphere Reserve showed stability within the forest cover change dynamics for the same period of time (Vaca *et al.*, 2012). In a study conducted by Paz *et al.* (2013) cattle ranching was identified as the main driver to deforestation in the Marques de Comillas region, while La Sepultura shows no deforestation drivers due to its biosphere reserve territorial status.

Although this section has introduced the general characteristics of the study areas, Chapter 5 provides a fuller description of the community case studies in terms of their natural resource management activities, socio-political characteristics and local economic activities.

3.6 Summary of the chapter

From the previous discussion of the history of land tenure structures in Mexico, political and social struggles and their consequences for the consolidation of civil society, as well as the situation in which local communities implement natural resources management strategies, and their potential value for the development of payments for ecosystem services schemes by environmental NGOs, there are a number of key points to identify for the interpretation of the case studies presented in subsequent chapters.

In relation to the implications of the *ejido* sector for Mexico's rural environment, and particularly in Chiapas, the distribution and occupation of land in remote areas, and its colonisation by peasants and

indigenous farmers has had multiple effects. In the case of collective *ejidos*, the territories became isolated safeguards of natural resources, because of the social organisation which favoured the protection of natural capital. However, the collective *ejidos* face other problems such as the absence of local development projects due to territorial isolation and associated lack of productive opportunities, as well as the potential emergence of trading processes in the rental or sale of *ejido* land due to the 1992 constitutional reforms.

In addition, and as a result of the natural resources conservation paradigm of public administration, collective *ejidos* within the boundaries of natural protected areas face jurisdictional problems which have significant impacts on their territorial administration. Despite local governance interest in maintenance of the natural capital, government institutions need to acknowledge social capital, cultural perceptions, traditional knowledge and common property rights, as key components of the wider territorial diversity of southern rural communities in Mexico.

Evidence of successful initiatives for local natural resources management exists in the form of payments for ecosystem services schemes which have been conducted by local communities supported by environmental NGOs. Despite some criticism of implementation, the potential for further expansion is apparent. Following the review presented on this chapter, I would argue that carbon-forestry projects, and related payments for ecosystem services schemes in rural Mexico, are possible at the project scale because of the active role played by local communities.

The advantages that collective *ejidos* offer for natural resources management, such as the community-based land-use planning framework, are major benefits in terms of the viability of international cooperation initiatives, for instance the *Plan Vivo* programme. A further feature is the organisational framework within which cooperation initiatives are implemented in Mexico; as noted already these are typically outside any government programme or representation because local NGOs are closer to local communities, enabling technical support and capacity building. This is a key aspect to consider for future implementation of REDD+ mechanisms due to their institutionalisation into a national strategy lead by the government.

Key characteristics of the case study communities were described in the final part of this chapter. These are further elaborated in the research methodology (Chapter 4), to provide important context for understanding the results of the PPGIS implementation presented Chapters 5 and 6, and the subsequent discussion in Chapter 7.

4. METHODOLOGY

4.1 Rationale behind the research design

This section presents the research design used to investigate how socio-cultural - including socio-political - conditions, relationships and practices affect the introduction of Public Participation GIS as a tool for local natural resource management in particular community case study contexts. Due to the relationships between research objectives and the many variables involved, it became apparent there was a need for multiple sources of evidence.

Action research techniques were selected for use in the study from among a limited variety of data collection approaches discussed in the PPGIS literature. This choice was made because of the qualitative nature of the investigation; due to the scope to intervene, interact, and participate, while documenting the PPGIS implementation processes; and as a result of previous experience interacting with local stakeholders in rural Mexico. Most important, action research techniques have been characterised as allowing the potential to conduct collaborative research, education and action towards social change (Kindon *et al.*, 2009).

The intervention consisted of introducing geospatial technology tools, and facilitating dialogue between local land management and conservation practices, within the sets of rules and agreements characterising local governance protocols in southern rural Mexico. The aim was to collect and compare qualitative evidence by implementing a pilot Public Participation GIS scheme in four different community contexts and investigating how this altered existing interactions between community members, local governance structures, local natural resource management requirements and community relations.

Such open-system enquiry needed a flexible research design, one that could evolve and develop through interactions with local circumstances, and consider intertwined data collection and analysis. The research design adopted to structure this study was a comparative case study design. According to Yin (2009, p. 18) a case study can be defined as *'an empirical inquiry that investigates a contemporary phenomenon in-depth and within its real-life context; especially when the boundaries between phenomenon and context are not clearly evident'*.

The justification for adopting a comparative case study design followed the need to both understand and collect evidence from the implementation of geospatial technology tools for local natural resource

management, while allowing comparison across different contexts, assessing the influence of underlying factors (Yin, 2009).

Because phenomenon and context are not always distinguishable in experimental situations, other research characteristics became key elements of the research design strategy. Two particular features of the comparative case study design influenced the process of data collection and analysis. These were i) the participatory character of the four Public Participation GIS implementation processes, and the subsequent independent pilots, and ii) concluding evaluation phases in which action research provided the tools to observe, participate, discuss, document and examine the progress of each intervention.

A significant advantage offered by combining review of documents, participant observation, maintenance of a research diary, group discussions and personal semi-structured interview protocols, was the possibility of expanding my observations by incorporating research participant opinions, perceptions, and knowledge into my own research experience and *in-situ* analysis (Robson, 2002). Each technique contributed to documenting a particular sort of evidence, during a particular stage, for defined purposes, in close relation to the research objectives as follows:

- a) The initial and more general literature review, allowed the identification of key concepts and theories which were translated in guiding questions to construct and justify the research goals (see Chapter Two, Section 2.4).
- b) Active participant observation during the scoping stage contributed my understanding of key contextual elements for the case studies and allowed me to be recognised within the structure and systems of rules of the communities in which the intervention took place. Attending local assembly meetings and field surveys during the implementation stage provided a good understanding of the external relations, and the impact of external initiatives over local governance and natural resource management.
- c) A detailed review of research design literature and the exploration of actor-network theory concepts, allowed the selection of a comparative case study design, closely related to an experimental evaluation framework design (see Chapter Two, Section 2.3).

- d) To support comparison across the community case studies, five key themes were selected to guide the experimental evaluation framework (e.g., social structure, IT skills, participation in development, external relations and power structure). These elements contributed to classifying the thematic analytical characteristics (see Table 4.1).
- e) In addition to the classification of evidence in relation to the analytical characteristics provided by the evaluation framework, group discussions and semi-structured interview protocols aimed to collect evidence to assess similarities and differences regarding the key thematic analytical characteristics.
- f) Document review, participant observation, group discussions and semi-structured interviews provided insights to help discern the preconditions of success for Public Participation GIS schemes in rural Mexico and identify future research directions.

Table 4.1 Structure of the evaluation framework oriented to help obtain a comprehensive explanation of the phenomenon occurring during the different stages of the PPGIS implementation strategy.

Actor-network theory key ideas	Themes	Documentation procedures
Interactions between society and technology	Social structure	Semi-structured interviews and group discussions
	IT skills	Participant observation, semi-structured interviews
Bring out the infrastructure of rural technological innovation	Participation in development	Participant observation in community assemblies combined with semi-structured interviews
Heterogeneous nature of interactions	External relations	Documents review, participant observation during PPGIS implementation seasons
Power relations	Power structures	Participant observation during working groups activities, group discussions and semi-structured interviews

The different techniques employed for data collection and analysis were adopted due to their flexibility to incorporate emerging elements from immediate interpretation of situations occurring during the scoping, training course and evaluation stages. As a result, my understanding of each community case study context expanded through assimilation of the natural resource management

context, in combination with the traditions and citizenship characteristics immersed within each particular social setting (Pain *et al.*, 2008).

My research diary proved valuable as tool to construct a narrative from the field experiences. I also made use of a video camera to record assembly meetings with larger attendance, such as in Sierra Morena and Tres Picos, so I was able to fully engage in the debates while having the possibility to review the events with a critical perspective.

One of the main contributions of my research diary to this thesis was to inform the narrative analysis presented in Chapter Five. Although research notes were taken in Spanish; some fragments have been translated to English and are presented in Annex 1 of this thesis. In addition, diary notes together with the testimonies from the semi-structured interviews, were important in documenting the insights gained from a participant observation approach.

4.2 Research process

4.2.1 Public Participation GIS as a research context

Despite the constant reminders of the necessity to prioritise and expand the discussion about ethical issues in GIS and Society (Pickles, 1995), it is arguable that even a comprehensive code of ethics has the ability to anticipate and prevent all the potential problems associated with the conduct of organisations or individuals within a political and sensitive practice. In this sense, in addition to reasons of ethical conduct, I consider it relevant to recapitulate the reasons by which the present study has been characterised by the usage of the terms ‘public’ and ‘participation’ within the GIS initiative.

The relevance of characterising the empirical GIS endeavour with the ‘public’ and ‘participation’ labels acquired meaning when considering the desired characteristics of the case studies involved in this investigation: i.e. the process of making collective decisions is embedded in the social organisation of collective agrarian communities. In essence, there is an *in-situ* tradition of local participation, which I see as an enabling condition to support the adoption of geographic information technology for specific decision-making exercises.

Moreover, in the rural natural resource management context, the visualisation of space and reality should coincide with those of the stakeholders if successful collaboration is desired (Stock *et al.*, 2007; Rambaldi *et al.*, 1998). As a result, the proposed Public Participation GIS initiative represents the adoption of a communication channel with government institutions and other stakeholders with the intention of sharing more of the responsibilities and resources involved.

Although there is an extensive literature on participatory methods, there is much less documented information about the protocols employed to introduce, use and organise access to technical tools to support planning activities and generation of information. The empirical explorations documented during the pilot Public Participation GIS implementations, aimed to establish practices by which the working groups used the computers and GPS devices provided for the purposes of the interventions. As important as these arrangements during the duration of the field seasons in the communities was the need to establish precedents for subsequent independent pilots.

In addition, the term Public Participation GIS was adopted because the concepts of public and participation are closer to the primary objective of investigating the potential to enhance community dialogue and interaction, as a result of geographic information production and technology implementation to support collective decision-making processes (Wright *et al.*, 2009; Carver, 2003; Abbot *et al.*, 1998); rather than exploring participatory approaches for GIS use. Likewise, Public Participation GIS became more relevant to the study because of the socio-cultural context in which I proposed the initiative to be incorporated; within a context in which the technical needs, as well as the social structure of the participating local groups are well defined.

Finally, I adopt the term Public Participation GIS, as the study area is in the North American region, regarding the idea that a typology should follow a GIS research parameter, rather than a classification in terms of the economic income of the country, without ignoring the methodological particularities and limitations of my choice. One of the challenges this study represents is to draw attention to the importance of Public Participation GIS as a research methodology in geographic information science; giving special emphasis to tools which can be used to communicate rather than to generate solutions to planning problems (Geertman and Stillwell, 2003; Obermeyer, 1998), as has been demonstrated in community-based land use planning (e.g., the envisioning system of Stock *et al.*, 2007).

4.2.2 Implementation process

The Public Participation GIS implementation strategy sought to enable four rural communities to use, and independently-run, a GIS application to enable wider communication with relevant agencies and support organisations in relation to local natural resource management initiatives. In the first place, Ambio representatives made the invitation which consisted of informing local authorities, general assemblies and villagers about the objectives of the research, and asking about their interest to participate in the pilot Public Participation GIS implementation initiative. As a reminder from Chapter Three, Table 4.2 summarise the key elements considered for the selection of the community case studies.

Table 4.2 Comparative elements within community case studies: proximity to a biosphere reserve, local economic activities and Plan Vivo project status.

		Proximity to a biosphere reserve	
		Next to a biosphere reserve	Inside a biosphere reserve
Economic activities	Traditional activities	La Corona	Tres Picos
	Alternative projects	Reforma Agraria	Sierra Morena
		Ongoing participants	Potential participants
Plan Vivo project status			

If the community manifested interest to participate, those citizens who were already participating in local natural resource management activities constituted the working group, previously selected by the general assembly of each ejido (e.g., La Corona, Reforma Agraria and Sierra Morena). For the case where natural resource management activities were not in place (e.g., Tres Picos), the invitation to participate in the working group was open and the selection of participants took place at a general assembly.

During the summer of 2008, La Corona and Reforma Agraria (located outside Montes Azules Biosphere Reserve) accepted the invitation to participate in the implementation of the pilot Public Participation GIS strategy. In relation to Sierra Morena and Tres Picos (located within La Sepultura Biosphere Reserve), formal invitations to the communities and organisational arrangements did not take place until the first stage for the fieldwork season in March 2009.

The pilot Public Participation GIS implementation process followed a strategy divided into three phases, of which the first and the third consisted of fieldwork activities in the communities, in combination with the research participants; while the intermediate phase was designed to be independently-run by each of the working groups. The original implementation plan of the comparative pilot study contemplated a standard implementation schedule to take place during the year 2009. The strategy consisted of a one month training course, an independent pilot lasting up to five months, and an evaluation process of ten days per community.

As part of the informed consent and regulatory mechanism involved with the communities, the researcher and Ambio as a witness signed a co-operative agreement. Each working group and local authorities, representing each communal assembly were invited to sign the agreement confirming the acceptance of the intervention, as well as the conditions related to the use of the personal computer and GPS devices provided for the purposes of the investigation. The document also established that each general assembly, represented by their local authorities, held responsibility for ownership of all territorial information generated by the research participants.

Participant observation activities included participatory mapping exercises, collaboration in forest surveys and inspections, attending and preparing documents for general assembly meetings, and talking with villagers and outsiders such as NGOs representatives and government officials. However, as a result of variations in the expertise and organisational structure of each community, the application of participant observation activities was different across the community case studies.

Participant observation within group discussions was the main element of interaction and opinion exchange with the research participants. The strategy within the group discussions consisted of presenting conflicting or challenging situations of natural resource management activities, and using these as themes for the practical sessions, while trying to incorporate potential solutions to practical problems, especially those involving collective decision-making procedures during general assemblies.

Semi-structured interview protocols aimed to document the following aspects across the community case studies:

- The degree of understanding of the objectives of the Public Participation GIS intervention.
- An opinion on the implementation procedures.
- Limitations associated with training exercises.
- Identify local enabling conditions for the adoption of Public Participation GIS schemes.
- Tracking interaction patterns and power position dynamics within the participants.
- Consider levels of use and application of IT during the independent pilot stage.
- Assess potential obstacles for the independent pilot stage.
- Recognize any changes resulting from the implementation strategy.

Further questions evolved as a result of particular interaction with each interviewee, as well as the immediate understanding of given situations exposed by the interviewing process. In total, 31 semi-structured individual interviews were conducted with all research participants in two stages, at the end of the training course and during the evaluation process. In addition, 10 semi-structured interviews were conducted with community authorities, Ambio's representatives, and government officials on separate occasions.

4.2.3 GIS training

The first phase, the GIS introduction, included a working agenda of one month per community. The objective was to provide a practical course in the use and administration of geographic information, and begin to operate the GIS pilot scheme. The equipment used during the training course was: Garmin e-Trex H handheld GPS navigators, PC desktop computers running Windows XP, digital cameras; as well as MS Word and Excel, and Arc GIS 9. Once the working groups were introduced to the objectives of the implementation process, and the working schedule agreed, the training course took place following a series of communal mapping exercises under the didactic principle of learn-by-doing (e.g. Jardinet, 2006 - land classification mapping).

The content of the course comprised five main elements: presentations, surveys, group discussions, team assignments and participatory mapping procedures. The most important element during the training course was to highlight the importance of participants' local knowledge, and reassure them of the value of their experience about their territory and its implications for local natural resources management initiatives.

The initial focus of the course consisted of identifying the territorial limits of each community case study and its different management areas. Once the territory limits and subdivisions were mapped, an overview of current practices and related issues focused on finding possible solutions to problems. For this purpose, the use of digital cameras to capture landscape features, handheld GPS receivers to georeference and measure those features, and a GIS desktop application on personal computers to visualize and manipulate the data generated were employed. The sequence of photos in Figures 4.1 to 4.11 provides a general outline of the structure of the training course.

Figure 4.1 Introductory discussions about the relevance of geographic information for local natural resource management strategies, La Corona, Mexico. March, 2009.



Figure 4.2 Villager's presentation of land use planning strategies and natural resource management initiatives, La Corona, Mexico. March, 2009.



Figure 4.3 Participatory mapping exercises of landscape features to establish basic guidance for surveying exercises, Sierra Morena, Mexico. May 2009.



Figure 4.4 Writing exercise to introduce the PC elements; and to obtain an initial testimony of participant's territorial perception, Sierra Morena, Mexico. May 2009.



Figure 4.5 Survey exercises oriented to practice how to operate, read and register data with the GPS receivers and capture landscape features with digital cameras, Reforma Agraria. April, 2009.



**Figure 4.6 Upload and display of GPS surveyed features in the GIS desktop application, La Corona, Mexico.
March. 2009**



Figure 4.7 Manipulation of GPS surveyed landscape features within the desktop GIS application, La Corona, Mexico. March, 2009.



Figure 4.8 Semi-independent surveys to map specific landscape features needed for the training course final map, Reforma Agraria, Mexico. April, 2009.



Figure 4.9 Group discussions and practice of daily exercises, Sierra Morena, Mexico. May 2009.



Figure 4.10 Exchange of ideas between participants and authorities for the planning of independent pilot activities, Tres Picos, Mexico. June, 2009.



Figure 4.11 Design of handouts to guide GIS procedures during the independent pilot stage, Reforma Agraria, Mexico. April, 2009.



Lastly, observations derived from the creation of written documents and maps generated during the training course were continuously recorded in the research diary, in order to record each one of the implementation procedures as well as to better understand the local natural resource management context. The outcome of the training phase was intended to provide new skills and capacities to the working groups in order for them to independently run the trial period (independent pilot phase).

4.2.4 Independent pilot

After each training course, the experimental stage of the investigation consisted of independently running a GIS application in each community case study for a trial period of up to five months. During this period of time, each working group had a defined task of completing a natural resource mapping exercise (e.g. the production of proposals related to the certification of communal reserves); or facilitating wider developments by carbon forestry projects (e.g. the design of work plans for farmers to enable payments for ecosystems services through carbon sequestration activities); according to the needs and level of involvement of each community within Ambio's initiative.

4.2.5 Evaluation process

The evaluation phase, and final step of the implementation strategy, consisted of returning to each community case study at the end of the trial period, in order to get feedback on their experiences of independently running the GIS application. The plan consisted of discussing the implementation of the pilot Public Participation GIS initiatives with local authorities and the research participants of each working group, with the purpose of assessing the development, effects and value of the pilot strategy. Within this, critical analysis of the implications of technology and its effects on the social setting and natural management tasks were of particular relevance.

The issue of representativeness within the working groups was determined by the local governance protocols and interests. Although the invitation to participate envisaged citizens already collaborating on local natural resource management initiatives, the representativeness of the working groups had the validation of the general assembly and as a result, it accounted for those individuals and groups with genuine interest or stake in local natural resource management activities. In the case where there were no local natural resource management initiatives in place (e.g., Tres Picos), although the

invitation was open, the general assembly had the task to select the participants, a mechanism by which the working group had the support of the community, and as a result was representative.

In relation to the proportion of local citizens involved in the PPGIS initiative, for the cases of La Corona and Reforma Agraria, this was similar to the number of delegates within the different traditional local governance groups in the ejidos (e.g., vigilance, health, administrative and natural resource management committees). For the cases of Sierra Morena, in which normal citizens were invited to participate; and Tres Picos, where no established local natural resources management groups existed, the proportion of participants was slightly larger than in the cases of the traditional local governance groups mentioned previously.

Although Chapter Five aims to present the narrative analysis for each community case study, Table 4.3 summarises the number of research participants (people included as part of the working teams), semi-structured interviews conducted and testimonies within the implementation and evaluation phases.

Table 4.3 Structure of the evaluation framework oriented to help obtain a comprehensive explanation of the phenomenon occurring during the different stages of the PPGIS implementation strategy.

	Located outside a biosphere reserve		Located within a biosphere reserve		Total
	La Corona	Reforma Agraria	Sierra Morena	Tres Picos	
Number of participants	6	6	10	8	30
Number of interviews or written testimonies	7	6	10	8	31
Interviews with community authorities, Ambio representatives, government officials					10

4.3 Qualitative analysis

The inclusion of actor-network theory key concepts to structure a framework for evaluation (see Chapter Two, Section 2.3) sought to describe the relations taking place during the pilot implementation of the Public Participation GIS strategy. With this in mind, I aimed to uncover patterns of interaction, which formed part of the socio-technological configurations within the selected community case studies. As a result, the exploration of the implementation process results sought to build a general model about the interactions between the analytical dimensions involved in this investigation (e.g., social structure, IT skills, participation in development, external relations and power structures).

Among the key dimensions of analysis derived from the research objectives (see Chapter One, Section 1.4), I aimed to assess the following:

- A comparison of changes in power relations in response to the intervention.
- The impact of natural resources management initiatives on the development of the experiment.
- An assessment of the impact of technology on traditional organisation arrangements.
- The exploration of conditions which potentially allowed or limited those changes to take place under specific community settings.

Trying to represent the patterns of change within different dimensions resulting from the initial narrative analysis, I embarked on the design of a qualitative analytical tool. Due to the diverse analytical aspects, and my wish to emphasize comparability across the case studies, the initial idea was to visualise the original characteristics, as well as the changes experienced after the intervention (Miles and Huberman, 1994).

As a result, a visual analytical tool was conceived which had its origin in the triangular texture diagram used by the United States Department of Agriculture in soil classifications (for details see Brady and Weil, 2008). The main advantage this approach offered was the possibility of an abstract comparison of the different dimensions considered in the qualitative analysis (see Chapter Six, Section 6.1).

4.4 Final reflections and limitations of methodological approach

The suggested qualitative analysis approach was conceived as a dynamic tool, being re-formulated at every stage of the investigation (Gavin *et al.*, 2008). The initial stage consisted of observing the organisational procedures followed by each working group during the training course activities. This involved the creation of written and drawn documents during the training course activities. After the first stage of the implementation procedures, a series of semi-structured interviews took place. Both authorities and all research participants were interviewed (see Table 4.3).

A significant advantage derived from the data collection design, in close proximity to the situation under investigation, consisted of the opportunity to compile my research diary on the basis of observation and active participation within the natural resource management and social organisational procedures during the time spend in the communities. Nevertheless, this procedure could be criticised for lacking a previously validated structure. In response, I argue that the possibility of uncovering local characteristics, comparing situations, deriving explanations and drawing general patters within the limits of the investigation during the fieldwork stages, allowed a clearer planning of the activities in the field.

5 NARRATIVE ANALYSIS

This chapter presents the narrative analysis derived from my observations, which intends to examine and articulate the events and processes which took place during the experimental stage of the study. The evidence and the results presented here have been structured in four main sections, corresponding to each of the community case studies. Each section has been divided in seven subsections representing the development of actions (i.e., selection and preparation, socio-economic background, power structures, relations, implementation, pilot and evaluation). Concluding this chapter, Section 5.5 provides some observations referring to the actual implementation schedule.

5.1 La Corona

5.1.1 Selection and preparation

As a result of their experience within Ambio's working structure, La Corona is a community in which the PPGIS implementation strategy had significant relevance within the carbon sequestration programme. Another advantage was that elected working group (local technicians) already had some experience in spatial information management and GPS usage. Finally and most important, the first impression in relation to the response of the community during the consultation process, showed strong interest in receiving and motivation to participate in the training course.

La Corona was selected as a case study mainly because of Ambio's recommendation. Among the reasons manifested by the regional co-ordinator of the Marques de Comillas region (Lacandon Jungle) was the role that La Corona played within the structure of the organisation and its image as a 'community model' within the carbon sequestration programme. In addition to these, the structure of the local working group in La Corona was one of the main motives for Ambio to recommend its participation, as their experience and training in natural resource management activities and local organisation was presented as a major asset for the implementation of the PPGIS strategy.

Following the selection of La Corona as a participating community case study, during the second half of 2008, Ambio's team in charge of Marques de Comillas region began the preparation for the training process. The first step consisted of informing the general assembly about the purpose of the PPGIS initiative, and consulting with the local working group regarding their interest to participate. Following the acceptance of both community and working group members, a dialogue with Ambio's team collected firsthand opinions from people working in Marques de Comillas region and made

preparations for comments on the implementation strategy during the opening meeting of the fieldwork season in March 2009.

My arrival in La Corona was scheduled to coincide with a meeting held between Ambio's representatives, government officials of the National Commission of Natural Protected Areas, local authorities and a group of international observers from potential support organisations. The aim of the meeting was to visit the community in order to have an exchange of experiences derived from the carbon sequestration programme. This was a part of a survey of natural resources management strategies on neighbouring settlements to nature reserves; and an invitation to have an introduction to the carbon sequestration programme and related activities Ambio support in the region. The presence of government officials and international observers in the community offered an opportunity to witness the interaction between the villagers and external observers and organisations.

During an introductory presentation about the La Corona, Ambio's director focused her comments on the community leadership situation in La Corona. The advice was to observe and identify how to work within the local power structure, based on the knowledge of the working group members and their roles in the community. Moreover, special attention was given to the role of the leader of La Corona's local technician's team, who held powerful positions at various levels within the community due to important relations with external agents.

5.1.2 Socio-economic background

La Corona is located in Marques de Comillas municipality, south-east Chiapas State which is considered the last region to be populated in Chiapas. Apart from the strong influence of different Church institutions, La Corona is an isolated rural community with practically no regular communication with external organisations other than Ambio. The geopolitical process which resulted in the distribution of lands among peasant farmers had the objective of inhabiting the jungle in order to guarantee its territorial possession, in response to the displacement of Guatemalan civil war refugees since the 1960s. The strategy consisted of offering free land to peasant farmers of the northern regions of Mexico, characterised by land tenure conflicts.

The colonisation of the jungle usually followed this sequence: to bring peasant farmers to specific areas of the jungle to use them as labour to cut the forest, distribute land, introduce intensive cattle

farming and seasonal crops for self-consumption. Under those circumstances, wood exploitation had a significant financial impact during the early stages of the colonisation, and most of the benefits of logging the forest were retained by private companies.

However, the case of La Corona was the result of a different protocol as the 'invitation' to obtain a piece of land was conducted by a retired general from the Mexican Army, who took advantage of his relationship with the agrarian authorities. The particularity of this case is the procedure by which peasant farmers from the central regions of Chiapas were asked to pay for the right to belong to the community, and to comply with the requisite of keeping the retired general as a leader and legal representative of the community.

Since its settlement, La Corona has experienced control practices which enhanced isolation and restrictions. The first account of these practices dates from 1978, when the self-elected leader designated two separated housing areas to keep control over the inhabitants. Although in the beginning he managed to control the social interactions among the inhabitants of the *ejido*, in the early 1980s community members began to re-structure the social configuration of La Corona by reallocating all inhabitants into a single housing settlement. After this event which put an end to the authoritative control of General Corona, the community began to build external relations with neighbouring peasant organisations enrolled in governmental agrarian programmes.

Marques de Comillas is located in a geographical area which can be described as the last corner of Mexico. Due to its remoteness, and lack of road infrastructure, La Corona was in complete isolation until 1998, when the first road reached the region. Before that, the Evangelical Church was the only external organisation having permanent presence in some of the communities in the Lacandon Jungle. As with the Catholic Church in Mexico, the role of evangelists was to spread their religious practise and also to generate an organisational structure within the region characterised by a strong institutional dominance factor. In the village, every citizen belongs to one of the three evangelical churches and the church has a very well established control over the population, as demonstrated by their daily events at which attendance was compulsory.

Currently, the main land-use related economic activity is cattle breeding; but only a small proportion of the population has access to it. At its best, around two thirds of the population has the ability to borrow land and the possibility of practicing self-subsistence agriculture. A stratified social organisation which showed at least three social groups was evident from my early observations. The

first were *ejido* members (beneficiary landowners) with full land tenure and productive benefits rights. Then land possessors with access to working lands via informal arrangements; and community residents, landless inhabitants excluded from continuous access to working lands. Both community residents and land possessors have neither agrarian nor voting rights (see Table 5.1 for a general overview of the economic activities in La Corona).

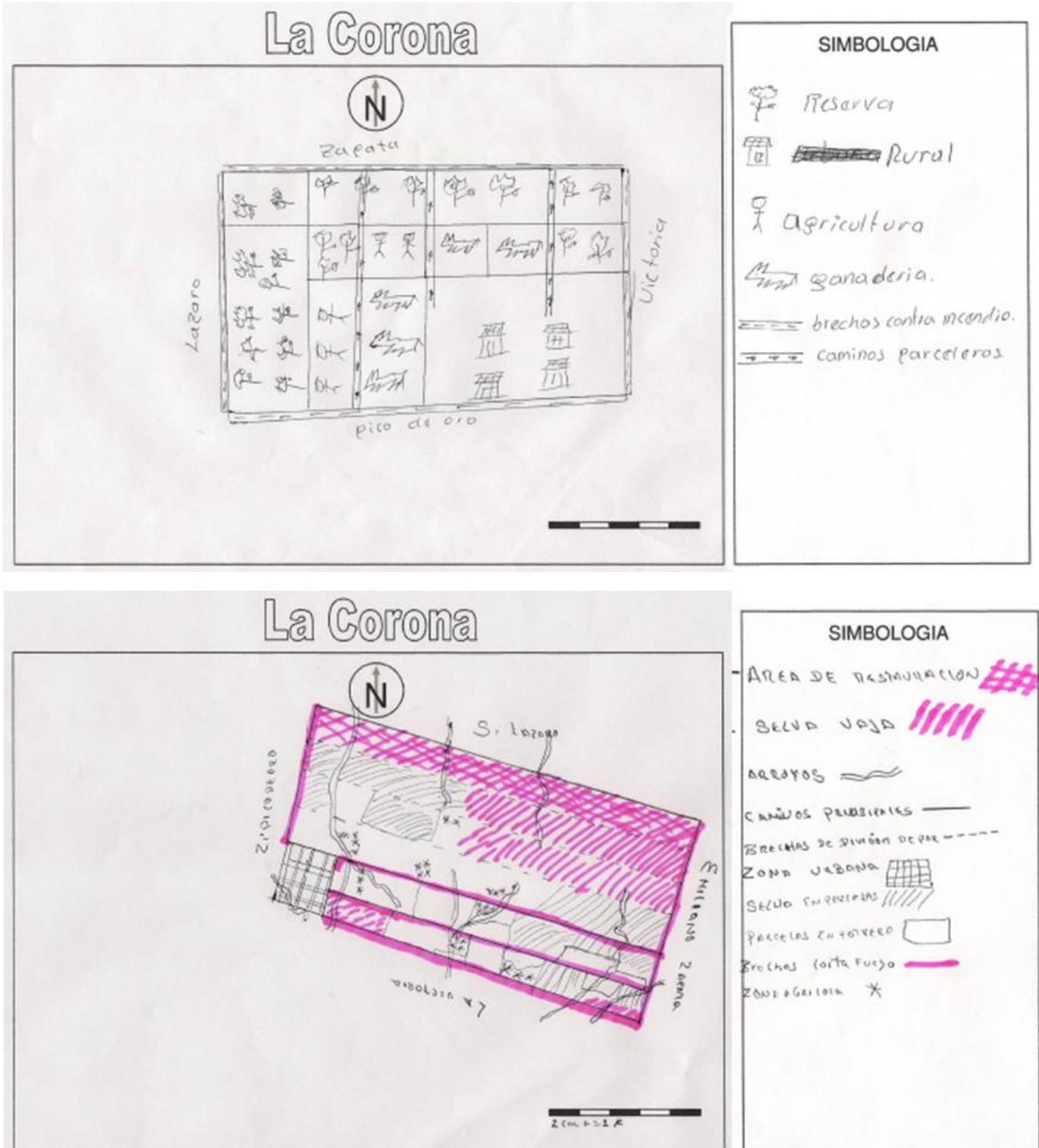
Table 5.1 Access and distribution of economic activities according land property rights in La Corona.

	Ejido members	Land possessors	Residents
Government programmes	✓	✓	✓
Agriculture	✓	✓	✓
Carbon profits	✓	✓	
Cattle breeding	✓		

A particular issue in La Corona is the land tenure system. Although the official status is one of a communal *ejido* (traditional village usage of common lands), the way in which the community operates is considerably different. Under the collective *ejido* arrangement, the woodland operates as an area of common use. However, in the case of La Corona, this area has been fragmented among 40 landowners; only because of the need to have a ‘common’ natural reserve in which the carbon programme could develop did the community assembly decide to give it the status of a common reserve. In relation to grasslands and agricultural areas, these have been subjected to subdivision and commercialisation among the landowners.

Figure 5.1 shows two examples of the sketch maps of La Corona’s territory, in which it is possible to appreciate the perception of group participants in relation to the different land uses in the *ejido*. Of particular interest is the level of detail in both, the representation of the land and land uses classification and related economic activities. The first representation shows the name of neighbouring communities and division among land use and economic activities (i.e., conservation area, human settlement, agriculture and cattle ranching). It also shows detail of firewalls and the roads to access agricultural parcels. In addition to the latter items, the second sketch map provides enhanced detail of firewalls, landscape features and vegetation types within the conservation area.

Figure 5.1 As a result of an initial mapping exercise with the local working group in La Corona, a series of sketch maps were made to represent the location and extension of the different land uses within the ejido.



The level of organisation of the local community technicians' brigade is a result of the experience gained as part of the regional wild fires control programme. The members of La Corona working group have obtained experience from attending training courses for wild fire control. This may seem a non-relevant characteristic, but in this isolated region, it has a powerful connotation as it opens the possibility of widening their knowledge of the region and establishing networks of organisation.

In terms of their natural resources, the fire management strategy and the payments for carbon sequestration activities are the most significant in the village. In 2002, Ambio started the carbon sequestration programme and as in 2009, the community was in the final year of the payment for ecosystem services project. The purpose of the PPGIS initiative was to provide a way towards making an administrative transition and delegate to the village some of the responsibilities needed to support future carbon related local development projects.

5.1.3 Power structures

An influential condition in La Corona has been the role played by the working group leader of the local communitarian technicians (training course working group). His multiple roles within the organisational arrangements can be considered as an unusual accumulation of power. Not only as a landowner, a member of the regional fire brigade and Ambio's employee with the role of following the progress of the projects administered in the region, and to co-ordinate and train the local teams of each community; he is also a local government employee in the department of wildfire control, and head of one local church. The amount of power of this person is enormous due to the benefits and the control over information flow he has obtained.

The community's working group has a degree of functionality in which no one can substitute the role of another member but also, the leader's figure is essential for the team to work. In a sense, this group learned how to work together by adapting the skills and abilities of each of its members. On the other hand, the social structure in La Corona is quite complex. It is possible to appreciate that the locally elected authority figure is a symbolic one. The fact that makes someone powerful in the community is the possibility to get, understand and distribute information from the outside. The local authority exists just because of its need. This situation shows its major impact in the case of the carbon sequestrations activities, in which no information is available for the local authorities or citizens. Particularly in the case of the financial administration, this project has neither transparency nor order,

and the access to information has as many bureaucratic obstacles as imaginable; starting with access to hardware and IT literacy.

During the four weeks I stayed in La Corona, and apart from the event in which Ambio's director brought to the community a group of representatives of an international NGO and the directors of the National Commission of Natural Protected Areas during my arrival, no organisation or government agency had presence in the community. Not even the government social assistance programme which has an extended coverage to bring economic support. In order to have access to such resources, the inhabitants had to travel to a neighbouring community to get their monthly payment.

5.1.4 Relations

The relation with Ambio has been long and complex. After nine years of interaction between the community and the NGO, a series of events have changed the way in which the two bodies interact and work. At some point, Ambio decided to hire a local leader in order to enable stable agreements and wider penetration in the Marques de Comillas region. As a result, the NGO transferred a significant amount of power to the leader who reminded me of the individual who began the colonisation of the community; but may not be that easy to remove.

Due to its isolation and relatively small size, La Corona has neither regular contact with government agencies nor officials. All related issues are administrated by community representatives, which usually rely on the leader of the working group to be resolved. As a result, La Corona shows limited interaction with government programmes, with exception of a credit programme to buy livestock.

The few organisations with some degree of contact with the community are limited to the carbon sequestration programme and related activities, like the wild fires control programme. Most visitors to La Corona are escorted by Ambio's personnel and rarely stay in the community for more than a couple of hours. This was the experience with the group of government officials and international observers who visited the community on the day of my arrival. For this event, a detailed presentation and explanation of the carbon sequestration project was carried out by the local authorities, giving the sense of a propagandistic montage to demonstrate the success of the carbon sequestration programme. Following the presentation, a short walk in the forest reserve had the objective of showing the visitors the monitoring sites of the programme.

My impression was one of a display in which Ambio encourages the participation of the local authorities, but in reality is just a performance of the desired working structure in which everyone participates within the carbon sequestration programme. From the first encounter, the communication with the people in La Corona was difficult and limited. The closest contact was with the members of the working team and to some extent, with the people constituting the local government body; as a result of periodical casual conversations with these villagers, I managed to verify my initial observations on the social structure and power relations.

The key difference in terms of Ambio’s carbon sequestration programme in the community is that La Corona was the first case in the region which welcomed the initiative. As a result, all *ejido* members committed to elaborate a communal land-use planning strategy as an initial framework for the carbon sequestration programme. This is, the land-use planning strategy was accepted by all citizens, but it is based on a biased land use tenancy regime.

5.1.5 Implementation

My introduction to the authorities and some members of La Corona took place during a general assembly in which a full reasoning for my working stay was explained. In correspondence, local leaders offered a short resume of their natural resources management activities, and explained the main concerns in relationship to their local development projects. During this meeting, members of the local working group (see Table 5.2) gathered and agreed on the working schedule and relevant themes to develop during the training course (see Annex 2 for working group testimonies collected during initial and final written interview exercises).

Table 5.2 Participants within the La Corona working group.

Participant	Ejidal status	Role within the community
Damian	Landowner	Technician coordinator, local church minister, cattle producer, Ambio’s representative and regional government employee
Antonio	Landowner	Cattle commission, field surveyor and labourer
Uriel	Landowner son	Administration commission and bachelor student
Saul	Landowner grandson	Field surveyor and labourer
Raul	Land possessor	Local wildfire commission, labourer and <i>ejido</i> commissariat
Rosenberg	Resident	Forestry commission, field surveyor and communication commission

In La Corona the concept of Geographic Information Systems is well known among the local brigade as a result of experience from capacity building activities closely related to local natural resource management projects. Although this familiarity provided a good starting point, I began the training by explaining what GIS was and how it could inform decisions based on the spatial element of carbon capture in the Marques de Comillas region (see Annex 3 for the slides used to explain the GIS concept).

In order to introduce the context of the PPGIS strategy, firstly, I illustrated with examples of how other communities have been using geographic information and IT in their land-use practises. After a general introduction to current PPGIS practise in similar settings, and due to the limited literacy among the members of the working group, the training course activities focused on learning by doing exercises and independent repetition exercises after the sessions. The training started with basic GPS and GIS usage supported by hand out instructions within the *learning-by-doing* framework (for an example of a hand out designed for La Corona working group, see Annex 4).

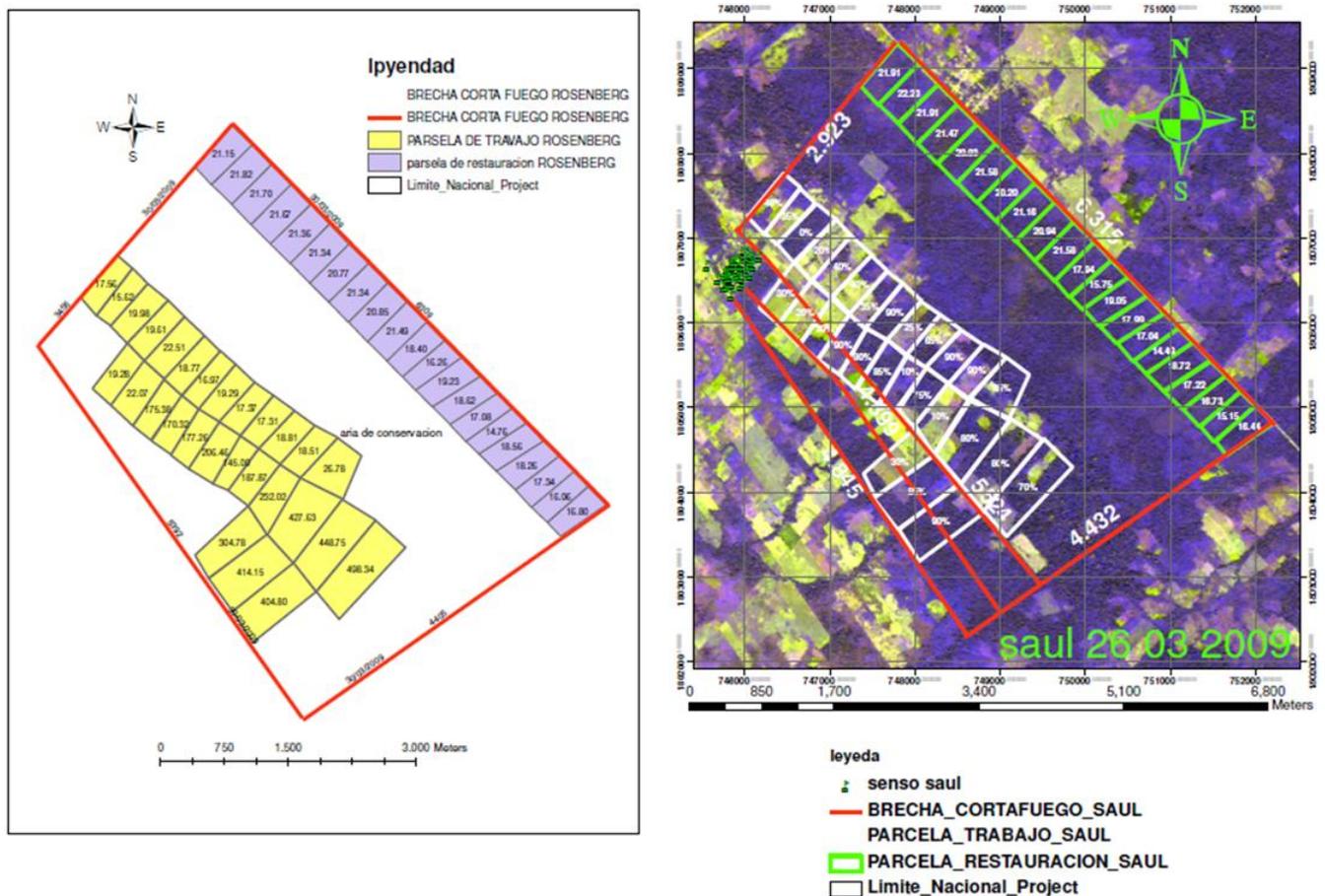
A characteristic feature during the initial sessions was the use of topographic maps and a satellite image with which the addition of geo-referenced landscape features enabled the initial interaction between the participants and the GIS desktop application. As a result, the participants came up with ideas of the different sorts of elements to include within their communal project in the form of a map legend. This included a revision of the various methods employed by the team members for surveying, and an initial explanation of database design within the GIS desktop application.

After the training sessions, during the independent practise, while trying to take a role of an independent observer, two things became apparent. First, an immediate sense of the ranking system emerged. Although I decided to treat every member of the group in the same way, this generated amazement among lower rank members as my attitude clearly influenced the internal power schemes. As a result, during the second week the leader of the team modified his attitude towards the course, such as coming at different times in order to get his training session separately. Although I welcomed his desire to modify his training schedule, this resulted in lost continuity in the team's learning processes.

The most comprehensive step of the implementation stage consisted of generating a community land-use inventory with the GIS desktop application. The outcome of the four weeks training course allowed the participants to understand the concepts and replicate the procedures learned during the course. As a result, after various surveying and mapping exercises, every working group member created a

land-use map in which the data collected during the surveys was shared among the participants. The final product of the course was a hand out assisted composition of an independent map in which landscape features were displayed over the satellite image (see Figure 5.2 for a series of examples in which the authors decided to highlight different items the individual plots in both the reserve and agricultural areas as well as the fire divides; original in colour).

Figure 5.2 Example of two maps created with the land-use information generated as a result of the GIS training course in La Corona. Significant features in both representations are the measurement of firewalls around the ejido as well as the display of areas sizes within agriculture and conservation parcels in the ejido.



In La Corona, the opportunity to implement a training course on the use of geographic information and IT among illiterate peasant farmers became possible and opened new possibilities to understand the logic of their natural resources management practices. Also, I witnessed first-hand the real situation and consequences in which the carbon sequestration programme is adopted, developed, and managed from its origin. The acquisition of such perspective transformed my perceptions of such activity.

However, my role in the community was limited to a restricted visitor, with no access to other voices than those supported by the project broker and its carbon sequestration programme. In addition, the interaction with the inhabitants was almost restricted only to the authorities and to those who were participating in the course, with the rest of the villagers not understanding the situation taking place in the community. A complete lack of community communication strategies became apparent for those issues regarding natural resources management initiatives. My final impression of La Corona was one in which the community had constructed a socially accepted censure on questions and answers related to the local brigade's unknown activities, in exchange of the perceived benefits of the programme.

5.1.6 Pilot

In order to carry out the independent pilot stage a series of three sub-tasks were assigned to the members of the working team, together with a working schedule. The plan for the independent pilot was to generate a detailed land-use inventory of the community within the GIS desktop application, following the same principles employed during the implementation stage.

After completing the training course in La Corona, in response to a petition of the working group, an agreement to have four extra sessions was reached. For this, the leader of La Corona's team committed to provide transportation to travel to the neighbouring community (Reforma Agraria) in order to have the extra sessions. Despite the agreement, none of the agreed sessions took place, this being the result of a team leader blockage by not facilitating transportation for the members of the team.

5.1.7 Evaluation

Before the evaluation process started in La Corona, I was informed by Ambio's personnel that the pilot stage had not been successful. During the first two weeks of the pilot, the working team of La Corona stopped practicing and as a result did not manage to complete the agreed working plan. In order to see what the cause of it was, during the evaluation stage carried out during the last week of November 2009, I conducted four interviews in the community.

Several factors made it very difficult to carry out the interviews with the people who participated in the training course as they did not feel free to talk when the team leader was present. Additionally,

different interpretations of why the working team did not manage to continue working circulated around. In order to get an idea of the reasons why the pilot did not succeed, I decided to join to some of the participants on their daily activities to get the opportunity and some space to talk.

As a result, once out of the public eye, I managed to interview the team leader and three other participants. The results of the interviews showed again different perspectives of the problem but did not bring any further clarification. Nevertheless, the interviews brought up interesting signs of what happened. After the first interview I learned that the desktop computer was stored a couple of weeks after I left the community. In the following interviews, I was informed that the usage of the computer was restricted to the supervision of the team leader; and soon it became a limiting issue for those who wanted to practise but could not comply with his supervisory agenda.

Even if La Corona was presented as a model in terms of its social organisation, which made them the most successful carbon sequestration case in the eyes of Ambio, my experience with the working team during the implementation and evaluation stages of the PPGIS strategy was completely the opposite. In La Corona, access to external agents, connections and fluxes of information are used as instruments of power. In the case of the PPGIS initiative, technology was also used as an instrument of power. The idea behind establishing mechanisms to restrict and control the use of the computer, access to further skills acquisition, and the fact that the training course sessions took place in the team leader's house fits within the pattern of local procedures to interact, control and employ external initiatives which are filtered to the community according to the needs or interests of its gatekeeper.

5.2 Reforma Agraria

5.2.1 Selection and preparation

During the initial meeting held with Ambio in 2008, several factors for choosing Reforma Agraria to be part in the implementation of the PPGIS strategy were considered. Firstly, they had participated in the carbon sequestration programme for a period of seven years (2002-2009); and secondly, because of the common interest in the potential outcome of the GIS implementation process, offered the possibility of experimenting under the particular collective organisation model of the community. A final and most relevant reason was the lack of geographic information management skills by the local team, which meant a strong dependency on external actors to execute their local administration activities within Ambio's carbon sequestration programme.

After establishing the working agreement with the general assembly of Reforma Agraria, Ambio's team in charge of Marques de Comillas region began a consultation with the authorities of the *ejido* and made the necessary preparations for the training course, as well as the selection of the working team participants.

At the beginning of the fieldwork season in Chiapas, in February 2009, an early contact with the assembly leader of Reforma Agraria confirmed the community's acceptance of my near-future arrival. My contact with the community deepened during a second visit to the *ejido*, when I was invited to join a local brigade to open a fire divide in the communal forest reserve. The leader of this team was Ambio's employee in the region, who was also the leader of the working group in the neighbouring community of La Corona. During the development of this task, I got an insight into the interactions and roles played by the two crucial elements, Reforma Agraria residents and the external technician.

By the date of my arrival to the community (April 2009), the previously established contact represented a significant advantage for the implementation stage. A community assembly was held prior to the beginning of the training course, gaining legitimisation and transparency of my presence in Reforma Agraria. Authorities encouraged citizens to participate and attend the training course, emphasising their participation as a service to the community. Although it was recognised by the assistants that there was a need for more participants, there was only one addition to the working team.

5.2.2 Socio-economic background

Reforma Agraria is a unique community in Chiapas because of the characteristics of its origins and settlement. In 1961, an organised group of indigenous peasants belonging to the Chinanteca ethnic group from Oaxaca State decided to escape from their community due to land tenure conflicts and political unrest. In the same year they arrived in Marques de Comillas region, which at the time was primary tropical forest with no human settlements.

As with many other groups coming from different regions of Mexico, they received a portion of land in order to establish a village in the Lacandon Jungle. In the beginning, the group settled on an area which did not provide sufficient working land to satisfy the requirements of all members in the group. This resulted in the separation of four families, who decided to search for another location free of pressure over land. The four families settled a few kilometres down the river Lacantun and in 1962 established Reforma Agraria.

The leader of these four families was a rural primary school teacher affiliated to a guerrilla organisation characterised by socio-political principles of education and equity for development. When the group established the statutes of their new community, the assembly decided to create an *ejido* constituted by sixty landowners. Within their principles, two were of significant relevance. The first was a progressive idea of land-use planning. The common lands were classified in three land-uses: forest reserve, agricultural plots and urban areas. The second was the recognition of guaranteed access for all sixty members to the three land-use types and the perpetuity of the size of each land-use.

Building up the organisational structure of the group, they started to get in contact with the neighbouring communities to constitute social movements to protect their interests. Since then, Reforma Agraria has been recognised as a front line community in social organisation and community rights defence. At the present time, Reforma Agraria represents a rare model of success in conservation, natural resource management and local development projects in Chiapas as all these strategies are seen as integral part of the community.

As illustrated in Table 5.3, there are five main economic activities, three of which follow the regional pattern (government assistance programmes, agriculture and cattle breeding) while the two other consist of carbon profits and an ecotourism project. The particularity of Reforma Agraria is the way in

which the economic activities are connected, especially the issue of the communal administration of all initiatives. The communal assembly in Reforma Agraria acts as a group which protects and promotes their interests as a unified organisation, even when not all sixty landowners are part of the different local projects. The social capital in the community is evident considering the great amount of governmental resources they have managed to obtain without compromising their political independence.

Table 5.3 Access and distribution of economic activities according land property rights in Reforma Agraria

	Ejido members	Land possessors	Residents
Government programmes	✓	✓	✓
Agriculture	✓	✓	✓
Carbon profits	✓	✓	
Cattle breeding	✓	✓	
Ecotourism	✓		

Reforma Agraria is one of the few communities practising intensive agriculture with distinctive procedures in the region (e.g. greenhouse plant production, irrigation systems and pest-free practices). Cattle breeding offers an important source of income, as is the case in most of the communities in Marques de Comillas region. Ecotourism is the main economic activity in the community and it is administrated by a cooperative established specifically for this purpose.

In Reforma Agraria, Ambio’s carbon sequestration programme is considered as a complementary income to the community in which the general assembly administration and socialisation of benefits are the key factors. In particular the fact that the area in which Ambio established the payments for carbon capture project is truly communal results in widely distributed profits among the community. Namely, they divide the income in three parts, the largest percentage is designated for community infrastructure; a second portion is divided among the 60 landowners, and the third part is given to the commissariat as administration expenses as this is the body in charge of administrating all local initiatives and the representation of these outside of the community.

5.2.3 Power structure

In Reforma Agraria power is not an advantage, but more a responsibility to enable a community to function. Decision-making is held and practised by the communal assembly under a majority vote system; while the organisation of the assembly is carried out by the commissariat to administrate all projects. In the case of the carbon sequestration project, Ambio also play a role as a technical advisor, the reason why they deduct an administration fee from the profits of the community.

The commissariat group is elected by all members of the community with a role of civil servants. Nevertheless, being a civil servant in Reforma Agraria is not equivalent to using power for single benefits but rather an obligation where the abuse of position is not an option as there are no individual benefits.

A significant characteristic of Reforma Agraria is its local governance structure which states that land is not a commodity and it is not possible to sell it, and as a result, incorporate outsiders to the community. That is why the category of land possessors does not exist in the *ejido*, while residents are all citizens who are related to a landowner.

5.2.4 Relations

There is a long history of collaboration between Reforma Agraria and Ambio. Although the differences between the two organisations are significant, their partnership is based more on the common benefits of carbon profits. In Reforma Agraria, Ambio has been questioned on many aspects of their carbon sequestration programme and on their approach to give technical assistance. However Ambio has maintained a negotiating position due to the relevance and institutional impact of their relationship with the community.

Reforma Agraria's independence and strong points are firstly, the number of relations with different organisations, including government agencies which are highly valued in Reforma Agraria, and secondly, their openness and collaboration with independent visitors. Regarding the first, Reforma Agraria is a small community used to welcoming people coming from universities, private organisations and government agencies interested in their conservation and natural resource management initiatives as well as their eco-resort project.

During my stay in the community I had the opportunity to witness deliberations between the commissariat and a dozen external organisations (neighbouring communities, government agencies, governmental development programmes, environment research institutes, social development agencies, universities, ecotourism networks, independent consultants and international representatives). Networking and lobbying were everyday activities in the *ejido*.

5.2.5 Implementation

The implementation stage in Reforma Agraria represented the most difficult challenge in all four communities. Due to the working and administrative structure of the community, the working group was constituted by the members of the *ejido* assembly group, but the major disadvantage was the advanced age of the three participants. As a result, three other young citizens were encouraged to attend the training course but the main obstacle for their participation was their personal activities outside of the community. As a result, the second group was conceived as a support team.

Although the two groups showed different skills (see Table 5.4 for an overview), this situation proved to be a motivating factor for the training activities. On the one hand, the members of the commissariat had vast knowledge of their territory and natural resources activities in the *ejido* but practically no IT background. On the other, the young citizens had a limited idea of the spatial characteristics of the *ejido*, but some degree of IT skills, acquired during their stay outside of the community as part of their bachelor education and management activities.

Table 5.4 Participants within the Reforma Agraria working group.

Name	Ejidal status	Role within the community
Victor	Landowner	Community commissariat and ecotourism cooperative
Emilio	Landowner	Vigilance commissariat and agriculture commission
Alcer	Landowner son	Bachelor student
Suzana♀	Landowner daughter	Ecotourism cooperative manager
Rodrigo	Resident	Commissariat secretary and wildfire control
Yazbeth♀	Resident daughter	Bachelor student

Note: ♀ female participants

The diversity of natural resources management activities in Reforma Agraria offered several options to be used as examples for the training course. In accordance to the fire management needs of the ejido and the general assembly, a straightforward approach was adopted. The implementation stage consisted of providing a basis to adopt a GIS application by offering examples of its usability through practical explanation. I based the example of the GPS usability on the wildfire control because this related to their existing spatial knowledge.

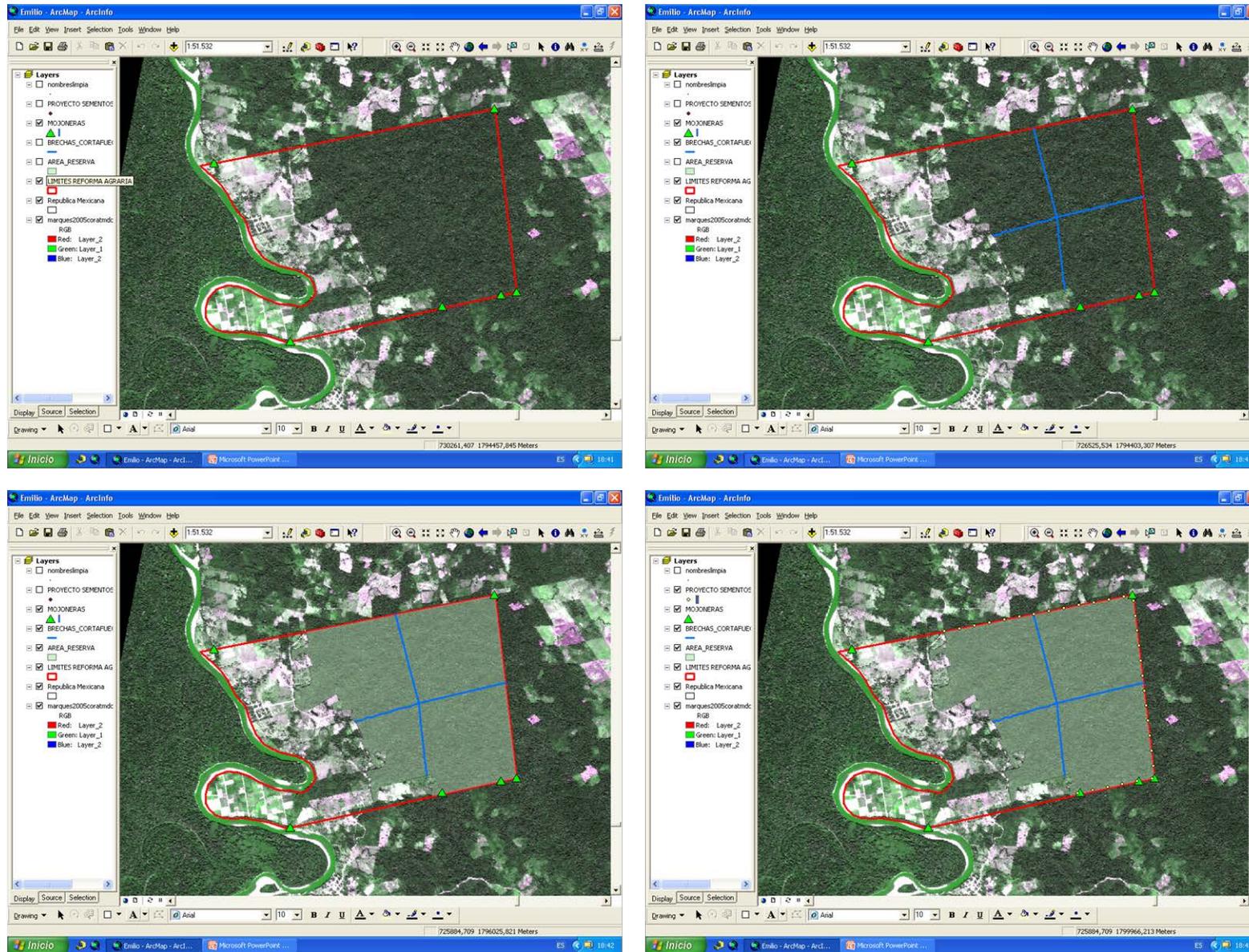
During the implementation stage I swiftly identified a major obstacle in their limited IT knowledge which hindered the expected progress and ability to cover the contents of the training course. It had been decided that the practise exercise would be continued with the working group on a daily basis and on a weekly basis with the support team which would provide a possibility of having a support facilitator for the future pilot development in the ejido.

The goal for the training course was a mapping project which required detailed surveying exercises and comprehensive training on how to operate, and get advantage of the data generated by the GPS receiver. Once data had been obtained, a series of mapping exercises were designed to show the advantages of the GIS desktop application. Although the working group in Reforma Agraria had limited IT skills, I got advantage of an outstanding spatial knowledge and used a satellite image as the baseline for the exercise.

Figure 5.3 outlines the four surveying and mapping stages which constituted the training course. For the first stage, the objective was to geo-reference the limiting landmarks of the *ejido*, and *by* using the satellite image and the limiting landmarks as reference, the limits of the community were created (green triangles and red segments in the left upper map); then, another survey campaign took place. This time the aim was to measure and map internal fire divides and the size of their natural reserve (blue segments in the right upper map; and polygon area in the left lower map).

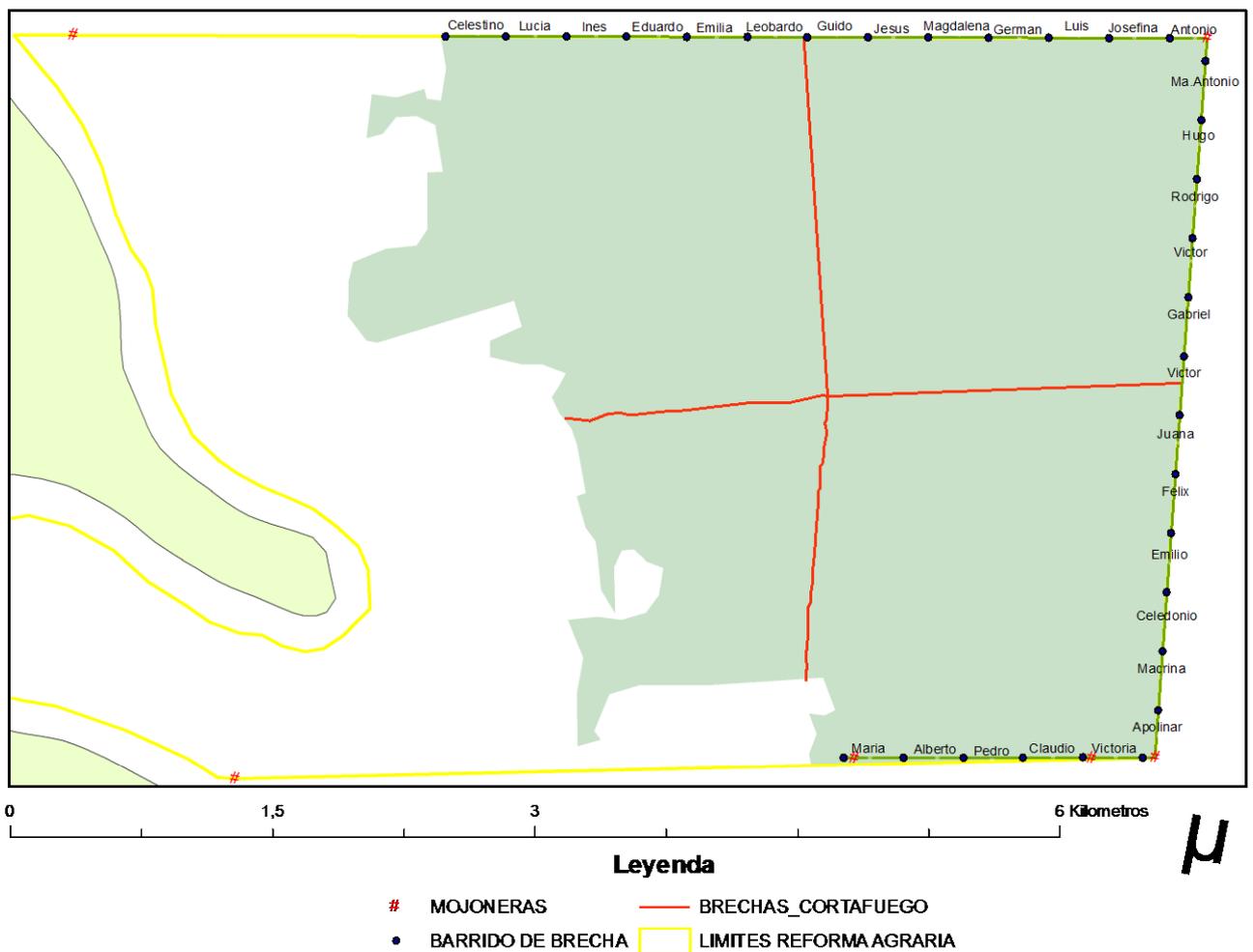
As the final stage of the course, a detailed measurement of the natural reserve's perimeter was executed and subsequently divided among the landowners, in order to assign each one with a segment for which they would be responsible as part of the fire mitigation measures (see yellow dots on the perimeter of the polygon area in the right lower map).

Figure 5.3 Sequence of the different surveying and mapping stages followed during the PPGIS implementation stage in Reforma Agraria.



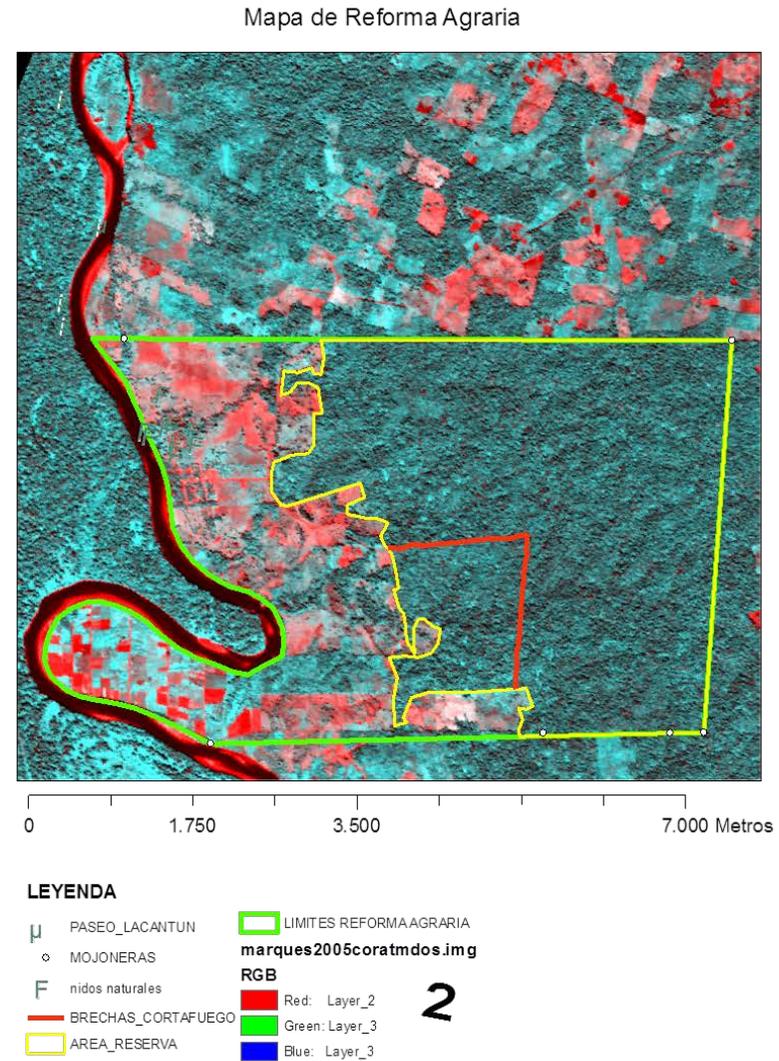
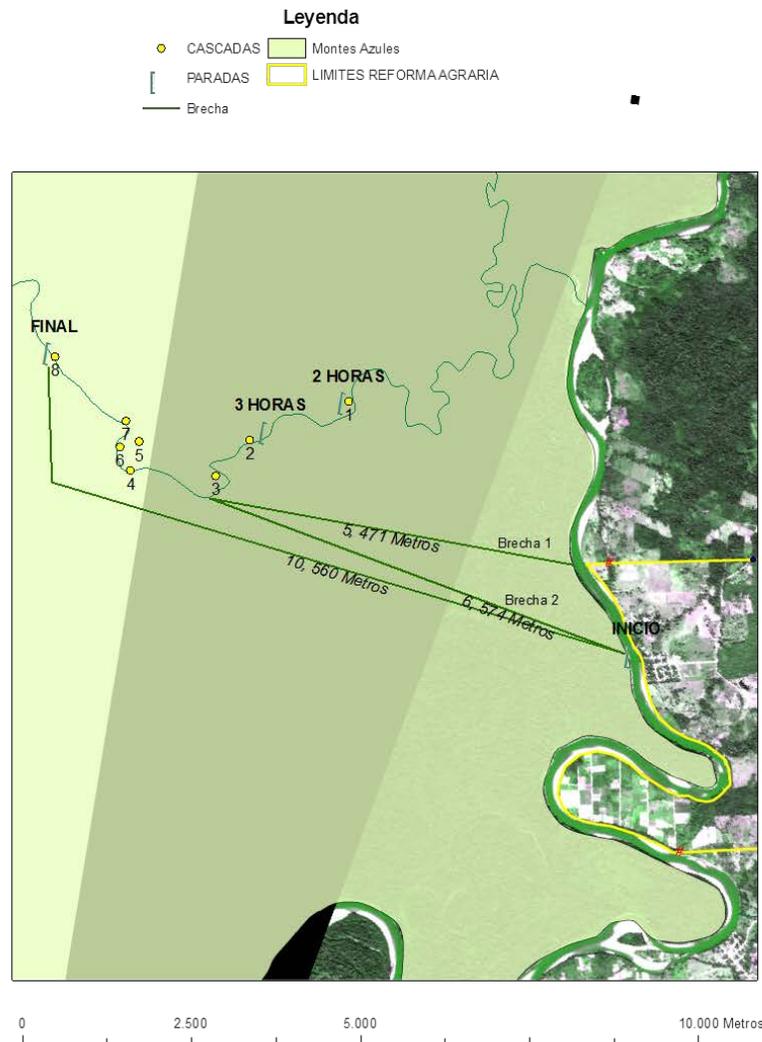
The outcome of the practical exercises consisted of an important amount of geo-referenced terrain features and as a result, a complete map of the community was created and used as an instrument enabling a decision-making process within the general assembly and ultimately, to legitimise the usability of the GIS application within all members of the ejido (see Figure 5.4 for the final product of the training course).

Figure 5.4 Result of the training course activities which were used to map and assign a segment of the external fire divide protecting the natural reserve. This map was used in an assembly meeting to inform to each landowner of the area for which they would be responsible.



Thanks to the agreement achieved with the map produced during the training course, the working group requested to conduct more surveying and mapping exercises related to a sightseeing trail in the Montes Azules Biosphere Reserve. For this, eight community members' surveyed three potential trails and a boat trip route within the biosphere reserve, while mastering the procedures to generate spatial information (see Figure 5.5 for two examples of the maps created).

Figure 5.5 Examples of maps created as a result of the training course activities. On the left hand map, it is possible to see a series of features inside Montes Azules Biosphere Reserve. On the right hand map, an example of segment assignment of the external fire divides protecting the natural reserve.



During my stay in Reforma Agraria I played several 'roles'. Firstly, I had the opportunity to witness and be part of their natural resource administration and management team and was welcomed as a project visitor. Secondly, as a facilitator, I had the opportunity of implementing practised exercises through which I was able to gain an insight in community activities and local knowledge. And thirdly, as a visitor I had the opportunity to spend most of my time getting involved with the community learning about their social structure while collaborating with them.

5.2.6 Pilot

After a demanding and challenging training course, with a successful achievement of goals but limited ability to replicate the exercises by the principal team, a working agenda for the independent pilot was established.

The objective of the pilot project was to create a document which would help towards establishing an officially recognised voluntary natural reserve which would be the first of its kind in Mexico. As a result of multiple efforts, the task was achieved and it enabled the certification of the reserve for a period of ninety-nine years, the maximum contemplated within Mexican laws. The outcome of the pilot was obviously quite important for the community as not even a broken computer stopped this independent pilot; as the commissariat decided to take the computer to the closest city to be repaired.

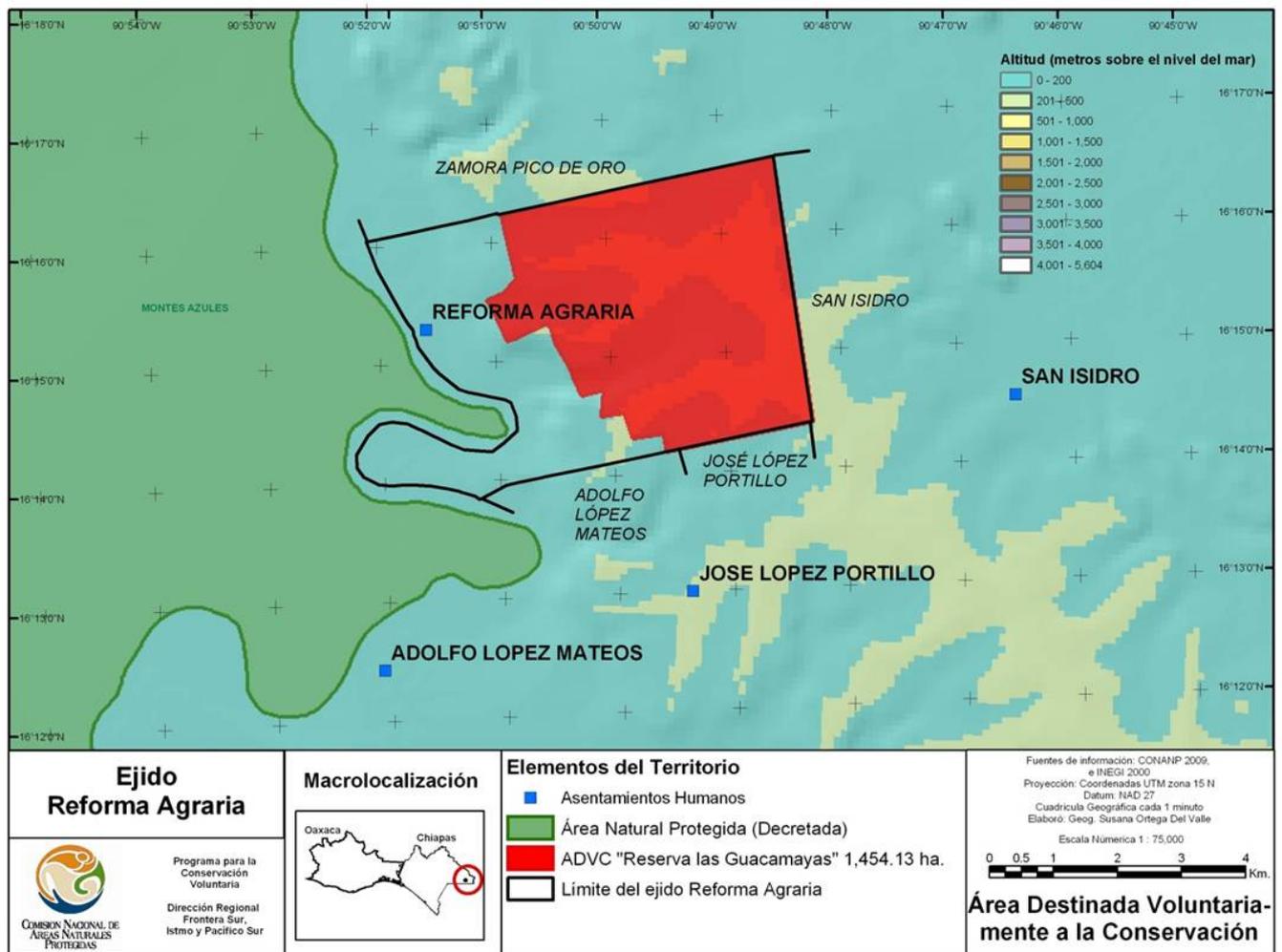
Even if the interaction with the technology was a major hindrance for the members of the working group, they managed to accommodate resources and people in order for the pilot project to be successful. These initiatives demonstrated not only the commitment with the independent pilot, but also the way their community-based organisation operates.

5.2.7 Evaluation

During my return to the community in November 2009, a series of interviews were organised to assess the development of the pilot stage, not only with the participants of the training course, but also with other citizens who showed interest and contributed during the pilot stage. In addition, at the time of interviewing the participants, other authorities expressed their interest to expand the usability of the GIS application and requested a short training course in order to conduct a series of surveying activities.

As with Ambio's carbon sequestration programme, the commissariat of Reforma Agraria incorporated the PPGIS strategy as a complementary practice to their project management activities. As for the purposes of the pilot stage, the commissariat managed to overcome their age disadvantage by inviting research visitors to use the GPS receiver while carrying out their own duties and incorporating the data into the GIS desktop application. Similarly, once data was obtained for the development of the natural reserve proposal, the commissariat managed to get support from the natural reserves officers to elaborate the necessary maps in order to complete the document with the proposal (see Figure 5.6 for an example of the maps included in the voluntary natural reserve proposal; and on the Annex 5 for full details of the submitted proposal).

Figure 5.6 Map included in the proposal to create a voluntary natural reserve in Reforma Agraria. The red area corresponds to the designated communal reserve and the green area represents the Montes Azules Biosphere Reserve.



The way in which Reforma Agraria optimised the new resources and managed to continue using the GIS application is an example of the way in which the community support and administrate their local development practises and may demonstrate some elements of their success recipe. As a result, this case study accomplished the objectives of the PPGIS initiative due to the achievement of the independent pilot tasks, resulting on the submission of a communal nature reserve proposal and its subsequent certification.

5.3 Sierra Morena

5.3.1 Selection and preparation

The study required a research design which allowed a comparative analysis of PPGIS implementation processes. As a result, the agreement with Ambio was to provide access to two communities in which the carbon sequestration programme had been already running for some time, and two others in which negotiations for the implementation of the carbon initiative had just began. At the same time, the research plan was to work in two communities adjacent to a nature reserve, and two others inside a nature reserve. Following the idea behind the research design, Ambio's suggested to invite Sierra Morena, a community in which the initial procedures to incorporate the carbon sequestration programme began in early 2009.

The reasons to extend the invitation to Sierra Morena were based on their internal model of organisation and its success in local development projects. Ambio's intention was to extend the invitation to the community in order to encourage their participation in the carbon sequestration programme, and to experiment and assess the practicalities of incorporating the PPGIS into their natural resource management strategies.

Subsequently, Ambio's team in charge of La Sepultura natural reserve began the consultation process with the community in February 2009. The invitation was widely welcomed by all sectors in the community and the preparation of the working group began.

Previous to my arrival, a communal assembly was held to designate the working group members who according to the local authorities had a compulsory mandate to participate in the course. Also, an open invitation to be a part of the working team was extended to the villagers with apparent failure to enrol more volunteers.

The beginning of the training course in Sierra Morena, the third community of the 2009 PPGIS fieldwork season, also implied a change in terms of the collaboration with Ambio. For the training courses in the two communities of La Sepultura reserve, Ambio's coordinator of the regional team agreed to travel with me to the community, and take part in the activities during the first two weeks of the training course, including in the team one of Ambio's regional technicians.

On the day of arrival to the community in May 2009, an informal meeting was held with the selected participants in order to establish the working schedule and explore the possibility of extending the invitation to the general public. After an apparent acceptance of calling for the participation of other villagers, strongly enhanced by my presence in the community, more citizens expressed their desire to participate of the training course. The unexpected fact for the already elected members of the working team was that a significant proportion of the new participants were young women with no acknowledged status or participation in the productive activities in the community.

5.3.2 Socio-economic background

In 1968, a year of remarkable socio-political unrest in Mexico, an organised group of thirty peasants began a land petition procedure to the agrarian authorities in Chiapas. The land in dispute belonged to a coffee plantation owned and operated by one wealthy family, in what was known as the *hacienda* system.

As a result of the deliberated land conflict, the tactic followed by the thirty peasants consisted of invading and occupying the land without waiting for the government resolution. According to Mexican legislation, an extension of land belongs to the individual or group of people who have occupied it for the last 25 years. The intention behind the actions of the group of peasants was to occupy the territory in order put pressure on the owners of the coffee plantation and force a favourable resolution by the agrarian authorities.

Because of the occupation and resulting confrontation events, the owners opted to abandon their coffee plantation and the agrarian authorities decided to confer the land tenancy rights of the disputed territory on the group of peasants. That was the beginning of the *ejido* known as Sierra Morena, which is now recognised as a community-based political organisation with a very strong, yet simple, internal structure, reflecting the way the territory was obtained.

As in the times of the *hacienda*, coffee production remains the main economic activity in Sierra Morena. Coffee production in southern Mexico has a long tradition of peasant organisations promoting and defending their agrarian, collective and trading rights. During the 1980's, coffee profits diminished due to trading barriers and this situation triggered the exploration of new economic

activities. In Sierra Morena, the alternative was to commercialise a native palm tree (*Chamaedorea quezalteca*), from which the pigments used for an ink to print U.S. dollar notes were produced.

Two decades later, a drastic change was introduced to the community. The territory in which Sierra Morena is located was turned into a natural biosphere reserve in 2006, and ‘sustainable’ practices had to be incorporated to all economic activities. Consequently, due to these changes, Sierra Morena gained regional recognition because of its ability to adapt their productive activities and comply with environmental regulations.

Within the new territorial scheme, the latest project in Sierra Morena is an ecotourism camp in which other peasants organisations come to learn from the experience of the community and its adaptation processes to local development projects.

In Sierra Morena, natural resource management initiatives are oriented to comply with the biosphere reserve environmental regulations while generating local productive opportunities. Figure 5.5 outlines the different economic activities in the community. Coffee production and agriculture follow the regional pattern of economic activities, while palm and ecotourism cooperatives stand as local productive initiatives in which Sierra Morena holds a leadership figure by configuring networking interactions with neighbouring villages.

Table 5.5 Access and distribution of economic activities according land property rights in Sierra Morena

	Ejido members	Land possessors	Residents
Government programmes	✓	✓	✓
Agriculture	✓	✓	✓
Coffee production	✓		
Palm cooperative	✓		
Ecotourism	✓		

Land-use and ownership in the *ejido* has maintained its original structure although the membership has been passed through the sons and daughters of the original *ejido* members. Although the *ejido* has

experienced a transition within its economic structure, represented by a more dispersed structure of the activities, its social structure maintains its original arrangement in which the general assembly is the main governing body. Under this scenario, Ambio contemplated the possibility of integrating the carbon sequestration programme in the community with the potential to expand it to other villages in La Sepultura Biosphere Reserve.

5.3.3 Power structure

The general assembly of Sierra Morena is seen and effectively operates as the main authority figure. Despite being characterised by the participation of several groups and independent initiatives, all parties of this community value and follow the protocol of the general assembly and participate in the election of the commissariat members.

The diversity of organisational structures in Sierra Morena ranges from independent coffee producers, associations of coffee producers, the palm and ecotourism cooperatives, a women's organisation, and an internal body to promote literacy among mature citizens. A distinctive characteristic is that no external organisation has a dominant presence in the community, even if the villagers and groups have a variety of strong relations with external agents.

My perception of Sierra Morena was that the issues related to power structures were conducted with a protocol and institutionally managed by the general assembly, but with a degree of independence for each internal group or individual. In the community there is no place to act outside the local law system, but it is possible to appreciate a significant degree of political independence within the villagers.

5.3.4 Relations

In Sierra Morena, the relations with external organisations are as diverse as with the internal groups. During my stay at the community I witnessed deliberations with four agencies, including Ambio. The way in which this community handles external agents is not only a result of its internal organisational model, but also a consequence of the continued development of social capital within the community. One characteristic of relations is that each external organisation negotiates with the group of interest, and it is the group itself that acts as interlocutor with the communal assembly. In most cases,

members of other groups are present as internal observers while deliberation takes place with external agency representatives with the intention of providing support.

In Sierra Morena, Ambio's carbon sequestration initiative had been openly criticised and questioned on several topics. One of them was the significance of the neoliberal market-oriented approach adopted by Ambio, in which they promoted the use of the forest resources in the community to satisfy the needs of rich entities without considering the ethics involved. Another remark made by the citizens in a general assembly was the incoherence of Ambio's programme in relation to the existing forest cover, which ignored the avoided Carbon dioxide emissions resulting from the preservation of their primary forests and woodlands.

As with Ambio's initiative, most external organisations are questioned about the purposes of their programmes, and as explained by the authorities, negotiations normally take long time due to the particular administrative procedures in Sierra Morena. The objective is not to obstruct the implementation of local development project, but to guarantee the viability of the initiatives while considering the social needs in the community.

5.3.5 Implementation

The PPGIS implementation process in Sierra Morena was characterised by an internal dispute within the working team as a result of a gender-related situation which I was not able to identify until my return to the community in November 2009. During the first week of the training course, all participants of the working group attended the course. The working dynamic was extremely interesting, not only because of the level of participation and discussions within the sessions, but also because of the support and legitimacy that Ambio's coordinator added with his presence.

After a week of daily working activities, three participants dropped out of their attendance at the training course, giving as an excuse a change in their working commitments. After the episode, no other changes occurred as the rest of participants continued attending the course until its end. In general, the working team in Sierra Morena (see Table 5.6 for details) had some degree of IT literacy due to the education levels within the working group (up to secondary school) and the ability to share their knowledge by supporting other team members. In particular, the presence of women within the

group offered the possibility of having support for the male participants, as women had better understanding of IT, as well as greater availability of time to practise.

Table 5.6 Participants within the Sierra Morena working group.

Name	Ejidal status	Role within the community
Domingo*	Landowner	Palm cooperative group
Laison*	Landowner	Palm cooperative group
Arturo*	Landowner	Palm cooperative group
Luis	Landowner	Coffee producer and natural resources commission
Omar	Landowner grandson	Community commissariat and Palm group
Isaac	Landowner grandson	Coffee cooperative group
Sandra ♀	Landowner granddaughter	Secondary student
Laura ♀	Landowner granddaughter	Secondary student
Robertoni	Resident	Ecotourism cooperative administrator
Adriana ♀	Resident	Householder
Tito	Ambio	Ambio's coordinator
Nicolas	Ambio	Ambio's local technician

Note: ♀ female participants; * participants that dropped out

Another phenomenon that made a significant difference in terms of IT skills acquisition was the peculiarity of mobile phones use in the community. Even if there was no mobile network coverage in Sierra Morena, mobile phones devices were used for many purposes, such as photo/video cameras, MP3 players, or torches, but not to make phone calls. A key characteristic that allowed the availability of devices was the proximity of Sierra Morena to a relatively urbanised area. As part of my observations, I established that the know-how derived from such devices made a significant difference to the time involved learning the logic behind some IT procedures.

The objective of the training course was to produce a base map of the *ejido* which would enable the development of the pilot stage and the three sub-projects. The amount of time and practise dedicated to this task was considerable as the distances and terrain features in which the limit landmarks were located demanded whole day expeditions. However as a result of the team commitment and motivation to participate, all landmarks were geo-referenced and data was shared among the participants.

After a successful implementation process, the agreement within the group was to constitute separate sub-groups to carry out the pilot stage as a series of independent tasks. An interesting situation was the request to have a coordinator figure to facilitate the use of the computer and further development of activities. The criterion to elect the coordinator was based on the understanding and ability to replicate and explain the GIS procedures. As a result of the distinctive progress that one of the female participants achieved during the training course, she was elected by the working group to be the coordinator of the pilot stage.

However, due to the gender-related internal conflict that I was not aware of, the three women decided to constitute a sub-group to work together for the development of the pilot stage in a village census project. A remarkable characteristic of these events was the degree of tolerance and respect in relation to the female participants, even if their presence caused some tensions, which originated the early separation of three members. Although female presence was not tolerated by every member of the team, they acknowledged their right to participate as a result of the support and legitimacy given by the assembly and Ambio's coordinator figure.

Another detail which captured my attention was the degree of spatial literacy among the participants and general knowledge of their environment. Independently of their affiliation or occupation, most participants shared the same understanding about the territorial characteristics and land use divisions within the *ejido*. Also remarkable was the ability and natural cohesion which enable them to work as a team, especially considering the number of participants and diversity within the working group. An example of the later is the series of sketch maps produced by the participants as part of the first mapping exercise (see map series in Figure 5.7) and the spatial similarity with the final product of the training course (see Figure 5.8). A land cover map of the *ejido* Sierra Morena is presented in Figure 5.9 for comparison purposes.

Figure 5.7 Series of sketch maps of landmark's limits and land uses in Sierra Morena, produced by the working group during the first mapping exercise.

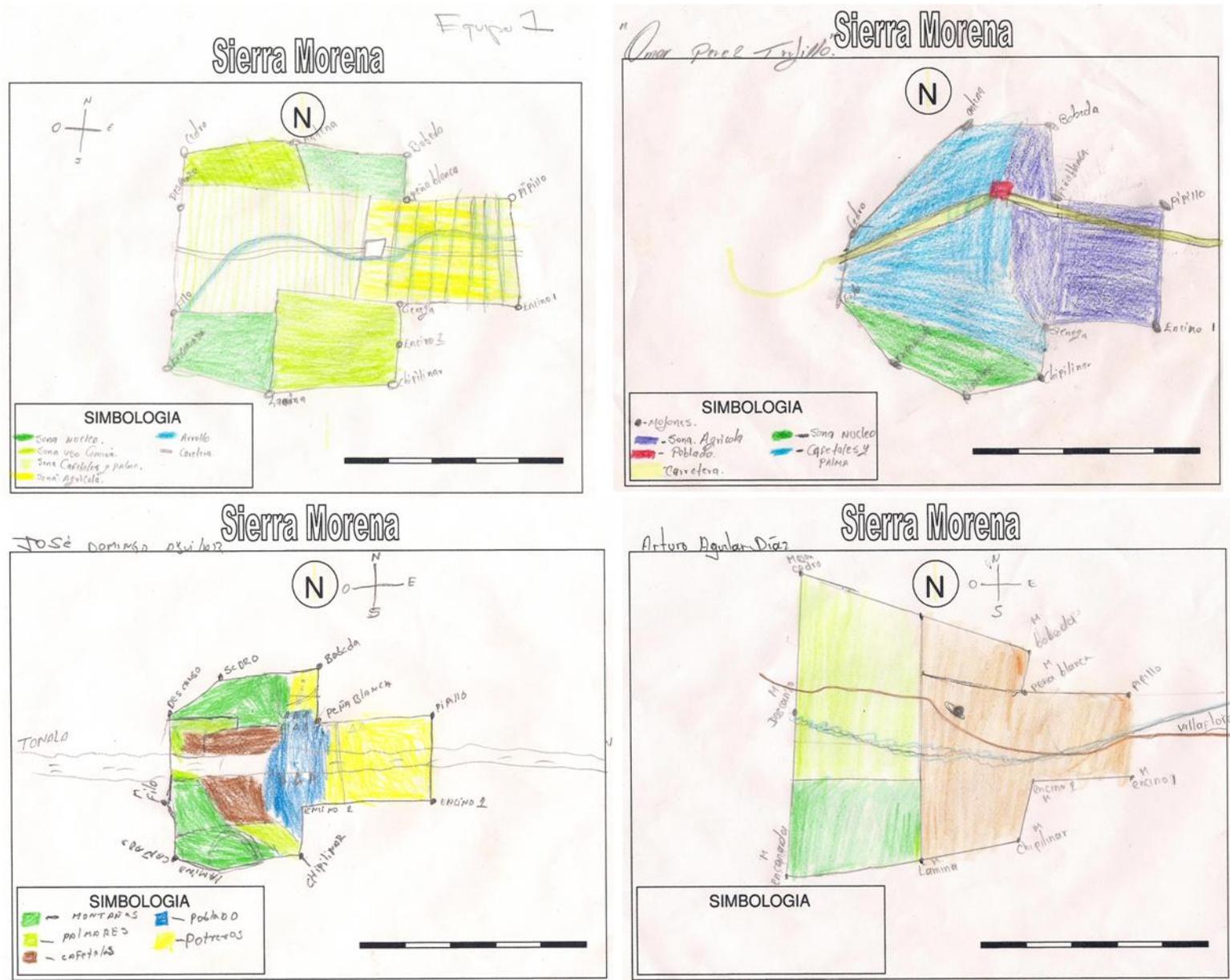


Figure 5.8 Outcome of surveying and mapping activities part of the implementation stage in Sierra Morena. The map represents the limits as well as the forest reserve of the ejido.

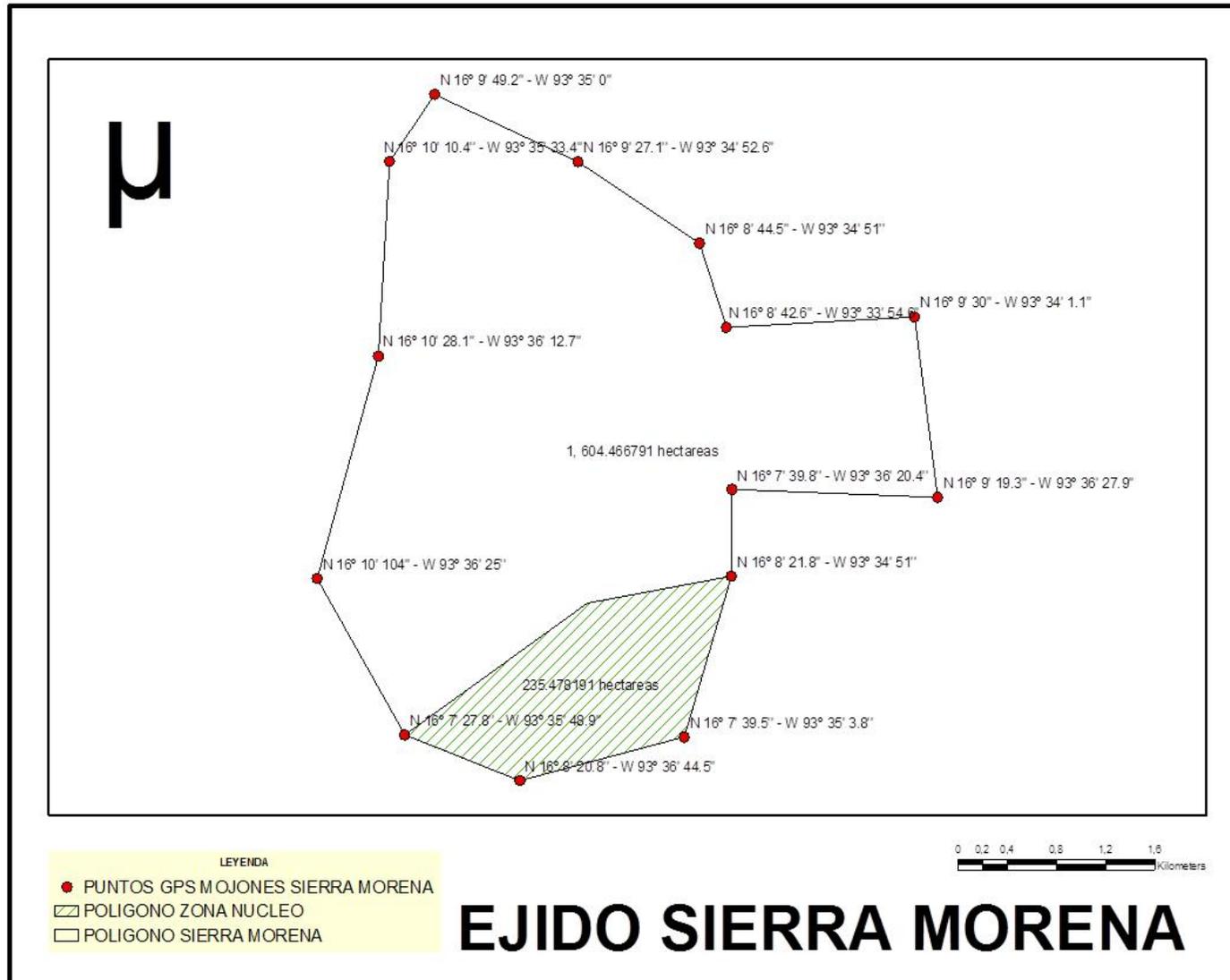
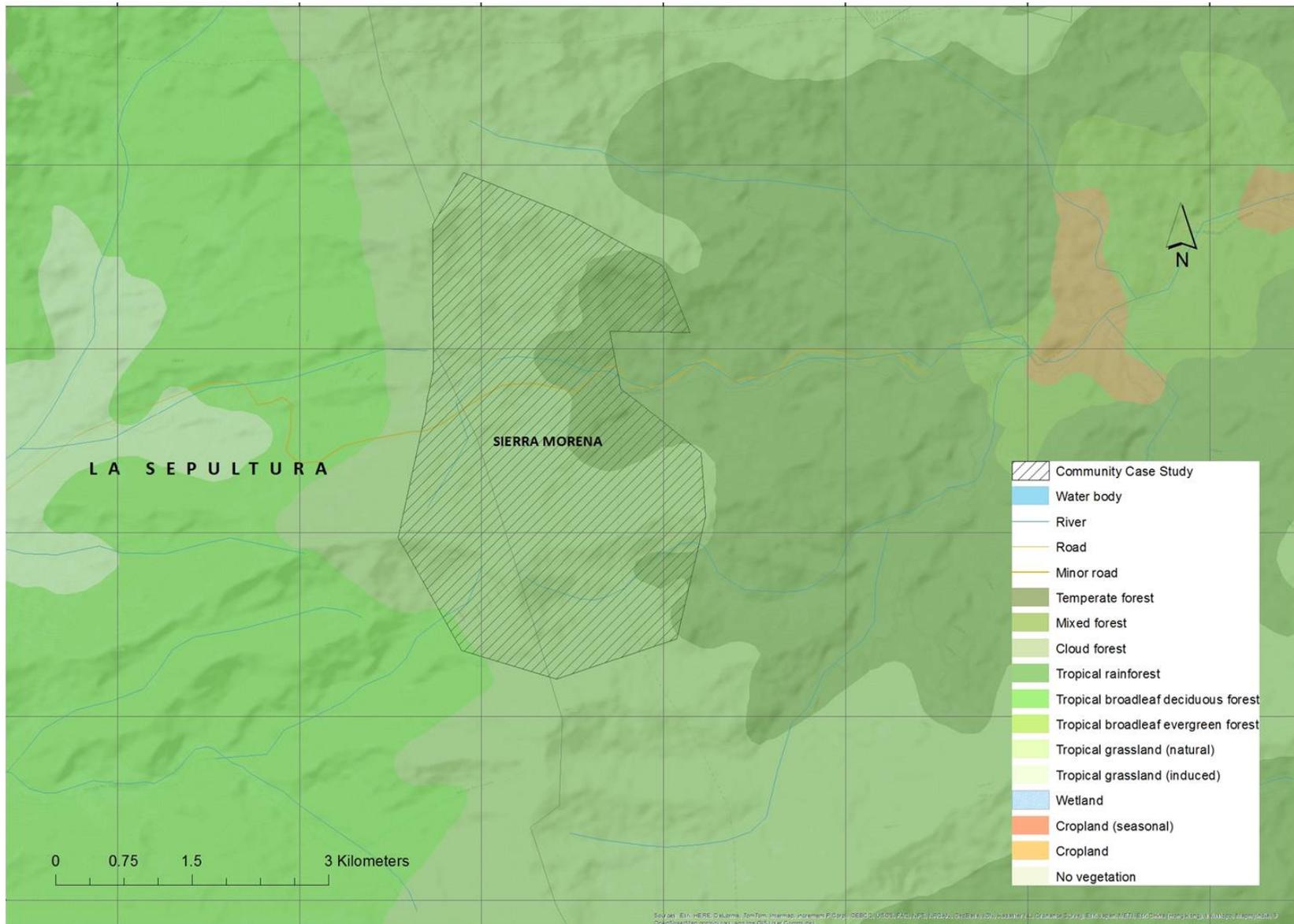


Figure 5.9 Land cover map of the ejido Sierra Morena



5.3.6 Pilot

Sierra Morena is an example of a successful implementation stage followed by an independent pilot experience characterised by conflict, as one of the pilot sub-groups hoarded the use of the computer. This situation resulted in the exclusion of other teams (census, ecotourism and land-use mapping tasks) from having access to practice and develop their pilot tasks. However, the outcome of this episode resulted in the realisation that without teamwork and mutual support, the completion of the pilot projects was impossible.

During the first eight weeks of the independent pilot, all sub-groups managed to complete only one out of three tasks (survey, mapping and project proposal production). The dominating group carried out a detailed survey of the parcels in which palm trees are produced. The working plan was to create a project proposal which needed a detailed inventory of the palm trees area to calculate the productivity of the fields, and to establish a sustainability index of their management practices. Similarly, the other sub-groups managed to carry out the survey stage of their projects, mainly because all parties had a GPS receiver and a detailed survey plan.

Nevertheless after the survey stage, all sub-groups failed to continue with the GIS mapping procedure and project proposal production. Although limited by the guidance of the group members with the ability to replicate the GIS procedures, the palm trees sub-group continued using the computer and incorporated new ways of capturing relevant data for their activities; while the rest of participants abandoned their projects, accepting the hegemony of the dominant group.

5.3.7 Evaluation

My arrival to carry out the evaluation stage in the community case study coincided with a day on which a general assembly occurs every six months, and is regarded as the most important organisational event in the community. The first reaction to my arrival was one of complete surprise, as participants and authorities never expected that I would come back to the community, and especially not on the day I said I would.

During the assembly, I was invited to intervene to openly enquire about the progress of the independent pilot. An immediate reaction from the sub-groups involved took place and the evident failure of the pilot became apparent to me. Although the situation proved to be tense, the local authority used the opportunity to question all parties of their perspectives and proposed solutions for the situation.

The underlying issue was the disagreement of some team members regarding the participation and leadership of women. As agreed for the pilot stage, women decided to work together and independently of other sub-groups. This situation represented a change in the internal power scheme, and the dominant sub-group in the community, as well as the vast majority of males, were not ready to accept such a change.

Once this matter was clearly recognised and openly discussed in the assembly, the discussion turned into the creation of an agreement to continue with the PPGIS initiative. The continuity was based on public commitment to accept the participation of the women's sub-group, but removing the presence of the elected female coordinator. Conciliation took place when the dominant sub-group accepted they needed women's participation in order to guarantee the full process required to submit project proposals. After this event, the interviews added plenty of information and valuable facts to my understanding of the main difficulties during the pilot process. They exposed many elements and explanations of how interactions take place within the local power structure, and especially on how the participants internalised such patterns within the working sub-groups during the pilot stage.

5.4 Tres Picos

5.4.1 Selection and preparation

After commencing the training course in Sierra Morena, Ambio's coordinator for La Sepultura proposed to extend an invitation to the neighbouring community of Tres Picos to be the fourth case within the PPGIS implementation stage. Although no particular reasons for the relevance of PPGIS project were established, the community was invited because of its potential incorporation into Ambio's carbon sequestration programme. The relevance of Tres Picos lies within its forest reserve due to its territorial status of belonging to La Sepultura Biosphere Reserve. This, along with the relatively ease with which afforestation success may result, were the main reasons for Ambio's interest in this community.

By the end of the coordinator's stay in Sierra Morena, I visited Tres Picos to present the idea to the commissariat, and make a formal invitation for their participation in the training course. On the arrival to Tres Picos, the commissariat who was notified one day before of my visit told us about a general assembly being organised to extend the invitation to the landowners, and to assess the relevance of the proposal.

At the general assembly, where at least eighty landowners gathered, Ambio's coordinator explained the objective of the carbon sequestration programme, trying to encourage the acceptance to the initiative. Furthermore, a short explanation of my temporary role within Ambio's structure and the relevance of my study for the community preparation to join the carbon initiative were given. Subsequently, I gave a short presentation consisting of a full reasoning for my working stay and the objectives of the project. Further speech by the community moral leader emphasized the need to welcome external initiatives. After the last intervention, no one dared to comment on any of the previous presentations and I decided to give a short summary on the development of the training course from the other participating communities.

The community's main reservation became obvious after a senior member raised the issue of paying for my 'services' and the costs of the course. After clarifying that there were no costs to be covered, and that I was not affiliated to Ambio, a discussion for a straight forward voting procedure took place among the landowners. The result was a clear majority welcoming my presence in the community in

order to conduct the implementation stage of the PPGIS initiative. However regarding wider acceptance, the abstention of some members was notable.

Once the consultation and internal enquiries concluded, I requested to establish the procedure to select the participants of the working group, favouring young citizens to participate to lessen the age-related digital divide issue. The assembly began a deliberation and proposed six young citizens to be part of the course, who were asked to join the assembly in order to confirm their interest in attending the course. With this, my participation in the general assembly was finalised and I left the community while internal issues were being discussed.

5.4.2 Socio-economic background

Tres Picos is a relatively large *ejido* because of the size of its assembly, i.e. ninety landowners. Parts of my enquiries regarding the community were focused on the origins and story of the village. For this case, it was neither possible to track the origins of the community nor to have a single vision on the recent socio-political events defining the history of Tres Picos. The information obtained suggested Tres Picos had been settled during the 1950's as a result of the division of a group of people from other communities in the region. According to this version, the separation was influenced by political unrest and concurrent decline and abandonment of development strategies in the region.

At present, the main economic activity in the village is coffee production and self-subsistence agriculture. Tres Picos is a place where it is possible to appreciate the economic crisis of rural Mexico expressed in the lack of viable economic activities. This situation results in the fragmentation of most families due to the high rates of labour-related emigration to the United States of America. The emigration followed a decline in coffee production during the 1980's, where the productive scheme in Tres Picos experienced fragmentation, resulting in a single communal cooperative administering the commercialisation of the harvest.

Another characteristic of Tres Picos is the advanced age of the landowners, this being reflected in the elevated proportion of land possessors and residents in the *ejido*. A summary of economic activities and access to them as a result of land tenancy status in the *ejido* can be seen in Figure 5.7.

Table 5.7 Access and distribution of economic activities according land property rights in Tres Picos

	Ejido members	Land possessors	Residents
Government programmes	✓	✓	✓
Agriculture	✓	✓	
Coffee production	✓		

5.4.3 Power structure

Tres Picos is a relatively large village lacking an effective and functional community-based organisation, which is easily identifiable by the absence of promoter organisations for coffee producers which normally encourage organic production of coffee across Chiapas. This situation is one indicator of the status of power relations in the community.

In Tres Picos the general assembly is acknowledged as a dialogue moderator between the different groups in the community. Although the general assembly and elected commissariat are recognised and supported, there is also a moral authority figure. Due to the large number of landowners and the absence of a local administrative role within the participants of the working group, it was difficult to make enquires and structure ideas about the organisational schemes in the community.

The absence of a grassroots organisation in the Tres Picos appears to be the principal obstacle to welcome external initiatives for local development. Although the general assembly takes into consideration the opinions of all landowners, it requires more than individual opinions or group agreements to promote and encourage participation for local initiatives.

5.4.4 Relations

Tres Picos is a community in which relations with external agents show a singular panorama. On the one hand, due its relatively large population size, a number of social services are present in the community. Of all four cases, Tres Picos is the only village with a medical centre and five schools representing the three basic education levels. Nevertheless, the absence of local productive projects is the main barrier for local groups to establish a connection with external agents.

Ambio were interested in working with the community because of the potential of the forest reserves but no meetings had taken place prior to my arrival. Within the duration of the implementation stage it was not possible to get involved with local groups other than the working group in order to establish an initial approach on the way this community perceives external initiatives for local development, or the opportunity to witness interaction or deliberations with other organisations. The closest opportunities I had to witness and understand the internal network of negotiations took place during four sessions of the general assembly occurring during my stay in the community. My perception of those events was of a divided community, aware of its weaknesses, but reluctant to enable changes within the local power structure.

After the completion of the implementation stage, and prior to the beginning of the evaluation process, I had the opportunity to interview government officials in charge of La Sepultura Biosphere Reserve. When I mentioned that one of the four communities in which the study was taking being implemented was Tres Picos, a surprising interest and support for future developments in this particular community were offered. My understanding as a result of the response from Ambio and the group of government officials was that Tres Picos has a great potential to implement natural resource management initiatives, but it also represent a significant challenge because of the difficulties associated with enabling the organisation of individuals without common organisational objectives.

5.4.5 Implementation

After the acceptance of the community to participate in the PPGIS implementation stage and the short notice given to the participants, the training course started. A significant characteristic of the working team was that only one of its participants had a role within the administrative structure in the community (see Table 5.8 for an overview). However the group of young citizens with basic IT knowledge and outstanding ability to understand and replicate GIS procedures were fully committed to attend the sessions. It was interesting to witness the genuine interest to understand the underlying ideas related to the use of geographic information for a potential local natural resource management initiative.

Table 5.8 Participants within the Tres Picos working group.

Name	Ejidal status	Role within the community
Darinel	Landowner	Forestry technician
Ruperto	Landowner	Labourer
Jose	Landowner son	Rural teacher
Alejandro	Landowner son	Unemployed
Orbelin	Landowner son	Unemployed
Marco	Landowner grandson	Social worker
Paulina ♀	Landowner granddaughter	Unemployed
Luis	Ambio	Ambio's regional technician

Note: ♀ female participant

In addition to the local participants, Ambio supported the course strategy by sending a regional technician to join the course. The participation of the technician contributed to a more direct exemplification of the potential needs and approaches to be considered within the carbon sequestration programme. An interesting shared training mechanism became apparent, and the contents of the training were easily covered.

Due to relatively fast learning skills showed by the working group, a different teaching approach was adopted which enabled quick explanatory surveys furthering a deeper coverage of the course activities. Nevertheless, because of the large extent of the *ejido*, and the lack of a natural resource management plan, the outcome of the training course was limited in terms of its representativeness of the territorial context. The effort of the implementation stage focused on transmitting conceptual principles and IT skills.

The wider objective of the training course was to enable the team to carry out the independent pilot schedule. This consisted of a detailed survey of the territory complemented with a land-use classification, and a tentative selection for the areas to be included within Ambio's carbon sequestration initiative.

5.4.6 Pilot

The first stage of the independent pilot consisted of mapping the limits of the community. This task took 20 days of continuous work and represented a challenge in terms of the difficulty to survey the limits of the community, as Tres Picos has the largest territory of all four cases. To continue with their activities, the working team needed support and collaboration of the landowners in order to measure the communal land plots and conduct an initial land-use assessment. However, failure in engaging the landowners resulted in the exposure of the situation in a general assembly, and public denouncements of lack of support, which all had adverse effect on the working group.

Part of the problem was that once the participants concluded the implementation stage, *ejido* members considered them to be qualified actors and pushed them to attend meetings with external organisations and to participate in outside activities related to the carbon capture initiative. However, when the working group tried to accomplish the independent pilot project, and included the participation of the community, the landowners diminished the purpose of the task by arguing that the participants had no authority to issue land certificates, and as a result the landowners saw the second task as a waste of time. The situation is quite well exemplified with their own words:

'We were qualified to invest our time in community matters, but I was not good enough to carry out internal activities which needed the engagement of every landowner'

Interview testimony (November, 2009)

After the failure to continue with the scheduled tasks, the working group lost interest in continuing with the pilot programme. During those months, Ambio's technician came to the community to offer technical assistance and also to provide an extra GPS receiver. His visit contributed to raise the enthusiasm within the working group. In spite of no possibility to engage the landowners, they made an effort to continue working with the purpose of employing the GIS application to measure and verify the extent of land plots for sale. A further obstacle, which limited the possibility to continue working, was that the commissariat of the community stopped providing resources, such as batteries for the GPS and the key to access the computer room. As a result, the independent pilot was unquestionably interrupted.

Under such conditions, an internal boycott took place within the working group. The situation was a result of the lack of support and recognition from the local commissariat and landowners to continue with the scheduled agenda for the independent pilot. The reason why the working team boycotted their activities was, among other issues, the beginning of a potential land tenancy conflict derived from the mapping initiative. This situation pushed the members of the team to delete all the data collected during the few weeks that the pilot stage lasted, having no evidence of their achievements other than the sketch maps produced during the implementation stage.

Figure 5.10 offers an overview of the territorial perception of some participants. Of particular interest was the territorial awareness demonstrated during the training course. Although the territory in Tres Picos presented the most difficult conditions for the course surveying exercises, the imminent transition of landownership became a matter of interest among the legal inheritors of the land.

The four representations displayed below share an interesting similarity within their design; all examples clearly show limit landmark features, symbolised with the grey dots on the outer edge, which were well known to every member of the team. Nevertheless, it is also possible to appreciate the lack of agricultural and natural resource management initiatives, as all sketch maps focus their attention on the human setting features, only implying the vast extension of forested areas or 'unproductive lands'. For a comparative purpose, see Figure 5.11 with the actual land cover map in Tres Picos.

Figure 5.10 Series of sketch maps elaborated during the implementation stage in Tres Picos.

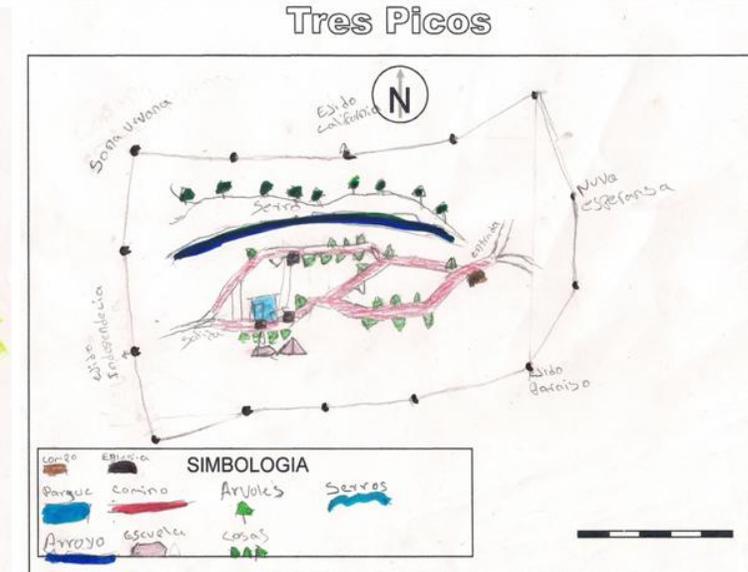
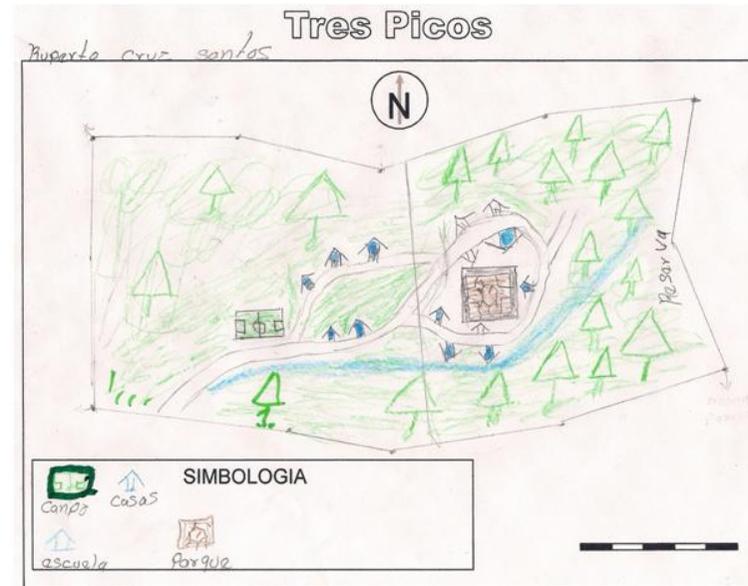
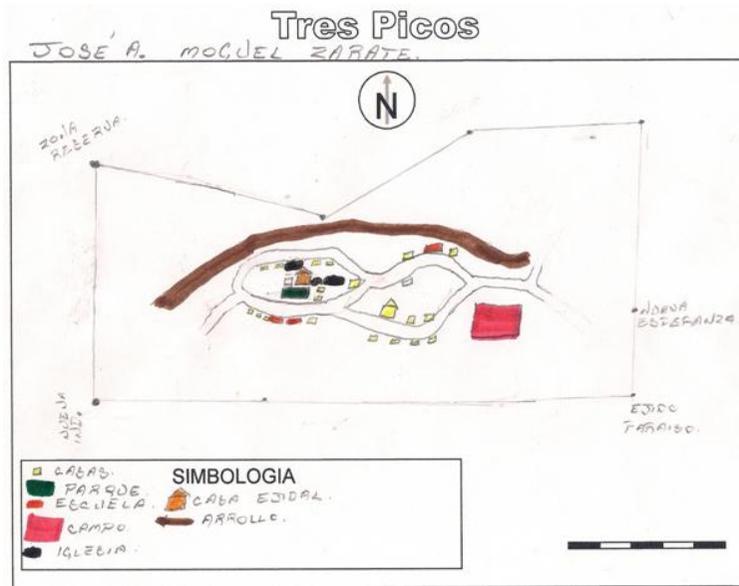
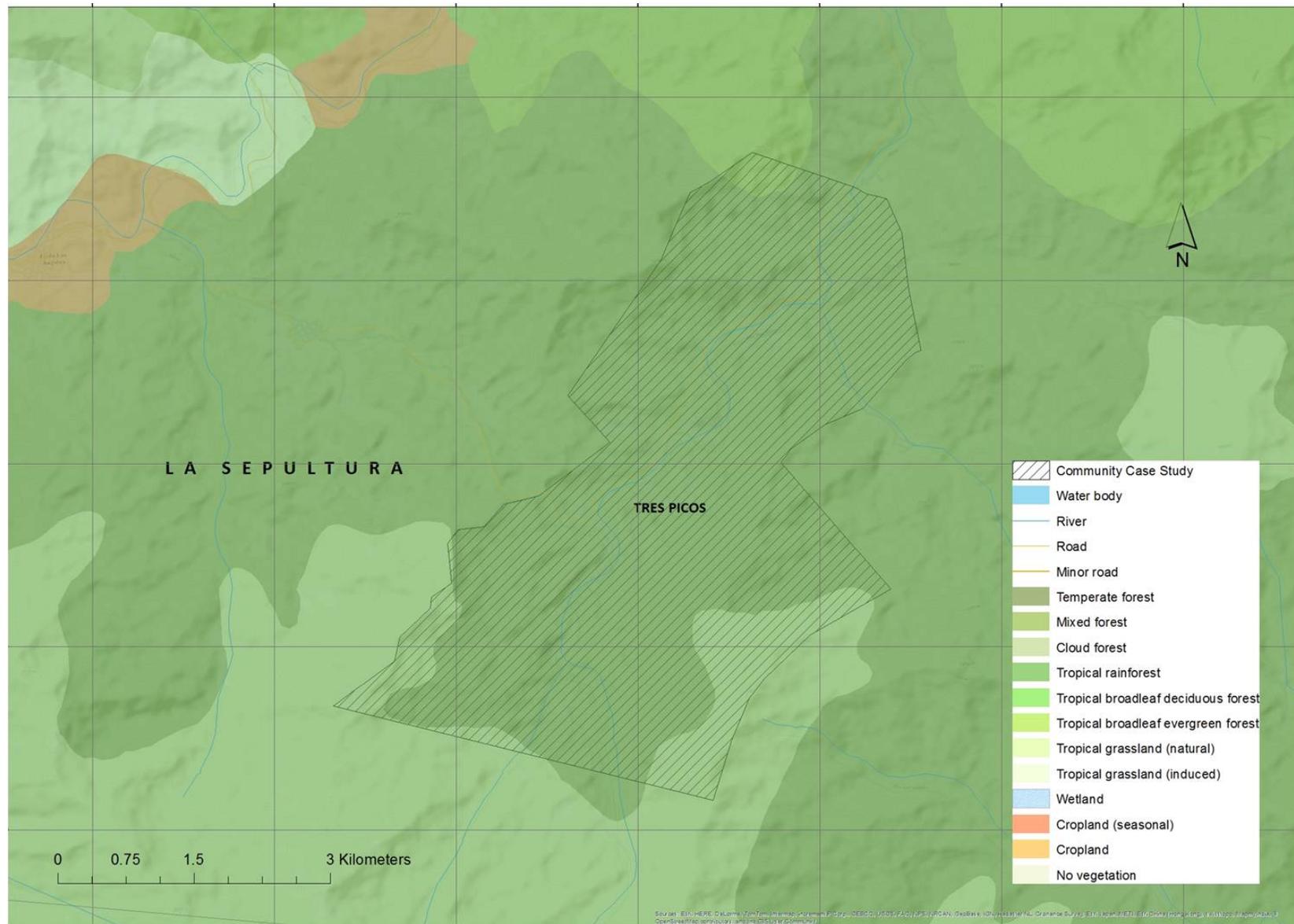


Figure 5.11 Land cover map of the ejido Tres Picos.



5.4.7 Evaluation

The initial interviews and the group interview pointed out several issues that blocked the progress of the independent pilot stage. One of the reasons was a lack of enthusiasm showed by the landowners to engage with the programme. Also mentioned was a situation which reflects the role of the power structures in this community, which I present here as a lack of leadership and trust in externally supported initiatives.

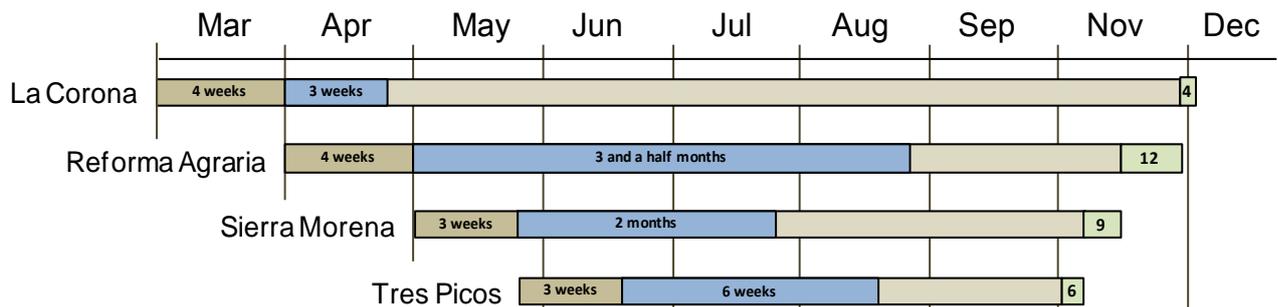
During the visit for the evaluation stage in the community, and after the interviews were conducted, I asked the authority and the working group to call for a general assembly to organise a public enquiry to decide on the future of the GIS application in the community. During the general assembly, the working team and the authority expressed their views on the situation. On one hand the working team wanted to continue working, however without landowner's engagement they had no chance to succeed. On the other hand, the local authority expressed its concern about the future of the PPGIS programme because the presence of the computer without a clear objective could have caused discordance within the community.

The outcome of the general assembly was to end the PPGIS programme, this being decided by the vast majority of *ejido* members. After the assembly, I carried out a second set of interviews to understand the thoughts of the working group. During this enquiry, as some members of the group were more eager to express their views, it was possible to identify the boycott situation that happened during the time of the independent pilot.

5.5 Observations

This chapter has presented a narrative analysis of the different perspectives obtained during implementation of the Public Participation GIS endeavour. It is necessary to highlight that although efforts were made to maintain a homogeneous record of observations, there were particular circumstances which altered the comparative character of the study. The most significant example of this is represented in Figure 5.12 which offers a graphic scale of the actual implementation schedule across the case studies.

Figure 5.12 Actual implementation schedule (2009) representing the different implementation stages: training course (grey), independent pilot (blue) and evaluation process (green).



Although the initial implementation schedule consisted of having similar time scales for every community case study, I found a series of challenges and obstacles which made the actual implementation process different to the original plan. The most significant variation within the implementation schedule across the case studies was reflected in the duration of the independent pilot projects.

5.5.1 Sampling approach evaluation

The sampling approach used in this research directly relates to the selection process of the participants within each one of the four working groups, in which the validation of the general assembly, as part of the local governance protocol was employed to grant citizen's the right to participate in natural resource management initiatives (see Section 4.2.5 for more details).

In this sense, the interviewees sample considered in this study took into account all people actively participating within the working groups, previously validated by the general assemblies, as well as a number of relevant stake holders (e.g., ejido authorities, Ambio representatives and government officials) which were selected based on appropriate situations rather than a previous sample size design (see Table 5.9 for reminder on the number of research participants, semi-structured interviews conducted, and testimonies within the implementation and evaluation phases interviewees summary).

Table 5.9 Structure of the evaluation framework oriented to help obtain a comprehensive explanation of the phenomenon occurring during the different stages of the PPGIS implementation strategy.

	Located outside a biosphere reserve		Located within a biosphere reserve		Total
	La Corona	Reforma Agraria	Sierra Morena	Tres Picos	
Number of participants	6	6	10	8	30
Number of interviews or written testimonies	7	6	10	8	31
Interviews with community authorities, Ambio representatives, government officials					10

A major strength of the selected sampling approach relates to the minimum interference on socio-political arrangements and socio-economic interests, acknowledging the sets of local rules and responsibilities to citizen participation. At the same time, the latter represents a significant weakness because it perpetuates the relation between access to land rights and the resulting right to participate in training and capacity building for local natural resource management initiatives. As a result, potential bias may include: exclusion of landless peoples and resulting opportunities to identify alternatives to equity and transparency in participation; preserving and strengthening power structures and barriers to knowledge democratisation; and, contributing to a broader division within local groups as a result of widening inequalities represented as economic, technological and knowledge divides.

5.5.2 Map analysis

Although only a limited number of maps were produced within the four PPGIS pilots, in the context of current study making maps resulted in wider implications than just representing landscape features and natural resources interactions. Due to local governance principles and practice, a map becomes a powerful instrument once it is presented and accepted at the local assembly. A map can be used to share knowledge and spatial understanding among community members, and as a mechanism to build consensus about territorial decisions.

The structure of the PPGIS implementation process involved at least four map producing stages. The first consisted of a series of sketch maps to understand team members' perception of their territory. The second consisted of using GPS receivers to record landscape features and GIS software to understand basic mapping principles, and produce a digital map to compare the accuracy of perceptions (sketch map) against a more accurate spatial representation (satellite imagery and georeferenced features). The third stage consisted of producing a thematic map about a specific local issue, in order to test the viability of consensus building among community members. The final stage considered the opportunity of using the skills acquired during the PPGIS implementation to produce a decision-making map to inform a specific process.

Each stage needed a successful accomplishment of previous one, adding complexity not only to the map making process but also to the degree of involvement to produce, validate, improve and present the map. In addition, the aim was to identify the limitations of current PPGIS approaches in relation to the abilities and needs of local communities to produce geographic information and enable wider and better informed decision-making processes.

Ideally, all the pilot communities would have been successful in completing the four mapping stages, allowing the comparison of the map making processes across them. Although the outcomes of the four community cases studies did not enable such comparison, a number of maps have been included in this chapter to illustrate the rationale described above and Table 5.10 provides a set of summary comments on the strengths and weaknesses of individual maps. These highlight the benefits of recording resource-related information in map form, but also the limitations of a number of the preliminary maps for decision-making purposes.

Table 5.10 Strengths and weaknesses of the maps produced during the different stages of the PPGIS implementation strategy.

Figure	Pilot	Mapping stage	Strengths and weaknesses
5.1	La Corona	Sketch map	S: Both maps show high local knowledge on land uses in the ejido, and to some extent also good agreement on relative size areas. W: Sketch maps pose the risk to represent ideal land distribution of land-uses, raising concerns about its correspondence to reality, making it in some cases unreliable.
5.7	Sierra Morena	Sketch map	
5.10	Tres Picos	Sketch map	
5.2	La Corona	Digital map	S: A comprehensive measuring campaign aimed at learning about the real size of each parcel, and more important, to overlay the different parcels with a satellite image to verify the agreed land-use in the ejido. W: This map triggered a discussion on the idea of subdividing the common protected area, so avoiding depletion of natural resources by outsiders. If local governance is at stake, maps can create more conflicts than bringing solutions.
5.8	Sierra Morena	Digital map	S: By having an accurate representation of ejido limits, it was possible for the first time to communicate the relative size and location of the common reserve. W: Although precise within the limits of the ejido, this map represents the general lack of local knowledge about land-use distribution in the ejido.
5.4	Reforma Agraria	Thematic map	S: The map presented to the general assembly allowed ejido members for the first time to understand the sequence of the external fire divide maintenance role. W: The negative effect of this map was clear at the ejido assembly when ejido members asked the question of how to divide the internal boundary of the reserve and the rest of the land, as there are no more people to carry out new tasks.
5.5	Reforma Agraria	Thematic map	S: Having a first thematic map incentivised other ejido members to represent other interests, like interest features in the biosphere reserve, of extreme importance for the ecotourism activities.
5.6	Reforma Agraria	Decision-making map	S: This map was part of a proposal to create a community reserve within the ejido's land. A clear example of a decision-making map, in which government officers collaborated.

6 QUALITATIVE ANALYSIS

This chapter aims to describe the results while providing details regarding how they were produced, in terms of the process of considering the ordinal variables, ranking the categories and scoring each case study. With this, I examine and compare the findings of the four community case studies in the context of the methodological and analytical approaches outlined previously in Sections 2.3, 4.1, and 4.3.

Section 6.1 provides an explanation of the process used to derive the analytical framework, proposing a set of analytical categories which were subsequently populated by a number of indicators in order to characterise the community case studies involved in the analysis. Interactions between key themes are described in a series of thematic tables and figures, providing a departure point for the explanation of the phenomena observed during the four PPGIS implementation processes.

Section 6.2 presents the results in terms of individual trends within each analytical category while Section 6.3 presents a comparative exploration of findings across the case studies outlining possible reasons why different communities behaved in the way they did. In an attempt to extend these findings, Section 6.4 elaborates on the observations presented in Sections 6.2 and 6.3 and proposes a series of scenarios for each community case study.

Section 6.5 reflects on the strengths of the investigation by critically evaluating how case studies were scored against these variables; how did the data collected inform this scoring process; as well as elaborating on the extent of uncertainty, and what are the implications of this uncertainty for the conclusions of this PhD thesis.

6.1 Analytical framework

The analytical framework presented in this section was derived from the analysis in the literature review and research context chapters. As a theoretical basis to investigate the interactions between technology and the specific social setting (Martin, 1998), actor-network theory key ideas contributed to define five themes on which the analytical framework was based (see Section 2.3).

Participation in development, information technology skills, social structure, external relations and power structures were the resulting analytical categories, intended to represent a number of characteristics within each community case study. To quantify and compare the relative magnitude of the characteristics within each analytical category, the literature review and research context analyses provided the basis for providing descriptions of five different levels for each indicator (see Section 6.2

for more details); so a scoring process could be implemented to allow the evaluation and comparison of interactions within each community case study and across them.

Table 6.1 provides a summary of the analytical categories, associated indicators and citations to the references that informed the ranked levels within each indicator. From this, it became possible to develop an analytical mechanism able to describe individual trends within each community case study and offer valid explanations across them; while providing a more general framework that could be compared with other studies and related themes.

Table 6.1 Summary of analytical categories, indicators and ranked levels

Analytical category	Indicators			Rank
Participation in development	Why participation in local development?	Why participation in NRM?	Necessary for participation	Rank
Minimum	Individual benefit	Individual interest	Land ownership	1
Limited	Related to power position	Related to power position	Skills	2
Traditional	Group benefit	Group interest	Ejidal affiliation	3
Progressive	Cooperative benefit	Cooperative interest	Open participation	4
Significant	Community benefit	Community interest	Community service	5
	Derived from: Cullingworth & Nadin, 2006; Bishop, 2008; Healey, 1997; Ostrom, 1990. See local governance structure in collective ejidos (Section 3.3.1); and, community-based land-use planning (Section 3.3.2).		Derived from: Bernal, 2007; Chapela, 2006; Ostrom, 1990; Otero, 1989; See community-based land-use planning (Section 3.3.2).	
IT skills	Previous exposure to technology	Ongoing use of IT for NRM	IT literacy	Rank
Limited	Absent	Absent	Limited	1
Basic	Communication purposes	Carried out by a third party	Basic	2
Some degree	Education / leisure	Learning	Some degree	3
Advanced	Productive activities	Facilitated	Advanced	4
Comprehensive	Inclusive	Independent	Comprehensive	5
	Derived from: Dunn, 2007; Weiner et al., 2002; Abbot et al., 1998; Harris et al., 1995.	Derived from: Corbera and Schroeder, 2011; Dunn, 2007; Abbot et al., 1998; Harris et al., 1995.	Derived from: Abbot et al., 1998; Harris et al., 1995.	

Social structure	Age	Gender	Occupation	Rank
Weak	Elder	Male	Assembly commission	1
Restricted	Group in power	Group in power	NRM commission	2
Traditional	Representatives	Representatives	Representatives	3
Progressive	Diversity	Presence	Farmer / household	4
Strong	Represented	Proportional	Previous plus landless	5
	Derived from: Bernal, 2008; Otero, 1989; See local governance structure in collective ejidos (Section 3.3.1); and, community-based land-use planning (Section 3.3.2); and Section 3.5 Regional context.			
External relations	Relations with neighbouring communities	Communication with government agencies	Programmes with NGO's – Universities	Rank
Minimum	Minimum	Minimum	Absence	1
Limited	Limited	Limited	With a single body	2
Typical	Active	Active	With a group	3
Open	Collaboration	Project	As part of a network	4
Wide	Partnership	Evolved	Several	5
	Derived from: International Association of Public Participation, 2011.	Derived from: Shividenko et al., 2005; White and Martin, 2002; Ostrom, 1990.		
Power structure	Group affiliation	Team leadership	Related actors	Rank
Centralised	Landowners	External	Not present	1
Towards centralisation	Skilled citizens 'experts'	Individual	Outsider	2
Customs and traditions	Ejidal affiliation	Group	Cooperatives	3
Towards de-centralisation	Volunteer citizens	Participants	Local groups/Institutions / Organisations	4
De-centralised	Proportional	Shared	Proportional	5
Adapted from: Mol and Jänicke, 2009; Harris et al., 1995.	Derived from: International Association of Public Participation, 2011; Bishop, 2008; Cullingworth & Nadin, 2006; Bray et al., 2006; Giddens, 1999; Healey, 1997; Wexler & Bray, 2006; Ostrom, 1990; Esteva, 1983. Also see local governance structure in collective ejidos (Section 3.3.1).	Derived from: International Association of Public Participation, 2011; Bishop, 2008; Cullingworth & Nadin, 2006; Jankowski and Nyegres, 2001.	Derived from: Corbera and Schroeder, 2011; International Association of Public Participation, 2011; Hickey and Mahan, 2004; Giddens, 1999.	

Once the evaluation framework was conceptualised, an iterative process of revisions took place. For this, a number of action research techniques provided the tools to observe, participate, discuss, document and examine the progress of each intervention, while documenting the evidence to assess the PPGIS schemes implementation. Table 6.2 provides a summary of how the assessment of each analytical category was informed by a documentation procedure, drawing upon different elements of the narratives presented in Chapter Five.

Table 6.2 Summary of the contribution of actor-network theory key ideas to build the analytical categories, as well as the methods employed to inform the evaluation framework.

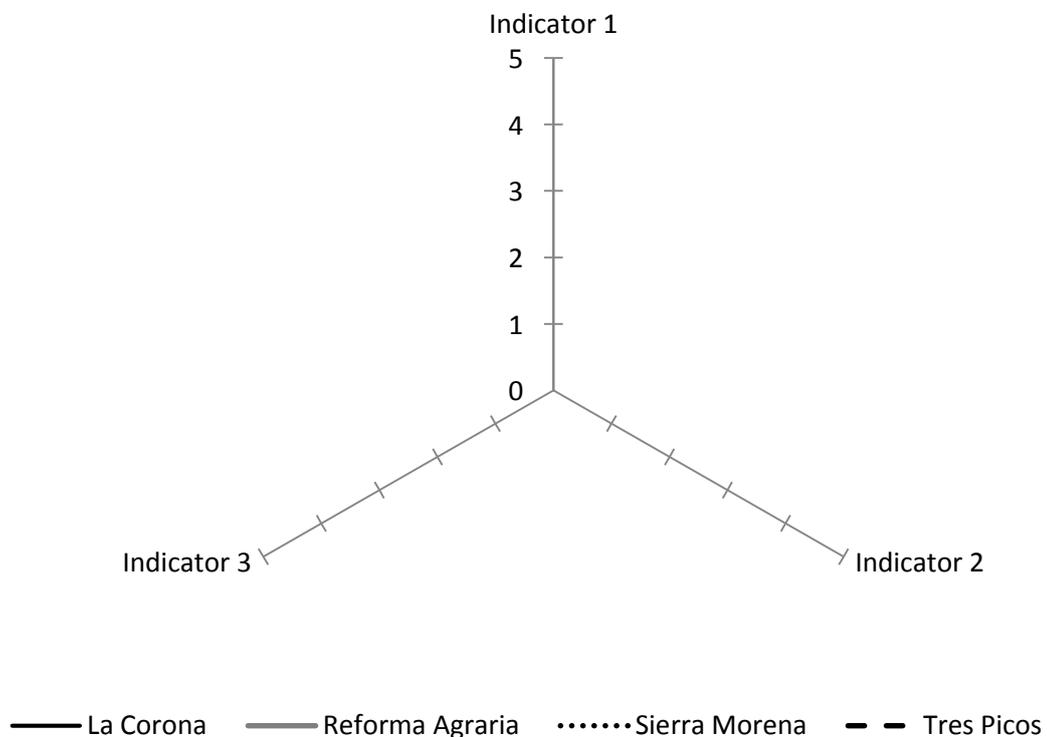
Actor-network theory key idea	Analytical category	Documentation procedure	Evidence in Chapter 5
Bring out the infrastructure of rural technological innovation	Participation in development	Participant observation in community assemblies combined with semi-structured interviews	Selection and preparation; Socio-economic background
Interactions between society and technology	IT skills	Participant observation, semi-structured interviews	Implementation, pilot, evaluation
	Social structure	Semi-structured interviews and group discussions	Socio-economic background
Heterogeneous nature of interactions	External relations	Documents review, participant observation during PPGIS implementation seasons	Relations
Power relations	Power structures	Participant observation during working groups activities combined with group discussions and semi-structured interviews	Power structures

After an extensive exploration of the possible descriptions of different levels for each indicator, the principle of majority was adopted as a basis for assigning levels. A key characteristic of the analytical framework was the interpretation of each indicator in ladder form (based on the Spectrum on Public Participation proposed by the International Association of Public Participation, 2011). This meant that the rank for each proposed indicator was regarded as increasing progressively, with all stages representing a key condition of local communities and being seen as necessary and equally important for the evolution of the processes.

In essence, the most common ranking level within the sets of indicators defined the score for each analytical category. In those very few cases where there was not a single category to define the indicator's rank (e.g. all the indicators had different levels) the average value was used to as a score for the overall outcome (e.g. regarding IT skills for Reforma Agraria in Table 6.6).

To expand upon the system of rules described above, a brief explanation of each of the five analytical categories employed in the qualitative analysis is presented in Section 6.2, at the beginning of each subsection. Similarly, the sets of indicators constituting each analytical category, as well as the different labels that define the characteristics of every indicator are described. Finally, a table summarising the scoring values conferred to each indicator, and to the resulting analytical category, is followed by a graphical representation of the characteristics in each community case study. To interpret the generic example presented in Figure 6.1, and similar ones which follow in this chapter, I next provide a brief explanation of how to evaluate them.

Figure 6.1 Rationale behind the triangular graphics



For each analytical category the three indicators are represented by one axis of the triangular graphic. Inner positions correspond to the lowest rank categories in Table 6.3 (i.e. indicative of weak social structure) while moving towards the outer points corresponds to higher categories in Table 6.3 (i.e. typifying a stronger social structure).

For example, if the social structure of a working group consisted of elderly, male participants whose occupation was being part of the ejido assembly commission (ranking 1), its representation would be confined to the inner area of the diagram. In contrast, if the relevant categories were towards the bottom rows of social structure in Table 6.3, then a rather larger area of the triangular space would be covered. All the data were analysed following the previous principles for all analytical categories.

6.2 Individual trends within the analytical categories

6.2.1 Participation in development

Participation in development aims to outline attitudes and access to social participation in development within the community case studies by presenting working team members' motives and requirements to get involved in local initiatives. This analytical category is derived from the lessons learned as part of the environmental decision-making paradigm transition of the Twentieth Century. It is conceived in opposition to the top-down structures which traditionally justified the exclusion of actors (Cullingworth and Nadin, 2006); and the constant conflict associated with the spatial distribution of the costs and benefits of a given solution (Bishop, 2008).

Under this approach, the value of society and social interaction is maximised in collaborative consensus building, leading to effective and accountable territorial decisions (Healey, 1997). Similarly, these rankings intend to oppose the Colonialist idea of political power based on landownership (Bernal, 2007, Chapela, 2006; Otero, 1989), as common property and the resulting social interaction associated to this type of land tenancy, may offer an advantage to build social networks, in which information, relationships and trust are articulated, enabling a greater potential to deal with complex dilemmas (Ostrom, 1990).

In some Mexican Ejidos, collective land tenancy is a viable system of possession and safeguard of natural resources. Such territories serve as a reserve, which offer alternatives to diversify sources of

income. Non-timber products, ecosystem services and eco-tourism among others, are a significant source of wellbeing, playing an important social role (see Section 3.1). Also, the community-based land-use planning framework (see Section 3.2.2) represents the continuation of a transformation paradigm, and as a reminder of the dislocation of authoritarian traditions which were inherited from the Colonial period (see Section 3.3.2).

In the participation in development analytical category three indicators are employed: reasons to participate in local development, motives for active participation in local initiatives for natural resource and land management, as well as necessary requirements to be included in local development projects. Table 6.3 shows the values of each indicator and the different values for participation in development.

Table 6.3 Proposed participation in development indicators and ranks

Participation in development	Why participation in local development?	Why participation in NRM?	Necessary for participation	Rank
Minimum	Individual benefit	Individual interest	Land ownership	1
Limited	Related to power position	Related to power position	Skills	2
Traditional	Group benefit	Group interest	Ejidal affiliation	3
Progressive	Cooperative benefit	Cooperative interest	Open participation	4
Significant	Community benefit	Community interest	Community service	5

A straight forward reasoning underpinned the sequence of indicator labels in Table 6.3. The premise was that social participation in local development initiatives would increase its reach in the same way that the motives and necessary requisites to participate portray more egalitarian fundamentals. As a result, individual participation benefits and interests, together with exclusive mechanisms of inclusion in the working groups, represent a minimum degree of participation; in contrast, common interests and benefits, together with an acknowledged sense of service, are the characteristics of a significant degree of participation in development. With these ideas in mind, Table 6.4 outlines the labels and community case studies scores proposed for this analytical category.

Table 6.4 Categorised indicators and participation in development score

	Why participation in local development?	Why participation in NRM?	Necessary for participation	Participation in development
La Corona	Individual benefit	Individual interest	Land ownership	Minimum
	Related to power position	Related to power position	Skills	Limited
	Group benefit	Group interest	Ejidal affiliation	Traditional
	Cooperative benefit	Cooperative interest	Open participation	Progressive
	Community benefit	Community interest	Community service	Significant
	1.5	1	2	
Reforma Agraria	Individual benefit	Individual interest	Land ownership	Minimum
	Related to power position	Related to power position	Skills	Limited
	Group benefit	Group interest	Ejidal affiliation	Traditional
	Cooperative benefit	Cooperative interest	Open participation	Progressive
	Community benefit	Community interest	Community service	Significant
	4	4.5	5	
Sierra Morena	Individual benefit	Individual interest	Land ownership	Minimum
	Related to power position	Related to power position	Skills	Limited
	Group benefit	Group interest	Ejidal affiliation	Traditional
	Cooperative benefit	Cooperative interest	Open participation	Progressive
	Community benefit	Community interest	Community service	Significant
	3.5	3	4	
Tres Picos	Individual benefit	Individual interest	Land ownership	Minimum
	Related to power position	Related to power position	Skills	Limited
	Group benefit	Group interest	Ejido affiliation	Traditional
	Cooperative benefit	Cooperative interest	Open participation	Progressive
	Community benefit	Community interest	Community service	Significant
	1	3	2	

In the same way that Table 6.4 presents the attitudes and necessary requirements that configure participation in development arrangements, Figure 6.2 provides a comparative perspective on the indicators for the four case studies.

Figure 6.2 Participation in development indicators

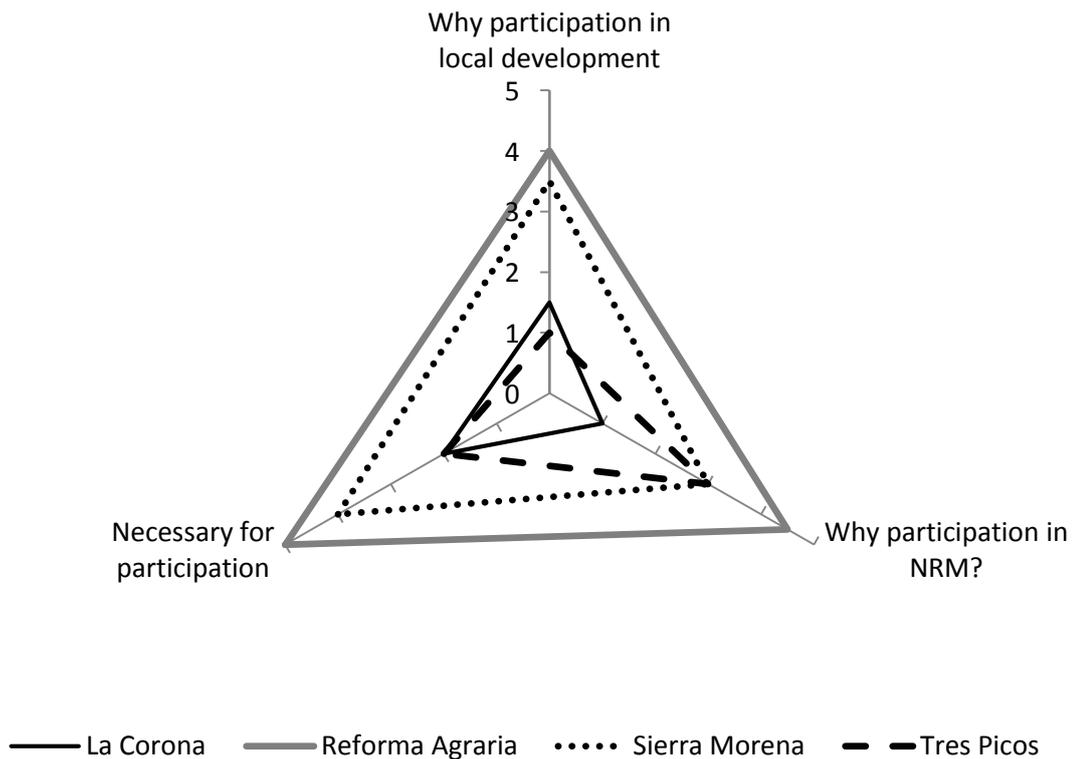


Figure 6.2 shows a diversified pattern in the characteristics of the participation in development levels. Although representing different levels in the magnitude of the configurations, the cases of Reforma Agraria, Sierra Morena and La Corona show some degree of symmetry in the distribution of values. In this sense, the hypothesis that more egalitarian motives and access to participation will offer a greater potential of success for the integration of IT tools for natural resource and land management initiatives was verified.

In addition, Tres Picos shows an interesting phenomenon in comparison with the other three community case studies due to the condition defining the reasons to participate in natural resource and land management initiatives. As a result I can observe that in the context of these common property regimes, ongoing natural resource management initiatives are a significant condition to enable wider development opportunities. Of all four cases, Tres Picos was the only community without established initiatives of natural resources and land management, and although the level on the attitude to participate in this sort of initiative proved to be above the other indicators, this situation proved to be a clear signal that attitudes alone do not provide enough enabling experiences for a community.

6.2.2 IT skills

This analytical category intends to group a set of technology-related conditions required for PPGIS implementation among non-expert groups, to facilitate their involvement, and inform them about the territorial alternatives they face, in relation to interventions with a spatial decision-making element (Abbot et al., 1998). This approach to technology transfer for natural resource management among non-expert users aims to improve social capital and local capacities. A situation in which local needs as well as IT skills find the opportunity to use geographical information to improve decision-making for land management in the context of rural sustainable development is strongly desired.

Corbera and Schroeder (2011) argue that implementation of successful carbon forestry requires a transition involving multiple actors, in which government institutions are willing to give local communities and forest dwellers a stake (capacity building, technical and administrative support, networking opportunities, among others) in their environment. Augmenting and supporting dialogue between different groups, hence facilitating the participation of citizens, is also acknowledged as an element of increased accountability (Carver, 2003; Abbot et al., 1998).

According to Weiner et al., (2002) PPGIS is a political process because of the territorial character of decision-making situations. Technology transfer must occur under local conditions, complying with local governance protocols, as a process in which participation increases progressively, and all stages are seen as necessary and equally important for the successful PPGIS implementation process (IAPP, 2011).

In general, IT skills describe the different degrees of technological expertise among the different working groups of research participants, while aiming to portray the processes leading to acquisition of abilities to use IT by integrating three indicators: previous exposure to technology, ongoing use of IT in local natural resource and land management initiatives, and IT literacy as a result of the training course (e.g. know-how on how to operate a digital camera, capture coordinates with a GPS, manipulate information within the GIS environment). Table 6.5 outlines the levels within each indicator and the different ranks that characterise IT skills.

Table 6.5 Proposed IT skills indicators and ranks

IT skills	Previous exposure to technology	Ongoing use of IT for NRM	Resulting IT literacy	Rank
Limited	Absent	Absent	Limited	1
Basic	Communication purposes	Carried out by a third party	Basic	2
Some degree	Education / leisure	Learning	Some degree	3
Advanced	Productive activities	Facilitated	Advanced	4
Comprehensive	Inclusive	Independent	Comprehensive	5

The procedure employed to assign the different labels to each indicator was the result of the continuous exploration and assessment of the independence and ability to manipulate IT tools among the research participants. Following from this, Table 6.6 shows the labels and ranking scale of IT skills for each community case study.

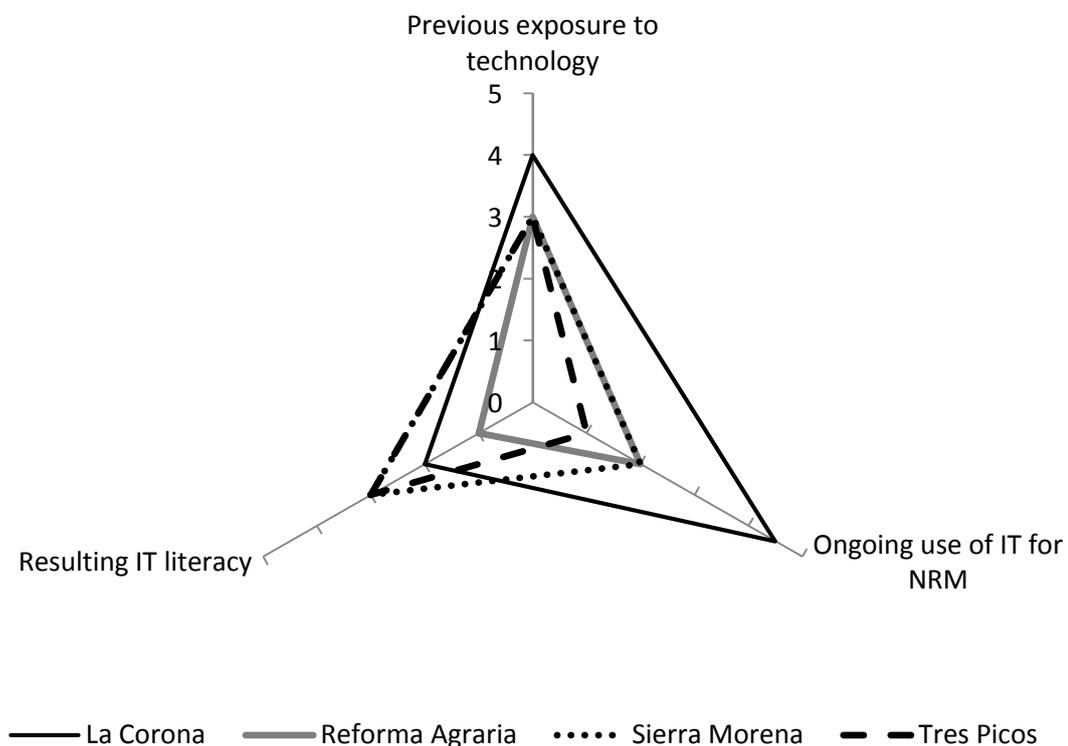
Table 6.6 Categorized indicators and IT skills score

	Previous exposure to technology	Ongoing use of IT for NRM	Resulting IT literacy	IT skills
La Corona	Absent	Absent	Limited	Limited
	Communication purposes	Carried out by a third party	Basic	Basic
	Education / leisure	Learning	Some degree	Some degree
	Productive activities	Facilitated	Advanced	Advanced
	Inclusive	Independent	Comprehensive	Comprehensive
	4	4.5	2	
Reforma Agraria	Absent	Absent	Limited	Limited
	Communication purposes	Carried out by a third party	Basic	Basic
	Education / leisure	Learning	Some degree	Some degree
	Productive activities	Facilitated	Advanced	Advanced
	Inclusive	Independent	Comprehensive	Comprehensive
	3	2	1	
Sierra Morena	Absent	Absent	Limited	Limited
	Communication purposes	Carried out by a third party	Basic	Basic
	Education / leisure	Learning	Some degree	Some degree
	Productive activities	Facilitated	Advanced	Advanced
	Inclusive	Independent	Comprehensive	Comprehensive
	3	2	3	
Tres Picos	Absent	Absent	Limited	Limited
	Communication purposes	Carried out by a third party	Basic	Basic
	Education / leisure	Learning	Some degree	Some degree
	Productive activities	Facilitated	Advanced	Advanced
	Inclusive	Independent	Comprehensive	Comprehensive
	3	1	3	

Following the same interpretation principles explained for Figure 6.1, Figure 6.3 illustrates the elements highlighted in Table 6.6, providing a visual representation of the selected labels constituting the IT skills score within the case studies.

In Figure 6.2 I can observe a unique configuration of the indicators values for each community case study. The first observation relates to the conditions in La Corona and Reforma Agraria. Although these communities present the highest and lowest levels in two of the three indicators in this category, the final outcome of the implementation processes was very different. As a result it is possible to affirm that an advanced degree of IT skills was not a determining factor in the adoption of PPGIS initiatives. Moreover, although considered as a key enabling condition prior to the empirical investigation, IT skills are among the factors that might be regarded as optional, so long as other dimensions have the potential to bring support in this area.

Figure 6.3 IT skills indicators



6.2.3 Social structure

Social structure in collective ejidos is strongly related to local governance in rural Mexico; a common trend is the inheritance of cultural values from the Colonial period, characterised by inequality and domination (Bernal, 2008; Otero, 1989). Moreover, in the case of Chiapas, the second Colonisation process which involved settling peasant farmers from other areas of the country (Castillo et al., 2007) also contributed to shape the way in which local communities organise.

This analytical category was conceived and ranked as a result of the contextual review on local governance structures and its relation to collective forms of land-use planning, including norms for access, use and management of natural resources. However, this description would not be complete without mentioning that the construction of this analytical category was strongly guided by learning, and in some cases participating in the social structures in the four community case studies.

Considering traditional social structures, characterised by some degree of authoritarian traditions inherited from the Colonial period, the aim was to propose a series of rankings across the indicators, to represent business as usual situations in rural Mexico, in contrast to progressive approaches oriented to provide effective local planning instruments in the context of social driven resources management initiatives, prioritising benefits derived from collective actions (see Section 3.3.2).

Social structure aims to depict the characteristics of the working groups by categorising the age, gender and occupation of the research participants within the working groups. Table 6.7 introduces the categories and ranking levels for each of the three constituent indicators. In order to interpret the rationale behind the categories for each indicator within the social structure analytical category, it is necessary to explain that in rural Mexico most social arrangements follow a pattern in which being an elder, male and part of the ejido assembly commission, offer greater possibilities of inclusion. Based on those characteristics, I propose five levels to categorise social structure configurations.

At the opposite end of the scale to the characteristics listed above, which I portray as representing a weak social structure, a group constituted by a proportional number of men and women, in which different age groups are represented, and where the inclusion of those citizens who lack regular employment is encouraged (in contrast to the trend by which local elites accumulate access to remunerated positions) is regarded as representing a stronger social organisation arrangement.

Table 6.7 Proposed social structure indicators and ranks

Social structure	Age	Gender	Occupation	Rank
Weak	Elder	Male	Assembly commission	1
Restricted	Group in power	Group in power	NRM commission	2
Traditional	Representatives	Representatives	Representatives	3
Progressive	Diversity	Presence	Farmer/household	4
Strong	Represented	Proportional	Unemployed	5

'Representatives' refers to a category in which those involved in the working teams of the PPGIS initiative acted on behalf of the actual community members.

Following this approach, and based on the results presented on Chapter 5, Table 6.4 defines each community case study in terms of both indicators and overall social structure. As with the other analytical categories discussed in this chapter, Table 6.4 indicates with bold the selected characteristic ranking each indicator. Then, according to the ranking levels presented in Table 6.7, a scoring value is assigned. In some cases, more than one category has been highlighted because a single category did not characterise the situation within the community case study; for those cases, the rule system introduced in Section 6.1 provided the criteria to define the overall analytical category. Finally, at the bottom of each column the scoring value of each indicator is presented (See Table 6.8 for details).

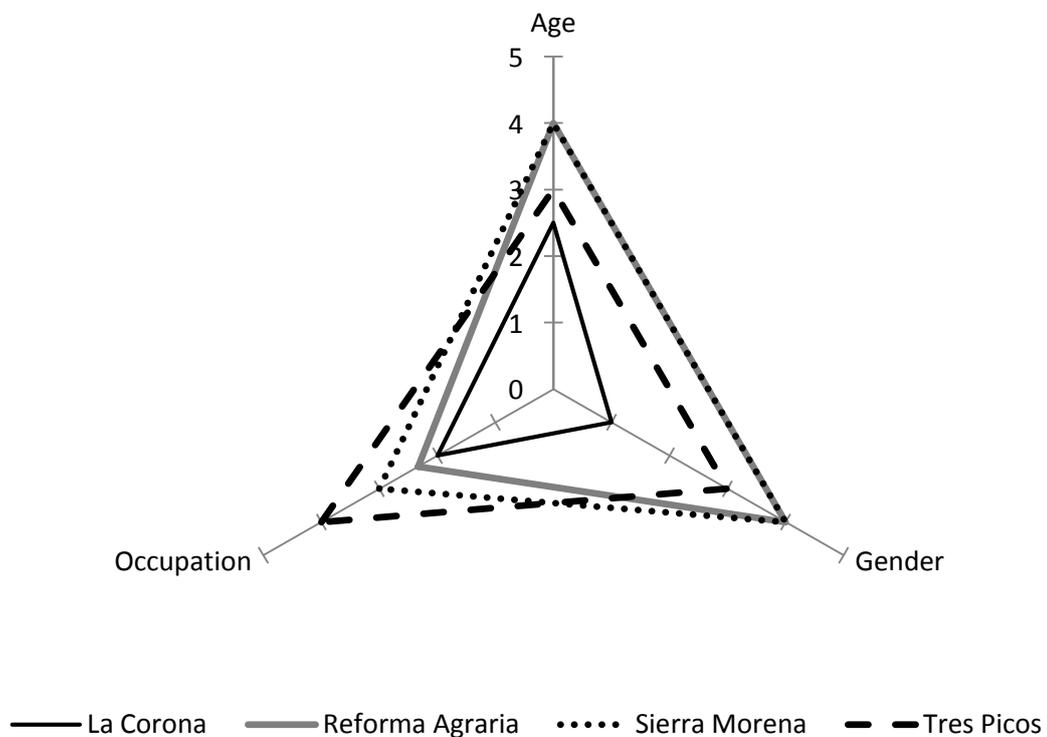
Table 6.8 Categorized indicators and social structure score

	Age	Gender	Occupation	Social structure
La Corona	Elder	Male	Assembly commission	Weak
	Group in power	Group in power	NRM commission	Restricted
	Representatives	Representatives	Representatives	Traditional
	Diversity	Presence	Farmer / household / student	Progressive
	Represented	Proportional	Unemployed	Strong
	2.5	1	2	
Reforma Agraria	Elder	Male	Assembly commission	Weak
	Group in power	Group in power	NRM commission	Restricted
	Representatives	Representatives	Representatives	Traditional
	Diversity	Presence	Farmer / household / student	Progressive
	Represented	Proportional	Unemployed	Strong
	4	4	2.33	
Sierra Morena	Elder	Male	Assembly commission	Weak
	Group in power	Group in power	NRM commission	Restricted
	Representatives	Representatives	Representatives	Traditional
	Diversity	Presence	Farmer / household / student	Progressive
	Represented	Proportional	Unemployed	Strong
	4	4	3	
Tres Picos	Elder	Male	Assembly commission	Weak
	Group in power	Group in power	NRM commission	Restricted
	Representatives	Representatives	Representatives	Traditional
	Diversity	Presence	Farmer / household / student	Progressive
	Represented	Proportional	Unemployed	Strong
	3	3	4	

In order to complement the categorisation of social structure presented in Table 6.8, Figure 6.4 shows three basic trends within the social structure of the community case studies. Reforma Agraria and Sierra Morena represent a strong social organisation as each one of the indicators occupies an external position, and most importantly, they show a balanced situation among them.

In contrast, the case of La Corona is represented by inner positions which confer a restricted degree of social organisation. Lastly, the distribution of the key categories in Tres Picos shows a community with traditional levels of social organisations, though the diversity of occupations among the working group members is more of a departure from the general pattern.

Figure 6.4 Social structure indicators



In relation to the results of the implementation processes, it is possible to observe that a progressive social structure was important in enabling the adoption of PPGIS initiatives. Although symmetry within the levels of the indicators of social organisation arrangements helped to enable wider interactions, diversity of occupation activities within the team members proved to be the key characteristic to enable a successful adoption.

6.2.4 External relations

External relations are strongly connected to citizen participation, representing the core element of collective decision-making in rural settings. The evidence presented by Corbera and Schroeder (2011), demonstrates the value of such relations at all scales; from regional with neighbouring communities, to subnational and national government agencies as well as with civil society organisations and academic institutions. The contemporary global economic model urges the consolidation of multi-level partnerships between public and private actors, and in particular with common land ownership (Ostrom, 1990), because of the opportunity to offer alternatives to balance initiatives for rural sustainable development and environmental management (Shividenko et al., 2005; White and Martin, 2002).

This analytical category intends to analyse the external relations which had an impact during the different stages of the Public Participation GIS initiative. This category has been created from the following indicators: relations with neighbouring communities, communication with government agencies and participation in programmes with NGOs or academic institutions. Table 6.9 provides further details of the labels representing each indicator, as well as the categorical ranks on the degree of external relations.

Table 6.9 Proposed external relations indicators and ranks

External relations	Relations with neighbouring communities	Communication with government agencies	Programmes with NGO's – Universities	Rank
Minimum	Minimum	Minimum	Absence	1
Limited	Limited	Limited	With a single body	2
Typical	Active	Active	With a group	3
Open	Collaboration	Project	As part of a network	4
Wide	Partnership	Evolved	Several	5

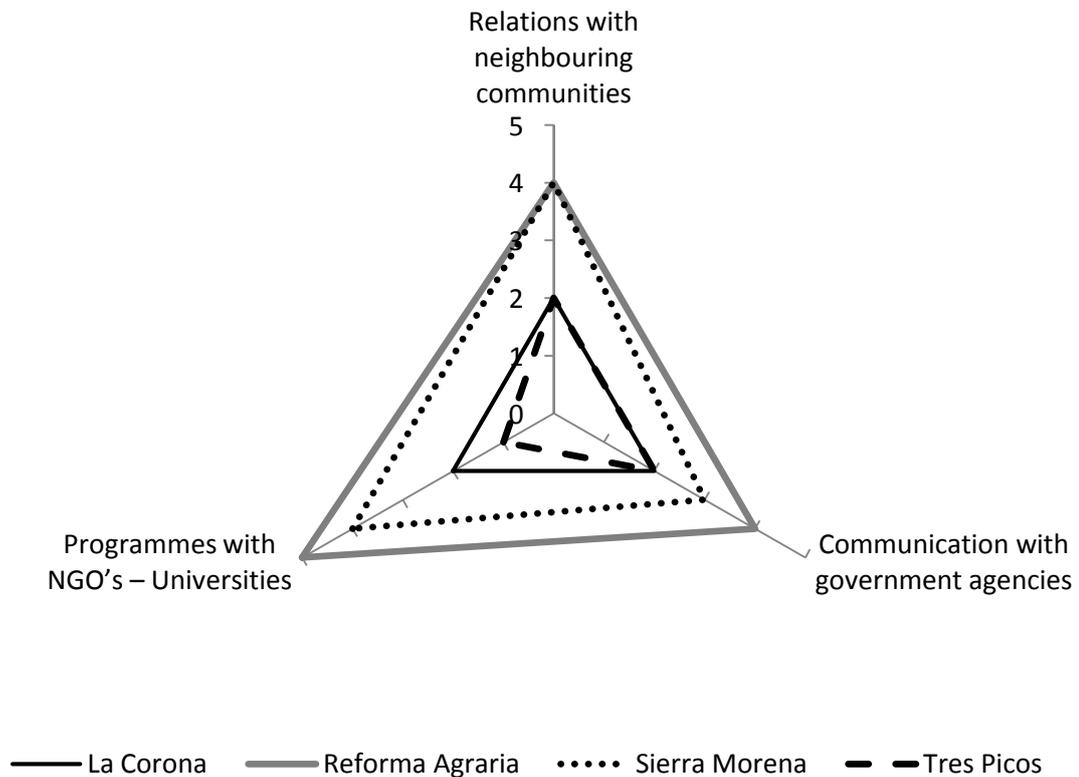
Although the PPGIS initiative focused on natural resource and land management activities, the labels proposed to categorise the indicators also consider wider interactions on initiatives of different character, but with potential degrees of impact on those existing relations. Table 6.10 presents the labels conferred to each indicator as well as the scoring of external relations within the working groups on each community case study.

Table 6.10 Categorised indicators and external relations score

	Relations with neighbouring communities	Communication with government agencies	Programmes with NGO's – Universities	External relations
La Corona	Absence	Absence	Absence	Minimum
	Limited	Minimum	With a single body	Limited
	Active	Active	With a group	Typical
	Collaboration	Project	As part of a network	Open
	Partnership	Evolved	Several	Wide
	2	2	2	
Reforma Agraria	Minimum	Minimum	Absence	Minimum
	Limited	Limited	With a single body	Limited
	Active	Active	With a group	Typical
	Collaboration	Project	As part of a network	Open
	Partnership	Evolved	Several	Wide
	4	4	5	
Sierra Morena	Minimum	Minimum	Absence	Minimum
	Limited	Limited	With a single body	Limited
	Active	Active	With a group	Typical
	Collaboration	Project	As part of a network	Open
	Partnership	Evolved	Several	Wide
	4	3	4	
Tres Picos	Minimum	Minimum	Absence	Minimum
	Limited	Limited	With a single body	Limited
	Active	Active	With a group	Typical
	Collaboration	Project	As part of a network	Open
	Partnership	Evolved	Several	Wide
	2	2	1	

Following the results presented in Table 6.10, Figure 6.5 shows a graphical vision of the indicators representing the external relations inputs during the implementation, pilot and evaluation stages of the PPGIS initiative.

Figure 6.5 External relations indicators



Of particular significance is the general symmetry observed in Figure 6.5 for all case studies, which gives an idea of the correlation between the selected indicators. In relation to the overall results of the PPGIS implementation processes, it is possible to establish external relations arrangements as a key characteristic for the adoption of local development initiatives. Evidence of this is the enabling character in which IT support and expertise was obtained as a result of the high levels of the external relations in the case of the working group in Reforma Agraria.

Although not experienced during the course of the empirical investigation, it could be anticipated that external relations have the potential to operate as a multi-enabling condition factor for the adoption of geospatial technology tools for natural resource and land management in local initiatives.

6.2.5 Power structure

Power structure was derived from the ecological modernisation typology presented by Mol and Jänike (2009). I therefore developed a traditional set of indicators representing degrees and benefits related to social affiliation, leadership and networks; in opposition to a power structure ranking characterised by modern instruments of policy making to address problems related to sustainability and natural resources worldwide (Spaargaren et al., 2009; Guiddens, 1999). The ranking process for this analytical category was derived from the analysis of the debates presented across the literature review and context to research chapters.

Our last analytical category, power structure within the members of the working groups, is the result of the interaction between power-related attributes which determined the roles and relationships established during the PPGIS training course. Those attributes have been translated into three indicators: group affiliation, group leadership and related actors involved within the Public Participation GIS initiative. Table 6.11 establishes the categories of each indicator as well as the five different power structure ranks.

Table 6.11 Proposed power structure indicators and ranks

Power structure	Group affiliation	Team leadership	Related actors	Rank
Centralised	Landowners	External	Not present	1
Towards centralisation	Skilled citizens 'experts'	Individual	Individual outsiders	2
Customs and traditions	Ejidal affiliation	Group	Groups / Cooperatives	3
Towards de-centralisation	Volunteer citizens	Participants	Institutions / Organisations	4
De-centralised	Proportional	Shared	Interested villagers	5

Although common property regimes stand for the community as a unit, hierarchies, elites and privileges also exist. In this sense, I categorised power structure indicators following the same principle as in the social structure analytical category (i.e. representing centralised configurations by top positions in Table 6.11 in opposition to de-centralised levels towards the bottom of the tables).

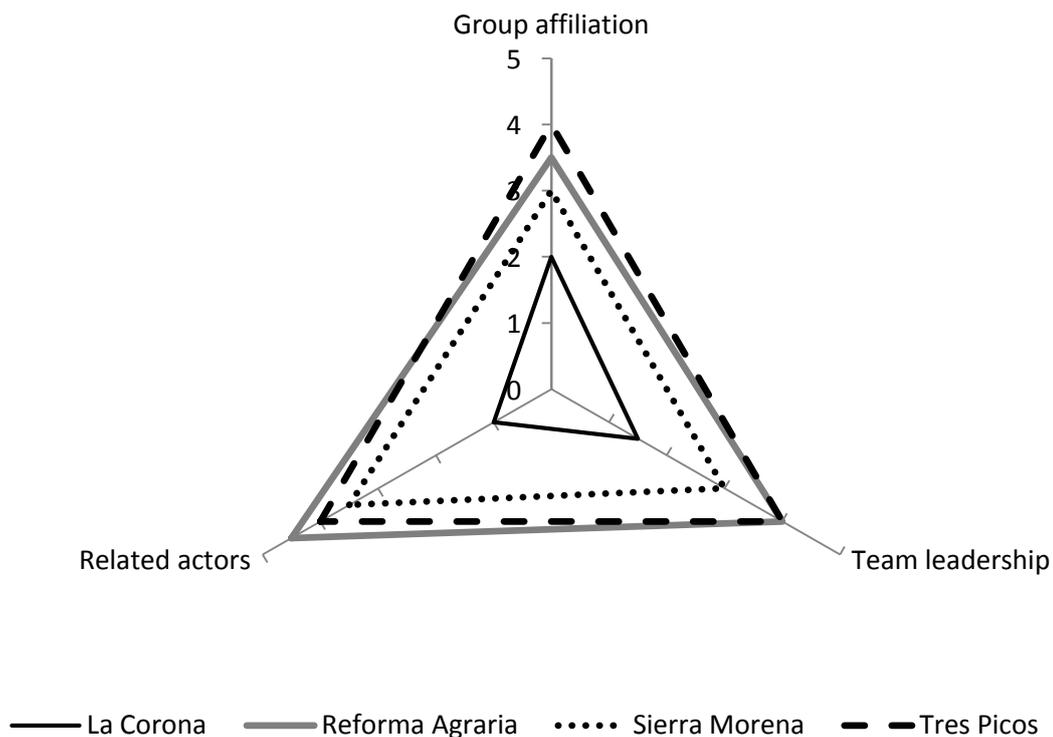
In this case, a centralised power structure is represented by those working teams in which landownership characterises the affiliation of its members. Likewise, an external organisation or individual would lead the team and no external actors were connected to the activities of the PPGIS initiative. The power structure dimension gradually opens in the sense that affiliation, leadership and related actors change their characteristics, as proposed in the different indicator ranks shown in Table 6.11. Based on previous principles, Table 6.12 presents the key characteristics defining each indicator as well as the score of power structure within the community case studies.

Table 6.12 Categorised indicators and power structure score

	Group affiliation	Team leadership	Related actors	Power structure
La Corona	Landowners	External	Not present	Centralised
	Skilled citizens 'experts'	Individual	Individual outsiders	Towards centralisation
	Ejido affiliation	Group	Groups / Cooperatives	Customs and traditions
	Volunteer citizens	Participants	Institutions / Organisations	Towards de-centralisation
	Proportional	Shared	Interested villagers	De-centralised
	2	1.5	1	
Reforma Agraria	Landowners	External	Not present	Centralised
	Skilled citizens 'experts'	Individual	Individual outsiders	Towards centralisation
	Ejido affiliation	Group	Groups / Cooperatives	Customs and traditions
	Volunteer citizens	Participants	Institutions / Organisations	Towards de-centralisation
	Proportional	Shared	Interested villagers	De-centralised
	3.5	4	4.5	
Sierra Morena	Landowners	External	Not present	Centralised
	Skilled citizens 'experts'	Individual	Individual outsiders	Towards centralisation
	Ejido affiliation	Group	Groups / Cooperatives	Customs and traditions
	Volunteer citizens	Participants	Institutions / Organisations	Towards de-centralisation
	Proportional	Shared	Interested villagers	De-centralised
	3	3	3.5	
Tres Picos	Landowners	External	Not present	Centralised
	Skilled citizens 'experts'	Individual	Individual outsiders	Towards centralisation
	Ejido affiliation	Group	Groups / Cooperatives	Customs and traditions
	Volunteer citizens	Participants	Institutions / Organisations	Towards de-centralisation
	Proportional	Shared	Interested villagers	De-centralised
	4	4	4	

Following the same interpretation principles explained during previous subsections, Figure 6.6 places the elements highlighted in Table 6.12 in a graphical format, providing a visual comparison of my observations on the power structure indicators within the working groups.

Figure 6.6 Power structure indicators



For the cases of Reforma Agraria and Tres Picos it is possible to observe a relatively high and balanced distribution of the key categories defining each indicator, representing a trend towards de-centralised power structures. However, although the case of Sierra Morena is close to the characteristics of the two previous cases, the ‘team leadership’ indicator occupies an inner position, breaking the balance within the representation. As a result of this observation, I can conclude that the combination of egalitarian leadership levels within the working groups, as well as participation of local actors who are not directly involved with the working teams, are the most significant elements within power structure arrangements.

Although it is difficult to establish the significance of group affiliation levels, my interpretation is that if this indicator shows lower levels within the power structure configuration, other dimension might have the potential to compensate the situation (i.e. community cohesion related to their social organisation configurations and experiences of participation in local development initiatives).

Of all the representations of the five analytical categories, the results displayed in Figure 6.4 and Figure 6.5 best correspond to the overall results of the empirical stage of this investigation. Both graphical representations serve as the summary of the overall impact of the PPGIS implementation processes in the four participating communities (i.e. the larger the area occupied, and the more symmetrical the triangular shapes, the more successful the PPGIS initiative). As a result it is possible to say that the indicators of external relations and power structures for the four community case studies best represent the overall achievements of the pilots.

6.3 Comparison across the community case studies

Following the assessment of the individual analytical categories in the context of the four cases, a comparison across the community case studies offers an attempt to explain why different communities behaved in the way they did. Alongside, a reflection on the use and implications of the evaluation framework approach is presented.

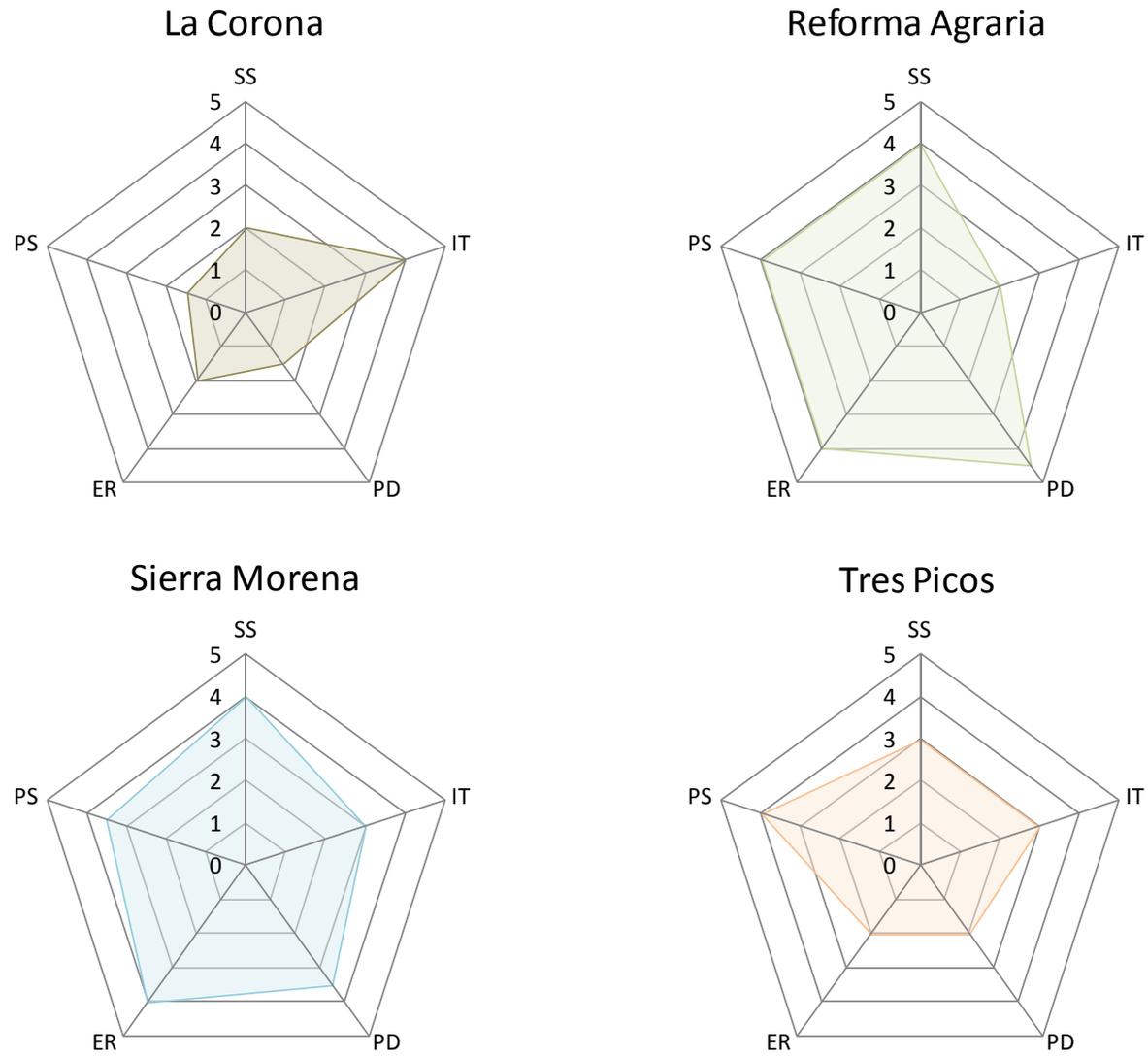
Table 6.13 presents a synthesis of the scoring for each analytical category across the community case studies. To complement this, and similar to the triangular representations displayed in Section 6.1, a series of pentagram graphics displayed in Figure 6.7 offer a comparison of the category scores for each community case study.

Table 6.13 Analytical categories scores across the community case studies

	Social structure (SS)	IT skills (IT)	Participation in development (PD)	External relations (ER)	Power structure (PS)
La Corona	Weak	Not compatible	Minimum	Non-existent	Centralised
	Restricted	Basic	Limited	Limited	Towards centralisation
	Traditional	Some degree	Traditional	Typical	Customs and traditions
	Progressive	Advanced	Progressive	Open	Towards de-centralisation
	Significant	Comprehensive	Significant	Wide	De-centralised
	2	4	1.5	2	1.5
Reforma Agraria	Weak	Not compatible	Minimum	Non-existent	Centralised
	Restricted	Basic	Limited	Limited	Towards centralisation
	Traditional	Some degree	Traditional	Typical	Customs and traditions
	Progressive	Advanced	Progressive	Open	Towards de-centralisation
	Significant	Comprehensive	Significant	Wide	De-centralised
	4	2	4.5	4	4
Sierra Morena	Weak	Not compatible	Minimum	Non-existent	Centralised
	Restricted	Basic	Limited	Limited	Towards centralisation
	Traditional	Some degree	Traditional	Typical	Customs and traditions
	Progressive	Advanced	Progressive	Open	Towards de-centralisation
	Significant	Comprehensive	Significant	Wide	De-centralised
	4	3	3.5	4	3.5
Tres Picos	Weak	Not compatible	Minimum	Non-existent	Centralised
	Restricted	Basic	Limited	Limited	Towards centralisation
	Traditional	Some degree	Traditional	Typical	Customs and traditions
	Progressive	Advanced	Progressive	Open	Towards de-centralisation
	Significant	Comprehensive	Significant	Wide	De-centralised
	3	3	2	2	4

In the same way as with previous triangular representations, the scores of each analytical category in Figure 6.7 is represented by a corner of the pentagram. Inner positions covered by the shaded area correspond to those categories on the top sections of each community case study presented in Table 6.13, while outer positions relate to categories towards the bottom of the tables.

Figure 6.7 Graphic comparison of category dimensions within the community case studies



Based on the outcomes across the community case studies I can make the following observations. In relation to the scoring levels within the analytical categories (i.e. the size of the area covered by the distribution of values) I observe that higher levels of configuration suggest greater possibilities of success in terms of pilot implementation purposes. However, as a result of the situation in which the PPGIS implementation procedures concluded and made a contribution to the community (e.g. Reforma Agraria) it is also possible to appreciate that it was not necessary for all five analytical categories to have high rank values.

Although the purpose of the study is not to classify the enabling potential of the proposed analytical categories, the results suggest that depending on the specific conditions of the setting, a combination of analytical categories with higher achievement levels have the potential to substitute the functions of certain other dimensions. For example, one of the elements that made possible the completion of the PPGIS implementation process in Reforma Agraria was the availability of IT support and expertise from external agents.

Following these observations, I also propose that size and symmetry within the levels of configuration of the analytical categories are important. Nevertheless, as the results in Sierra Morena indicate, the levels of certain analytical categories (i.e. power structure and participation in development) must be above the traditional standards of collective *ejidos* to make the initiative viable. In this sense, the research shows that the more symmetrical the values within the analytical categories with higher achievement levels, the wider the opportunity to achieve those enabling conditions necessary for the adoption of pilot PPGIS strategies.

At the other end of the spectrum a minimum number of above traditional level characteristics, along with size and symmetry, proved to be relevant, as the cases of La Corona and Tres Picos demonstrate. Even if those community case studies did not manage to accomplish a successful pilot, the outline of their characteristics is of enormous importance in terms of considering what needs to be done in order to promote the necessary changes to achieve a more favourable condition for a successful PPGIS implementation.

For example, although having the highest degree of IT skills acquisition among the four communities, the limited configuration of power structures and participation in development experience in La Corona obstructed the development of the PPGIS independent pilot. In a similar way, although social and power structures were better in Tres Picos, and IT skills acquisition was remarkable due to the

engagement of research participants, the limited degree of participation in development experience as well as the almost non-existent level of external relations were the main elements limiting the conditions for a successful pilot implementation.

The configuration and detail of categorisation levels provided by the indicators within the evaluation framework proved to be of significant value, as it allowed a detailed assessment and comparison to a degree in which it was possible to identify the impediments to progress within the four community case studies. The framework had a significant impact on the overall outcome of the investigation, as it provided key elements of analysis for those situations in which the pilot PPGIS implementation did not succeed (e.g. La Corona, Sierra Morena and Tres Picos), as well as on the case study in which the successful completion translated into a direct contribution to the community (e.g. Reforma Agraria).

Moreover, the framework not only proved to be relevant for differentiating enabling elements in the successful community case study; it also provided interesting insights to make a more refined assessment in those cases which generally speaking, offered favourable conditions to implementation (e.g. Reforma Agraria and Sierra Morena). In this sense, I argue that detailed understandings of the contextual elements within the community case studies, as well as a comprehensive documentation process are essential components to achieve an accountable degree of understanding.

6.4 Future states

This section elaborates on potential scenarios for the community case studies as a way of extrapolating the evidence provided by the evaluation framework analysis. The relevance of this is to elaborate on observations related to the impediments to successful PPGIS pilot implementation initiatives, and to explore ideas and formulate what needs to be done to provide favourable conditions in the longer term.

6.4.1 Potential scenario in La Corona

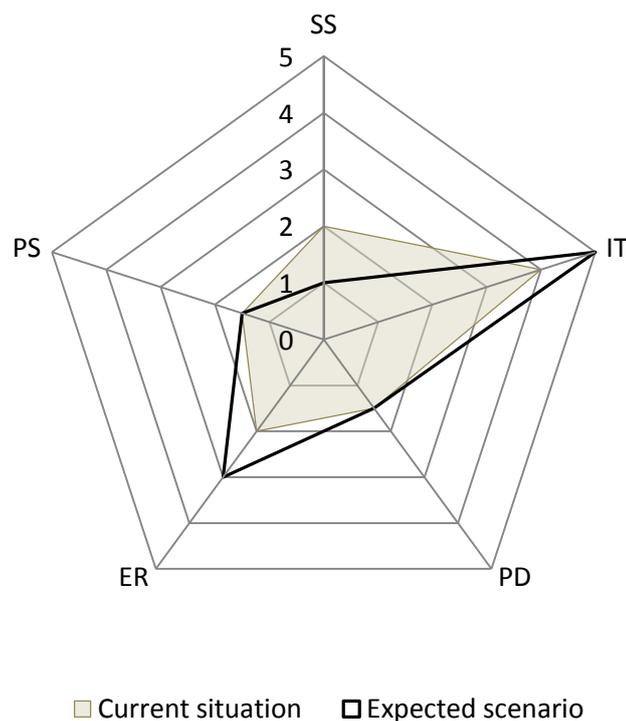
La Corona presented a challenging community case study mainly because of the obstacles presented by an individual dominant figure, whose interest in getting the skills provided in the training course for his own benefit resulted in various intents to block the implementation process, having as a consequence the almost immediate collapse of the pilot stage.

In correspondence, and as a result of the evidence obtained during the implementation of the PPGIS initiative in La Corona, I can anticipate a series of re-adjustments within the analytical categories considered in the study. However, before presenting the estimated scenario, it is necessary to incorporate a reflection on two regional factors which are likely to affect the course of natural resource management initiatives in the community.

The first is related to the current situation of territorial fragmentation in the country. In my opinion, those communities with fewer social capital and local development assets present a higher degree of vulnerability to territorial fragmentation due to land trading processes. As a consequence, natural resources will experience a significant degree of deterioration, affecting the potential to play a role in payments for ecosystem services programmes and conservation initiatives.

The second major threat with high risk to affect current natural resource management initiatives in the Montes Azules region are wildfires (see Figure 4.2 for a map of the area). In the event of a major fire, La Corona would face devastating consequences for their local development projects, including their participation within the carbon sequestration programme. After presenting previous regional considerations, which in my opinion represent a significant risk to La Corona, Figure 6.8 shows a graph of the expected conditions in the next ten years.

Figure 6.8 Proposed scenario for La Corona



In La Corona, few changes are expected to take place. As a result, the role played by the dominant figure will continue in the community. In consequence, social organisation is expected to experience weakening conditions, while power structures are likely to maintain their centralised character, due to the collateral effect in supporting current productive advantages for the local elite. If this trend continues, reductions in current mechanisms of social participation in local development initiatives are likely to reach a minimum level. Nevertheless, IT skills acquisition strategies are expected to be a priority for the leader, due to their potential to augment external relations and individual benefits for the local elite.

6.4.2 Potential scenario in Reforma Agraria

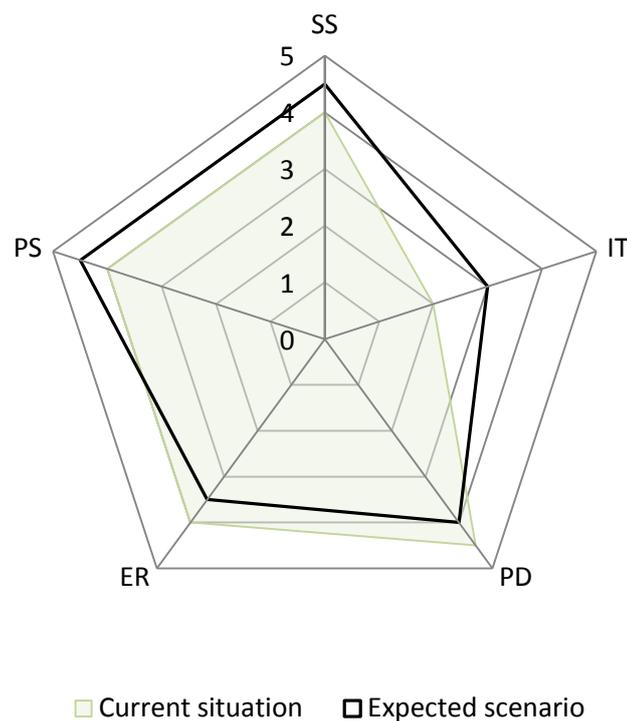
Although IT skills represented an initial limitation for the adoption of the pilot PPGIS initiative in Reforma Agraria, the determination to get the most out of the PPGIS intervention generated an interest to produce ready-to-use information, a situation complemented by full support and involvement from communal leaders as well as a unique opportunity to access and participate within community initiatives. In addition, the key of success in this community was the ability to continue with the pilot stage, despite the IT skills limitations, by taking advantage of the diversity of external relationships. In addition, the organisation of the community and members can be regarded as key elements resulting in the success of the PPGIS initiative.

Despite the generalised risks that regional threats represent to those rural settings adjacent to Montes Azules biosphere reserve, such as wildfires and territorial fragmentation, Reforma Agraria has put in place contingency measures to protect their territory. As a result, such threats represent considerably lower risks than to neighbouring communities (i.e. La Corona). The latter is a direct result of community-based land use planning principles being encouraged since the settlement of the community.

Although already experiencing some of the highest levels of territorial planning and social capital expected for an organised rural collective setting in southern Mexico, in Reforma Agraria some changes are likely to happen in the next ten years. Figure 6.9 shows a graph of the proposed future state within the analytical categories considered as part of this study.

As a result of the demographic structure in the community, composed of a majority of elder citizens, mature women and a considerable number of young people, social organisation and power structures will face changes. The imminent demographic transition will diversify social organisation arrangements, accompanied by the modification of power structures, in which a comprehensive decentralisation is likely to take place. In consequence, a small decrease of social participation in local development would be expected, in response to the immediate transition of leadership roles.

Figure 6.9 Proposed scenario for Reforma Agraria



Moreover, in relation to the implications of social participation re-adjustments, I also anticipate a temporary drop in the external relations maintained by the community. However, these changes have the potential to represent an opportunity to reconsider and renew the nature of relations with external agents, taking into consideration the new challenges and needs faced by the younger and more diverse leadership in the community.

Due to the transition in social and power organisation mechanisms, in addition to adaptation of social participation practices and relations with external agents, the most radical change expected in Reforma Agraria will be a significant increase in IT skills at a community level. On the one hand, experience derived from current development projects has proved that IT knowledge offers the potential to establish connections and bring financial resources to the community. On the other, the

investment placed on social capital has begun to show results as some of the first generation of young citizens who left the community to study in urban centres have started to return.

Although a new group of citizens is expected to take over the leadership of decisions for the community in the near future, thoughtful preparations have shaped the transfer of decision-making responsibilities by guaranteeing a strong legacy of traditions and values, as is the case of their communal reserve which is due to exist for the next nine decades. However, Reforma Agraria is not immune to potential problems, among which I can identify the risk represented by new forms of government intervention and control manifested by recent payments for ecosystem services instruments, such as the national REDD+ strategy.

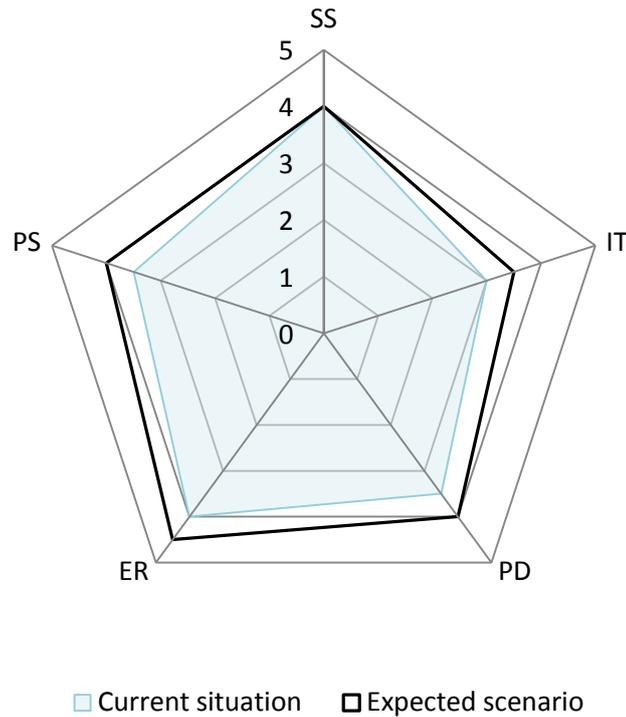
6.4.3 Potential scenario in Sierra Morena

The dominance of one of the most powerful groups in Sierra Morena impeded the completion of the pilot stage in the community, despite of having significant prospects of success as a result of a fruitful training course. Power relations issues became apparent when external interference within traditional arrangements impacted traditional means of leadership, creating disequilibrium of power relations during the pilot stage of the PPGIS initiative. Although different 'clans' managed to work together, changes in existing power structures were responsible for the collapse of the independent pilot stage.

In my vision, Sierra Morena faces the most challenging future among the case studies of this investigation. Key decisions are to be made as the community will experience new conditions due to successful local development projects and the increase in external relations. Figure 6.10 shows a visual representation of the transition within the analytical categories considered for the next ten years in the community.

A major asset in Sierra Morena is the combination of a traditional power structure that encourages social participation and young leadership of local development initiatives. Although the practises associated with the social learning process are accumulating experience, some changes are needed to provide strong community cohesion. In this sense, my prognosis points a gradual equilibrium between social and power structures, in which social organisation will experience a minimum transition while power structure mechanisms will continue towards de-centralisation.

Figure 6.10 Proposed scenario for Sierra Morena



As a result, the same gradual trend will be expected in social participation in local development as well as in IT skills. Although at a relatively lower speed, those changes are likely to have a positive impact on external relations, with the most significant element of progress being harmonisation among the degrees involved within the five analytical categories considered in the study.

6.4.4 Potential scenario in Tres Picos

In Tres Picos, the absence of ongoing natural resource management initiatives in addition to the very limited of experience within external development initiatives brought confusion and fear about change, which manifested in a lack of recognition and support to the independent pilot stage of the PPGIS initiative. In general I argue that lack of experience with development interventions and external relations are the main limitations due to which the PPGIS initiative did not manage to succeed in this community case study.

Although I am confident about the proposed trends to be experienced in the previous community case studies for the next ten years, for Tres Picos my forecast is less confident. In consequence, the assumptions point out at two different scenarios affecting the community which are presented in Figure 6.11.

On the one hand, Scenario A would consider a situation of relative stagnation within the analytical categories considered in the study, with the most significant change being a limited transition in the social and power structures due to ongoing emigration trends and demographic changes. However, without clear leadership accompanied by an explorative attitude of social participation and active involvement in external initiatives, the acquisition of IT skills will experience a decrease, limiting further collaboration with agencies and institutions.

Figure 6.11 Proposed scenarios for Tres Picos



On the other hand, Scenario B contemplates the possibility of an intervention conducted by an external body (i.e., NGO or an academic institution), oriented to implement a natural resource management initiative in conjunction with the community. If such an initiative takes place, a progressive transition in social and power structures is likely to occur. In consequence, the beginning of a local culture of social participation accompanied by learning of IT skills will lead to a gradual accumulation of external relations, as well as a potential exploration of alternative development projects which are not restricted to natural resources and land management initiatives.

Independently of the scenario considered for Tres Picos, territorial fragmentation due to commercialisation of land represents a major threat for the community. Due to its natural reserve territorial status, I consider that government intervention in Tres Picos is likely to be justified, resulting

in a relatively easy colonisation region to implement 'official' schemes of payments for ecosystem services with limited social benefits to the community, widening social divisions and jeopardising land and resources access and rights.

6.5 Critical evaluation of the scoring procedures

I departed from the idea of ranking each indicator from the most general conditions in which rural communities exist in Mexico, taking into consideration a series of labels to characterise each one of the indicators. Subsequently, as conditions improve towards local benefits and improved conditions, the descriptive level related to a higher rank context. Data collection presented two general stages. The first one consisted of understanding local contexts, relationships, interests, limitations and perspectives on the elements described by 15 indicators grouped in five analytical categories.

The proposed classification of indicators and analytical categories aimed to enquire about 15 general conditions, I considered representative to measure the conditions that allow or limit PPGIS initiatives. In relation to the extent of uncertainty, I can argue that the iterative process involved in the design of an evaluation framework allowed to correct my observations and uncover patterns of interactions corresponding to a revised reality, also thanks to the experience resulting from the comparative character of the research design.

7 DISCUSION

The aim of this chapter is to provide a discussion of the implications of the outcomes of the thesis. The intention is to evaluate the concept of Public Participation GIS, while contextualising the implications of the barriers to PPGIS uptake encountered by this investigation in rural lower-income settings. For this purpose I begin by presenting the set of ideas that have been tested, followed by subsections providing an explanation on how they were tested, highlighting the main results.

The main ideas tested related to the following issues:

- 1) Debates around better understanding of relationships between NGOs and local communities
- 2) Actor-network theory as a viable mechanism to study PPGIS implementation for natural resource management in lower income rural settings
- 3) Geospatial technology usage by non-expert groups seen as innovative instruments of participation in natural resource initiatives
- 4) State institutions and local communities: Their role in a REDD+ mechanism

7.1. Debates around better understanding of relationships between NGOs and local communities

The design of the intervention itself was at the core of testing the relationship between NGOs and local communities. Recent decades have been characterised by the emergence of new collaborative arrangements in society. In Latin America, NGOs have shaped a paradigm with interesting results in some areas. However, in relation to ecosystem services schemes in Mexico, I question if these sorts of arrangements are the best option to promote international cooperation towards climate change?

Understanding the linkages between traditional management systems and innovative instruments of participation in natural resource initiatives, in particular those related to geospatial technology usage by local and non-expert groups, can contribute to adapt and improve natural resource management practices for better implementation processes. Moreover, the socialisation and democratisation of such innovative participation instruments provides the potential to stimulate political interaction among people, organisations and institutions guiding local change.

In this respect, non-governmental organisations have played a decisive role in promoting citizen participation within mechanisms of cooperation towards poverty reduction and sustainability. However, independent of their nature, NGOs are private organisations and it is therefore difficult to

know how well these interests represent popular concerns. Moreover, power distributions and their potential to reproduce inequality, as part of the conflicts associated with citizen participation, are a constant reminder about how participation is viewed and desired.

An interesting result of this investigation highlights the case in which the development of the PPGIS independent pilot was obstructed by a local power figure, which during the process of the PES programme has been repeatedly selected to receive technical capacities, hence gaining political status within a community characterised by a centralised power structure configuration. The latter illustrate the issue of power distribution within power structures in rural Mexico, caused because of equity disparity between local authority roles, and government and NGOs structures, limiting the local impact of such initiatives. Given the power relations discovered in this particular community case study, I question the ethics of the approach taken by Ambio, in which the NGO opted to guarantee their presence in the region, at the expense of strengthening the power position of one person.

According to Corbera and Brown (2010) and Corbera *et al.*, (2010), the major critique of NGOs programmes to offset CO₂ emissions is that they limit the autonomy of local governance to assess the financial mechanisms within ecosystems services schemes of community participation. In relation to gender issues, this investigation highlights an excluding situation within rural contexts in Mexico and Latina America, which generally speaking tend to marginalise women from participation in decisions concerning the forest commons. Similarly, it has been recognised that knowledge transfer to local producers and equitable participation in project decision-making is still limited. Although interesting and with a series of potential benefits for Mexico, Payments for Ecosystem Services initiatives like the one promoted by Ambio, still need to be better adapted to suit local challenges instead of preserving funding needs of non-government organisations (Brown and Corbera, 2003).

Discussions within the civil society sector in Latin America suggest the need to establish a new paradigm, in which international NGOs and cooperation agencies explicitly see citizenship as the only meaningful foundation for development and participation (Grugel, 2000). It has also been highlighted in the environmental global debate that there may be implicit trade-offs between equity, economic efficiency and environmental effectiveness, as those individuals and organisations delivering the service in the most cost-efficient and environmentally effective way may not necessarily be low-income farmers and community organisations (Scherr *et al.*, 2004, 59; in Corbera *et al.*, 2007).

In my opinion, and following on the reflexion made by Mol and Jänicke (2009, p.19), the State should move towards a more flexible, decentralised, and preventive institution to create networks with other societal actors and participate in the design and implementation of a variety of instruments to guide society, particularly into directions of international agreements and national commitments on sustainability and climate change mitigation strategies. In this context, I suggest that NGOs should play a role of supporting government and civil society, including local communities, to democratise knowledge and best represent the interests of all parties; as NGOs are not, and should not be a replacement for sound policies and enforceable laws (Klooster, 2006).

The testing of ideas around NGOs and local community relationship suggests the possibility of refining the impacts of those interventions focusing on the implementation of PES programmes. An interesting result is the link between power distributions within local governance structures, which in some cases still have an impact on the trade-offs associated with NGOs key decisions in project implementation. In my opinion, NGOs represent an alternative to enhance collaboration between citizens and governments. However, the State must promote the institutionalisation of programmes, so all sectors can participate on a carefully guided process, so the potential to reproduce inequality is limited by coordinated, informed, transparent and accountable rules.

7.2 Actor-network theory as a viable mechanism to study PPGIS implementation for natural resource management in lower income rural settings

In recent literature the acquisition of socio-cultural and socio-political data before implementation of pilot PPGIS initiatives in rural settings is rare (Bernard *et al.*, 2011; Wright *et al.*, 2009). In this sense, the results presented in previous chapters support the idea of advocating collaboration partnerships among NGOs, local communities and researchers (Sieber, 2003), as a mechanism to support and validate the involvement and participation of diverse sets of actors in order to understand and better document the details of the PPGIS interventions.

In studying science, technology and society, Bruno Latour (1997) and Michael Callon (1986) argue that scientific knowledge is local and constructed by a network of actors. This research has focused on processes rather than outcomes, mainly because the dimension of the phenomena under investigation varied as a result of socially constructed situations. In addition, and due to the comparative character of the research design, it was necessary to develop an analytical approach sensitive to the context of local natural resource and land management in rural communities; which at the same time provided a

uniform analytical framework to construct and compare a simple explanation of the evidence, considering a reflexion on the quality and accuracy of the results.

In this sense, actor-network theory contributed to the design of a qualitative analytical approach that enhanced the possibility to explore the activity of the Public Participation GIS implementation processes, by identifying analytical categories which are not usually considered when policy instruments and citizen participation are evaluated. As a model, actor-network theory allowed the incorporation of evidence from a variety of sources, while being a useful tool for highlighting the specific differences that need to be addressed by any formal approach to reconciling data with different ontological sources (Combera *et al.*, 2003).

The analytical approach informed by actor-network theory aimed to determine the interactions, connections and activities of actors involved, identifying and ranking a number of potential indicators of actors and situations. As a result, the networks of the four PPGIS implementation processes were uncovered through an analysis of published literature, scoping organisations and case studies. These were augmented by participatory action research approaches such as participant observation, group discussions and semi-structured interviews with research participants, NGO representatives and government officials.

Analysis of the interactions between five analytical categories, and across four community case studies, provided greater understanding on how power structure changed in response to the intervention; the impact of local natural resources management initiatives on the development of the experiment; an assessment of the impact of technology on traditional organisation arrangements; and exploring the conditions which potentially allowed or limited those changes to take place under specific community settings.

As an analytical guide, actor-network theory proved successful in representing the individual and comparative views of those involved in the research process of a multiple PPGIS implementation exercise. As proved by the outcome in Reforma Agraria, it also enabled a greater understanding of the impacts of such an intervention and the potential to evaluate whether it had the possibility to enhance collective understanding of natural resource management practices, inform decision-making processes, lead to better shared decisions and enhance local social capital within a wider rural sustainable development scope.

7.3 Geospatial technology usage by non-expert groups seen as innovative instruments of participation in natural resource initiatives

When using geospatial technology for land demarcation with local communities in Nicaragua, Jardinet (2006) concludes that well organised communities, in which members are very much involved, are key factors for the success of experiences. My findings support this perspective as I acknowledge participation in development as a key characteristic, especially if social and power structures are reinforced by the involvement and cooperation of community leaders. During my experience in the community case studies, training courses were influenced by the presence of key people with a degree of local knowledge of the territory and resources used by the communities. Similarly, they were helpful during the semi-structured interviews and community assemblies, as they provided strategic answers. Identifying such people and facilitating their collaboration will enhance the adoption of similar initiatives.

Evidence from Google's Outreach Programme supporting geospatial technology tools for local communities participation in emissions reductions initiatives in the Brazilian and Bolivian Amazon Moore (2009) and Butler (2006), found that traditions and socio-political contexts within local communities have the potential to enable and contribute to local development initiatives. As the findings presented in this thesis suggest, local land use planning strategies have the potential to adapt geospatial technology to support traditional decision-making processes. In particular, community-based land use planning frameworks contribute with a set of practices, widely accepted rules and effective management mechanisms, as a local governance arrangement that is already facilitating livelihood improvements for millions of forest inhabitants around the world.

The results presented in the thesis also suggest that it is possible to identify enabling conditions in order to achieve a set of potential benefits resulting from the integration of geospatial technology usage within collective natural resource management initiatives. However, it is necessary to examine the degree of adaptability and functionality of policy principles, and compare them according to the structure of the different natural resource management strategies within forest sector and public policy approaches in each particular context. As Dunn (2007) points out, usage of geospatial technology tools by non-expert groups in lower-income countries are context- and issue-driven rather than technology led.

Experiences from international partnerships between public and private sectors within forestry activities suggest that public administration mechanisms limit social and environmental benefits in certain contexts (Shvidenko *et al.*, 2005; White and Martin, 2002). Reflecting on the similarities within the community case studies involved in this research, I conclude that although private and public actors impact local development projects, it is also possible to enhance their presence and coordinate efforts to support such interventions.

7.4 State institutions and local communities: Their role in an eventual REDD+ mechanism

Reducing emissions from deforestation and forest degradation, conserving and enhancing forest carbon stocks, and sustainably managing forests (REDD+) is an international climate policy framework aimed at generating incentives to protect and better manage forest resources, by recognising and establishing an economic value for the additional carbon stored in biomass, or not emitted to the atmosphere. To be effective, REDD+ requires several coordinated national and regional policy programs, sub-national projects, and involve multiple actors, including governments, NGOs, multilateral agencies, private organizations, communities and individuals (Corbera, 2012).

This investigation presented a perspective on the implication of Public Participation GIS as a tool to enhance collective decision-making in local natural resource management initiatives linked to Payments for Ecosystem Services. In relation to an eventual REDD+ programme, the role of local communities might be enhanced by adopting specially designed PPGIS tools with the possibility to enable community-based monitoring of local forest resources, and a potential contribution to the required national-scale forest monitoring systems in the context of monitoring and reporting activities for REDD+.

Following previous ideas, Butler (2006) and Moore (2009) suggest that government agencies in Latin America are very interested in the experiences and information resulting from geospatial technology interventions with local communities. My experience validates the previous observation; however I argue that a balanced distribution within the analytical dimensions proposed by this investigation has the potential to enable wider participation of government agencies and private organisations which in the end will lend credibility to the initiatives. In this respect, Chapin's (2006) recommendation of involving government officials to lend credibility to non-expert maps proved its relevance in the community case study that as a result of the PPGIS initiative, managed to submit a voluntary community reserve application (see Section 5.2.7 for more details).

Summary of the chapter

The ideas presented on this chapter challenge the simple adoption of PPGIS as an attempt to transfer geospatial technology for the use of non-expert groups. This study proposes a series of recognisable indicators to assess how pilot PPGIS implementation processes show progress and change over time. The analytical categories presented as the basis for an analytical framework have the potential to enable the development of models to systematically observe and compare PPGIS initiatives; and to facilitate a structured qualitative analysis and reporting basis on the implementation of pilot case studies.

For instance, the findings of this research suggest that symmetry in categorical dimensions will be important in identifying communities with the capacity to support local decision-making processes regarding natural resource management initiatives. In addition, when a number of analytical categories show high achievement levels, it may be possible for a community to substitute the functions of other dimensions with more basic indicators (i.e., limited IT skills as well as age - education barriers could be supported by an extended network of external relations and strong culture of participation in local development).

In my vision, technology itself cannot, and should not, be adopted as a single instrument to guarantee more equitable opportunities for local development in rural lower-income settings. Some researchers have argued that ongoing international environmental governance protocols are marked by too little representation, accountability, and effectiveness in addressing the fundamental challenges of global environmental change and the needed transition to sustainability (Newell and Bulkeley, 2010). In this sense, the issue of equity within common property regimes can find a positive response if the aim of geospatial technology initiatives is to consider the societalisation of skills rather than the achievement of individual project-based goals. Thus, the aim should be to facilitate citizen involvement by informing their decision-making processes, as well as by communicating about the alternatives they face in relation to the spatial element of local natural resource management initiatives.

Although it is necessary to adopt a conservative vision regarding the potential of REDD+ to contribute to poverty alleviation and climate change mitigation, in recent years more and more debates agree on the potential for community forestry to contribute to climate change mitigation in Mexico (Bray,

2010). A comprehensive study of the potential for carbon sequestration by different land uses in Mexico found that the most cost-effective method for sequestering carbon appears to be the improved management of natural forest on communal lands (De Jong *et al.*, 2000). In this sense, the perspective presented in this thesis can contribute to a near future REDD+ scenario in which PPGIS in the form of community-based monitoring, manages to be recognised as a key theme in relation to the role those local communities should play within global emission reduction programmes, and as a mechanism to validate and assume co-responsibility in the wider decision-making of REDD+.

However, as Boyd *et al.*, (2007) report in an assessment of current practice and future approaches for certified emissions reduction mechanisms to parties with commitments to reduce their greenhouse gases, many countries with a high potential income from REDD+ score very low across a range of governance indicators, opening the question if these entities will ever succeed in lowering their high deforestation rates; and be able and have the will to pass on monetary benefits from the national government to communities and other small stakeholders on the ground. Similarly, if all these challenges can be achieved, a preparation process to strength the capacity of civil society, NGOs, environmental enforcement agencies, and local systems will have to be sharply increased.

Finally, I would like to comment on a consideration commonly repeated within the early PPGIS literature, referring to the quality and accuracy of local knowledge (Elwood and Cope, 2009; Sheppard and Cizek, 2009; Sieber, 2007; McCall, 2006; Rambaldi, 2005; Abbott, 2003; Aitken, 2002; Carver, 2001; Kingston, 1998; Brandt, 1998; Weiner *et al.*, 1996). In my experience, the quality and accuracy of local knowledge depends on its social domain and not on its representation on the digital grid. I propose that accuracy needs to be re-defined in terms of PPGIS, as this new form of 'accuracy and quality' refers to the capacity of a natural resource management group to communicate it and disclose it to new participants within and outside of the community (e.g., overall result of Reforma Agraria's PPGIS initiative). In other words, the democratisation of local knowledge will enhance its accuracy and quality.

8 CONCLUSIONS

The previous chapters provide an account of the accomplishment of the research objectives formulated as part of this investigation. The final chapter of this thesis summarises the main elements of the proposed evaluation framework, as the central contribution to knowledge produced by this investigation, considering its novelty and importance, and a reflection on its potential value for future application. Next, I summarise the key conclusions by answering the original guiding questions and sharing some personal reflections derived from the study, particularly concerning the main challenges, limitations and strengths of the investigation. I conclude the chapter by reflecting on the limitation of current research and future research priorities.

8.1 Contribution

The main contribution to knowledge produced by this investigation is a new evaluative framework for assessing PPGIS pilot implementation initiatives, particularly in the context of rural settings exposed to multi-scale natural resource and land management initiatives. In order to address what I identified as relevant knowledge gaps in the reviewed literature, I embarked on the design of a plan to guide the construction of an evaluation framework, able to document, classify, compare, and as a result, better understand those enabling and limiting conditions to geographic information technology transfer and adoption.

The construction of the evaluation framework was guided by the social, cultural and natural resources management interactions experienced during the four PPGIS pilot implementation strategies. In order to conduct the interventions, and systematise the evidence documented with pilot participants, it became necessary to undertake an iterative revision of the general strategy, considering the improvement of specific actions designed as part of the multi-case study implementation. The resulting evaluation framework was intended to quantify and compare the relative magnitude of a number of key characteristics within each community case study and across them. The categories of analysis within the evaluation framework were social structure, information technology skills, participation in development, external relations and power structures.

The novelty and importance of the approach developed consisted of identifying and promoting good practices for PPGIS pilot implementations, characterised by full recognition of local governance bodies, and compliance with local procedures and structures. The latter became the corner stone of the PPGIS pilot implementation strategy, resulting in public and transparent negotiations, which generate trust

and legitimacy among outsiders, technical and administrative support organisations, local authorities and citizens participating in the pilot PPGIS implementation. Assembly agreements and commitments were vital along the different stages of the implementation processes. Similarly, designation of participants, identification of territorial features and natural resources conditions provided a strong basis to generate agreements on local management needs and problem issues. Overall, the findings suggested that symmetry in achievements across the five categories is important in identifying communities with the capacity to support local decision-making processes regarding natural resource management initiatives. In addition, when characteristics such as extended networks of external relations and a strong culture of participation in local development are present then it may be possible for a community to compensate for lower achievement on factors such as IT skills.

Potentially, the results derived from this investigation will advance the recognition of local governance structures that contribute to multi-scale natural resources management initiatives. Future developments may consider the participatory customisation of IT tools and validated sampling and measuring protocols to support data collection, storage, processing, and analysis; aiming to inform both local decision-making processes and larger scale initiatives which require consistent spatial data (i.e., carbon monitoring approaches to detect biomass changes and estimate carbon pools).

A near future scenario would be to envisage the implementation of institutionalised PPGIS strategies in rural settings, as the basis to generate systematic field data that supports the fusion of satellite, airborne and terrestrial remote sensing, oriented to feed and improve regional, national and global forest monitoring systems. Ideally, such platforms will provide useful information by integrating complementary tools to visualise and assist multi-scale spatial decision-making in the context of climate change global initiatives, re-defining the scope of Planning Support Systems and their relationship to citizen participation in the 21st Century.

8.2 Answers to the guiding questions

Is the experience of other studies where PPGIS has been used for natural resource management in rural lower-income settings borne out in Mexico?

The findings and observations presented in previous chapters have limited similarities with published Public Participation GIS and Participatory GIS studies. In part, this is because of the descriptive nature

of single case reported experiences, the focus of the pilot geospatial technology initiative (i.e., local communities role within green economy instruments of innovation) and the absence of a general framework to evaluate these sorts of initiatives (Laituri, 2003).

Nevertheless, evidence presented in this study supports the idea of conducting research and facilitating initiatives of '*geospatial technology societalisation*', by establishing cooperation protocols between local communities and public/private bodies sharing responsibilities across multiple country contexts (Sieber, 2003). In this sense, my experience fully validates the idea that progressive forms of local governance and traditional practices of land management are enabling factors for implementing initiatives regarding non-expert usage of geospatial technology in rural lower-income settings (Moore, 2009; Jardinet, 2006; Butler, 2003).

What insights can actor-network theory provide into the interpretation of the community case studies results?

By setting a framework to categorize interactions between the components involved in the implementation contexts (e.g., non-expert usage of geospatial technologies, natural resource management local initiatives, socio-cultural and socio-political conditions and green innovation instruments); actor-network theory enabled me to explore from different perspectives both anticipated and spontaneous situations documented during the implementation stages of four geospatial technology transfer pilot schemes.

In particular, the indicators developed within the evaluation framework helped to better understand and compare the conditions that enable or constrain geospatial technology transfer processes. From these results, it was possible to discern the impact of pilot geospatial technology interventions on traditional forms of social organisation (Martin, 2000).

Of special interest were i) changes in power relations in response to the technical intervention and ii) identification of the enabling conditions which allowed rural non-expert users to adopt geospatial technology and make it work, or not, for their benefit. Better understanding of power roles as a property of the 'systems' in turn contributes to better understanding the impact of geospatial technology usage for green initiatives involving traditional systems and local resources.

How important are pre-existing IT skills for the adoption of PPGIS schemes?

In contrast to the initial hypothesis about the role of pre-existing IT skills for the adoption of PPGIS schemes, and against any potential conjecture about the relevance of acquired IT literacy, I conclude that this factor is less important than several others. Although it is relevant for the understanding and adoption of geospatial technology initiatives, in situations where the local culture of social participation and the degree of external relations show outstanding development, these can provide the capacity to overcome deficiencies in skills.

Nevertheless, what the skill acquisition represents, in terms of a precedent for change in traditional systems is of significant relevance for the adoption of any technology-related scheme. Similarly, the value of the intervention itself also relates to the impact of the technology on traditional organisation arrangements.

How important are local power structures for PPGIS implementation?

Local power structures are among the most significant elements to consider, and engage with, if pilot PPGIS implementation processes are to succeed. However, I do not pretend to restrict to a single element the explanation of success in terms of pilot implementation of PPGIS initiatives. In some cases, power structures have not been a significant influence during PPGIS implementation procedures (Wright, 2009).

However, evidence from the community case studies considered in this investigation does suggest that implementing PPGIS initiatives is highly context dependent. In this research there were certainly situations where local governance protocols were more influential than organisational structures or programme characteristics, demonstrating that the issue of power within PPGIS practice is still present (Chambers, 2006; McCall, 2006; Rambaldi, 2005).

What other factors facilitate the adoption of PPGIS initiatives?

The experience of the four community case studies was sufficiently varied that any generalisations need to be accompanied by a note of caution. However, the research suggests that on top of pre-existing IT skills and local power structures, social structure, experience and traditions of participation

in community development and external relations are key elements that in certain contexts within collective property regimes will facilitate the adoption of PPGIS initiatives at the community level.

In this sense, support for guided and independent action by academic promoters, acknowledgement from related programme organisers, and trust from local groups are the most important factors that allowed the implementation of the pilot PPGIS interventions within the communities investigated.

Does PPGIS change the way of working in local communities?

I can argue that interventions in which local communities accept and experience a degree of external involvement, through which knowledge and skills are transferred always have an effect on the workings of every community, group or individual. However, it would be impossible to generalise by stating that traditional mechanisms in the communities always improve as a result of such interventions. In this sense, all actors involved within cooperation protocols of sustainability have significant responsibility in maintaining or adapting existing working patterns.

Nonetheless, in relation to the potential for external actors to modify, and in some cases transform the way in which local communities work, results from the community case studies strongly suggest that PPGIS initiatives can represent enabling conditions to stimulate change within the networks of local communities. Based on the experience of this study, perhaps the question should be re-formulated as follows: *Is it possible to identify key characteristics which influence how non-expert geospatial technology usage re-shapes traditional ways of land and natural resources management?*

To what extent can geospatial technology usage by local groups effectively support social participation mechanisms for natural resource management global initiatives?

There is still much to do in relation to experimentation and validation of mechanisms to support social local participation involved in global initiatives that target disadvantaged groups in possession of key resources, especially where the adoption of geospatial technology is present. However, the most significant learning from the execution of this investigation must be to reflect on the wider contexts involved; it is necessary to revise the focus on policy relevance of technology transfer mechanisms, especially when related to poverty alleviation.

In order to address challenges towards the synchronisation of traditional natural resource management practices and green innovation instruments, I strongly recommend a deeper rethinking of how global initiatives for natural resource management are conceived, assessed, implemented and evaluated before attempting to transfer information technology initiatives. The potential is there, it depends on the nature of the initiatives, the equity and transparency behind them, but most importantly on the history of the communities.

What is the future of geospatial technology usage in common property regimes of rural lower-income settings?

In my view, geospatial technology usage by non-expert groups is a reality which is increasingly generating successful experiences of implementation and usage. Current efforts in lower-income settings are being focused in two main directions: on the one hand, a diversity of organisations and government agencies are interested in increasing experience in natural resource management initiatives with the aim of improving administration procedures, rather than focusing on implementation exercises to socialise technologies.

On the other, open source and web-based platforms, like the widely known case of Google Earth, are becoming available to some groups in some regions, potentially taking away the momentum and opportunity that geospatial technologies could offer to social capital assets, as access to the Internet is still very limited. However, there is a definitive need to encourage a more rigorous implementation and report of PPGIS approaches.

In my opinion, is impossible to think of the future of geospatial technology usage by non-expert groups as an isolated topic. In emerging economies like Mexico, it will depend enormously on public and private paradigms to promote and implement natural resource management local initiatives; and of course, on the timescales over which benefits (including profits) are evaluated. For example, if current approaches towards payments for ecosystem services prevail, an increase in revenues, derived from using, adopting or transferring innovation technologies is likely to be at odds with objectives of achieving equitable distribution of benefits among the rightful owners of natural and energy resources.

8.3 Challenges and limitations

Among the set of messages this study aims to share with the wider PPGIS community and those involved in improving natural resources and land management practices, the importance of transparency and impartiality are amongst those that must be most emphasised. This study aimed at documenting a comparative PPGIS intervention within an established network, actively collaborating towards informing land management practices in the context of rural sustainable development. However, when considering the circumstances involved when working with local communities in rural-southern Mexico, I started the study as a complete outsider, rather than a member of the network, aiming to documenting and analysing a socio-technological intervention, highly dependent on power, social, economic, and political circumstances.

Such approach has its challenges, limitations and advantages. Among the challenges faced during the course of the investigation, those related to undertaking this kind of study in the chosen localities, were the most difficult to deal with. An initial challenge consisted of negotiating access to local groups in rural communities by exploring the programmes and activities of regional non-governmental organisations, with particular focus on rural sustainable development. Once such organisations and their interests were identified, it was necessary to discern the viability of conducting the study with the proposed communities. However, this became a complex task as limited availability of information made it necessary to search for other communication channels with actors familiar to the reality of such organisations, projects and communities.

Once the communities were selected, the engagement with them required a strategy to find the most effective means to fit within local governance protocols and interests. Multi-tasking became a significant requirement as I had to actively participate in training activities, documenting evidence and carrying out in-situ analysis, also considering finding solutions to unexpected situations. In addition, the locations of La Corona and Reforma Agraria required developing a complex field intervention campaign due to the remoteness of the communities. All these previous conditions made the field implementation stage the most critical process in conducting this study.

Although overcoming the initial challenges required significant effort, having a clear idea about the iterative nature of the research design was of major advantage as this allowed me to adapt the strategy and redirect efforts according to local-context driven circumstances. Similarly, presenting a

clear and well-structured intervention plan to the organisations and communities; as well as availability of financial resources to conduct field activities and provide equipment and tools to the participating teams, were significant factors in the accomplishment of the research objectives presented in this thesis. The diversity of conditions within the case studies, represented by a set of environmental, social, economic and natural resources management contexts, is a strength of this investigation, as it offered more scope to identify key enabling conditions and increase potential transferability of the findings.

Among the limitations of this investigation, the most significant relate to the number of case studies, the difficulties that this created for a comparative evaluation framework and the associated uncertainty within the analysis. Although the intention was to provide a robust and reproducible analytical approach, geographic information technology transfer involves more than providing training in GIS techniques. This investigation intended to establish four operational pilots, so data collection could enable a comparative analysis with a more robust analytical outcome. However, out of four community case studies, only one was able to undertake all stages of the study.

If the outcome of the planned multi-case study pilot implementation had been fully successful, one of the key inputs for analysis and comparison would have been the accuracy of the maps produced by each pilot. As part of this, one idea was to facilitate a local debate about how such maps could inform local decision-making processes, in terms of increasing knowledge and building consensus towards a particular strategy definition. In other words, how well such maps would have enabled a collective decision over a single question or problem.

As a result of the outcomes of this study, I would argue that the absence of successful examples in which institutional programmes engage with local interests and governance protocols; lack of trust and transparency in implementing and administering external interventions; restrictions on access to participation and technology due to local and gender power structures, as well as gatekeepers and third party interests; and lack of socialisation mechanisms to locally share information about programmes and initiatives, are the main factors with potential to limit the success of PPGIS socio-technological approaches adoption.

In addition, some lessons can be identified from the cases studies about the barriers which can impede successful implementation. The most important is the need to support, coordinate and engage government institutions to contribute to a better understanding of the needs and challenges that local

communities face when interacting with international climate change and poverty reduction mechanisms. In particular Latin-American countries are experiencing a transition in the execution of institutional priorities due to international climate agreements which add a degree of complexity and uncertainty to the already complex task of leading the path towards having better natural resources and land management instruments and policies.

External initiatives and the bottom-up approach in natural resources management and land use planning more generally, will only succeed if promoting actions which result in wider trust and accountable transparency. Furthermore, local barriers such as the possibility to individually profit from relations and access to information, and prioritising third-party profits over local communities benefits, need to be resolved if the planning paradigm transition is to guide international initiatives to adapt and mitigate climate change. Rules for access to participation, integration of gender equity strategies and compliance to make relevant information available to the different sectors involved in land and natural resources management are issues that deserve further inspection and analysis. With this in mind, future proposals integrating the approach suggested as part of this thesis, will be in a better position to provide an integrated and more robust evaluation framework, hence better assessing the viability of promoting socio-technological change for natural resources and land management.

Having reviewed the challenges and limitations of the current study, I also want to briefly describe two main areas of potential uncertainty associated with the evaluation framework results. The first relates to the scoring process across the analytical categories. Although the use of an ordinal scale can be questioned, the decision to define ranked levels enhanced the ability to combine indicators scores and so characterise the multiple interactions that may shape particular outcomes. On the other hand, there is a potential problem of equifinality in trying to generate recommendations according to the overall profile of the analytical categories. The advice to prevent such problems is to invest time and resources in as detailed assessment and understanding of local structures as possible, since this, in turn, will help ensure that the different levels are as meaningful as possible..

Uncertainty may also arise from cases in which land tenancy conflicts and disputes; vaguely defined governance protocols; and a diversity of economic activities are evaluated with the specificity of the current evaluation framework. The idea of designing an instrument with special emphasis on the role of geospatial technologies in planning support systems, and the broader relationships with natural resource management in southern rural Mexico, is in fact a limiting factor of this study, in terms of its

transferability to other Latin-American contexts. However, the implications of this source of uncertainty for the overall results and conclusions in this thesis are relatively limited due to the framework being shaped by the broader context presented in the literature review. The advice if attempting the adaptation of the proposed evaluation framework would be to contextualise social, political and cultural characteristics in great detail.

A pending task concerns evaluating the effectiveness of the presented framework. For this, I would look for a future opportunity in which other developments and initiatives enable a more robust implementation process, guaranteeing data availability for exploring the implications of interactions across a wider set of case studies, opening the possibility to present a more robust instrument, ideally with the opportunity to substitute some context-relevant analytical categories (i.e., social and power structures ranks).

8.4 Future research priorities

Geospatial technology usage is experiencing a definitive historical moment in rural lower and middle-income settings with respect to strategic resources and mechanisms of value for green economy initiatives; in my opinion, either 'armies of geospatial technology consultants' (Dunn, 1999) will become normal among the groups of geospatial information users; or academic, non-profit and institutional developments in geospatial technology analysis transfer will generate a stronger platform of experiences and methodologies for non-expert users.

I can anticipate a number of public and private programmes in which Public Participation GIS principles and methods would have the potential not only to be adopted, but also considered as a critical element to support international environmental governance principles within green innovation schemes (i.e., the different country-level preparation processes for REDD+; and the territorial distribution and eventual marketisation of the renewable energy sector in Latin America). In this sense, research towards identifying institutional and local governance arrangements to promote and maintain social participation in community based management at the local scale is encouraged.

In relation to current ecosystems services instruments, in order to re-shape current social and political dimensions within green innovation, it is necessary to take several actions. For example, enabling the monitoring and spatial analysis of multiple (i.e., marketable and non-marketable) ecosystem services (Golicher *et al.*, 2012), has the potential to allow local communities to specify what is of importance to

them and support compensation in some way by green markets. Moreover, current software programming and IT developments open the possibility to customise geographic information technology solutions in response to local needs, contexts and skills.

In this sense, the study strongly recommends the development and adoption of frameworks for assessing pilot PPGIS initiatives in order to facilitate a dialogue to understand the weaknesses and strengths of specific contexts and case studies (Laituri, 2003). As important as sharing experiences of implementation initiatives related to strategic resources management in rural settings, is the generation of ideas and pilot developments focusing on how to improve and integrate local information into wider instruments of environmental decision-making. My experience in conducting this study leads me to advocate the continuation of research initiatives which seek to better understand the local conflicts and challenges associated with the implementation of national and international policy through collaborative programmes in lower-income rural settings.

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ANNEXES

Annex 1. Series of fragments translated from my research diary, originally written in Spanish

La Corona, Chiapas. Training stage, March 10th, 2009

Although I am not keen on the way in which things are organised in the first community, I decided to continue with the training course. A particular issue in La Corona was the co-ordinator of the working group. The source of the problem, as far as I could identify, is his multiple roles in the organisational structure. He is a landowner, a member of the technicians team in the community, Ambio's employee (his job is to follow the progress of the projects administrated by Ambio and to co-ordinate the technicians teams in the region); also, he is a local government employee in the area of wildfires control, and head of the local church. The amount of power this person has is enormous and not precisely because his authority or abilities; its more because of the place he has been put in, and as a result he took control over information flows and as Ambio's technical service provider in the region. This is like a vicious circle making the comparison to the situation between Ambio and the alliances with the academic institutions relating to satellite imagery and spatial analysis; the co-ordinator presence increases dependencies and generates GPS data control in the other communities; I wonder why this happens in various scales; the smaller the scale, the more absurd the implications.

On the other hand, the social structure in La Corona is quite complex. It is possible to appreciate that the elected local authority figure is a symbolic one. The fact that makes someone powerful is the possibility to get, understand and 'distribute' the information from the outside. The local authority exists just because it has to. This situation shows its major impact in the case of the payment for carbon sequestration activities initiative, where no information is available for the authorities or the general public. Particularly in the case of the financial administration, this project has neither transparency nor order, and the access to information has as many (and ridicule) obstacles as you can tell.

La Corona, Chiapas. Training stage, March 16th, 2009

Many things differ from Ambio's perspective or understanding. The fire management strategy and the payments for carbon sequestration activities are not in the stage suggested by Ambio. The feeling I got from the meeting with Ambio is that they are trying to cope with a lot of work, and as both communities (La Corona and Reforma Agraria) are in the final year of the PES project, they see in the PPGIS investigation a way to make the transition with both communities and give them some skills to continue searching for funds alone.

For practical reasons I had to modify some of the activities and contents described in the research plan in order to reach the point of general participation and understanding of the PPGIS application (e.g., instead of creating vulnerability maps, a survey to map the firebreaks was more useful due to the importance for the participants to add information to this 'layer'; other example is the mobile GIS exercise that was too complex for the users).

During the second week in La Corona, the first effect derived from the training course emerged. In the beginning I had the impression that some of the participants were attending to the course against their own desire... As any outsider would do, I treated every member of the group in the same way and this generated some kind of amusement among the 'lower rank' members due to the change this represented in the power scheme. When this happened, the coordinator changed his attitude towards the course. He started to come alone at different times in order to get his training session. I decided to take this as if any other member would ask for a special schedule. The result of this was that he lost some continuity on the processes and for the first time, the other members of the group were on a higher position due to the skills obtained.

La Corona, Chiapas. Training stage, March 26th, 2009

During the third week of my stay in La Corona, I ask for an assembly with the authorities and representatives of the community to inform the coming end of the training course and to make an invitation to join the pilot programme and get trained by the local participants. During the meeting something strange happened. The team co-ordinator adopted the role of moderator and gave a quick and confuse report on the financial status of the community. At the end of his intervention the local authority asked why there were no reports of the financial activities corresponding to the payments received for the carbon sequestration activities. The co-ordinator said that the information was available in a PC which none of them know how to operate, and when asked about printed copies he said that the printer ran out of ink, and the only chance to get a printed copy was to buy a new ink cartridge (which is not available in the area).

By the time they were finished I emphasised that the aim of the meeting was to inform the authorities of the status of the course and make a public invitation to join the group. After that two members approached me asking for the schedule of the course, and then I ask to the participants to set a time table to show the structure of the application. The day after one of the two elders came by to see how

they worked, and surprisingly two of the participants showed him how to create and add information into a layer.

In relationship to the reasons why I had to turn citizens away, my decision was not based on the coordinator aim to domain the training course, it was due to the lack of more computers/time to accommodate them and also because of the situation with the group. The participants were able to reproduce the exercises but they couldn't communicate the steps to do the exercises. It was after the third week that they accumulated experience and as a result they were able to support the other older citizens who manifested interest in the closing assembly.

La Corona, Chiapas. Training stage, April 5th, 2009

The cascade system suggested on a communication with my supervisor was put in place during the last week of the course, when the participants understood the whole application and were able to explain the exercises. I would say that the entire concept of the GIS application was not understood until they started creating the layers and adding information.

A general problem I noticed within all members of the group was their limited ability to read, follow and understand the instructions provided in the handout. Despite of knowing this, I emphasized the use of the handout because that will be the only real reminder they will count with during the pilot phase, as Ambio support personnel showed up only once.

At the end of the course the group manifested their interest in having a weekly session to address the first troubles or doubts they will have as a result of independently-running the application. I agreed to have a weekly meeting in Reforma Agraria, in order to answer questions and help them to revise the structure of the layers they will create and feed with information. So far the first weekly appointment passed and I have no news from them.

The experience in La Corona was completely different to what I expected, although I experienced some sort of surprise and disagreement with the way in which things happen there, I was able to focus my efforts in order to achieve the objective of the implementation stage.

In a final assessment, I have many doubts of why La Corona is Ambio's 'most successful' case. I wonder if that is because of the power control they have by getting the support of a regional dominant figure as the co-ordinator is... or just because the citizens are 'non-conflictive' in relationship with the way in which the administration of the project is running. I don't know if Ambio is handcuffed to him or this person represents the only way to organise such a complex community... At the end I left La Corona achieving the objective of implementing the agenda for the pilot phase.

Reforma Agraria, Chiapas. Training stage, April 8th, 2009

One week before going to Reforma Agraria, I asked to the local authority to call for an informative assembly to the members of the team and also to the general public. On Sunday 29th of March I had the meeting and I had the opportunity to introduce myself and the objectives of the PPGIS project to the members of the community. The agreement derived from the assembly was that three members of the technician team plus three women are going to participate in the training course. Other landowners manifested their interest of participating but made no compromise due to the regular activities they have; indirectly this gave support to the training course. I emphasised my disposition to offer extra sessions at the time of their convenience.

So far, the working agenda in the Reforma Agraria is less rigorous because the authorities and the women are quite busy as a result of the Easter break (they run an ecotourism project which provides employment and extra income to the community). Despite of this, both groups are showing interest in the course.

Reforma Agraria, Chiapas. Training stage, April 20th, 2009

The positive factor in Reforma Agraria is that even if they are less skilled in the technical abilities to comply with Ambio's regulations, they have a very different power scheme. Here the authority is shared by all the landowners, and so far I haven't had the opportunity to identify a single power figure. A key factor is that even if in both cases the carbon sequestration activities are catalogued as collective, in La Corona the reserve has been divided among the landowners, in the case of Reforma Agraria their reserve is really communal. Last week I had the opportunity to support the fire brigade in the opening of a new firebreak. Their reserve and their jungle is an authentic primary forest (in La

Corona the reserve area is a series of former agricultural plots turned into a reservoir that was consumed by wildfires in 1998).

In Reforma Agraria, Ambio has been questioned on many aspects of their approach to give technical assistance. If GIS is about power, I wonder if there is a baseline power level which determines the possibility to implement such strategies.

Tres Picos, Chiapas. Evaluation stage, November, 5th, 2009

At the moment I finished the interviews and group discussions in Tres Picos, but some issues came out, and there is no overall assessment due to the complexity of the situation. I present a brief resume of the findings I came across during the past days.

The working team managed to replicate the procedures in an excellent way succeeding with the first part of the working agenda which consisted in mapping the limits of the community, a task that took 20 days of continuous work. The challenge this task represented in terms of the difficulty to map the limits of the community was the biggest from all four case studies.

The problem came once they concluded the first task because they needed the support and collaboration of the landowners to continue with their activities. In other words, to carry out the second task they needed to expand the network. The purpose of that task was to measure the communal land plots in order to conduct an initial land use assessment.

After the first failure in engaging the landowners, they exposed the situation in the general assembly, and as a result of the public denounce of lack of support, things went more adverse for the working team. The initial interviews and the group discussion point out at a series of factors and situations that blocked the progress of the pilot programme. Some of the reasons they express, have to do with the lack of enthusiasm showed by the landowners to engage with the programme. They also expressed a situation which reflects the role of the power structures in Tres Picos, which I see as a phenomenon of unwillingness to work and avoid responsibility.

Once the participants finished the GIS training, the community considered them as qualified actors and pushed them to attend meetings with other organisations and to participate in external activities related to the carbon capture initiative. On the other hand, when the working group tried to expand the network and include the rest of the community, the landowners diminished the purpose of the second task arguing that the participants had no authority to emit land certificates, and as a result the landowners saw the second task as a waste of time. The situation is quite well exemplified in their own words:

“We were qualified to invest our time in community matters, but we were not good enough to carry out internal activities which needed the engagement of every landowner”.

After the network failed to expand, the working group lost interest in continuing with the pilot programme. At that moment, Ambio’s technician came to the community to offer technical assistance and also to bring another GPS receiver. His visit contributed to raise the enthusiasm within the working group; and with no possibility to expand the network, they made a second effort to continue working. They decided to adapt the strategy for other purpose: to employ the GIS application to measure and verify the extent of land plots for sale.

Even with the initial failure, the working team managed to continue their activities. But another situation limited the possibility to continue working. The authority of the community stopped providing access to resources like batteries for the GPS and the key to access to the place where the computer is. After conducting the interviews and the focus group, I asked the authority and the working group to call for a communal assembly in order to organise a public enquiry to decide the future of the GIS application in the community.

The situation is complex because if the working team is not going to receive the necessary support to continue with the GIS application, the computer will become a matter of conflict within the community. The working team and the authority mentioned their views on this topic. On one hand the working team wants to continue working but they recognise that without engaging the landowners it will be impossible. On the other hand, the authority is concerned with the future of the programme in the community because the computer without a clear objective will cause discordances within the community.

The assembly in Tres Picos resulted in the decision of ending with the PPGIS programme. After the assembly I continued with a second interview stage, and as imaginable, multiple factors contributed to block the support to the pilot. Most interesting and somehow, less understandable for me was a sort of “boycott” that originated within the working team. The main reason for this to happen was the lack of support recognition from the authorities and a potential land tenancy conflict.

Tres Picos, Chiapas. Evaluation stage, November, 8th, 2009

After concluding the interviews in Tres Picos, I decided to go to the neighbouring village of Ambio’s technician in order to explore his progress and conduct the interview. The use he had given to the GIS application within the local projects under his responsibility and the overall data management in Ambio was an interesting outcome. The other role he played was to give technical assistance to the four case studies during the pilot scheme, even though his support had not been possible in some of the cases.

After all, I am very satisfied with the response to the evaluation process, even if the outcome of the pilot programme is not as successful as I expected. A conclusion I draw from the assembly is that some landowners had no or not enough information about the project, that the group did no effort to offer training to the rest of the landowners. Hence some landowners seemed frustrated that they had been given no chance to participate. Others realised they had wasted an opportunity and tried to convince me to give them a second chance by saying they would work the coming week and he would see results if he would come back. However, I felt they only said this to be able to keep the computer which is status symbol for them.

Sierra Morena, Chiapas. Evaluation stage, November 11th, 2009

Continuing to Sierra Morena, I found a motivating situation. It happened that I arrived on the day the community was having a general assembly (once every six months) and they were quite surprised to see that I came back. They invited me to intervene in the assembly and I could benefit of the situation by making a public enquiry on the progress of the pilot programme. This was interesting and helpful as it brought up the opportunity to question the group who blocked the participation of the ladies; it also contributed to create consensus and gather support about the future of the PPGIS.

After this event, the interviews added plenty of information and valuable facts to my understanding of the main difficulties during the pilot process. They exposed many elements and explanations of how the network was expanded and how the actors interacted within the working group and with the external institutions.

Sierra Morena is an example of a successful implementation followed by a problematic pilot programme which derived in the configuration of a network dominated by one out of three power groups. The segregation of some of actors had an unexpected result: the lack of capacity to replicate the full GIS procedure. After the general assembly, conciliation came to place when the dominant group accepted they needed women's participation in order to guarantee the full process required to submit project proposals.

Sierra Morena, Chiapas. Evaluation stage, November 15th, 2009

After my visit to Sierra Morena I decided to attend to the meeting with the government officer from the Natural Protected Areas Commission. He was open and interested in the general idea. The fact that he was not surprised with the outcome of the two communities in La Sepultura Biosphere Reserve gave me some tranquillity, mainly because it was difficult for me to understand the boycott, especially coming from the most "committed group".

The agreement derived from the meeting was the provision of some more GPS receptors and a printer for the Sierra Morena. They were very happy to hear that I managed to conciliate and restore the participation of women in the PPGIS project.

Reforma Agraria, Chiapas. Evaluation stage, November 23rd, 2009

At the moment I am in the successful case in the jungle. Things here went extremely good and it is very pleasant to conduct the evaluation process because of the way in which these people expanded the network: even if the interaction with the technology was a major issue, they managed to accommodate resources and people in order to succeed. The most relevant result is the submission of a local proposal to create a voluntary community reserve. The relevant issue here is that this

application procedure is the first in the country which considers the project for a period of 99 years, the maximum contemplated within Mexican laws. The use of the information produced during the pilot scheme was the crucial element to constitute the document.

After finishing with Reforma Agraria I have the intention of conducting the interviews in La Corona. I already know that the pilot was not successful there, and I will go there with an exploratory approach to get the most on how the gatekeeper role blocked the pilot scheme.

Annex 2. A series of testimonies from all members of La Corona working group (see Table 5.2, p.112) are presented here as an example of the evidence collected by asking each participant what was his/her role the natural resource management local group, at the beginning of the implementation stage (March, 4-6 2009). Similarly, at the end of the implementation stage (March 24-26, 2009) I undertook the same exercise, this time I asked for feedback on the implementation activities and about their expectations in terms of the pilot implementation stage.

Translating my research diary in full would require weeks of effort. The following testimonies were selected from all case studies due to the dislocation between discourse and action occurred in La Corona, the most advanced pilot in terms of its awareness of natural resources management but also with local power relations that limited the PPGIS implementation effort.

DAMIAN GORDILLO GARCIA

TECNICO RESPONSABLE DEL PROYECTO DE CAPSA-PSA

SUPLENTE DEL COMISARIADO EJIDAL

TECNICO DE LA COOPERATIVA AMBIO DE LOS PROYECTOS DE INCENDIOS FERESTALES

UNAS DE MIS LABORES QUE DESEMPEÑO EN LA COMUNIDAD ES DE VIGILAR BUEN EL DESARROLLO DEL PROYECTO Y LA COORDINACIÓN DE LOS TECNICOS QUE PARTICIPAMOS EN EL TRABAJO DE CAMPO Y LA COORDINACION CON EL APOYO QUE RESIVIMOS POR PARTE DE LA HACESORIA TECNICA QUE PROPORCIONA AMBIO Y EL COLEJO DE LA FRONTERA SUR COMO SON..

ORGANISACION COMUNITARIA

EN LO QUE RESPECTA A ORGANISACION TENEMOS NUESTRAS NORMAS PARA PODER TOMAR DECISIONES QUE AFECTEN O VENEFICIEN A LA COMUNIDAD –

PRIMERO .. LO COMENTAMOS A LAS AUTORIDADES Y ESTAS A LA VES LO SOMETEN A LA ASAMBLEA GENERAL PARA SU ANALISIS Y SE ACIERTA EN LA ACTA DE ASAMBLEA QUE SE LEBANTA Y LUEGO SE ES MUY URGENTE TOMAR LA DECISION SE ACUERDA LA FECHA PARA SU APROBACION Y LA FIRMA DEL ACTA PARA HACER VALIDA EL ACUERDO TOMADO SI NO ES TAN URGENTE LO QUE GENERALMENTE SE HACE ES QUE SE DEJA POR LO MENOS HASTA LA PROXIMA ASAMBLEA GENERAL PARA SU APROBACION

PROPUESTAS QUE SURJEN DEL EQUIPO TECNICO PARA EL MEJORAMIENTO DEL DESARROLLO DEL PROYECTO –CAPSA-PSA-

UNAS DE LAS PROPUESTAS QUE SALIO DEL EQUIPO FUE DE REALIZAR LAS ACTIVIDADES DEL PROYECTO POR LOS MISMOS TECNICOS DE CAMPO EN CADA UNAS DE LAS AREAS QUE CADA UNO REPORTARA AL AREA DE ADMINISTRACION EL AVANCE DE LOS SEGUIMIENTO DE SUS ACTIVIDADES Y ESTAS A LA VES MANDARLAS PARA SU ANALISIS CON EL TECNICO DE AMBIO EN LA ZONA SE SOMETIO PARA LA APROBACION A LA ASAMBLEA Y DESDE EL AÑO PASADO ESTAMOS OPERANDO DE ESTA MANERA

EN ADMINISTRACION ECONOMICA

SE DECIDE QUE CANTIDAD DE RECURSO SE DESTINA PARA CADA ACTIVIDAD YA SEA AGRICOLA, GANADERA, INFRAESTRUCTURA Y GASTOS OPERATIVOS

POR CADA UNAS DE LAS AREA DEL EQUIPO TECNICO DESENPEÑA DIFERENTES ACTIVIDADES

AREA GANADERA

EN ESTA AREA ESTA ACARGO DE C. JOSE ANTONIO GOMEZ GOMEZ.

EL REALISA ACTIVIDADES DE VUJILANCIA DE ENFERMEDADES CALENDARIO DE VACUNACION Y ARETADO DEL GANADO LA CAMPAÑA DE BRUCELA Y TUBERCULOSIS YE VA TANVIEN LA CONTAVILIDAD DE CUANTOS VIENTRES SA LEN Y CUANTOS VIENTRES NUEVOS LOS EJIDATARIOS REPONEN CUANTOS SEMENTALES SE MEJORAN CUANTAS ECTAREAS DE PASTOS MEJORADOS SE ESTABLECEN Y TODA ESTA INFORMACION DE CAMPO SE RESPALDA CON FOTOGRAFIAS Y LOS CORRALES SE GEOREFECIAN PARA TENER EL DATO GUARDADO

AREA AGRICOLA

ESTA AREA LO MANEJA EL COMPAÑERO ROSEMBERG ALVORES V.

EL SE DEDICA A MONITOREAR CUANTAS ECTARIAS SE ESTABLECEN DE AGRICULTURA Y SU ACTIVIDAD VARIA DE CADA AÑO POR LO QUE ESTA ACTIVIDAD ES MUY POCA POR QUE ESTA COMUNIDAD ES MAS GANADERA SU VOCACION. POR LO QUE EL NOS APOYA EN OTRAS AREAS PARA EL AVANCE COMO SON EL MONITERO DE SERCOS VIVOS GEOREFERENCIA AREAS

SALUD

ESTA AREA ESTA ACARGO DE LA COMPAÑERA **MARIA ISABEL GARCIA PEREZ**

ESTA AREA ES LA QUE YEVA EL CONTROL DE LA SALUD DE TODOS DE LA COMUNIDAD Y DE LOS NIÑOS RECIEN NACIDOS ,CONTROL DE PESO Y TALLA CALENDARIO DE VACUNACION CONTROL DE PLANIFICACION FAMILIAR SEÑORAS ENBARASADAS Y COMO DATOS DE POBLACION

ADMINISTRACION

ES EL AREA DE URIEL JIMENEZ GARCIA

EL YEVA TODO LA INFORMACION QUE JENERAN TODOS LOS TECNICOS Y LO PROSESA TANVIEN YE VA EL CONTROL DE FACTURACION CORRESPONDIENTE ALOS AÑOS DE APOYO ECONOMICO QUE PERSIVEN CADA UNO DE LOS EJIDATARIOS POR ANUALIDAD DE LOS APOYOS DE CAPSA.PSA

LA BRIGADA DE INCENDIOS FORESTALES

La brigada de incendios se encarga de yevar el control de los reportes de quemas y su verificación en campo de las parcelas que se ocuparan en el huso de tierras para la produccion de maíz o que mas de potreros en la comunidad y la vigilancia de nuestras colindancias en los perímetros de la

comunidad por lo que creemos que es una actividad muy importante para el desarrollo del proyecto

LA BRIGADA FORESTAL

La brigada forestal se dedica al levantamiento de datos de campo para verificación de datos decada citio de monitoreo que están levantando cada año

El citio se georreferencia y se toma los datos de DAP altura de arboles nombres comunes de los arboles y su nombre científico de cada unas de las especies que se encuentran en el citio de levantamiento y cada sitio se encuentra numerados para su ubicacion

MI NOMBRE ES RAUL GÓMEZ MORALES SOY POBLADOR INTEGRO ALGRUPO DE BRIGADAS DE INSENDIO COMUNITARIO MIRESPONSABILIDAD ES DE BERIFICAR BRECHAS CORTA FUEGOS COLINDACIAS CON OTROS EJIDOS QUE TODAS ESTEN LIMPIAS BARIDAS ASTA SUELO MINERAL EN LA TEMPORADA DE SECA SOMOS SINCO INTEGRANTES EL JEFE ORGANISA Y ASE PLANES DE TRABAJOS SE ASE LA BERIFICACIÓN DEPENDIENDO EL TIEMPO CLIMATICO SI NO LLUEVE SE ASE EL RECORIDO CADA OCHO DIAS EN MIPERSONA LLEVO TRES AÑOS CON ESTA TEMPORADA EMO RECIBIDO CURSOS DE CAPACITACIONES DE CÓMO MANEJAR Y CONTROLAR EL FUEGO ASTA ELMOMENTO ATRABÉS DE NUESTRO APOLLO NO A HABIDO INCENDIOS GRANDES COMO UBO ANTES DE QUE SE FORMARA EL GRUPO DE BRIGADAS COMUNITARIOS.EN CADA QUEMAS QUE ASEN LOS COMPAÑEROS SOMOS RESPOSABLES DE BERIFICAR QUE LA LINEA ESTÉ DE CUATRO METROS ACOMO SE ACORDÓ EN LA ASAMBLEA EJIDAL.ANTES DE QUEMAR SE ASE UN FORMATO HO UN PERMISO LA BRIGADA DECIDE HO DEFINE SI SE REALISA LA QUEMA SI EL JEFE DA EL PERMISO JUNTAMENTE CON EL CONSEJO DE VIJILANCIA FIRMAN ELLOS Y LA PERSONA QUE BÁ QUEMAR Y SI EN EL LUGAR DE QUEMA EMPIESA UN FUERTE VIENTO SE SUSPENDE Y SI EL DUEÑO DE LA ROSADURA LE PRENDE LUMBRE POR SU MOTIVO PROPIO QUEDA RESPONSABLE SI EL FUEGO SALE DE CONTROL ESTOS SON LOS TRABAJOS Y RESPONSABILIDAD DE UN BRIGADISTA COMUNITARIO

MI NOMBRE ES ROSENBERG ALBORES VAZQUEZ

AVESINDADO DE LA CORONA E PARTICIPADO EN LA BRIGADA PREVENCION DE INCENDIOS EN LOS PRIMEROS AÑOS NOS NOMBRARON EN LA ASAMBLEA Y SE ACORDARON EL TRABAJO DE BRIGADA ES DE 3 MESES Y LAS LABORES ES VIGILAR LAS COLINDANCIAS DE QUE LAS BRECHAS ESTEN LIMPIAS LOS 4 METROS DE ANCHOS Y VER SI NO AY INCENDIOS DE LOS EJIDOS VESINOS VIGILAR QUE LOS EJIDATARIOS QUE VAN A SER UNA QUEMA TENGAN SU GUARDARALLAS DE 4 METROS O DEPENDIENDO EL PELIGRO QUE AY ALADO DONDE SE VA A SER LA QUEMA AUTORIZAR CON UN DOCUMENTO FIRMADO Y SELLADO POR EL CONSEJO DE VIGILANCIA Y JEFE DE BRIGADA APOYE POR 4 AÑOS EN LA BRIGADA .

EN EL AÑO 2005 EN PESAMOS CON EL INVENTARIO FORESTAL DEL LA COMUNIDA PARA EL PROYECTO DE CAPTURA DE CARVONO DE UNA BRIGADA 5 PERSONAS NOS CAPASITARON LOS DE ECOSUR Y ANBIO DESPUES DE LA CAPASITACION SE DIVIDIO EL TRABAJO DAMIAN PARA NAVEGAR CON EL GPS ANTONIO PARA MEDICION DE DIAMETRO Y USAR LA BRUJULA Y AMI ME TOCA MEDIR ALTURA DE LOS ARBOLES EL PRIMER AÑO SE MIDIO ALTURA DE JUSTE Y DE COPA Y LOS SIGUIENTES ALTURA TOTAL Y AL LLEGAR AL PUNTO SE ASE EL CIRCULO DE 1000 METROS CUADRADOS Y SE USAN 4 CUERDAS DE 17 METROS Y 80 CENTIMETROS EN PESANDO POR EL NORTE A ESTE Y EL TERCE AÑO APREDI A USAR EL GPS PARA PODER LLEGAR AL PUNTO EL 2006 ME NOMBRARON TECNICO COMUNITARIO EN EL AREA AGRICOLA PERO MAS E APOYALLO A LO FORESTAL EN RECIBIR CERCOS VIVOS EN LAS PARCELAS DE CADA EJIDATARIOS EL TRABAJO ES REFERENCIA Y MEDIR CON CINTA METRICA PARA SABER CUANTOS METROS SENBRO Y CUANTAS PLANTAS HAY Y DIBUJAR COMO ESTA LAS LINEAS DE LOS CERCOS.Y REFERENCIAR AREAS DE TERRENOS NUEVOS PARA SABER CUANTAS HECTARIAS SE HICIERON. ESTO SE TRABAJO EL AÑO 2006. Y E APOYALLO EN RECIBIR BRECHA CORTA FUEGO DE LAS COLINDANCIA.Y ACONPAÑAMOS A PERSONAL A LOS RECORIDOS EN CANPO ESTO ES TRABAJO QUE SE ASE Y SEDA A CONOSE CON LA ASAMBLEA

MI NOMBRE ES SAÚL ARGUETA VELASCO

EJIDOLA LA CORONA MAQUÉS DE COMILLAS CHIAPAS

MI TRABAJO ES ANOTAR LOS DATOS DEL SITIO EL SITIO ES 17 METRO A LA REDONDA ESTÁ DIVIDIDO EN DOS PARTE CIRCULO DE 100 Y CÍRCULO DE 1000 EN EL CÍRCULO DE 100

SE MIDEN LOS ARBOLES MAYORES 5 CENTÍMETRO DE DIÁMETRO Y EN EL CÍRCULO DE 1000

SE MIDEN LOS ARBOLES MAYORES DE 10 CENTÍMETRO DE DIÁMETRO Y MI FUNCIÓN ES

ANOTAR LOS DATOS PRIMERO TOMO LAS COORDENADAS DEL SITIO Y EL NÚMERO DEL SITIO Y EMPEZAMOS A TRABAJAR ANTONIO MEDA EL DIÁMETRO DEL ÁRBOL Y EL NOMBRE DE LA ESPECIE Y YO LOS ANOTO Y ROSEMBERG ME DA LAS ALTURAS DEL ÁRBOL Y ESO ES LO QUE HAGO EN EL SITIO Y LOS DOCUMENTO SE LOS DOY A URIEL QUE LOS ARCHIVE Y YO SE LOS DOY A AMBIO

Y REFIRIÉNDOSE A LA ASAMBLEA DE EJIDATARIOS SOBRE EL PROYECTO DE CAPTURA DE CARBONO CUANDO TRATAN ALGÚN PUTO ES LA DECISIÓN LA MAYORÍA PARA REALIZAR LOS TRABAJO

Y TAMBIÉN FUI BRIGADISTA DE INCENDIO FORESTA DE LA COMUNIDAD CUANDO UN PARCELERO VA QUEMAR EL LA RIA QUE LIMPIO TIENE QUE PEDIR PERMISO CON EL JEFE DE BRIGADA PARA PODER REALIZAR LA QUEMA LA GUARDARRAYA TIENE QUE SER DE 3 METRO Y BIEN BARRIDO Y LA GUARDARRAYA TIENE QUE SER DENTRO DE LA ACAHUAL MÍNIMO UNOS 5 METRO DE LA tumba para que el fuego no llegue tan recio a la guardarraya y antes de empezar a quemar se tiene que ver el tiempo como está el viento y las quemas tiene que ser en la tarde para poder quemar y la quema son 3 mese y los meses son marso abril y mayo y para quemar en esos meses tiene que ser en abril pero si llueve y si no llueve tiene que ser hasta mayo para poder que mar y para combatir el fuego se ocupan las herramientas como el machete bomba una motocierra cargar agua y el equipo de la brigada son bomba un maclauz un hacha y eso es todo lo que es cribo y gracias

MI NOMBRE ES JOSE ANTONIO GOMEZ GOMEZ SOY EJIDATARIO DEL EJIDO LA CORONA MUNICIPIO MARQUES DE COMILLAS MI PARTICIPACION EN LA COMUNIDAD COMO TECNICO FORESTAL FUE DEL AÑO DE 1996 CUANDO COMENZO EL PLAN PILOTO FORESTAL Y EN EL AÑO 2005 ME NOMBRA LA COMUNIDAD NUEVA MENTE COMO TECNICO FORESTAL PARA REALIZAR LOS TRABAJOS DE LOS SITIOS DE MONITOREO PARA EL PROYECTO DE CAPSA Y ASTA LA FECHA SEGUIMOS TRABAJANDO.

EN EL AÑO 2007 POR ACUERDO DE ASAMBLEA FUI NOMBRADO COMO TECNICO COMUNITARIO DEL AREA GANADERA. PARA DARLE SEGUIMIENTO EL PROYECTO DE CAPSA MI TRABAJO EN EL PROYECTO ES DE RESIVIR CURSO DE CAPASITACIÓN DEL MANEJO DEL GANADO VOBINO, MEJORAR EL ATO GANADERO, MEJORAMIENTO DE PAZTIZALES, PARA NO SEGUIR AMPLIANDO MAS AREA. VERIFICAR LOS CERCOS VIVOS DE CADA EJIDATARIO Y CONTAR LAS PLANTAS QUE HAY EN LA LINEA DE LOS POTREROS , TOMO FOTOGRAFIA PARA ASER LA PRESENTACION DEL PROYECTO DE LA COMUNIDAD DE LOS TRABAJOS QUE SE REALIZAN.

EN ESE MISMO AÑO ME INTEGRO ALA BRIGADA DE PREVENCIÓN DE INSENDIOS FORESTALES LOS TRABAJOS QUE REALIZA LA BRIGADA ES ASER RECORIDOS LAS BRECHAS COLINDANTE DE EJIDOS VECINOS PARA PREVENIR LOS INSENDIOS EN LA AREA DE CONSERVACION TAMBIEN VERIFICAMOS LAS GURDARALLAS EN LAS AREAS AGRICOLAS PARA TENER QUEMAS CONTROLADAS EN LA COMUNIDAD .ESTE ES EL TRABAJO MAS FUERTE QUE ASE LA BRIGADA.

Nombre: Uriel Jiménez García

Papel en el equipo de téc.: Administrador

Encargado de levantar y de llevar el control en hojas de cálculo la comprobación de facturas adecuadamente, con forme al monto económico que recibe cada ejidatario, se factura un 60%, también encargado de plasmar las actividades realizadas durante el año, e incluirlas al reporte, el cual se entrega anualmente, para darle seguimiento al proyecto, además de eso ayudar a realizar las listas de raya que también se entrega anualmente.

El impacto de información en asamblea, es en el que los ejidatarios ven el avance de cómo va realizándose las actividades, en ocasiones es de ver si están cumpliendo todos conforme los acuerdos realizados en asamblea, tanto técnicos como los mismos ejidatarios.

En la toma de decisiones afectaría de manera en como los ejidatarios ven el avance de información para el seguimiento del proyecto, en la información que pasa el coordinador de técnicos en cada asamblea, para su validación es necesario que los ejidatarios vean la forma de información que se plasma en el informe y que ellos den sus puntos de vista e inquietudes ya que ellos son los portadores de información de cómo van trabajando en campo, en la siembra y el cuidado de sus plantas, y la realización de actividades como son el mantenimiento de sus brechas para la protección del área de conservación, si están debidamente realizadas y toma de nuevos a cuerdos conforme indique las observaciones que nos hacen por parte de (CONAFORT) ya que ellos son quienes evalúan el informe.

Ejido la corona municipio de marques de comillas Chiapas.

25 de Marzo del 2009.

TEC.Damian Gordillo Garcia.

Lo que yo espero de este curso es tener las herramientas que me permitan dar a conocer lo que nosotros como ejidatarios tenemos en nuestra comunidad y como grupo de técnicos que estamos dando el acompañamiento a los proyectos comunitarios que se desarrollan en bien de los que estamos avitando en esta comunidad y que esta herramienta que estamos aprendiendo a manejar podremos comunicar a nuestros compañeros la información necesaria de valorar las capacidades. y somos capaces de aprender cosas nuevas y tener las herramientas para poder también compartir con las otras comunidades la necesidad de implementar y poder enseñar las bondades de este programa y que nos permitan darnos a conocer y poder manejar nuestros recursos con mayor eficiencia en el desarrollo de nuestra comunidad.

Quiero también ser sincero por que yo el lo personal no habia manejado este programa en la computadora pero estoy seguro que si dedicamos tiempo seremos capaces de generar nuestra información clara y oportuna para todos los que lo quieran conocer con información relevante y clara y entendible para todos.

Y gracias por dedicar de su tiempo y conocimiento.

Damian gordillo garcia

RES. DE PROYECTO

ESCRIBE.ROSENBERG

MI COMENTARIO DE LA CAPCITACION PARA UTILISA ESTA ERRAMIENTA ME ES MUY UTIL PARA ASER LOS TRABAJO MAS LUEGOS Y PARA TENER LAS INFORMACIONE CUONDO SE NECESITEN PORQUE HEMOS HECHO TRABAJOS Y TODA LA INFORMACION SE ESTRAVIAN PERO TENIENDO ESTAS ERRAMIENTA NOS SERA DE MUCHO BENEFICIO AUNQUE EN MI CASO NUNCA AVIA UTILISADO ESTAS APARATOS QUE PARA MI ES NUEVO Y QUE EN UN MES DE CAPACITACION E APRENDIDO MUCHO Y NUESTRO ACESOR NOS APOYO Y TUVO PACENCIA

LO QUE PIENSO ES QUE ABRA MAS INFORMACION PARA LA COMUNIDA EN LAS BRECHAS CORTA CORTAFUEGO SE ARAN MAS FASIL LAS INFORMACION DE LOS CERCOS VIVOS SE PRODRAN ASER MAS FASIL LOS MAPAS DE PARCELAS DE LA CONIDA O ARIAS TRABAJOS Y ASER MEDIDAS EN MENOS TIEMPO

La corona marques de comillas Chiapas

Fecha 26 03 2009

Para mi todo lo que hemos estado haciendo durante este mes ha sido muy bien porque hemos aprendido a usar un poco la computadora y a manejar un programa que es como a ser un mapa del ejido la corona como medir las brechas cortafuego como trazar las parcelas y como meterle información a cada parcela de ejidatarios y para mí el programa fue muy bien porque aprendí muchas cosas que tal vez nunca había aprendido a usar un programa como a ser mapas de la comunidad para estar más informado sobre las áreas de la restricción cuantitativa en total y ver con la imagen de satélite los usos del suelo y tener bien de taya da meter tener información de la comunidad para cuando venga al guien de alguna institución requiere tener información de comunidad es más fácil tener la información en un mapa de la corona

Si se trabaja organizado como equipo durante los siete meses el programa piloto será un éxito pero cada quien le ponga interés al programa piloto gracias

Saul Argueta Velasco

EJIDO LA CORONA MUNICIPIO DE MARQUES DE COMILLAS CHIAPAS

JOSE ANTONIO GOMEZ GOMEZ

PARA MI FUE MUY IMPORTANTE APRENDER ESTE CURSO EN PARTICIPACION PUBLICA Y SISTEMAS DE INFORMACION GEOGRAFICA PARA LA COMUNIDA ES IMPORTANTE SABER LOS CUATRO TIPOS DE USO DE SUELO QUE TIENE.AREA FORESTAL,AREA AGRICOLA,AREA GANADERA,Y LA ZONA URBANA.LO QUE EMOS APRENDIDO EN ESTE CURSO YA TENEMOS UNA INISIATIVA PARA PONERLO EN PRACTICA EN LA COMUNIDAD EL EQUIPO TECNICO QUE TRABAJAMOS EN DIFERENTES AREA EN EL PROYECTO DE CAPTURA DE CARBONO.

EL EQUIPO TECNICO TIENE QUE TRABAJAR ORGANISADO PARA PONERLO EN MARCHA EL PROGRA PILOTO DURANTE LOS PROXIMOS SIETE MESES PARA MOSTRA NUESTRO INTERES EN EL CURSO QUE NOS A DADO MANOLO PARA NO PERDER LA VICION QUE CON GRAN ESFUERSO NOS A ENSEÑADO TENEMOS QUE EGERSER UNA GRAN RESPONSABILIDAD Y ESFUERZO PARA EL PROGRAMA PILOTO.

Ejido la corona municipio de marqués de comillas Chiapas

Nombre: Uriel Jiménez García

fecha: 25 de marzo de 2009

Pos a mí me pareció muy bien el curso en participación pública y sistemas de información geográfica, porque con base al programa podemos identificar de cómo está ubicada cada parte de la comunidad, por ejemplo: los tipos de uso de suelo con los que cuenta y en donde está ubicado cada uno de esos usos, el cual nos serviría para poder ubicar con mayor precisión dicho uso, que esto sería de mucha importancia para poder incluir al reporte del proyecto CABSAs, y que ellos puedan ver las áreas por la cual funciona dicho proyecto y que avances tienen los ejidatarios por ejemplo: la limpieza de brechas cortafuego, siembra de cercos vivos etc.

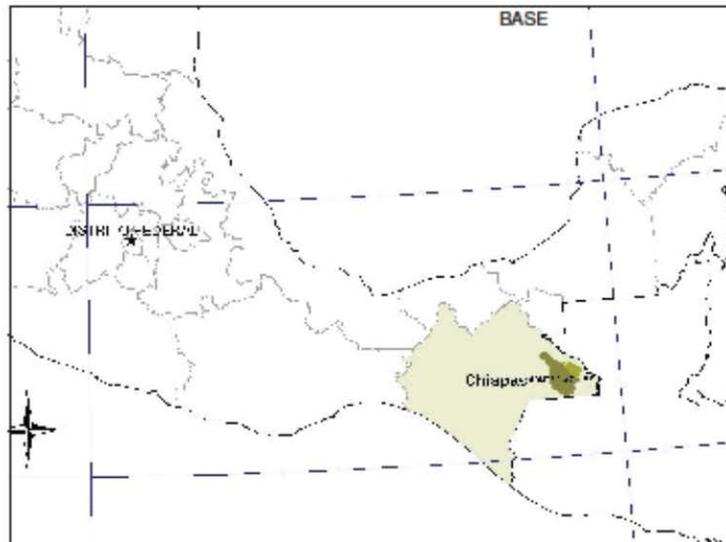
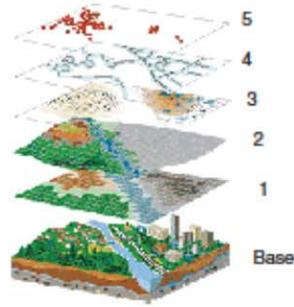
Pos la verdad es de qué quizá no hemos dominado a un 100% pero si una iniciativa de cómo poner en práctica y así poder llevar a cabo el programa piloto en el cual estaría registrado totalmente la estructura del ejido y las áreas con las que cuenta, y lo más importante es trabajar en equipo y ayudarnos a ambos con algo que no le aigamos captado bien y lo importante es llevar paso a paso cada capa de información que se agregue y la verdad agradezco por la paciencia y por brindarnos su conocimiento de dicho curso.

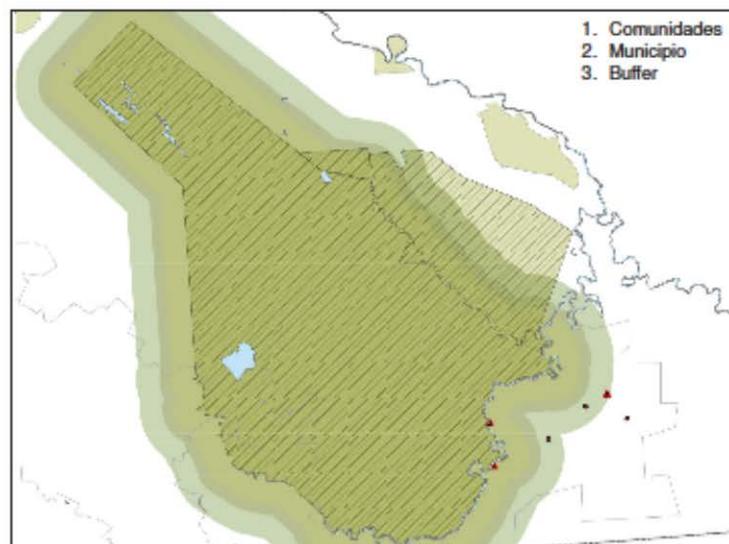
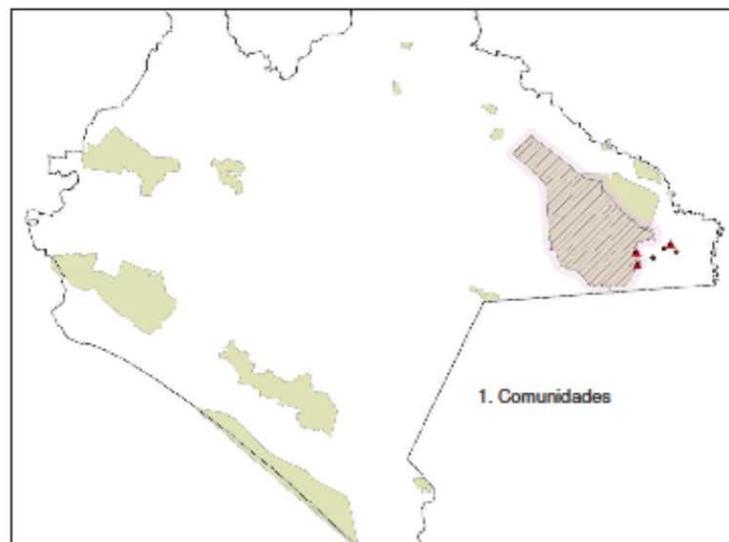
La verdad es de que quizá yo no esté después de que se lleve a cabo el plan piloto pero considero de que los demás integrantes del curso tendrán la capacidad de poder transmitir sus conocimientos a las comunidades vecinas y quizá también obtener ganancias y mayor práctica en uso del programa ArcMap.

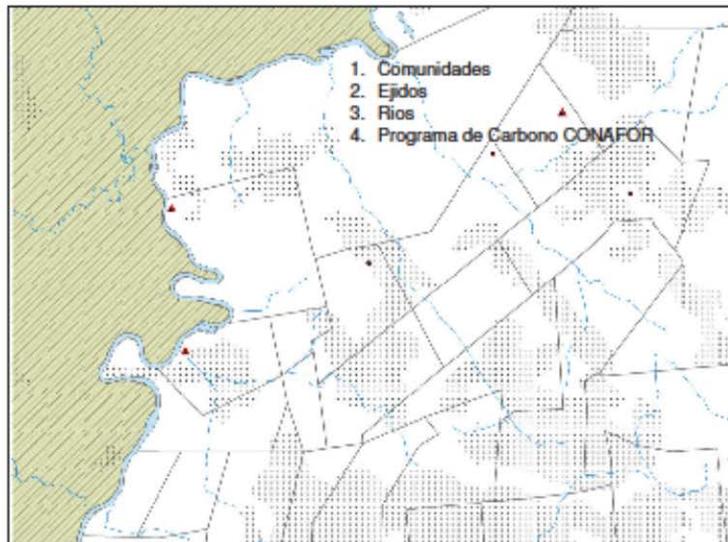
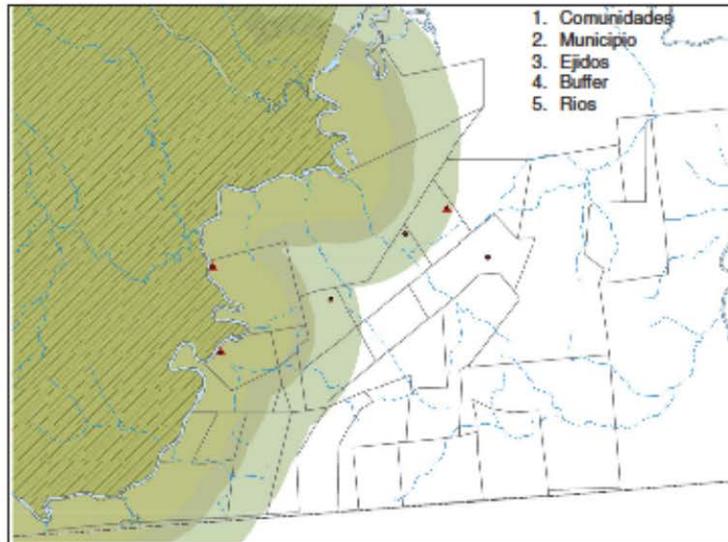
Lo importante es de que tendremos una detallada información del ejido y tener mejor presentación en el proyecto CABSAs y herramientas bases para poder quizá dar seguimiento a un nuevo proyecto, ya que es muy importante la conservación de la selva.

Annex 3. Series of slides used to explain the GIS concept during the implementation stage in Reforma Agraria during April 2009.

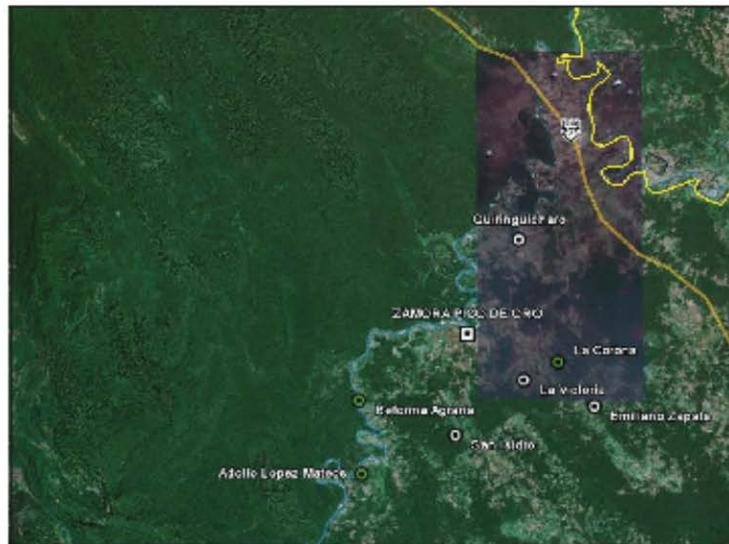
Capas de información para la planeación territorial
en el ejido La Corona

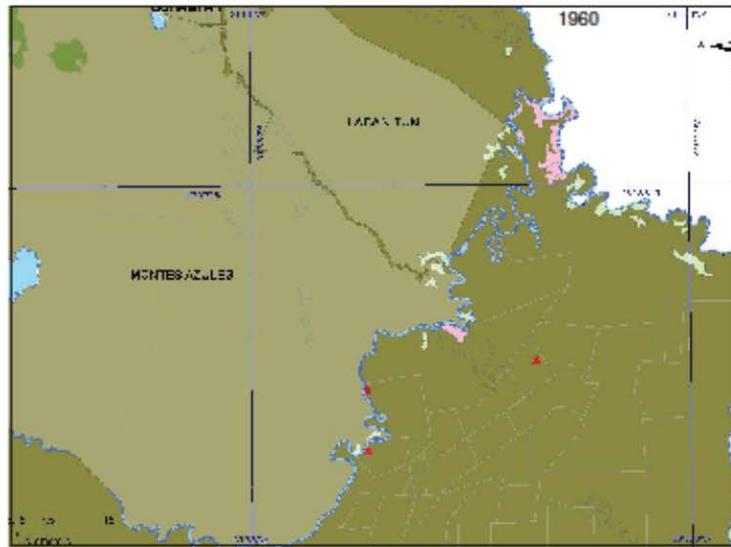
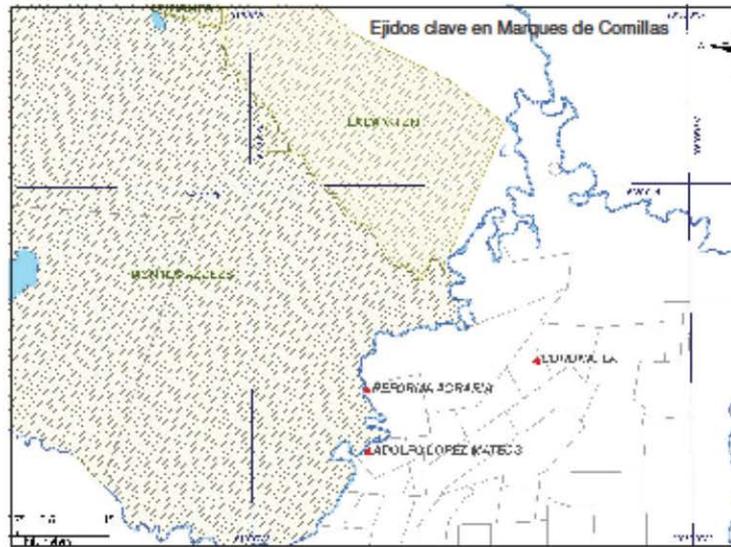


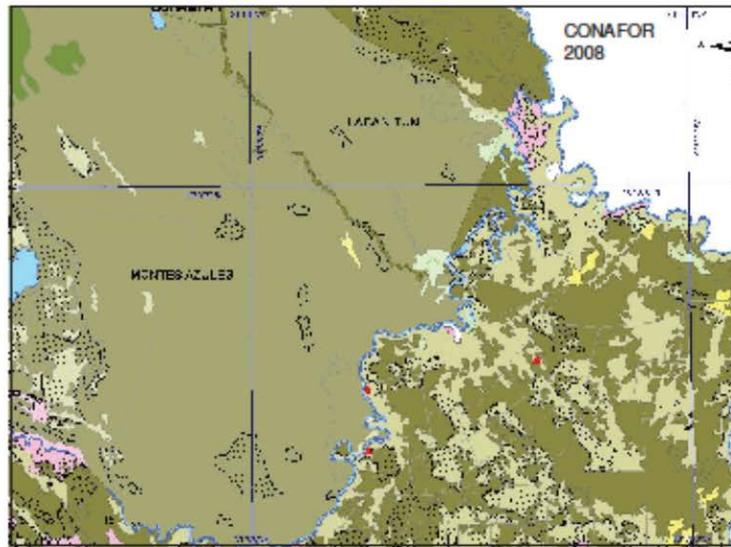
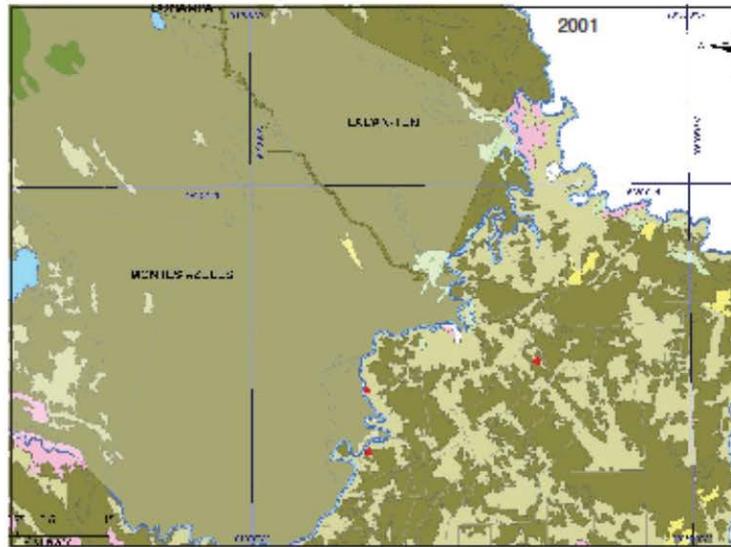


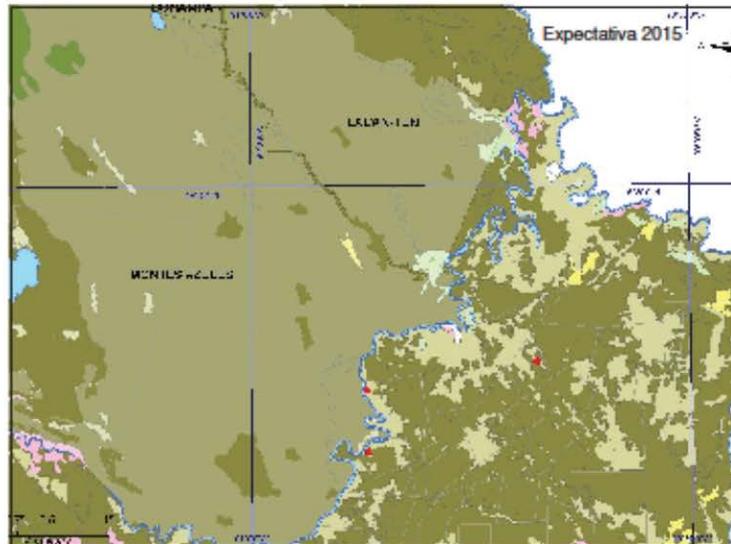


Visualización del uso del
suelo y su cambio en el
tiempo mediante
Sistemas de Información
Geográfica







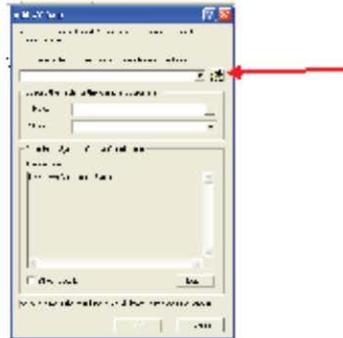


Así comienza todo...

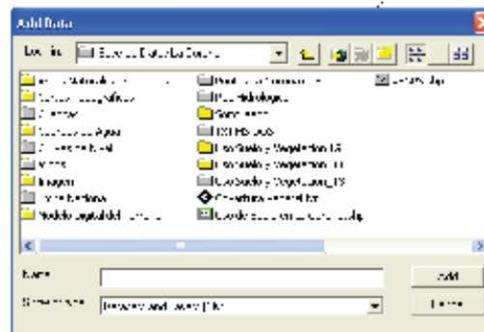


Annex 4. Example of the hand out employed to facilitate the replication of the procedure to upload GPS points into the GIS environment.

- 7) A continuación aparecerá el siguiente menú, en donde deberás indicar la ubicación del archivo de TEXTO (MS-DOS) que contiene las coordenadas que deseas mapear. Los archivos se ubican en **C:\Base de Datos La Corona\Puntos La Corona GPS**.



- 8) Una vez que hayas indicado la ubicación del archivo, será necesario que indiques el sistema de coordenadas de tu GPS. Para ello deberás dar clic en el botón 'Edit...' y después el botón 'Select...' para seleccionar el sistema de coordenadas geográficas 'Geographic Coordinate Systems' con el cual trabaja el GPS. En el caso del ejercicio, el sistema de trabajo se encuentra en la carpeta llamada 'World' y se llama 'WGS 1984.prj'.
- 9) Para corroborar que los puntos muestreados con el GPS se encuentren en la zona esperada, podrás agregar la Imagen de Satélite. Para ello deberás dar clic en el botón 'Add data'  y navegar hasta la carpeta que contiene la imagen (recuerda que deberás subir  a **C:\Base de Datos La Corona** para buscar la carpeta deseada.

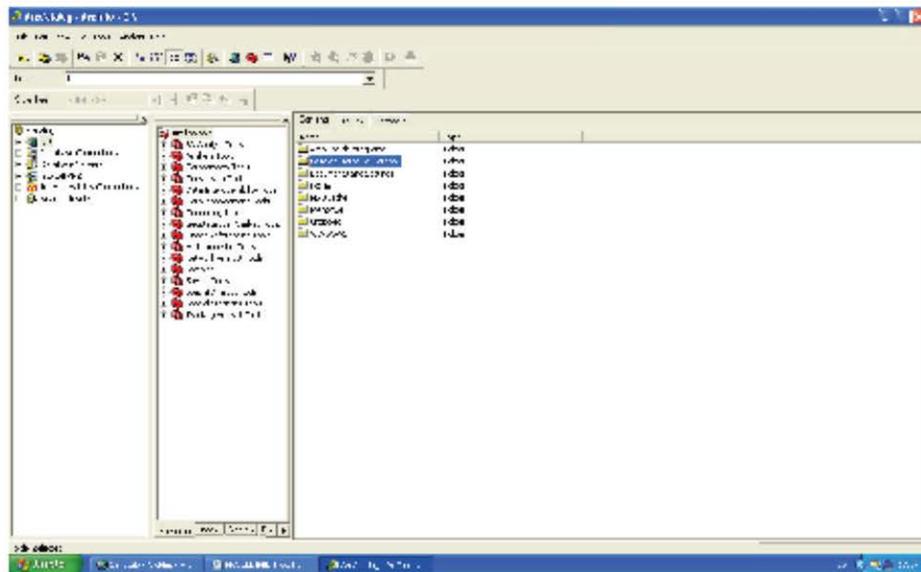


- 10) El último paso consiste en guardar los puntos GPS como una capa de información 'Layer'. Para ello deberás dar clic con el botón derecho del ratón sobre la capa que contiene los puntos GPS y seleccionar la opción 'Save As Layer File...'. A continuación escribe el nombre y ubicación deseada para guardar tu capa. Las capas con puntos GPS se archivarán en la carpeta llamada 'Puntos La Corona GPS'.

Procedimiento para crear capas de información con los puntos de referencia GPS

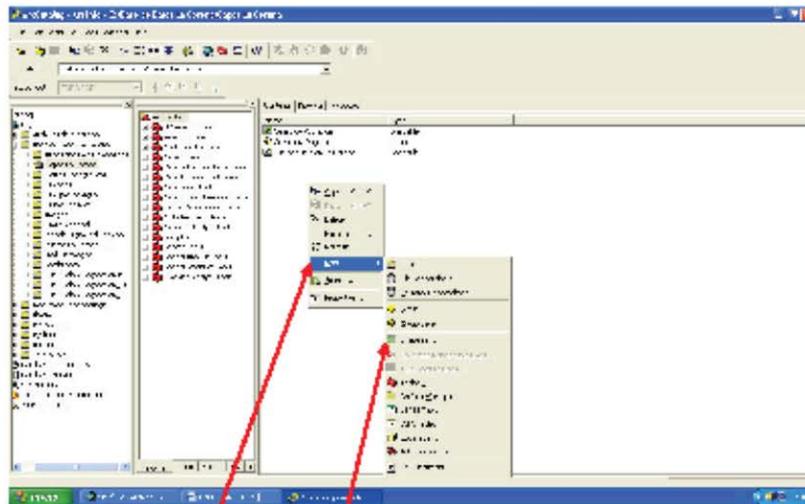
Los puntos de referencia GPS ofrecen la posibilidad de generar capas de trabajo con información espacial precisa y detallada. El siguiente procedimiento describe los pasos a seguir para crear capas de información con PUNTOS, LÍNEAS o POLÍGONOS usando los puntos de referencia muestreados con el receptor GPS.

- 1) El primer paso consiste en abrir *ArcCatalog*. Éste programa nos permite crear y modificar los archivos contenidos en la Base de Datos La Corona, que se encuentra en: C:\Base de Datos La Corona.



- 2) Una vez abierto *ArcCatalog*, es necesario ubicar la carpeta con el nombre 'Base de Datos La Corona'. Ingresando dando doble clic. Dentro de la carpeta encontrarás otra carpeta con el nombre 'Capas La Corona', ingresa a esa carpeta nuevamente.

- 3) Dentro de la carpeta 'Capas La Corona' crearemos una nueva capa de información. Para ello deberás dar un clic con el botón derecho del ratón sobre el área en blanco y aparecerá el siguiente menú de opciones:



- 4) Selecciona 'New' y luego 'Shapefile'
- 5) A continuación aparecerá la siguiente ventana:



- 6) En ella deberás asignar el **NOMBRE DE LA CAPA** que desear crear, el **TIPO DE ELEMENTO A GENERAR** (PUNTO, LÍNEA o POLÍGONO) y el **SISTEMA DE COORDENADAS GEOGRÁFICAS**.

Para asignar el sistema de coordenadas, es necesario dar clic en el botón 'Edit...' y después en 'Import...' para importar el sistema de coordenadas de la carpeta 'Imagen' donde se encuentra el archivo 'marques2005coratmdos.img'.

Como parte del ejercicio generarás 3 nuevas capas con la siguiente información:

Capa No.	NOMBRE (Name)	ELEMENTO (Feature Type)	COORDENADAS Importar desde carpeta:
1	PARCELA_RESTAURACION2	POLYGON (polígono)	IMAGEN
2	PARCELA_TRABAJO2	POLYGON (polígono)	IMAGEN
3	BRECHA_CORTAFUEGO2	POLYLINE (línea)	IMAGEN

- 7) Para finalizar con la creación de la nueva capa de información da clic en **ACEPTAR** y después en **OK**.
- 8) A continuación minimiza *ArcCatalog* y abre el programa *ArcMap*. Selecciona la opción inicial 'A new empty map' que significa crear un mapa nuevo y presiona **OK**.
- 9) Selecciona la herramienta 'Add data'  que significa agregar datos. Agrega la capa 'Limite_Nacional_Project' y la imagen de satélite 'marques2005coratmdos.img'.

- 10) Agrega la capa con los puntos GPS que se encuentra en C:\Base de Datos La Corona\Puntos La Corona GPS.

El nombre de la capa es: **BRECHA_CORTAFUEGO_GPS.lyr** 

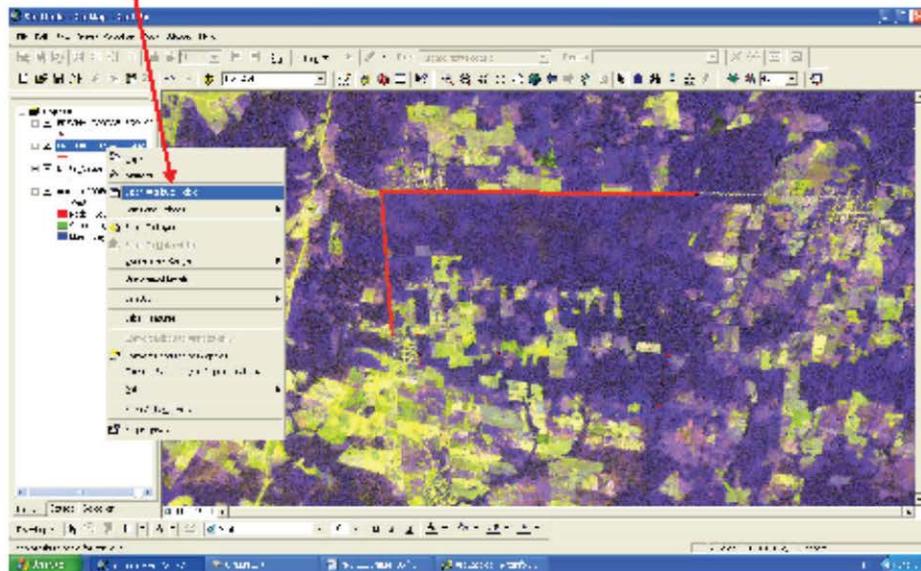
RECUERDA QUE DEBES **CAMBIAR EL NOMBRE DE LA CAPA** PARA LOS CASOS DE LA PARCELA DE TRABAJO Y DE LA PARCELA DE RESTAURACIÓN

- 11) También agrega la capa que se encuentra en C:\Base de Datos La Corona\Capas La Corona. El nombre de la capa es: **BRECHA_CORTAFUEGO2.shp** 

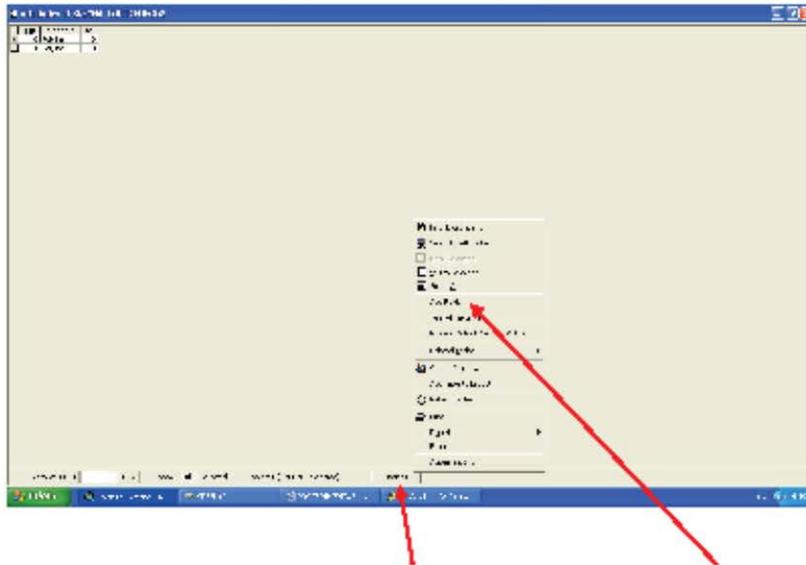
RECUERDA QUE DEBES **CAMBIAR EL NOMBRE DE LA CAPA** PARA LOS CASOS DE LA PARCELA DE TRABAJO Y DE LA PARCELA DE RESTAURACIÓN

- 14) Para comenzar a editar los objetos deberás seleccionar la herramienta representada con un lápiz . Para trazar los objetos utilizarás como referencia la capa con los puntos GPS (modifica el color y tamaño de los puntos GPS para hacer un trazo preciso).
- 15) El proceso consiste en trazar una línea entre los puntos que simbolizan los límites de los objetos requeridos. Para trazar la línea debes poner el cursor sobre el primer punto deseado y dar clic. A continuación pondrás el cursor sobre el segundo punto, darás clic nuevamente (si es necesario, repite para el 3er y 4to) y para finalizar el trazo presiona la tecla F2.
Asigna una línea de grosor y color conveniente para que puedas apreciar el trazo de los objetos (puntos, líneas o polígonos) con suficiente detalle.
- Repite la operación anterior hasta que completes el trazo de todos los objetos
- 16) Al terminar de marcar los objetos (puntos, líneas o polígonos) de la capa, da clic sobre el botón 'Editor' y selecciona la opción 'Stop Editing' que significa terminar de editar. Finalmente da clic en SI para guardar la edición de los objetos.
- 17) Se recomienda remover  la capa con los datos GPS para evitar confusiones en la edición de la información.
- 18) El siguiente paso consiste en abrir la tabla de atributos de la capa que contiene los objetos marcados. Para ello deberás presionar el botón derecho del ratón sobre el nombre de la capa (BRECHA_CORTAFUEGO2) y seleccionar la opción 'Open Attribute Table'

CAMBIA EL NOMBRE DE LA CAPA PARA LOS OTROS DOS CASOS



19) Una vez hecho esto, aparecerá la siguiente tabla de atributos:



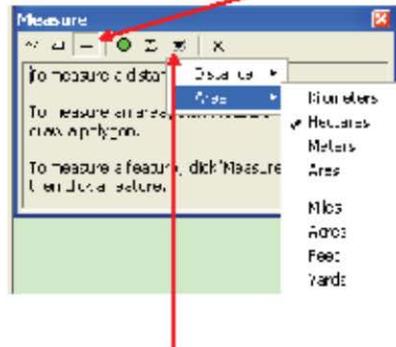
A continuación darás un clic sobre el botón *'Options'* y seleccionarás el menú *'Add Field'* para comenzar a ingresar los campos de información que te interese agregar en la capa. En la ventana escribe el nombre del campo que deseas ingresar y selecciona el tipo de dato que requieres.

Ejemplo para la capa: **BRECHA_CORTAFUEGO2**

NAME (nombre)	Type (tipo de dato)
BRECHA No.	<i>Short Integer</i>
EXTENSION	<i>Text</i>
MANTENIMIENTO PASADO	<i>Date</i>
PROXIMO MANTENIMIENTO	<i>Date</i>
RESPONSABLE MANTENIMIENTO	<i>Text</i>

20) Una vez completados los campos, deberás editar la capa para ingresar la información en los campos recién creados. Para ello debes activar la opción *'Editor'*. Una vez seleccionado el botón *'Editor'*, dar clic en *'Start editing'* que significa comenzar a editar. En la ventana que aparecerá, deberás seleccionar la capa ubicada en: C:\Base de Datos La Corona\Capas La Corona y seleccionar el nombre de la capa **BRECHA_CORTAFUEGO2** 
CAMBIA EL NOMBRE DE LA CAPA PARA LOS OTROS DOS CASOS

- 23) Utiliza la herramienta medir  para comenzar a ingresar los datos del campo EXTENSIÓN en la tabla. Recuerda que al seleccionar la herramienta marcada como + medirás los objetos sin necesidad de trazar una línea de medición.



Es importante seleccionar las UNIDADES DE MEDICIÓN que se ajusten mejor a tus necesidades. Para el caso de áreas utiliza HECTÁREAS y para el caso de distancias utiliza METROS

- 24) Al terminar de escribir la información, da clic sobre el botón '*Editor*' y selecciona la opción '*Stop Editing*' que significa terminar de editar. Finalmente da clic en SI para guardar la edición de los objetos (puntos, líneas o polígonos).
- 25) A continuación repite el procedimiento desde el punto 10 para las otras dos capas de información (PARCELA_TRABAJO2 y PARCELA_RESTAURACION2).

Es muy importante que recuerdes que las instrucciones hacen referencia a la capa: BRECHA_CORTAFUEGO2.

Para las capas PARCELA_TRABAJO2 y PARCELA_RESTAURACION2 deberás **abrir, agregar y editar las capas con el nombre apropiado.**

**Annex 5 Document proposing the establishment of an officially recognised
voluntary natural reserve in Reforma Agraria.**

**Dr. Ernesto Enkerlin Hoeflich,
Comisionado Nacional de Áreas Naturales Protegidas.
Camino al Ajusco 200
Col Jardines en la Montaña CP. 14210
Tlalpan, D.F.**

Por este medio, los abajo firmantes solicitamos a usted atentamente la certificación de nuestros terrenos, con base en lo dispuesto por los artículos 46 Fracción XI, 55 Bis, 59, 74 y 77 Bis de la Ley General del Equilibrio Ecológico y la Protección al Ambiente. Siendo sus características las siguientes.

1.- Nombre del área certificar:

Reserva las Guacamayas

2.-Ubicación:

Estado: **Chiapas**

Municipio: **Marqués de Comillas.**

Localidad: **Ejido Reforma Agraria.**

Acceso (Caminos): **De la ciudad de Comitán, Chis., se toma la carretera que va hacia Lagunas de Montebello, posteriormente se dirige hacia el Este por la carretera 190 pasando por el municipio Maravilla Tenejapa, se continúa por la misma carretera, pasa la boca Chajul con rumbo a Zamora Pico de Oro donde antes se vera la desviación al centro ecoturístico Las Guacamayas del ejido Reforma Agraria.**

3.- Superficie a certificar en Hectáreas: **1,454-13- 42.112 has**

4.- Propietario **Ejido Reforma Agraria**

Nombre: **Ejido reforma Agraria**

Dirección: casa ejidal, **domicilio conocido**

Teléfono, Fax, Correo Electrónico: **guacamayaescarlata@hotmail.com**

Número de personas que amparan el área

Hombres: **59**

Mujeres: **52**

Total: **111**

En caso de grupos indígenas especificar la etnia: **Chinanteca**

5.- Plazo de certificación: **99 años**

6.- Indicar quien será el administrador del predio o del área a certificar.

El comité destinado a la administración del se conforma de la siguiente manera: C. Luis Hernández Dávila, C. Víctor Hernández Lara Y C. Germán Hernández Dávila, como Presidente, Secretario y Tesorero respectivamente.

Cuadro de construcción del polígono "*Reserva las Guacamayas*"

Punto	X	Y
1	734165.481	1800840.534
2	734656.908	1796727.107
3	732381.782	1796317.585
4	732336.280	1796608.801
5	731853.953	1796545.097
6	731744.747	1796945.520
7	731389.827	1796909.118
8	731426.229	1797309.540
9	731089.511	1797236.736
10	730880.199	1797755.464
11	730707.290	1798073.982
12	730598.084	1798383.399
13	729970.149	1798119.484
14	729669.833	1798774.720
15	729924.647	1798874.826
16	730124.858	1799084.138
17	729933.747	1800085.193
18	731908.556	1800458.313

9.-Descripción de las características físicas y biológicas generales del área

a.- Descripción del predio

El ejido Reforma Agraria tiene en posesión una superficie de 2,463- 59- 17.22 has., su resolución presidencial es de fecha 18 de diciembre de 1963, pertenece al municipio de Marqués de Comillas, Estado de Chiapas. Posee vegetación de Selva alta y mediana perennifolia, y vegetación de acahual. Se distribuyen de la siguiente manera el territorio: 172 has. de agricultura, 768 has. de ganadería, 40 has. de zona urbana, 20 has. de zona escolar y 1,463 has. de reserva ejidal permanente.

Topografía

El predio forma parte de la región fisiográfica Montañas de Oriente. La mayor parte de la superficie se conforma de lomerío con llanuras; el 1.76% de cuerpos de agua y el 0.04% de sierra alta volcánica. La altura del relieve va de los 110 m y hasta los 200 m sobre el nivel del mar.

Clima

Am(f) cálido húmedo con lluvias en verano,

En los meses de mayo a octubre, la temperatura mínima promedio va de los 21 °C a los 22.5°C, mientras que la máxima promedio oscila entre 33°C y 34.5°C.

En el periodo de noviembre a abril, la temperatura mínima promedio va de 18°C a 19.5°C, y la máxima promedio fluctúa entre 27°C y 30°C. En los meses de mayo a octubre, la precipitación media fluctúa entre los 1400 mm y los 2300 mm, y en el periodo de noviembre a abril, la precipitación media va de los 350 mm a 600 mm.

Edafología

El suelo que predomina en el ejido es de tipo : Acrisol (CA) ; es un tipo de suelo clasificado por FAO para su taxonomía de suelos de la (World Reference Base for Soil Resources), que tienen un horizonte argílico "B" que tiene una capacidad de intercambio catiónico de menos de 24 cmol (+) /kg y de una saturación baja (por el 1M NH₄OAc en pH 7) de menos de 50 % en por lo menos una cierta parte del horizonte B, a 125 cm de la superficie; careciendo de horizonte E, y cubriendo un horizonte lentamente permeable, el patrón de la distribución de la arcilla y es diagnóstico para Planosoles, Nitisoles y Podzoluvisoles.

El término Acrisol deriva del vocablo latino "acris" que significa muy ácido, haciendo alusión a su carácter ácido y su baja saturación en bases, provocada por su fuerte alteración. Los Acrisoles se desarrollan principalmente sobre productos de alteración de rocas ácidas, con elevados niveles de arcillas muy alteradas, las cuales pueden sufrir posteriores degradaciones. Predominan en viejas superficies con una topografía ondulada o colinada, con un clima tropical húmedo.

Hidrología

Las principales corrientes son los ríos perennes Caoba, Cruz, Delicias, y Arroyo Bravo. La mayor parte del territorio se encuentra dentro de la subcuenca Chixoy (de la cuenca Chixoy) y en menor proporción en la subcuenca Lacantún (de la cuenca Lacantún).

b.- especies relevantes a proteger de flora y fauna, ecosistemas relevantes o servicios ambientales.

Flora

Caoba (*Swetenia macrophylla*), chicozapote (*Manilkara zapota*), guapaque (*Dialium guianense*), ceiba (*Ceiba pentandra*), hule (*Castilla elástica*), ceibo (*Berooullia flamea*), ramón (*Brosium alicastrum*), chacá (*Bursera simaruba*), cedro (*Cedrela odorata*), Amargoso (*Vatairea lundelli*), guayacan (*Tabebuia guayacan*).

Fauna

Enseguida se mostraran los listados de diferentes grupos de fauna del lugar.

Listado faunístico de aves

Guacamaya roja (*Ara macao*), loro cabeza amarilla (*Amazona autumnalis*), loro corona blanca (*Pionus senilis*), loro cabeza oscura (*Pianopsitta haematotis*), loro corona azul (*Amazonia farinosa*), tucan pico amarillo (*Ramphastos sulfuratus*), martin pescador (*Ceryle torquata*), pava cojolita (*Penélope purpurascens*), halcón huaco (*Herpetotheres cachinnans*), aguililla gris (*Buteo nitidus*), águila caminera (*Buteo magnirostris*), garza azul (*Egretta caerulea*), hocofaisan (*Crax rubra*),

Listado faunístico de mamíferos

Mono sarahuato (*Allouata pigra*), mono araña (*Ateles geoffroyi*), tigrillo (*Leopardus pardalis*), jaguar (*Panthera onca*), puma (*Puma concolor*), tapir (*Tapirus bairdii*), jabalí de collar (*Pecari tajacu*), martucha (*Potos flavus*), tepezcuitle (*Agouti paca*), armadillo (*Dasypus novemcinctus*), tejón (*Nasua narica*), venado temazate (*Mazama americana*) y cola blanca (*Odocoileus virginianus*; *tepezcuitle* (*Agouti paca*)).

Listado faunístico de reptiles

Iguana verde (*Iguana iguana*); cocodrilo de río (*Crocodylus acutus*); tortuga lagarto (*Chelydra serpentina*), boa mazacuata (*Boa constrictor*), nauyaca real (*Bothrops asper*), salamandra (*Bolitoglossa mulleri*); tortuga blanca (*dermatemydidae mawii*)

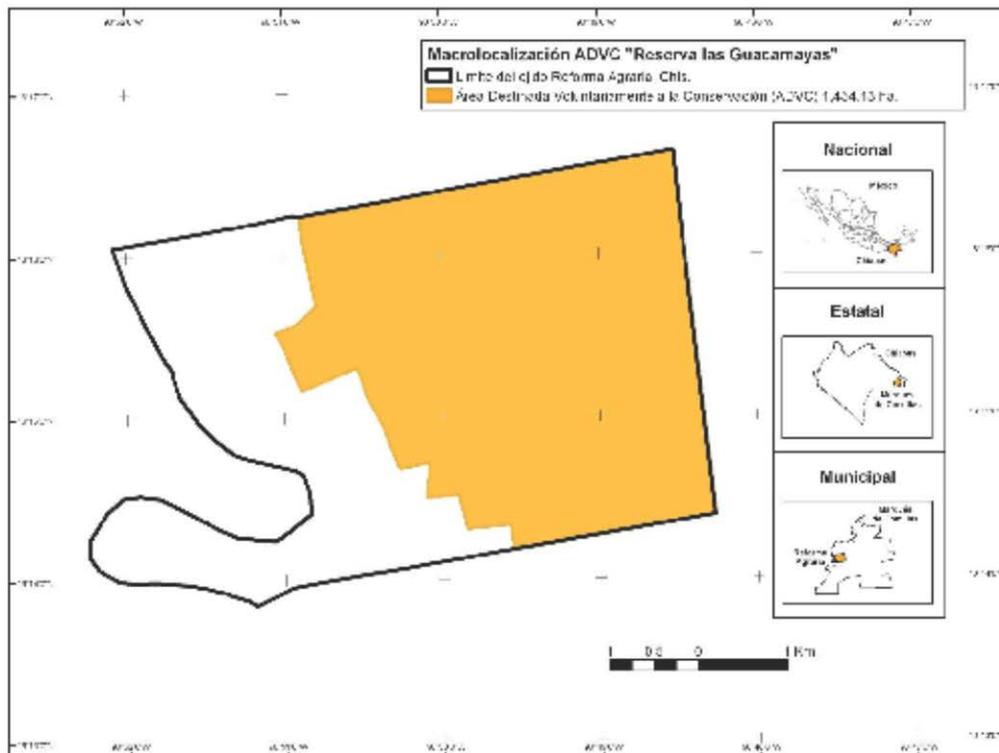
Listado faunístico de anfibios

Anfibios rana de ojos rojos (*Agalychnis callidryas*), sapo (*Bufo marinus*), rana arborícola (*Smilisca baudini*)

c.- Valores culturales, arqueológicos, etnológicos, históricos.

El ejido es de reciente creación, se formó a partir de una migración de una comunidad indígena chinanteca de Oaxaca hacia la zona, en la década de los 70's, quienes desde la fundación del ejido se han distinguido por la planeación de sus actividades en la búsqueda de opciones para mejorar su economía, sin dañar el ambiente. En 1989 empiezan con algunos programas de educación ambiental, apoyados por el instituto nacional indigenista en 1991 se comienza con el proyecto de conservación de la guacamaya roja. En 1996 se forma la sociedad cooperativa Ara Macao, recibiendo apoyos de sector para infraestructura turística. Posteriormente se ha seguido consolidando como centro ecoturístico Las Guacamayas.

d.- Plano de ubicación



e.- Fotografías

10.- El uso actual que se le da al predio es.

Se tiene un área de ecoturismo, donde se tiene funcionando una UMA de guacamaya roja, y se tiene el área de reserva comunitaria, la cual está destinada prácticamente a la conservación y solo se contempla, una pequeña zona para futuros senderos de interpretación ambiental.

11.-Estrategia de manejo que incluya la zonificación del área.

El régimen de manejo y zonificación que tendrá el ADVC del ejido Reforma Agraria es el siguiente, la zonificación incluye dos subzonas: ecoturismo y conservación.

ESTRATEGIA DE MANEJO DEL ADVC "RESERVA LAS GUACAMAYAS" DEL EJIDO REFORMA AGRARIA, MPO. MARQUÉS DE COMILLAS, EDO. CHIAPAS.					
ZONA	Política	Criterios	Lineamientos	Actividades Prohibidas	Observaciones
-Ecoturismo	-Turismo	-Turismo amigable con el medio ambiente	-La aplicación de las reglas de estancia por los visitantes. -Realizar recorridos con un guía de la comunidad. -Observación de flora y fauna. -Tomar fotos y video. -Señalamientos hacia turistas. -Acondicionamiento de senderos.	-Entrar a caballo. -Construir cabañas. -Hacer ruido excesivo, música o jugar.	Se trata de un proyecto ecoturístico sustentable que ya esta funcionando desde 1991 fuera del área de conservación, por lo que esta zona sería completaría y de menor uso.
-Conservación	-Conservación	-Protección del ecosistema	-Investigación científica con el permiso de las autoridades ejidales y la CONANP. -Servicios ambientales. -Fomentar las actividades de conservación de fauna.	-Cualquier otra actividad que dañe los recursos naturales de la zona.	-Esta área se destina por completo a conservación, pero no esta exenta del manejo de su ecosistema.
-General a toda el área	-Operación	-Administración	-Vigilancia del área y del cumplimiento de las reglas de funcionamiento de la reserva. -Hacer y controlar el saneamiento y utilización de madera muerta por la comunidad, -Hacer señalización de las áreas. -Manejo del fuego.	-Desobedecer las reglas de funcionamiento de la reserva. -Cacería. -Extracción de flora y/o fauna. -Fogatas. – Ganadería y agricultura. -Entrada de personas ajenas sin el permiso de la autoridad ejidal. -Tirar basura. -Contaminar cuerpos de agua.	Acuerdos con los ejidos colindantes. Se cuenta con brechas corta fuego y brigadas contra incendios. Se buscaran apoyos y financiamientos para las actividades



De antemano agradecemos sus finas atenciones, para con nuestra solicitud.

Atentamente

COMISARIADO EJIDAL

C. VICTOR HERNANDEZ LARA
PRESIDENTE

C. RODRIGO RAMIREZ CASTRO
SECRETARIO

C. JOSE GUIDO AVENDAÑO RODRIGUEZ
TESORERO

CONSEJO DE VIGILANCIA

C. EMILIO HERNANDEZ
PRESIDENTE

C. GABRIEL HERNANDEZ BAUTISTA
PRIMER SECRETARIO

C. ANTONIO AVENDAÑO RODRIGUEZ
SEGUNDO SECRETARIO

