Forest Conservation Policies and the Neoliberal Land Reform in Mexico: A Cultural Ecology Approach to the Payments for Environmental Services in the Huasteca Potosina Region

By

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Abstract

This research analyzes the relationship between the environmental and social elements in Mexico's Payment for Environmental Services (PES) program in the Huasteca Potosina region from 2003-2011. Both the regional and local scales are examined to understand patterns of deforestation and identify the factors influencing community forest conservation.

The multi-scale approach to deforestation on social properties is based on GIS analyses of land tenure and forest change in 613 agrarian *nucleos*, or social properties, from 1980 to 2010. At the community scale, a sample of 43 agrarian *nucleos* in 12 *municipios* was selected to explore the potential correspondence between implementation of the PES program, the National Forest Comission (CONAFOR) prioritization scheme, deforested areas and extreme poverty. To assess the PES' impact on raising social awareness about the environment and decreasing deforestation and to analyze the potential linkages between poverty, land tenure systems, and forest management a combined methodology including GIS analysis, participant observation, questionnaires and interviews with participants and stakeholders involved in the program at different levels were used.

The research shows that poverty and the lack of certified property rights have not been the major triggers of deforestation as forest conservation policy-makers in the country have claimed. The analysis of forest coverage from 1980 to 2010 points to different factors leading to changes in deforestation rates. Although it is true that forest conversion into agricultural lands has been the leading cause of deforestation, it has been strongly promoted by government programs, especially during the first decade of study for valley forests (as opposed to mountain forests). In comparison, the last two decades showed a significant decrease in the deforestation rates, mainly because few remnants of forest remained in the valleys.

The land reform of the 1990s altered deforestation rates differently according to which agrarian *nucleos* participated and how. From the 613 *nucleos* examined in the Huasteca Potosina region, the majority, 76 percent, certified their properties at the individual parcel level, 13 percent certified only the perimeter of their boundaries along with a few communal parcels like school plots, and the remainder either stayed uncertified or privatized some or all of their individual plots under *dominio pleno* (meaning full domain of the property). On the whole, forest coverage decreased by a little less than seven percent during the first decade of the certification process from 1990 to 2000; however, there were important variations depending on types of land

tenure chosen. The nucleos with *dominio pleno* lost 24 percent of their forest, and *nucleos* that certified individual parcels saw a six percent decrease. Contrary to predictions, the uncertified *nucleos* and those that certified only the perimeter of their territories lost virtually no forest (two percent). Over the last decade deforestation rates have decreased, and *nucleos* that certified their perimeters, those that certified all individual parcels, and those remaining uncertified even saw increases in forest coverage by three percent, one percent, and less than one percent, respectively. Those with *dominio pleno* continued to experience deforestation by two percent. Still, when taking into consideration how land availability, population, and traditions have influenced deforestation before, during, and after the certification process, the results show that the certification program has had little impact in increasing or decreasing forest coverage over the decades.

In regard to the Payments of Environmental Services (PES) program, intended to prevent deforestation on social properties, the economic impacts were low, as seen in the lack of land use diversification and forest under communal lands. A marked geographical variation can be seen, however, between the more successful northern *mestizo* area dominated by temperate forest, and the less successful southern indigenous areas dominated by shade-grown coffee in more tropical forests. Despite the different economic impacts, PES projects proved to be sustainable where community organization and land use traditions were stronger.

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Table of Contents

Table of Figures

I. Introduction

The Payments for Environmental Services Program (PES) is one of the most recent trends in forest conservation policies worldwide. The purpose of this dissertation is to analyze the program's impacts on decreasing deforestation and poverty in social properties (*ejidos* and agrarian communities) at a regional and local level in the Huasteca Potosina region of Mexico, from the inception of the program in 2003 until 2011. Most forested properties in Mexico are socially owned and managed, and in 1992 Mexico began a voluntary program of converting such properties to individual private properties. Thus, any analysis of the PES program must take into consideration the influential process of and changes in land titling. Has the change in property tenure affected the success of the PES program? Moreover, the PES program has the explicit goal of reducing extreme property. Has this actually happened, have the poor participated, and if they have, has the program worked to reduce their poverty? Ultimately, have all types of land tenure systems and people at all socioeconomic levels seen a slowing or even reversal of deforestation at equal rates, or have these rates been differential? To help answer these questions, GIS data was complemented by interviews and the application of questionnaries of a variety of landholders about the effectiveness of the program. Overall, this multi-scale study attempts to give a better understanding of the most remarkable social and environmental impacts on the implementation of the Payments for Environmental Services (PES) program.

i. Objectives

To analyze the PES program's impacts in the Huasteca Potosina region, the following objectives were set:

1. Evaluate the correlation between patterns of deforestation and extreme poverty in the region.

PES programs in Latin America are conceived as a way to reduce deforestation by compensating landowners' stewardship of their forests, with the underlying assumption that poverty triggers deforestation. Following this logic, Mexico's national strategy for PES has prioritized very high and high poverty areas. The first step in researching this relationship was to map the spatial correlation of the forested areas under risk of deforestation and the economically poorest areas at the *municipio* and *nucleo agrario* level. A sample of 43 *nucleos* (communities and ejidos) was chosen and a Geographic Information System (GIS) was constructed to define the risk of deforestation index and the overall economic marginality of the *nucleos agrarios*.

To obtain the risk of deforestation index of each *nucleo*, two datasets were used: one vector shapefile defined by the National Forest Commission (CONAFOR) and the Environmental Protection Prosecutor (PROFEPA), and a raster dataset developed by the National Environmental Institute (INE). To analyze the deforestation patterns over time, forest covers of the National Institute of Statistics and Geography (INEGI) land use and vegetation inventory series SI (1980), SII (1990), SIII (2000) and SIV (2010) [1] were used in conjunction with Landsat 3 and 5 (TM) imagery from the same decades. The land use changes and areas under risk of deforestation in the sample communities and ejidos were then compared to the high poverty zones in the region at the *municipio* and *nucleo* level using the database of the National Council of Population and Housing (CONAPO) marginality index per locality.

2. Explore the potential correspondence between the implementation of the PES program on communities of the Huasteca region and CONAFOR's prioritization of areas scheme.

[1] Series I was constructed in the 1980s with fieldwork reference of 1968-1981-1988, Series II was constructed in the 1990s with fieldwork reference of 1993-1996, Series III was elaborated in 2002 and 2003, and Series IV was constructed during the period of 2007-2010.

The priority areas or eligible zones were areas already delimitated by CONAFOR and available in shape file format; these were added to a GIS to evaluate their spatial correspondence with the implemented PES programs from 2003 to 2011. Besides the spatial correspondence between PES and priority areas, CONAFOR's environmental and social criteria required for the implementation of PES were evaluated in the sample of 43 communities in terms of their correspondence with the allocated PES projects.

3. Evaluate the contribution of the PES toward stopping deforestation in the Huasteca Potosina.

To evaluate the influence of the program at a regional level, the percentages of forest cover to non-forest cover were tracked in the 43 sample communities from the inception of the program in 2003 to 2011, with attention being paid to the forests covered in the program. Other elements like property regimes, population density, and marginality were considered for their possible influences on forest conservation.

4. Evaluate the perceptions and impressions of its participants of the PES program to gauge its social impact on the study area.

Semi-structured interviews and questionnaires were conducted on participants and non-participants in the 43-community sample to document their experiences and perceptions of the PES's impacts on forest management, social organization and local economy. The communities' perceptions were also compared with their deforestation patterns before and after the implementation of the program.

5. Evaluate the program's influences on community land tenure, rights, access, use and decisions over forests use.

After the agrarian land reform of 1992, communities and ejidos have embraced different degrees of privatization and forest access that influences the way the program is implemented. At the beginning of the PES implementation, CONAFOR decided to include in the program only the areas certified under the PROCEDE program, but due to the amount of forested areas under uncertified lands, the program decided to expand its criteria. For this study, different types of land tenure systems were selected to reveal the degree to which this variable has influenced participation in and implementation of the program.

ii. Hypothesis

The overarching hypothesis for this dissertation is that the social factors of extreme marginality and indigeneity are not strongly associated with forest depletion patterns. Rather success of the PES program depends instead on other social phenomena like community organization, land use traditions and experience working on conservation or agro-productive programs that are stronger determinants of the maintenance or the depletion of forest in communities. Under this general hypothesis are the following corollary hypotheses:

1. The poorest communities are less likely to deforest, but they are the most likely to be included as "priority areas for conservation" under the PES program.

Although the PES program tries to reach the poorest in order to stop deforestation in the hilliest and least-arable regions where most standing forests remain, (Alix-Garcia, De Janvry, and Sadoulet 2008), such forests are at least risk to begin with. For example, in Costa Rica it is precisely the poor who impact the forest the least that participate most in PES programs (Pagiola 2002, Sánchez-Azofeifa et al. 2007). In Mexico where the conservation strategy is to reach priority areas under risk, the program is most likely to reward the good managing practices of the poor communities as well. Thus, the assumption that the poor are the greatest threat to forests, watersheds, and soil preservation must be re-evaluated.

2. Communities with well defined property rights are more likely to conserve their forest and participate in conservation programs than the ones without.

Property rights have been implemented as part of the neoliberal strategy to alleviate poverty and the deterioration of natural resources under the assumption that insecurities in land tenure are one of the first threats to the forest and biodiversity conservation (Landell-Mills 2002, Merino and Martinez 2009, Larson et al. 2013). This is the highly contentious "tragedy of the commons" argument of Hardin (1968). The logic behind securing property rights to individuals is based on two assumptions. One is that legal recognition of boundaries creates both a sense of security in property ownership and thus a community's or individual's willingness to invest and take care of that property.

Secondly, it is thought that people, regardless of culture or social condition, are inherently egocentric and thus will selfishly and recklessly appropriate and exploit any resources that are not their own, including communal forests, before others do. Privatization, then, will cause people to take better care of what is legally theirs and theirs alone while providing them with crucial tools to regulate land uses and the environmental governance of their lands (Spears et al. 1994). On the other hand, an opposing logic is that social and economic factors like land privatization and poverty can disrupt community governance and lead to forest overexploitation (Heynen 2005). The PES program has indeed prioritized the certification of property rights for eligibility to participate and it is also intended to prevent community disruptions that could threaten the forests.

3. The addition of an economic value to the environmental services of forests has spurred positive adaptations in the way communities and ejidos manage their resources.

It was expected that the selling and buying at forest services to achieve more rational land uses receive positive responses especially in forested communities with no commercial timber. This market-oriented conservation strategy compensates land owners for the provision of environmental services over other land uses on their properties by adding an economic value to the conservation of forest and diversifying the local economy (Velázquez et. al. 2002, Muñoz-Piña et. al 2008). The PES approach of protecting areas under risk by rewarding good forest practices can diversify and improve local economies while increasing environment awareness and the appreciation of environmental services.

4. The effects of the PES program on decreasing deforestation varies geographically, depending on the topographical characteristics of the *nucleos agrarios* and their degree and time of dependency on agricultural and cattle ranching activities.

It was expected that communities located in the lowlands with longer dependency on activities like sugarcane production or cattle ranching would be less likely to appreciate program benefits in the long term than mountainous communities practicing a slash and burn agriculture that benefits from long fallow periods. The level of dependence on agriculture and cattle ranching has also been influenced by federal and state subsidies for agricultural development that counteract forest conservation efforts.

5. The maintenance of traditional community organization is an essential factor for the sustainability of forest conservation programs.

With the new land reforms in Mexico, communities have had the option to maintain the rights to their common social property or divide the land rights into individual properties. As several studies have shown, well organized communities and *ejidos* with internal rules for its management that have maintained their forest as communal lands also have a positive record of involvement with NGOs in forestry management programs (Alcorn 1984a, Velázquez, Durán-Medina, and Jean-Francois 2003, Klooster 2002, Alix-Garcia et al. 2009). Communities with good internal organizations are then not only more likely to participate in environmental conservation programs but also to maintain them in the long term.

iii. Methodology

With what kind of approach can one evaluate how the environmental and social elements of the PES program have behaved at a regional and local level regarding patterns of deforestation and poverty reduction? This chapter sets out to answer this question.

The study required the creation of a multi-scale geographical information system (GIS) for the spatial analysis of forest cover change, land tenure, marginality and the implementation of PES at a regional and *nucleo* scale. The data collection at the regional and *nucleo* level combined archival and bibliographic research about the region's history on land tenure, development, environmental impacts and forest conservation initiatives to obtain the context of the present PES program and its implementation. In addition I did 11 months of ethnography walking forested areas under the PES program, applying community surveys, interviewing community leaders, and participant observation at myriad meetings related to the PES program.

The multi-scalar approach

The area of study at the regional scale is defined by the Huasteca Potosina boundaries, which includes 22 *municipios.* At this scale a regional analysis of social properties was made using data collected from 611 *nucleos agrarios*, which include *ejidos* and indigenous communities, and focused on the diferent land tenure systems and changes in forest over three decades. At the municipal level, only 11 *municipios* where a fair amount of forest still exists were considered for the study of forest conservation, marginality, and PES (see Map 1). Within this area, two sub-areas – the northern and southern – were identified and compared based on their economic and cultural characteristics. At the local scale a sample of 43 *nucleos* within these eleven *municipios* was selected for the analysis of the program's implementation and local impacts. For finegrained longitudinal analysis of the PES impact on reducing deforestation, only the six *nucleos* that participated in both periods (10 years total) were considered.

The data development at the regional level

The data sources used for the construction of the digital database for the analysis of spatial correspondence between areas under risk of deforestation, extreme poverty, and the different land tenure systems in the Huasteca Potosina included:

- The National Council of Population and Housing (CONAPO) marginality index per county and locality as a way to measure poverty. The marginality index is based on the following variables of the INEGI's national census of population and housing made every five years.

Variable	Abreviation
% Illiterate population of 15 years old or more	p15YM_AN
% Population of 15 years or more with uncompleted primary school	p15PRI_IN
% Population without sewage and sanitation services	pVPH_S_EXCSA
% Population living in houses without electricity	pVPH_S_ELEC
% Population living in houses without tap water	pVPH_AGUAFV
% Houses with a level of overcrowding	PROM_OCUP
%Population living in houses with dirt floors	pVPH_PISOTI
% Population living without refrigetator	pVPH_S_REFRI

Table 1. Marginality variables

CONAPO created two different indexes, one for the *municipio* and one for localities.[2] The first one was used as it was created, and the second one was aggregated to calculate the marginality index at the *nucleos agrarios* level since one *nucleo* can contain several localities.

- To identify the areas under risk of deforestation, two national databases were used, the "Critical Forested Zones" shapefile that the Assistant Prosecutor for Natural Resources (*Subprocuraduria de Recursos Naturales*) and the Federal Prosecutor for the Protection

[2] Localities are an INEGI classification of a populated space that can range to a single house to a settlement of thousands concentrated spatially.

of the Environment (PROFEPA) use to define areas where the natural vegetation has reached high rates of destruction. The second database was the "Risk of Deforestation Index" raster image IRDef 2.0.1, created in 2011 by the National Ecology Institute (INE), which contains a more accurate classification of the areas under risk of deforestation by economic pressures. The IRDef 2.0.1 data is available by state at the webpage http://www.ine.gob.mx/irdef-db.

The Critical Forested Zones database is good for monitoring areas where environmental violations are usually registered, but it is not accurate at the *nucleos* or community level. The Risk of Deforestation Index on the other hand was especially design to be used by CONAFOR staff to better allocate their programs like PES. The values of the index are based on the Von Thünen model, which weighs the factors guiding landowners to change from forest land use to more profitable ones like agriculture or cattle ranching. The variables that increase or reduce the profitability of the land use change in this model are: distance to local or regional markets, the type of forest, the existence of primary and secondary vegetation, elevation, slope, accessibility to towns and urban centers, adjacent agricultural densities, corn yield, marginality level, number of inhabitants in the nearest center, natural protected areas, and prices of corn and cattle (INE 2011). The patterns of deforestation during the last decade were used to obtain a better estimate of fluctuation caused by each variable.

- The agricultural, livestock, and forestry census data from 1991-2007 were used to document land use over time at the *municipio* level. Specifically, the variables used were:
  - Agricultural surface data,
    - for perennial and seasonal crops
    - rain-fed zones and irrigated zones
  - Cattle ranching data,
    - Heads of cattle and its zoo-technical function per *municipio*
    - Surface area of cultivated grasses and alfalfa
  - Deforestation data
    - Surface deforested for agriculture and cattle ranching activities
  - Timber exploitation data
    - Volume of timber extracted by tree species
    - Number of sawmills that report timber by species per *municipio*
  - Reforestations
    - Surface reforested by specific tree species

- The aggregated information of the *Censo ejidal* 2007 was used to document the distribution of land and its uses by social properties in each *municipio*. The variables used were:
  - Agricultural, cattle ranching and forestry land use
    - economic activities and methods of operation, collective or individual
    - overall agricultural surface in parceled areas, including documentation of irrigation technology
    - parcels farmed communally
    - area cleared for communal agriculture and cattle ranching
  - Land distribution
    - Total number of *ejidatarios, comuneros*, and *posesionarios* (children of *ejidatarios*) by *municipio*
    - *Ejidatarios* and *comuneros* according to gender and possession of individual parcels
    - *Posesionarios* by gender and possession of individual parcels
    - *Ejidos* and communities with *avecindados* by gender

For the land tenure categorization and organization of social properties, the agrarian nucleus database created for the Huasteca Potosina (Kelly et al. 2010) was used as a base. In particular, the variables used from the database included: size of communal lands, land tenure, percentage of forest, number of land owners, and drawing from the national census data of 2005 and 2010 total population, percentages of indigenous population, and marginality indexes.

Data collection at the *nucleos agrarios* level

Little data exists or is unavailable at the *nucleo agrario* level, so most had to be collected in the field or constructed.

- The marginality index per *nucleo* was constructed by aggregating the mean value of the localities' marginality indices inside each *nucleo*. The variables taken into account at the locality level are the same as at the *municipio* level, except for the percentage of working population earning twice the minimum wages, which was replaced with the percentage of houses without a refrigerator. According to the CONAPO statistical analyses, the last variable proved to have more weight in defining marginality at the locality level.

- The variables for INE's economic risk of deforestation index (IRDef) were used for the development of the index for the 43 *nucleos* of the sample.

- For the land use change analyses, the INEGI vector datasets of national land use and vegetation inventory series SI (1980), SII (1990) and SIII (2000) and SIV (2010) [3] were used to look for spatial correspondence between deforested areas and marginality.

- I visited participant and non-participant *nucleos* in the sample for the application of community questionnaires (see appendix IV). For the areas under the PES program, I also visited their participant area to observe the conditions of the forests as well as the environmental service activities they were doing.

Field work

Initial fieldwork began in the summer of 2009 while doing a reconnaissance of the region's forest programs. I became interested in communally owned forests and management after previous work in the region related to participatory research mapping and the changes in the social land tenure systems brought with the counter-reforms. In 2009 I focused on CONAFOR's national reforestation program, which preceded the PES program. While visiting communities and *ejidos* in the program I found out that for some the reforestation program was actually part of a follow up to the PES program. The new PES program covered substantially bigger areas and involved more communities, which attracted my attention to it.

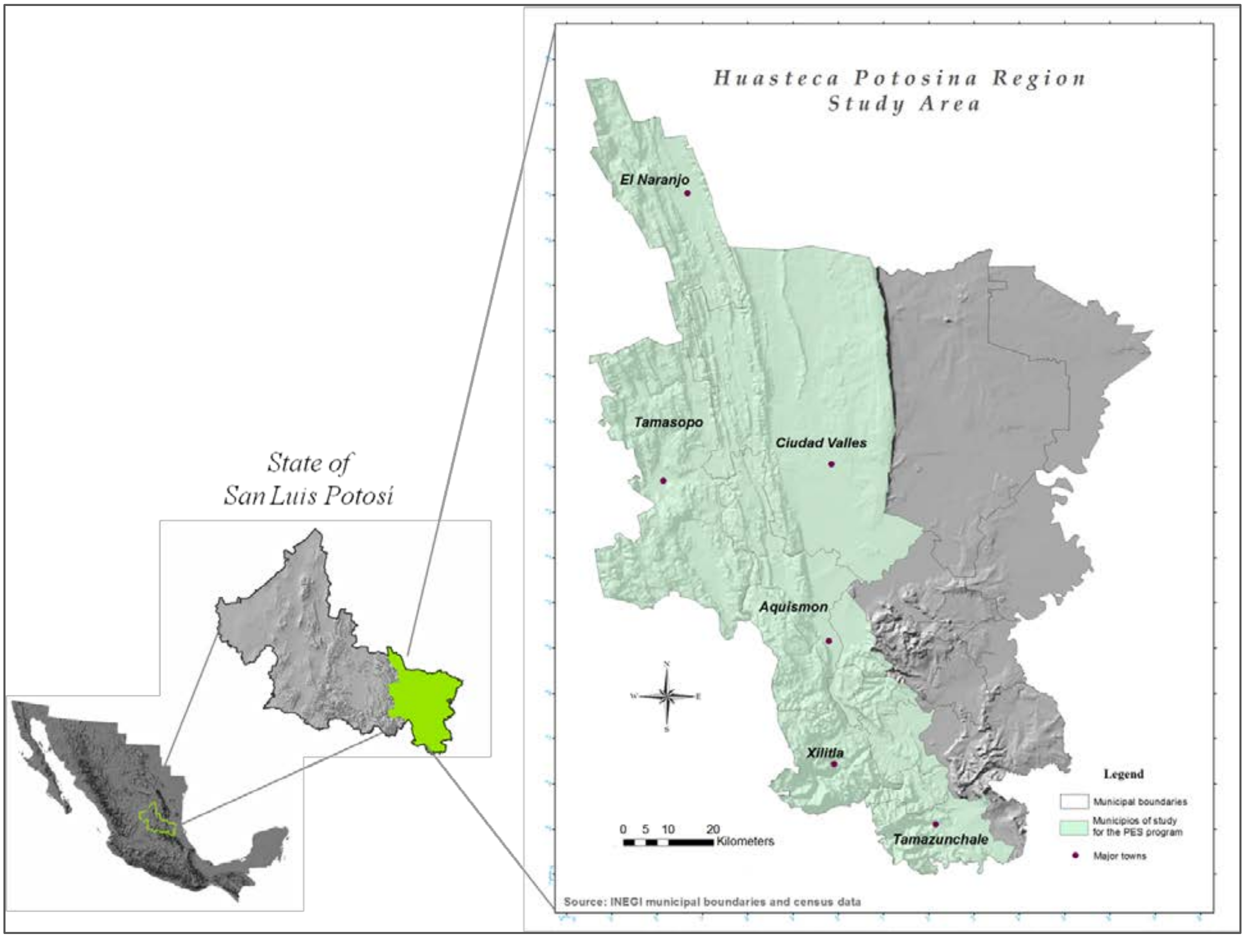
Selecting the sample of communities and ejidos for the study

The second fieldwork season, from March to August 2011, I focused mostly on the indigenous southern part of the Huasteca Potosina study area. Since most of the PES programs in this region are located in the *municipio* of Xilitla (see map below), I chose it as my base of operations. I made a list of communities and *ejidos* participating in PES since 2003 and started visiting them, first asking the head officials known as *comisariados*, whether I could attend their next community meeting (*asambleas)* to talk about my research and ask for their participation on my survey. The survey was composed of 58 questions related to general aspects of their community or *ejido*, the land uses, access and distribution, and their participation and management of the PES program. Depending on the communities' management of the PES

[3] INEGI land use and vegetation series were constructed: I in the 1980s with fieldwork reference of (1968)-1981-1988, II was constructed in the 1990s with fieldwork reference of 1993-1996, III was elaborated in 2002 and 2003, and the most recent series IV was constructed during the period of 2007-2010.

program, the interviews and questionnaires were applied to either the general assembly, the PES committee, or both. In addition to the questionnaire, we arranged for a tour of their forests under the PES program. In exchange and gratitude for their participation in the study, I offered a map of their *nucleo* that included the location and area of the PES program in which they were participating, which, ironically, most of them all lacked. For the southern region I selected 27 *nucleos*, 19 of which had participated in the PES program for at least one period and eight had yet to participate.

The third fieldwork season was made from February to April, 2012 in the northern region covering the *municipios* of El Naranjo, Cd. Valles, and Tamasopo (see map below). The fieldwork there was delayed by a wave of narco-trafficking violence during 2011. El Naranjo was my base of operations, where I applied the same approach I used to reach the *ejidos* on the south. One advantage, though, was that I had previously met many of the *nucleos* committee members at previous PES regional meetings, which greatly facilitated gaining their participation. For this region I selected 16 *nucleos* of which 10 had participated in the PES program for at least one period and six that had applied for entry but so far had been rejected.



Map 1. Study Area

Differentiating the CONAFOR staff from me

PES staff visits the properties in the program at least every two years, often depending on a community's standing in the program, to verify the environmental services work. There are also technicians that are subcontracted by participants to provide technical assistance and who often visit potential participants to encourage their enrollment. Although I constantly explained my doctoral project, community members and even technicians constantly mistook me for an under-cover inspector for CONAFOR. The program technicians are not employed by CONAFOR but need to be certified by it in order to work as assisting technicians for communities. The constant confusion unintentionally opened doors for me, but eventually nearly everyone came to accept the explanation of my independent project. I met most of the technicians in the region, and some allowed me to join them in their regular visits to my targeted communities as well as others under their responsibility, greatly enhancing my acceptance by the communities. Some technicians, though, were suspicious and perhaps corrupt, and not only refused to participate but spread rumors about me to the communities to the effect that participation in my project would put their PES in jeopardy. Luckily, these were in the minority, and some communities welcomed me despite their technician's warning.

Visiting the areas under the PES program

I used different approaches depending on whether the environmental services used pertained to agroforestry or hydrological services. In areas with hydrological PES programs, I convened a meeting with at least the designated community committee to apply my questionnaire. During this meeting, I asked when the next scheduled maintenance of their forests was planned, at which time the committee members would guide me on a tour that usually included several hours of mountain walking. For the areas under the agroforestry PES program, which were mainly in indigenous *nucleos*, visits were made to several shade-grown coffee orchards, and interviews with the owners were also made there in the countryside, including questions about the maintenance of their parcels and the variety of species involved. These hikes, though grueling at times, turned out to provide invaluable ethno-botanical data and forums in which community members felt the freedom to speak out about the program.

Additional interviews were made with key actors in the region like the CONAFOR technicians implementing and overseeing the program, other CONAFOR staff, and ecology personnel in the municipal governments. I also interviewed staff from NGOs, governmental agencies, and academic groups involved with the program as official Management Units (UMAFORES) in promoting, supervising, and elaborating projects.

GIS Analyses

All of the GIS analyses were made using the ArcGIS 10 program.

Spatial correspondence between poverty and deforestation patterns

The spatial correspondence between these two variables was applied to the municipal and *nucleo* level using the marginality index developed by CONAPO at the locality and municipal levels, including two data sets of deforestation risk (the San Luis PotosíIRDef 2.0.1 data developed by INE and the PROFEPA data) and the four INEGI land use and vegetation series that run from 1980s to 2010. The PROFEPA data was only used to identify broad areas subject to deforestation, and its inclusion of other land uses besides forest makes it unsuitable to evaluate the forested areas under risk. Thus, the IRDef high resolution focus on forested areas allowed the analysis of areas under deforestation risk at the *nucleos agrarios* level. The size of the IRDef raster grid corresponds to 300 meters by 300 meters or nine hectares on the ground.[4] This data allowed for gauging the overall risk of deforestation of a specific area by using the mean level of risk.

Risk of deforestation at the municipios level

To obtain the risk of deforestation per *municipio*, the IRDef data was intersected with the municipal data on GIS. The raster image was converted into a polygon using the "Level of risk" as the attribute value for grouping into different categories. Once the polygons for risk of deforestation were created, the shapefile was then intersected with the municipal marginality index data. The "intersect" geo-processing tool was then used to create areas of coverage of thousands of polygons sharing the same attributes. The "dissolve" geo-processing tool allowed for the statistical analyses of the numeric data like range, or standard deviation and the mean risk of deforestation by *municipio*.

The same geo- processing tools were applied to indentify the types of forest at risk of deforestation by intersecting the IRDef shapefile with the INEGI's most recent land use and vegetation data: the SIV series. The resulting data (Risk_Intersect_VegetationIV) was then summarized by *municipio*. The correlation analyses of these variables were made using the SPSS statistical program, at the *municipios* and *nucleos* level, using both parametric and non-parametric methods.

Identifying poverty and the government programs to reduce it

Poverty is conceived by the government, as a structural problem of societies when its members lack the opportunities for development or the capacities to reach it. In Mexico, the National Council for the Evaluation of Social Development Politics (CONEVAL) addresses poverty's multidimensionality and classifies it in two blocks: 1- the lack of social rights, which

[4] The cells data is categorized in four ways: 1) NIV_Riesgo - a qualitative level of risk classification that goes from very low to very high, 2) Riesgo - the economic pressure of deforestation index with four decimal values from 0.0000 to 0.9999, 3) Value - a discrete value that reflects the probability of deforestation from 1 to 9999, 4) Count - the number of cells that have the same value of risk

are: food, education, health, social security, and household; and 2- earning an income below 'well-being' (at least two minimum wages per month). People are considered poor if they lack at least one of the mentioned social rights or have an income below the well-being index, and are considered extremely poor when they lack at least three social rights and their income is below the wellbeing.

The incidence of poverty in Mexico is greater in rural areas than in urban areas (61 percent of the population versus 40 percent), and within rural areas, indigenous populations tend to be more marginalized than the mestizo population (72 percent versus 42 percent) (CONEVAL 2012). At the state level, San Luis Potosí occupies ninth place, with at least 50 percent (~1,353,300 people) living in poverty.

To combat poverty, successive governments have implemented several programs to improve social rights and economic wellbeing of the marginalized population. In 2012 there were 275 national programs to combat poverty, 189 more than in 2004 (ibid.). Programs are divided in three categories: budgetary, where implementation requires following operational rules like the PES program; subsidiary, which follow guidelines like *Oportunidades*; and "direct action", which provide public services. The programs with operational rules represent 35 percent of the federal budget, followed by subsidiary programs with 33 percent, and the provision of public services with 32 percent (ibid.).

The government's main focus has been education, with 103 programs, followed by 51 for economic wellbeing, and 41 related to health; these three areas alone consume 78 percent of the annual budget (around $62,114,400 USD) (CONEVAL 2012). The greatest improvements can be seen in regard to access to health services, where the percentage lacking dropped from 58.6 in 1990 to 21.5 by 2012 (Bis). Most relevant to this dissertation are the 24 programs for healthier environments. SEMARNAT is in charge of the healthy environment programs and oversees 30 that cover several of the social and wellbeing rights, most of them (20) directly related to the environment while others are more indirectly linked through education (1), economic wellbeing (4), health (2) and housing (3). Eighteen of these programs fund technical assistance, including studies and the implementation of environmental services, infrastructure, and production or microcredit programs. In 2012, SEMARNAT funding amounted to 99.1 million Mexican pesos (Bis).

Programs target specific populations. For *nucleos agrarios* nine programs address the social and economic dimensions of poverty, five give direct economic aid for wellbeing, two are focused on a healthy environment, including the PES program, and others involve social security and employment. The total funding designated for nucleos agrarios in 2012 was USD $182 million (CONEVAL, 2012), and from 2003 to 2011 the PES program alone received an average of USD $54 million per year to support 5,967 *nucleos agrarios*, for an average of $9,000 each (CONAFOR 2012).

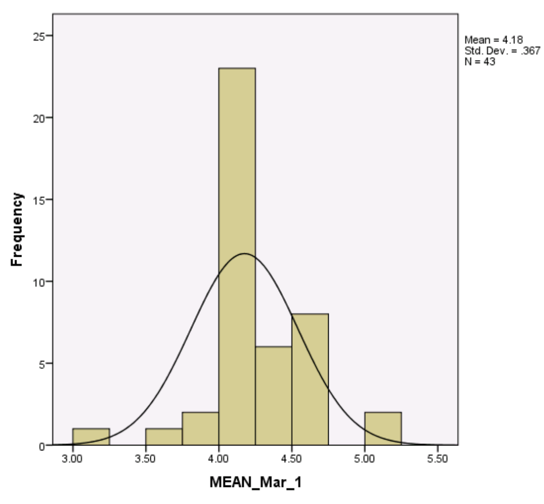
Marginality and risk of deforestation at the nucleos level

Construction of the Marginality index

The marginality index of the *nucleos* was obtained through several steps: first, the 2010 marginality index of the 1662 localities inside the Huasteca Potosina region was obtained from the CONAPO's webpage (http://cat.microrregiones.gob.mx/catloc/) for San Luis Potos and added to the GIS database. The five nominal classes of the index were changed into a rating system of degrees of marginality, from 0 to the lowest to 5 as the highest. Not all localities showed marginality, but this was mainly because of the lack of specific census information for having less than 6 persons. Due to lack of information, 327 localities had to be excluded from the marginality analyses, although they were included in the analysis of total population at *nucleo* level. The total number of localities included in the marginality calculations was 1336 with a mean marginality index of 4.1 (high).

The second step was to accurately identify the localities that belonged to each *nucleo.* The 2010 INEGI census data for localities available in shapefile format was used to spatially locate the localities or points inside each *nucleo's* polygon using the "intersect" geo-processing tool in Arcmap. Since several *nucleos* have populations living outside their designated lands, the accuracy of each *nucleo's* total population was enhanced by verifying the position of the localities near the polygon borders. This was greatly facilitated by using the catalog for localities in the National Agrarian Register (RAN, http://www.ran.gob.mx/ran/index.php) for each *nucleo* in. This database, however, has two disadvantages: one is that it only contains the data of the *nucleos* that have been already certified by PROCEDE, so uncertified nucleos could not be verified; the other is that the catalog has not been updated since the 2005 census, so several new localities from the 2010 census were not in the catalog. Nonetheless, the verification process provided information for a great number of missing localities while also helping to review the boundaries' of the certified nucleos. Fieldwork and GPS recording of the localities also helped to improve and rectify the database. For example, the *ejido* "Las Abritas y anexos" appeared in the catalog as part of the *municipio* of Cd. Del Maíz, which was recently divided to create the new *municipio* of El Naranjo, where this ejido now belongs. In addition, the catalog shows the ejido without any localities inside the *nucleo,* but from the 2010 census and fieldwork, two localities were identified inside the polygon. In other *nucleos* like "La Hincada" and "Tanlacú" the polygon boundaries had to be reshaped because of recently added annexes and incorrectly placed localities.

Once the localities for each *nucleo* were identified and the polygons database was updated, the localities were spatially aggregated to the corresponding polygon on the GIS using the "intersect" function. The 358 localities within the sample *nucleos* had an overall mean marginality of 4.3, with a very small standard deviation value of 0.5269. The localities data was then summarized by *nucleo* using the "dissolve" geo-processing function to obtain the mean marginality value and the total population per *nucleo.* The mean marginality within the sample of 43 *nucleos* resulted in a 4.17 value, with a standard deviation of 0.36. As the mean marginality value of all the localities in the Huasteca, this variable's fluctuation is very low, which means that the majority of the localities are highly marginal. Statistically, it means that this variable does not have a normal distribution, causing a ceiling effect that inhibits significant correlation with other variables. The graphic below shows how the distribution of the variable tends to concentrate in the 4^{th} index value.



Graphic 1. Distribution of the marginality index at the localities inside the sampled *nucleos*

Although the results show that the *nucleos* are similarly marginalized, previous research suggested there were differences in the degree of marginalization between the northern and southern area. Therefore, a more precise index was calculated for the *nucleos* in an attempt to correlate marginality with risk of deforestation and total forest change at this scale by weighting the same eight variables of the census that CONAPO used to calculate the localities' marginality. The descriptive statistics of the variables among the sample are shown in the table below.

Descriptive Statistics

	Minimum	Maximum	Mean	Std. Deviation
p15YM_AN	4.87804878049	34.00000000000	16.5176250452747	6.93656358510593
p15PRI_IN	14.1643	41.1429	26.302794	6.9399233
PROM_OCUP	3.0000	9.0000	4.697674	.9394751
pVPH_S_EXCSA	.0000	24.1379	5.181007	4.9950880
pVPH_S_ELEC	.0000	107.6142	15.148441	21.9584607
pVPH_AGUAFV	.0000	285.0254	50.841292	49.9772418
pVPH_PISOTI	3.3613	107.1066	29.267070	20.9673328
pVPH_S_REFRI	13.24	100.00	55.3110	23.19803
Valid N (listwise) 43				

Table 1. Descriptive statistics of the marginality variables on the sampled *nucleos*

The correlation analyses between the eight variables shows the percentage of illiterate population (p15YM_AN) expectedly related to the population with incomplete primary school, but also with the infrastructure-related variables like having no electricity (pVPH_ELEC) and running water (pVPH_AGUAFV) and even more strongly with houses with dirt floors (pVPH_PISOTI) (see the matrix below).

Correlations

		p15YM_AN	p15PRI_IN	PROM_OCUP	pVPH_S_EXCSA	pVPH_S_ELEC	pVPH_AGUAFV	pVPH_PISOTI	pVPH_S_REFRI
p15YM_AN	Pearson Correlation	1	.330*	.232	.087	.314*	.383*	.502**	.380*
	Sig. (2-tailed)		.030	.135	.580	.040	.011	.001	.012
	N	43	43	43	43	43	43	43	43
p15PRI_IN	Pearson Correlation	.330*	1	-.066	.033	.113	-.064	-.078	-.063
	Sig. (2-tailed)	.030		.675	.834	.471	.685	.618	.687
	N	43	43	43	43	43	43	43	43
PROM_OCUP	Pearson Correlation	.232	-.066	1	-.193	-.062	-.003	.142	.340*
	Sig. (2-tailed)	.135	.675		.216	.694	.983	.365	.026
	N	43	43	43	43	43	43	43	43
pVPH_S_EXCSA	Pearson Correlation	.087	.033	-.193	1	.518**	.122	.236	.095
	Sig. (2-tailed)	.580	.834	.216		.000	.437	.128	.543
	N	43	43	43	43	43	43	43	43
pVPH_S_ELEC	Pearson Correlation	.314*	.113	-.062	.518**	1	.630**	.713**	.411**
	Sig. (2-tailed)	.040	.471	.694	.000		.000	.000	.006
	N	43	43	43	43	43	43	43	43
pVPH_AGUAFV	Pearson Correlation	.383*	-.064	-.003	.122	.630**	1	.754**	.323*
	Sig. (2-tailed)	.011	.685	.983	.437	.000		.000	.035
	N	43	43	43	43	43	43	43	43
pVPH_PISOTI	Pearson Correlation	.502**	-.078	.142	.236	.713**	.754**	1	.526**
	Sig. (2-tailed)	.001	.618	.365	.128	.000	.000		.000
	N	43	43	43	43	43	43	43	43
pVPH_S_REFRI	Pearson Correlation	.380*	-.063	.340*	.095	.411**	.323*	.526**	1
	Sig. (2-tailed)	.012	.687	.026	.543	.006	.035	.000	
	N	43	43	43	43	43	43	43	43

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3. Correlation matrix of the variables used for the marginality index at the *nucleos'* scale

Following CONAPO's procedure at the localities level, the variables were standardized before evaluating their weight in the marginality index. Once the variables were standardized, a "Principal Component Analyses" or PCA method was used to obtain their weight in the marginality value. The table below shows the components or variables in the same order of the matrix, so the first is the percentage of illiterate population and so on. The results of the significance of each variable for marginality differ from what CONAPO identified as the most explanatory using the 2010 census. In their analysis, the percentage of houses without a refrigerator (the last component in this table) had the most weight, while my analysis at the scale of the *nucleos*, the percentage of houses with dirt floors (the 7th component) had the most (see table of principal component analysis below).

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.160	39.496	39.496	3.160	39.496	39.496
2	1.443	18.040	57.536	1.443	18.040	57.536
3	1.210	15.125	72.661	1.210	15.125	72.661
4	.839	10.490	83.150			
5	.515	6.441	89.591			
6	.465	5.814	95.405			
7	.207	2.589	97.994			
8	.160	2.006	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component		
	1 ω	2	3
1- (p15YM_AN)	.632	.289	.505
2- (p15PRI_IN)	.066	-.095	.940
3- (PROM_OCUP)	.168	.808	-.029
4- (pVPH_S_EXCSA)	.385	-.636	.001
(5- (pVPH_S_ELEC)	.838	-.357	-.021
(6- (pVPH_AGUAFV)	.791	-.076	-.174
(7- (pVPH_PISOTI)	.909	.034	-.158
8- (pVPH_S_REFRI)	.652	.399	-.120

Extraction Method: Principal Component Analysis.

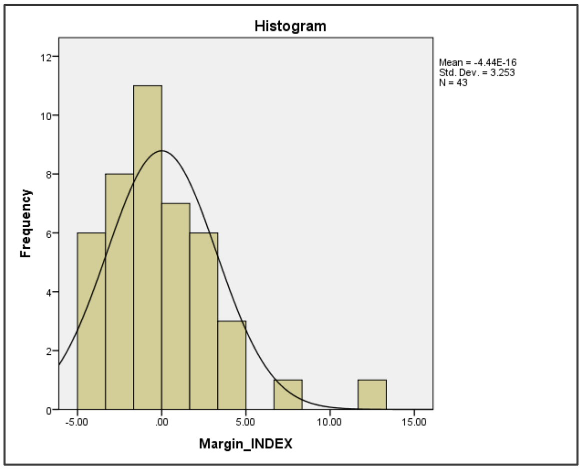
a. 3 components extracted.

Table 4. Principal Component Analysis of Marginality Variables at the Nucleos Level

The components used to create the marginality index for each *nucleo* (Yi) were based on the values of the first column on the component matrix of (ω) multiplied by the standardized values (Zi) and summed to obtain the total measure (IM). The equation is expressed as:

$Y\text{i} = \omega_{1,1} Z_{i,1} + \omega_{1,2} Z_{i,2} + \ldots \omega_{1,8} Z_{i,8} = \text{IM}$

The values obtained after computing the formula for each *nucleo* resulted in a wider range of marginality values from -4 to 12 with a std. deviation of 3.25 for the sample of 43 (see graphic below).



Graphic 2. Distribution of the marginality index at the sampled nucleos

The marginalization categories from (1 to 5) were assigned to the *nucleos* using CONAPO's classification as follow:

Category	Inferior limit	Superior limit
1 Very low	-1.83197	-1.32309
2 Low	-1.32309	-1.06870
3 Medium	-1.06870	-0.81425
4 High	-0.81425	0.71231
5 Very high	0.71231	11.2608

To determine what these values indicate in the categorization of CONAPO's marginalization index, the technique of Dalenius and Hodges was used to stratify these values into the five groups or categories of the localities index. The stratification was made using the statistical program "R". Because the program does not accept negative values, 3.4 points were added to the index values in order to make them positive. The method uses the covariance which is CV= for the modified values and the requested number of stratums (Ls= 5). The constructed marginality index for the *nucleos* was then ready to be used in correlation risk of deforestation and other total change in forest cover.

Construction of the risk of deforestation index at the nucleos level

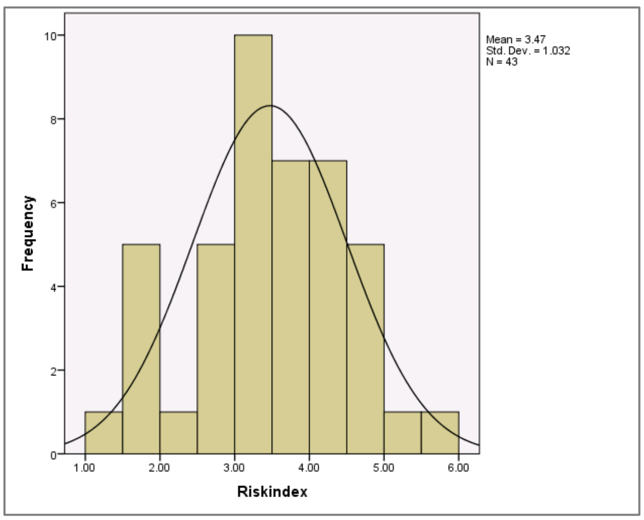
Once the value of marginality was evaluated for the 43 *nucleos*, the risk of deforestation index was calculated in order to correlate them. The risk index was obtained with the help of GIS and the raster dataset of IRDef 2.0.1. The raster image was first cropped to the *nucleos'* polygons using the spatial analysis tool of “extraction” by polygon option. The cropped image was then converted into a polygon shapefile in order to be intersected with the *nucleos’* shapefile. The outcome file identifies all the polygons with different indexes of risk inside each *nucleo*. To calculate the area of deforestation risks, a geometry calculation tool in the attribute data was used and the different degrees were then summarized by *nucleo.*

To obtain the mean risk of deforestation per *nucleo* (DefR), the following equation was used:

μDefR=$\sum(D1 * A1) + (D2 * A2) + (D3 * A3) + (D4 * A4) + (D5 * A5) / \sum(A1{:}A5)$

Where:
D = the degree of deforestation risk (1: very low to 5: very high)
A = the sum of areas covered by a specific degree of risk (1 to 5)

The resulting values were added to the attribute table of *nucleos.* The data was also analyzed with the SPSS statistical software, where it shows it with a normal distribution.



Graphic 3. Risk of deforestation index’s distribution in the sample *nucleos*

Patterns of land use and vegetation change at the nucleos level

To determine the changes in forest cover within the *nucleos*, the INEGI land use and vegetation series from the 1980s (SI), 1990s (SII), 2000s (SIII) and 2010 (SIV), and the National Forest Inventory of the year 2000 (t3) were used as bases of analysis. These covers were clipped and intersected to the nucleos’ polygons to calculate their geometric areas using Arcmap. The categories considered for forest cover included temperate (TE) and tropical (TR) primary forests and secondary forests under the arboreal and scrub stages, excluding the herbaceous stages under the premise that they have recently experienced major disturbances.

The vegetation series data were corroborated with the Landsat (TM) imagery, ortho-photos from 1985, and Google Earth's more recent images for the area in 2010 and 2011 for major discrepancies. To compare the last vegetation series with the most recent imagery on Google Earth, the vegetation and the *nucleos* layers had to be converted into a KML format.

The percentage of total forest change from the 1980s to 2010 at the *nucleos'* level for TE and TR were made for the 43 *nucleos* of the sample and were then included as the variables for total changes in temperate and tropical forest in the correlation matrix.

The following nine variables form part of the correlation matrix:

1- Total population: the total population living within the *nucleos'* jurisdiction in 2010.
2- Indigenous population: the percentage of people that speak an indigenous language or that identifies themselves as indigenous.
3- Region: North and south regions described in the introductory chapter.
4- Communal areas: the percentage of communal area coverage in the total *nucleo* area
5- Years in the program: the years that the *nucleo* has been participating in the PES program
6- Marginality Index: calculated by weighting eight variables of the locality census for each nucleo.
7- Deforestation Index: calculated from the mean value of the IRDef cells within the *nucleo*
8- Total change in TE: percentage of temperate forest change from 1980 to 2010
9- Total change in TR: percentage of tropical forest change from 1980 to 2010

Analysis of the spatial correspondence between CONAFOR'S priority areas and the actual PES program areas in the Huasteca.

CONAFOR has significantly changed its priorities for areas to be included in PES since the program was launched in 2003; however, the last prioritization schemes of 2009-2012 have consolidated most of the elements of previous versions, which in turn were used in this study to evaluate the allocation of PES on the sample of *nucleos*.[5]

[5] The 2010 and 2012 CONAFOR versions of PES zonings were compared with the PES grading scores of each *nucleo* of the sample.

The delimitation of the areas eligible for PES was based on six general environmental variables defined at the earlier stages of the program. Each variable has an assigned number of points that reflects its biological importance, and an area can have various overlapping variables. A total of at least six points qualifies an area as eligible for PES. The variables and their grading are as follows:

Environmental Variables	Points
1. Natural Protected Areas	7
2. Important areas for bird conservation	5
3. Ramsar sites (wetlands of international importance)	4
4. Priority mountains	3
5. Terrestrial priority regions	2
6. Hydrological priority regions	1

Once the areas were designated, the different payments were calculated according to the land use, the type of vegetation recorded in INEGI series IV, and risk of deforestation using INE's risk of deforestation by economic pressures (IRDef data)[6]. The areas with differentiated PES were downloaded from CONAFOR's website and compared with INEGI's land use vegetation series IV to analyze the type of vegetation under eligible areas.

In addition, CONAFOR has created a new process for assigning eligible areas based on the aforementioned data. The process involves a grading system that considers eight general and six specific variables in each category (hydrological, biodiversity, etc.) for which a community is applying.

The eight general variables include:

1- The proposed area must have at least 200 hectares (ha) and 50 percent of it must be forested. Priority points are awarded according to the type of property: five for lying within a biosphere reserve, four for being in a federally protected natural area, three for location within in a state protected area, two for inclusion in a privately owned protected area, and one for being outside any protected area.

[6] See INECC (2013) webpage http://www.inecc.gob.mx/irdef-db for more details about the IRDef index

2- The area lies within the same watershed with other properties in the PES program (five points, one if not). The Founding Trust of Shared Risk (FIRCO), a branch of the agricultural ministry of (SAGARPA), officially delimited all watersheds nationwide.
3- The *ejido* or community has constituted an environmental surveillance committee accredited by PROFEPA (five points, one if not).
4- The area lies withint a zone targeted by CONAFOR for development via PES programs (five points, one if not).
5- The forested property has a sustainable planning program approved by its members and is registered in CONAFOR's online list (five points, one if not).
6- The property is at risk of deforestation as defined by INE and described previously. The grading points increase with the risk: medium risk (two), high risk (four) and very high (six).
7- The area is at strong risk of natural disaster as defined by the National Center of Disaster Prevention (CENAPRED). Such risks in the Huasteca include landslides, frosts, and especially floods and droughts. The CENAPRED's identified risks of natural disasters at the municipal level are available on their website: http://www.atlasnacionalderiesgos.gob.mx. The grading points increase with risk: medium risk (two), high risk (four) and very high (six).
8- The participants have presented a geo-referenced proposed polygon according to the operation rules (Four points, one if not).

Hence, a property can have a maximum of 37 prioritization points for entry into the PES program. Then, according to the PES category they are applying for (hydrological, biodiversity or agroforestry), six more specific variables are evaluated for a potential maximum of 29 prioritization points. The highest scores among each state have better chances of being approved for the program.

For hydrological PES the following six variables are considered:

1- The percentage of the arboreal coverage of the proposed area: over 70 percent (five points), between 61 and 70 percent (three), and between 50 and 60 (one).

2- The area covers overexploited aquifers, as determined by the National Water Council (CONAGUA). The list of overexploited aquifers[7] in the country is available on line at http://www.conagua.gob.mx/atlas/ciclo21.html. San Luis Potosí has five overexploited aquifers in the altiplano (high, dry) region but none in the Huasteca.
3- The polygon is located in a watershed with available surface water. The grading score increases at the highest points of the watershed and amount of water availability. According to CONAGUA, the Huasteca Potosina is within the IX hydrologic watershed called *Golfo Norte* (North Gulf). Human pressure on water sources there is rated at 19%, or "moderate", and thus only receives two prioritization points. Nevertheless, it is located in a zone of extreme drought (map 17) (CONAGUA 2012), which increases its risk for this kind of natural disaster. An online digital atlas details the functional areas (or altitudes) of the watershed http://mapas.ine.gob.mx/mediofisico/hidrologia/zonfun/ that are used to grade the polygons. Priority scores range from seven in the highest areas to one point in lowlands.
4- The degree of soil degradation, as identified by a map made by the College of Postgraduates (COLPOS, Mexico) and SEMARNAT at the national scale of 1:250,000 (http://www.conabio.gob.mx/informacion/metadata/gis/degra250kgw.xml?_httpcache=yes&_xsl=/db/metadata/xsl/fgdc_html.xsl&_indent=no). CONAFOR assigns three points for low degradation, two for medium, and one for high.
5- If the area lies within a CONAFOR strategic zone for restoration or attention (three points, one if not). Maps of such zones are also available in shapefile format and can be downloaded at the CONAFOR's website.
6- The biomass density of the area according to the South Frontier College (ECOSUR) evaluation, with five for the highest density, three for medium, and one for low.

To be eligible for the biodiversity PES program, properties need to be within CONAFOR areas delimited for this category, except for the ones applying for agroforestry, which do not need to be within any areas. For a PES application on this category, the highest possible score is also 29 points and the grading variables are:

[7] Overexploited aquifers are the ones in which the rate of water extracted exceeds the rate of natural replenishment.

1- The property is within the Conservation Areas for Birds (AICAS) delimited by National Comission of Biodiversity (CONABIO) or within a Ramsar site (the world's important wetlands), (four points, one if not).
2- The property is within a hydrological or terrestrial priority region defined by CONABIO (four points, one if not).
3- The property lies within a CONABIO-defined "endangered" or "protected" species zone. Endangered and protected species are listed in the NOM-059-SEMARNAT-2001 and can be spatially located at: http://www.conabio.gob.mx/informacion/gis/. Properties within species in danger of extinction receive seven points, threatened or specially protected species receive five, and one point is assigned otherwise.
4- The property lies within a priority area for biodiversity conservation defined by the GAP, CONABIO, CONANP, The Nature Conservancy, and PRONATURA (Urquiza-Haas et al. 2009). Extremely high priority areas receive seven points, high priority areas receive five, and medium priority areas receive three. The data in shapefile format is also available at the CONABIO website above.
5- The property lies within a biological corridor published by CONABIO (four points, one if not).
6- Properties registered as shade-grown coffee with the National Funding to the Agricultural Community (ASERCA) (three points, one if not).

The actual scores given by CONAFOR to the participating social properties in my study area are kept confidential and unavailable to the public, but I applied the CONAFOR priority points or scores to all social properties in my sample area regardless of their actual participation or not in PES programs so as to evaluate which program best suits them, if any (see Appendix I. PES grading prioritization in nucleos). Sometimes I found, for example, that communities were participating in programs that were less suited to their type of environmental than other programs. For the *nucleos* applying for participation in a program, I considered the total forested area. Also, for properties previously rejected by CONAFOR, an additional four points are awarded, which I took into consideration in my application of the priority scores. Social factors like high marginality and indigenous population mentioned earlier are not assigned a prioritization score by CONAFOR, but they are considered in the application form for submission.

Once all the variables were calculated for each *nucleo*, a correlation matrix of the environmental and the social elements mentioned above was made using the SPSS program. The values of the variables were first standardized and then correlated using the Spearman's correlation coefficient for a non-parametric analysis and the Pearson's correlation coefficient for the parametric test.

Evaluation of PES's contribution to halting regional and local deforestation.

At the regional level, the percentage of forest covered by the program since the beginning of its implementation in 2003 to 2011 in relation to the total amount of forest was considered for the analyses.

At the local level, the patterns of deforestation calculated for the 43 *nucleos agrarios* were tracked over the course of the program, with attention paid to the total change of temperate and tropical forests for each nucleo. In addition, using one-way ANOVA, an analysis of land use and vegetation series from 1980 -1990, 1990 -2000, to 2000 – 2010) were made at the *nucleos* level to find out when the region experienced the most changes cover.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
%ofchange80-90TE	Between Groups	231.218	2	115.609	.226	.799
	Within Groups	20444.465	40	511.112		
	Total	20675.682	42			
%ofchange80-90TR	Between Groups	558.280	2	279.140	.202	.818
	Within Groups	55273.907	40	1381.848		
	Total	55832.187	42			
ofchange00TE	Between Groups	1785.069	2	892.534	1.181	.317
	Within Groups	30218.615	40	755.465		
	Total	32003.684	42			
ofchange00TR	Between Groups	70182.544	2	35091.272	1.346	.273
	Within Groups	964495.618	37	26067.449		
	Total	1034678.162	39			
ofchange10TE	Between Groups	14812.645	2	7406.323	6.566	.003
	Within Groups	45121.244	40	1128.031		
	Total	59933.890	42			
ofchange10TR	Between Groups	288.988	2	144.494	.067	.936
	Within Groups	86560.379	40	2164.009		
	Total	86849.367	42			

Graphic 4. Analysis of variance of the percentage of change in TR and TE forest between three decades

As previously mentioned, field observations of the program areas were also carried out to verify the correspondence of the actual vegetation with the vegetation inventory data, including the stage of the forest (secondary or mature forest), presence of orchids, cultivated crops, and land without vegetation. For non-participating areas, walkable observations were not always possible since residents were less interested in the program and my research.

These results were compared to the participants' perceptions on the PES impacts reducing deforestation to see if they coincided or not.

II. Theoretical context

iv. The cultural and political ecology approach

The theoretical foundation on which this dissertation is built is the field of human geography, particularly the subfields of cultural and regional geography and political ecology. The dissertation integrates cultural, political and ecological processes that occur within a specific region where the protection of natural resources is promoted.

Definitions of ‘culture’ vary according to the issue under investigation; in cultural geography, it refers to “the diverse patterning of human communities and their varied interactions with the environment as well as expression of ideas and values through human fashioned landscape change” (Price and Lewis 1993). How culture is expressed across landscapes has driven cultural geographical research since Carl Sauer established the Berkeley tradition at the University of California in the 1930s, and thus the human-environmental relationship has been a central topic. Sauer focused on the historical transformations of the landscape, patterns of environmental and cultural diffusion, and domestication processes as a way to understand the human transformation of the earth. Complementing this tradition has been the school of Human ecology emphasizing the mutual relationship between humans and their environments, which was founded by Barrows at Chicago in the 1920s in response to the environmental determinism that still dominated geography at the time (Grossman 1977:128). Human ecology paid particular attention to natural hazards and how societies responded to them, while the Berkeley school had a predilection for the study and interpretation of rural and agricultural landscapes in Latin America, thereby also enriching regional geography studies (e.g. West 1948, Parson 1955, Denevan 1966, 1971, Johansen 1963). The Berkeley school established a tradition of research methods that include historiography via archival research, intensive long-term fieldwork, detailed observation, and qualitaive methods that are still used today. The introduction of cultural ecology to geography is attributed to Sauer by his many intellectual heirs, although he never actually used the term. Cultural ecology was first developed by anthropologist Steward (1955) in his explorations of the processes of human adaptation to the environment and the effects it had on social organization (Grossman 1977:132). Steward had studied at Berkeley under anthropologist and confidant of Sauer, Alfred Kroeber. Despite the school's attention to history, critics pointed out that political and economic history, such as processes of globalization and colonialism, were ignored by the tradition even though they were absolutely essential to understanding human-environmental dynamics.

With the influence of general system theory during the 1960s, human ecology developed a heavy focus on energy flows and the subsistence system analysis at micro scales. To this theory followed the adaptive dynamics approach with a great number of studies focusing on subsistence agricultural societies and the evolution of agricultural landscapes. The Berkeley school contributed to the systems ecology field with Denevan (1966) and his students' work on environmental history of pre-Columbian agricultural systems of the Maya, Amazonia, and the Andes: Nietschmann (1972) and Waddell's (1971) works show the influence of general systems and ecosystems concepts in human ecology. Central concerns in their work were sustainability of indigenous production systems and local knowledge. As with the earlier cultural ecology approach of Steward and Sauer, criticisms of systems approaches called attention to their lack of attention to the external influences, particularly political and economic, of land use and modification, as adaptations are not enacted in a self-contained vacuum. Moreover, critiques have also been directed at reducing all social and cultural phenomena to ecosystemic adaptation. While agreeing with these critiques, it is nonetheless recognized the intellectual debt to the cultural ecological tradition established by Sauer in this dissertation, especially in the tradition's focus on agricultural landscapes and their processes of change, and the methodological value placed on archival research, long-term fieldwork, detailed observation, and the development of multi-scalar databases and maps. As will be seen, both the selection of the topic of deforestation and forest conservation in the Huasteca Potosina region as well as the methods of investigating them, are ultimately outgrowths of a scholarly tradition established by Sauer.

Political ecology was in some ways a response to the apolitical systems approaches of the 1950s and 60s, and an approach to modern humanity's glaringly obvious destruction of environments on all scales in the 1970s. Rather than replacing cultural ecology per se, polical ecology has enriched it by drawing attention to political and economic influences in human–environment interactions at multiple scales. Thus, the social relations of production and access and control over resources, for example, were problematized, and the focus was turned away from adaptation to politics, i.e., how all actors, however weak or powerful, interact with each other and the environmental resources in the pursuit of their interests, adaptive or not (Bryant 1992).

Early contributions in political ecology revolved around attacks against the Neo-Malthusian environmental research of the time, which attended to topics like 'overpopulation' without attending to the political-economic interests and processes leading to human destruction of ecologies (Bryant and Bailey 1997, 10-12). The field strengthened and congealed with attention to natural hazards and disasters by O' Keefe, Westgate and Wisner (1976), Watts (1983), Blaikie (1985), Bunker (1985) and Hecht (1985), who stridently called for work on the political economy of environmental change (ibid.). Later works by Vayda (1983) and Grossman (1984) demonstrate the maturation of the field by urging attention to all political and economic structures influencing a given locality's connections with the outside world. In geography, Hewitt's (1983) *The Interpretation of Calamity* is considered one of the fundations for the development of political ecology, and the policy oriented journal of *Land Degradation and Rehabilitation* founded in 1989 by Blaikie and others helped consolidate the called political ecology approach in the discipline (Zimmerer and Bassett 2000, in Paulson et al. 2005). One critique that found its mark against the early political ecology of the time was the over-emphasis on political economic structure and top-down power, including the trendiness of Marx's 'false consciousness', Gramscii's 'hegemony', and Foucault's 'discourse', which downplayed the role of grassroots actors by portraying them as unwitting victims unable to resist their subordination and even contributing to its perpetuation.

This led to an evolution in political ecology away from neo-Marxian determinism to attentions towards how power relations between all people mediate human-environmental interactions. Some of the most representative works of this period are: Blaikie and Brookfield (1987) on land degradation; Hecht and Cockburn (1989) on tropical deforestation in Brazil; Guha (1989), Peluso (1993) and Neuman (1992, 1999) on dominant conservation discourses in forest policy; and Watts and Peet (1993, 2004) on various topics in political ecology (Bryant and Bailey 1997, 13). The notion of "resilience" has also been gaining currency in political ecology in recent decades in tandem with the crises of global climate change and economic recessions (Turner, 2014). Resilience refers to both human and ecological responses to change induced by each other, the study of which therefore implies both natural and social science (ibid).

Thus, political ecological approaches come from different angles, from specific environmental problems (like soil erosion, tropical deforestation, water pollution, etc.) to concepts perceived to have important links to political ecological questions, like the ways in which ideas or discourses are developed or understood by different actors to reinforce or challenge existing social and economic arrangements (Escobar 1998).

From the broad range of applications of political ecology, Offen (1994) identifies five key elements that characterize the subfield in geography: "1) livelihood production and reproduction as the focus of study; 2) the relationships among social, economic and environmental change; 3) international, colonialist and corporate interventions at the community level; 4) causes and consequences of environmental and social marginalization and its remediation and 5) empirical and historical research" (Offen 2004). One could reasonably expand this list to the analysis of dominant discourses behind scientific forest policies and their implications, as in the early works of Peluso (1992, 1993, 2001), Jewitt (1995), and Bryant (1996). More recently, the study of the governmentalities on carbon offsetting (Bumpus and Liverman 2011) and the commodification of environmental services, as well as their local impacts, have expanded the understanding of the complex relations developing between humans and environment on a globalized arena.

This dissertation pertains to political ecology in its attention to the impacts, logics, and operation of environmental protection (Peet et. al. 2011), and actually considers all of Offen's elements as well as the more recent ones on environmental services when analyzing the PES program within the regional context of the Huasteca Potosina region and its impacts at the community level. It contributes to this budding body of knowledge on environmental services in particular, taking as a point of departure predominant assumptions about nature, green or sustainable development, political economy, and the discourses behind forest conservation programs and their relationship to actual practices.

A second phase of political ecology evolved from the concerns of deterministic neo-Marxism in an effort to demonstrate how power relations of all people mediate human-environmental interactions. Some of the most representative works of this period are: Blaikie and Brookfield (1987) on land degradation, Hecht and Cockburn (1989) on tropical deforestation in Brazil, and Guha (1989), Peluso (1993) and Neuman (1992, 1999) on dominant conservation discourses on forest policy, and Watts and Peet (1993, 2004) on a mix of articles of political ecology (Bryant and Bailey 1997, 13).

As the growing literature on the political ecology shows, approaches come from different perspectives, from specific environmental problems (like soil erosion, tropical deforestation, water pollution, etc.) to concepts perceived to have important links to political ecological questions, like the ways in which ideas or discourses are developed or understood by different actors to reinforce or challenge existing social and economic arrangements (Escobar 1998). From the broad range of applications of political ecology, Offen (1994) identifies five key elements that characterize the subfield in geography: "1) livelihood production and reproduction as the focus of study; 2) the relationship among social, economic and environmental change; 3) international, colonialist and corporate interventions at the community level; 4) causes and consequences of environmental and social marginalization and its remediation and 5) empirical and historical research." (Offen 2004). This dissertation also considers these elements when analyzing the PES program within the regional context of the Huasteca Potosina region and its impacts at the community level. There is a political ecology of environmental conservation where the focus has been on the impacts, logics, and operation of environmental protection itself (Peet et. al. 2011) as this study focus on. More recently, the study of the governmentalities on carbon offsetting (Bumpus and Liverman 2011) and on the commodification of environmental services, as well as their local impacts, continue to increase the understanding of the complex relations developing between humans and environment on a globalized arena.

The present dissertation relates to them in the sense that conservation discourses are taken as the starting point on the analysis of deforestation. Specifically for the analysis on the implications of the dominant discourse for scientific forest policy are the earliest works of Peluso (1992, 1993, 2001), Jewitt (1995), and Bryant (1996). Neoliberal ideas about nature, green or sustainable development, and political economy are of preeminent concern in this dissertation.

v. Neoliberal Reforms and Environmental Conservation Policies in Latin America

The term "Neoliberalism" is contentious and has had different connotations over time. The term emerged among European liberal scholars in the 1930's as a theoretical ideology and it was not until the 1970s with Pinochet's economic reforms in Chile that it was reintroduced and began to be used widely in a practical sense (Chase 2002). In general, it is understood as a strategy for economic growth that involves "freedom" in the sense of liberalization (no restrictions) of markets, privatization of public goods and services (the reduction of the public sector), and the deregulation of capital for the promotion of market-oriented management practices (Perreault and Martin 2005, Goldman 2005). For Latin America, the seeds of neoliberalism were planted as a response to their countries' foreign debt crises that begun in the early 1970's. This chapter is intended to explain how neoliberal policies in Latin America have impacted environmental policies and the environment itself up to the present.

The most influential institutions in the rapid expansion of the international economy after WWII, particularly in Latin America, have been the World Bank and the International Monetary Fund (IMF). These banking systems set the pace of development through financial loans and support for repayments. Developed countries used the World Bank to invest in the development of what were hoped to be emerging economies in the Global South, but growth has often come at the cost of the environment and indigenous peoples, or those trying to subsist outside the market. Since its creation in 1944, the World Bank has evolved from a reluctant banker[8] focused on reconstruction into a productive hub of interactions among such entities as economic departments at universities, Wall Street investments firms, agro-industrial corporations, rural research institutes, to other powerful elites like environmental organizations (Goldman 2005, 12). The rise of the World Bank's power occurred during 1968-80, when its rhetoric of poverty alleviation matured into the development for the global South, transforming the bank into a major transnational institution that facilitated the massive flow of investments to developing countries as well as the production of development knowledge by combining the principles of

[8] Specially during the Bank's first twenty years, only the most direct investments in productive capital like roads, ports and power plants were promoted and only to the more affluent countries (Japan, Italy, France and The Netherlands) as other social fields like the construction of schools, hospitals, water works, etc; needed in the poorest countries did not directly increased the ability of countries to cancel a debt (Kay 2002, 57)

economic growth, social welfare, and global security (ibid. 50-51). Investments in the South have had different foci over time, from the early creation of steel mills, oil refineries, and assembly factories to the inputs of improved seeds, chemicals, fertilizers, technical assistance, and educational and environmental conservation programs, all to increase productivity (Kiss, Castro, and Newcombe 2002, Castells and Laserna 1989, Goldman 2005). Some of its most significant infusions occurred in agriculture with the green revolution (1940's-1960's), when millions of hectares of forest were cleared for agriculture and cattle ranching (Roberts and Demetria-Thanos 2003b). Globalization and structural adjustment programs that emerged with these interventions have been perceived as some of the most disruptive external forces on natural resource management in Latin America; however, the same institutions have been concerned about sustainability. This research focuses on one environmental program promoted by the World Bank in Latin America and in the Huasteca in particular.

As seen above, land tenure has been vital for the management of natural resources and has been a constant subject of study and debate by multiple disciplines. Land tenure and reforms impact not only the environment but environmental conservation policies and practices and their success.

For Latin America, forest ownership has been impacted by three important shifts in land tenure: privatization of corporate lands that occurred in many countries after the colonial period; the structural adjustment era in which many social programs were cut; and the most recent neoliberal era in which land redistribution was restricted and privatization was enforced. The first liberal land reforms in Latin America occurred in the 20th century, where land redistribution was encouraged in some countries by the high concentration of land under a few owners after the colonial period while at the ame time there was an increasing number of landless population, a growing prospects of equity, and the urgency to increase production for international markets (Dorner 1992). Since 1945 Latin America incorporated its agricultural sector into a global agro-industrial food regime with the help of agrarian reforms that dismantled the colonial land tenure of *haciendas* and large estates (Kay 1995); unfortunately few peasants got the opportunity to engage in agro-industry. The more equitable distribution of lands to peasants also intended to ease the growing social unrest while gaining political support for the intended industrialization of the countryside (Kay 2002, 1995). In an effort to prevent "another Cuba" and promote a new agro-industrial paradigm encouraged by the U.S. in the "Alliance of Progress" declaration of the

Inter-American Economic and Social Council of 1961 land reform legislation was enacted in nineteen Latin American and Caribbean countries (Stringer 1989a). The agrarian reforms of the 20th century had important geographic differences in regards to institution-building, integration with international programs, and environmental impacts. Mexico (1917), Bolivia (1952), Cuba (1959), and Nicaragua (1979) for example, attempted extreme agrarian reforms that evolved from social revolutions, while other countries like Chile (1964-1979) implemented agrarian reforms by elected governments or military regimes like Peru (1965-75), and in other cases like Argentina that did not experiment with land reforms at all (Kay 2002). Regardless of the impetus, the reforms hardly accomplished the end of structural inequalities. A main strategy of most reforms was the implementation of collective and state structures to allow the government's direct control over production but collective and state farms ended up being cultivated individually anyway. Land reforms were accompanied by Import Substitution Industrialization (ISI) in which governments both subsidized and protected national agro-industry from the 1940s until the late 1980s (Kay 1995). Ironically, ISI was meant to diminish dependency on international markets, but industrialization, including for the Green Revolution, required massive financial and technological inputs from investors in northern countries.

Land reforms had different environmental impacts depending on the type of land distribution and involvement on development programs. According to Thiesenhusen's (1989) analysis, Bolivia had the highest percentage (83) of forest and agricultural lands affected by its land reform in 1977, while in Costa Rica only seven percent of its lands were affected in 1980. Despite the massive land use transformation that came along with the ISI and the colonization programs, poverty and economic inequalities remained because the process was too exclusionary and mostly landlords took advantage of the capitalization. Many peasants that received land were ignored and neglected from subsidies, while the bulk of government and market services continued benefiting preexisting commercial farmers (Dorner 1992). Perhaps what is most striking about this agro-industrial period in Latin America is the development of an increased dependency on international loans and the gap between the rich and the poor that it created. In regards to the environment, often land reforms were not redistributions of agricultural lands at all but simply opening up new forests, often occupied or used by indigenous people, for the poor to colonize, deforestation and indigenous displacement also marked this period of land reforms.

The accumulated debt during these period followed by explosive interests rates and costs in petroleum impoverished Latin America to the point that by the early 1980s, the entire region, starting with Mexico, declared themselves in bankruptcy (Dorner 1992). This period of economic recession marked the end of radical agrarian reforms and the beginning of a stronger international interventionism. The IMF, meant to help countries with their balance of payments, suddenly imposed structural adjustment programs (SAP) in exchange for loan readjustments for developing countries. Part of the SAPs were, demands for land tenure structures to be changed for the development of macro-infrastructure projects.

The SAP projects of the 1980s included the construction of airports, highways, dams, mines, subsidys and fewer regulations for industries, lumber operations, and agricultural projects, all of which severely damaged ecosystems and caused social displacements throughout Latin America (Agrawal and Redford 2009). These megaprojects have been environmentally categorized by Taylor (1998) as either demographic push or pull: massive roads and highways pull settlers and businesses into new areas for resource exploitation, while other projects displace or push peasants off the land, as in the case of dams. In Brazil, for example, 400,000 people were displaced when millions of hectares of forest were flooded in the creation of several dams (Taylor Berardo 1998, Pfaff et al. 2007). The SAP programs were an economic boon to some, but for the poor and indigenous they exacerbated land problems, economic inequalities, and environmental degradation.

Colonization programs and mega-projects triggered early approaches to conservation of natural resources during the 1970s and 1980s, but such efforts privileged conservation of areas over the survival and interests of the peasants and indigenous people living on the land. In projects like natural protected areas, biosphere reserves and corridors, local people – “zeros” in the global economy – had little say. In fact, 70 percent of the natural protected areas and parks in Latin America were created during the late 1970s and 1980s and criminalized human occupation and traditional subsistence systems (Neumann 1999). Finally, popular protest against soil erosion, unsustainable farming, biodiversity depletion, over-exportation of raw materials, and massive social displacements in the early 1990s forced the World Bank to address the social and environmental problems brought with their development projects and come up with a greener economic agenda (Goldman 2005, 7-13). Partly due to the SAPs, development aid for the poor was still considered more important than ever, and multiple NGOs proliferated during the 1990s to subcontract with and consult for the World Bank (Goldman 2005, 37). The World Bank's reconfiguration and expansion in the 1990s, including the integration of environmental impact assessments into development projects, marked a turning point in the way conservation and development were seen and applied worldwide.

World Bank projects now included a wide range of considerations, including new legal regimes, regulation and management of natural resources, social impact assessments, and the strengthening of relationships with conservation institutions. In 2000 the World-Wide Fund for Nature (WWF) established the Center for Conservation Finance, which merged the world of conservation with that of international finance to create a new generation of income-generating conservation models that could be replicated all over the world. After heated disputes between northern investors and the southern countries, a global conservation agenda[9] compatible with biodiversity conservation, sustainable use of natural resources, and equitable sharing of benefits was finally agreed upon in the 1992 Convention of Biological Diversity (CBD) (Raustiala 1997). The treaty committed developing nations to establish protected areas, regulate natural resources, and rehabilitate degraded areas with the financial support of developed countries and the administration of the World Bank's Global Environmental Facility (GEF) (CBD 1993). United Nations agencies (UNEP,UNESCO, and especially the Man and the Biosphere Program-MAB), the International Union for the Conservation of Nature (IUCN), big international non-governmental organizations (BINGOs) like Conservation Inter-national, The Nature Conservancy (TNC), the World Wide Fund for Nature (WWF), and the World Resources Institute (WRI), combined to lead these neoliberal conservation efforts (Roberts and Demetria-Thanos 2003b). Latin America received the most funding for biodiversity conservation projects, and in fact, Central America's and Mexico's percentage of areas under protection rose above of the worlds' average by 1997, soon followed by South America (Zimmerer, Galt, and Buck 2004). By 1999, Mexico, Costa Rica, Guatemala, Peru, and Chile were receiving major donations for projects that included 23 transnational natural protected areas for the maintenance

[9] Raustiala (1997) details the development of the international regulations of the Convention of Biological Diversity and its applications on the United Kingdom and United Sates of America, two states deeply involved in the process but with remarkably different internal institutional responses like the US rejection of the treaty, especially to the Intellectual Property Rights (IPR) commitments and the increase on responsibilities beyond their extended federal management of biological resources.

of habitat connectivity (Zimmerer, Galt, and Buck 2004). A key part of the conservation efforts was attention to property rights and resource management at the local level.

The increasing number of international institutions and BINGOS involved in environmental conservation have created larger networks of actors, development of ideas, knowledge and funding, but also has increased the number of decision-makers and thus complexity over local land management. This increased involvement of international institutions in the local ecologies of developing countries has prompted some to decry a new era of colonialism (Kenneth Iain 2005). Increasingly, local level actors must adhere to global agencies' priorities, culture of administration, accounting, types of ecological and social assessments, and timelines or be cut out of the networks.

The creation of buffer management zones, community based conservation (CBC), managed forests, and extractive reserves are some examples created to integrate conservation and socioeconomic development. However, social issues related to land rights, especially on communally owned lands and indigenous territories, have remained a core problem among conservation projects in many Latin American countries (Roberts and Demetria-Thanos 2003b). The Mesoamerican Biological Corridor (MBC) is perhaps one of the earliest documented projects exemplifying the dual purpose of neoliberal conservation and preserving land rights. The MBC was envisioned in the early 1990s in Mexico President Zedillo's Plan Puebla Panama (PPP) and Central American Free Trade Agreement (CAFTA) meant to integrate eight countries from southern Mexico to southern Panama in a massive investment scheme. Besides support for superhighways, high speed railroads, maquiladora complexes, and agro industry, the Plan also called for a natural corridor linking 600 natural protected areas for the purpose of green production of certified products, environmental services for the protection of watersheds and forested areas, and "fair" market channels for the local people (Finley-Brook 2007). Advocates claim that unlike the macroeconomic projects of the 1970s and 1980s, this strategy protects the environment and social elements like culture and identity (Taylor Berardo 1998). Protesters, on the other hand, argue that this market-friendly conservationist model has increased resource extraction, land use conversion, peasant bankruptcy, displacement of indigenous people, and the loss of traditional practices (Chase 2002, Roberts and Demetria-Thanos 2003b, Mansfield 2004, Heynen 2005, Perreault and Martin 2005, Heynen et. al. 2007, Igoe and Brockington 2007, Agrawal and Redford 2009).

As the World Bank and the Inter-American Development Bank (IDB) redefined eco-development and became more inclusive, security of land rights remained a primary focus under the assumption that they would bolster conservation practices and reduce poverty via free market integration. Hardin's Tragedy of the Commons theory was revived in Latin American countries, with the conflation of communal property and unregulated exploitation of natural resources. Thus, the World Bank pushed land privatization in nearly all its projects, which has meant greater concentration of power and wealth in capital-intensive operations and further marginalization of peasants and the reinvigoration of land claims based on ethnicity (Kay 2002, 26), despite the Bank's official policies claiming to protect them. The neoliberal shift away from land redistribution and communal enterprises towards the privatization and de-collectivization of lands required a new investment infusion for land registration, titling programs, and the collection of taxes. The idea of securing property rights for the poor was first suggested by the Peruvian economist Hernando De Soto as a way to reinvigorate the urban financial system and overcome the 1980s crisis of Peru (Fernandes 2002). Although he has published few articles in academic journals, his work has been popular among policymakers on development economics, especially in the World Bank and the International Monetary Funding (IMF). The titling and registration of the informal property system started in the early 1990s in Latin America purportedly as a strategy for conserving forests and other natural resources, but also to create incentives for external investment (Igoe 2007). Secured land tenure was also thought to support sustainable agriculture on the assumption that small farmers would invest in long-term land-use strategies and qualify for commercial or public credit programs (Taylor Berardo 1998). Loans, however, can also provide the capital for unsustainable practices, such as the inputs of transgenic seeds, pesticides and fertilizers.

Although the term neoliberalism is commonly associated with state disempowerment by deregulation, decentralization and privatization (Heynen 2005), the states' power over the management of natural resources has grown with spiraling regulations that have kept governments as the main administrators of such resources. Currently, 74 percent of the forest worldwide is administered by governments, two percent is owned by states or provinces, and nine percent is owned by local communities, while 14 percent is privately owned (Sunderlin, Hatcher, and Liddle 2008). In some developing countries like Nicaragua, Brazil, Bolivia, Guatemala, and Mexico, land reforms are starting to cede forest rights to local people (Larson et al. 2010), but their governments maintain strong top-down administrative power over the natural resources through conservation programs (Chase 2002, Roberts and Demetria-Thanos 2003b, Castree 2008). In Nicaragua, the shrinking of public finances due to SAP's has caused officials to turn to bio-prospecting or tourism with the help of private enterprises or NGOs to fund conservation programs (Finley-Brook 2007). With some exceptions, the neoliberal conservation agenda in Latin America has had a re-regulation focus, where states in conjunction with multilateral agencies have rather active roles in the decision making over natural resources.

As for local participation in the protection of their environment and resources, many multinational conservation projects have been criticized for only consulting with local residents rather than fully including them in planning and implementation. Many conservation projects have been criticized as being determined by the founders (development banks, aid agencies, foreign consultants, corporations and central governments) where all the "valuable knowledge" is produced while local's inputs are barely taken into account. Finley-Brook's (2007) analysis of the the MBC in Nicaragua exemplifies the top-down administrative structure and the exclusion of local participation. The degree and ways in which communities should participate is still contested, and although everybody agrees that sustainable conservation and development projects require local communities' participation, centralized multinational or national planning continues to overshadow community buy-in (Roberts and Demetria-Thanos 2003a, Jackiewicz 2006). On the other hand, some blame neoliberal conservation projects for putting too much responsibility on communities while not providing the appropriate rights and tools for success (Escobar 1995). A long line of participatory approaches have been tried going back to the 1970s (Herlihy and Knapp 2003). Examples of initiatives where local participation has been successfully included in resources management and development programs have merged under methodologies like Participatory Research Mapping (PRM), which attempts to gauge how indigenous people use their natural environment and make informed decisions related to conservation, land rights, and development. The PRM methodology has been applied in the establishment of biosphere reserves project in Central America like the Tawaka Biosphere Reserve in the Mosquitia (Herlihy and Leake 1990), the Río Plátano Biosphere reserve (Herlihy 1999, 2001), the Bosawas International Biosphere Reserve in Nicaragua (Stocks 2003), and other projects in Darién and Panama (Herlihy 2003). Such projects have been successful because locals are invested in their lands, resources, and livelihoods and their knowledge surpasses any other outside knowledge related to their region, which is critical to long-term agreements for natural resources use and management.

The Development of Payments for Environmental Services (PES) in Latin America

In this new trend of local participation and legal property rights, came the idea of payments for the provision of a range of environmental services (PES) in the late 1990s as an innovative way to encourage local conservation. In 2003 a World Bank report addressed the question of sustainable development in the context of pressures on local and global common property resources (water, air, soil and fisheries, etc) as well as the ability of the planet to absorb waste and regulate the climate. Although relatively new in Latin America,[10] PES quickly reached $1.5 billion annually for conserving 12 to 15 million hectares in less than a decade (Ferraro 2001). By 2002 more than 300 projects used financial incentives for the protection of resources in developing countries (Landell-Mills and Ina T. 2002b). While the logic behind the rapidly evolving PES approach is simple -- turning environmental services into a commodity to achieve more “rational” land use -- its implementation is anything but simple (Wunder 2005). Part of the problems lies in the premise that it is the losers in the marketplace, i.e., the poor, who are the most environmentally destructive and thus need monetary incentives or compensation to care for the forests (Pagiola et al. 2002a; 2005, Velázquez et. al. 2002, Muñoz-Piña 2003).

While the PES logic reduces deforestation to local decisions, there are many other forces at play. Structural adjustment program (SAP)-driven government’s subsidies that encourage forest conversion into agriculture and livestock production are one. Thus, a partial view of the situation can lead to policies that fail to anticipate side effects like the introduction of new income, consumption, expansion of labor, and land markets, all of which can have a deleterious impact on the environment.

Another problem of PES programs has been their preference for privatization and well defined property rights to develop eco-markets. Although not absolutely required, strongly protected property rights have always been considered a key ingredient for the success of the

[10] A similar strategy started to be implemented in United States by The Nature of Conservancy in 1951 (The_Nature_Conservancy 2010). More recently, payment initiatives have been implemented in Europe in the form of financial incentives to keep farmers from overproducing certain crops or letting their lands revert to wilderness. From 1993 to 1997, 14 European nations spent an estimated $11 billion to revert more than 20 million hectares of farmland back to forest (Ferraro 2001).

PES programs (Landell-Mills and Ford 1999, Landell-Mills 2002, Grieg-Gran, Porras, and Wunder 2005, Merino and Martínez 2009, Lyster 2011, Ezzine-de-Blas et al. 2011, Larson et al. 2013, Resosudarmo et al. 2013), which has generally not been the case in Latin America, where property rights are often not well defined and resources like forests are often held in common or have overlapping claims, access, and management. There, negotiations over commonly held lands must be made with groups, not individuals, increasing the administrative cost of PES implementation. The legalization of property rights and privatization of the commons has been suggested as a shortcut (Lipper, McCarthy, and David 2009), but even if privatization may give landholders the freedom and security to invest in natural resources, PES motivates individual owners to restrict certain land uses that threaten the environment. In this respect, Wunder (2005) argued that the main concern for PES implementation should not be on private property rights but the *de facto* use of the natural resources, although he concludes that the more open the access to land and resources the less likely that PES will meet their intended outcomes.

Thus, the resolution of land tenure issues on protected and prospected areas has been a main objective in projects like the MBC (Finley-Brook 2007), PES projects, and eco-markets since the early 1990s. Property rights and payments for environmental services pioneered by Costa Rica have spread throughout Latin America as the main toolkit for forest conservation and it has been adopted by the UN program for Reducing Emissions from Deforestation and Forest Degradation (REDD), the most recent multinational conservation endeavor that will be analyzed later.

The E*volution of Payments for Environmental Services of the Forest*

There is a wide variety of overlapping benefits attributed to forest preservation, but four have been directly linked to the evolution of eco-markets: (1) greenhouse gas mitigation or carbon sequestration, (2) biodiversity conservation; (3) hydrological services; and (4) scenic value. The benefits, therefore, may be strictly local, as in the case of preserving the quality and quantity of local water sources, or global and local in the case of carbon sequestration. Other secondary benefits might include prevention of soil erosion (Pagiola, Landell-Mills, and Bishop 2002a). ES can also be combined with other conservation strategies, as in the Mesoamerican Biological Corridor, which includes the promotion of biodiversity in shaded coffee plantations in El Salvador and Guatemala along with the Payment of Environmental Services (PES) in Costa Rica.

In general, payments compensate landowners during a set period of years for the protection of the existing forest (primary or secondary) or agroforestry systems and the prevention of land-use changes during these years. When PES requires reforestation, contracts demand owners to plant trees on agricultural or other abandoned land and maintain them for 10 or 15 years via doing soil restoration activities (Bray et al. 2003, Mansourian et al. 2005). The payment periods are the same for sustainable forestry contracts, where landowners are compensated for enlisting a sustainable, low-intensity logging plan while keeping forest services intact (Muñoz-Piña et al. 2008, Sánchez-Azofeifa et al. 2007, Pagiola et al. 2005). Compensation varies among countries and categories: for sustainable silvopastoral practices in 2003, the average payments per farm in Colombia were $357 USD, $557 USD in Costa Rica, $446 USD in Nicaragua (Pagiola et al. 2005), and $472 USD for agroforestry in Guatemala (INAB, 2010), but generally in Latin American countries landowners are paid around $30 to $50 USD per hectare (Ferraro and Simpson 2002). The length of programs vary from five to 10 years according by category.To ensure that recipients maintain their contracts, payments are made in installments, commonly 50 percent the first years for the implementation of a management plan and 50 percent in the following years for maintenance.

Among the early problems encountered in PES programs is “slippage,” where recipients clear lands not in the program to replace the resources lost under PES (Wu 2000).

Moreover, many Latin American countries face poor institutional and physical infrastructure to support PES programs, which is reflected at the implementation and monitoring stages. Starting with the design, when PES projects are disconnected from local realities with regulations that tend to restrict the use of natural resources from which poor people rely for their subsistence, they are destined to be unsustainable (Alix-Garcia et al. 2009, Lipper, McCarthy, and David 2009). Another common problem of poor design is when programs end up only rewarding areas where resources are at risk of being lost, devaluing and threatening the areas where sustainable conservation practices are being implemented (Lipper, McCarthy, and David 2009). This, in turn, increases social tensions. In this way more harm than good may be done especially in really poor areas where lower environmental impact practices might already been applied.

Another problem is the preponderance of informal land rights, which often prohibit communities from contracting with public, NGO, and private entities. Latin American countries have been addressing this in a variety of ways, and Guatemala is a good example of the complications involved. There, where most the communities occupy municipal lands, mayors can provide a land certificate that legitimates their use of a specific area, with which they can enter a variety of PES programs. According to the manager of an incentives program for forestry or agroforestry activities (PINPEP) on small holdings that began in 2010, the granting of certificates for land use are confusing for some participants who might think they amount to titles, so in order to avoid misunderstandings and conflicts they prefer to work with a third party institution (NGO's or municipal delegations) without the communities' acknowledgement[11]. Such arrangements seem odd since the main point is to legitimize participants' provision of environmental services, but in countries like Guatemala where land titling for peasants is only beginning, they are the only way forward.

Costa Rica, the F*irst* I*mplementation of PES in Latin America*

PES programs in Costa Rica were among the earliest and have been the most closely examined by other Latin American countries. PES in Costa Rica emerged as a nationwide program based on previous forest subsidy schemes that were among the most highly-agreed successful conservation projects in Latin America. These conservation efforts, which included the creation of forestry laws and reforestation projects, were a reaction to the loss of approximately forty percent of the country's forest-cover to agriculture and pasture between the 1970s and 1990s (Pagiola 2002b). Forest subsidies allowed credit-constrained farmers to invest in reforestation and familiarized the population with the economic rewards of conservation. The four categories of PES previously mentioned have all been implemented in Costa Rica in two phases: the first from 1997 to 2000 compensated forest owners for the value of natural or recovered forest; and in the second from 2001 to 2011, eco-markets and micro- or local targeting schemes were developed, in which businesses pay landowners directly for environmental services (Sánchez-Azofeifa et al. 2007).

Costa Rica's National Financing Foundation (FONAFIFO) was the first to establish a system of payments for water benefits based on a study of the impact of forest on hydro-energy

[11] Personal communication with the engineer Mauricio Aguirre, in charge of the Program of forest insentives for small land-owners (PINPEP) 06/18/14.

power production on local watersheds (Pagiola 2002b).[12] As discussed above, the PES premise popularized by the World Bank and UN that nature must be commoditized to be appreciated and conserved has generated heated ideological and technical debate. On the technical side, payments for hydrological and carbon sequestration services have been fraught with disagreements as to how to quantify the rewards of conservation. How much forest cover, and what kinds, generates how much water and carbon secuestration? It is indisputable that forests help preserve hydrological systems, but the scientific understanding of the relations between forests and hydrology flows is still unclear. The same is the case for detailed measures and adequate monitoring for carbon (CO2) preserved by the different types of forest cover, which complicates calculations of forests' monetary value (Kaimowitz 2001). Thus, Costa Rica's calculations of the economic value of forests for hydrology flows were a major advance. Unfortunately, its hydrological PES ran into another snag. The services were financed ear-marked fossil fuel sales tax revenues in 1997, but those revenues began to be applied politically to other expenditures and since 2000 most payments have come from the World Bank and the GEF.

Pagiola's (2002)[13] case study of Costa Rica's water services highlighted several challenges, including the limited targeting of priority areas due to land tenure issues. Costa Rican law forbids public contracts with landowners unless they have land titles, but many occupants of desired areas of forest conservation do not have titles (Pagiola 2002b). In response, eventually a private fund for such occupants was created, although they still remained marginalized by the program and eco-market contracts with hydroelectric power plants, breweries, rafting and venture companies, and water utility companies (Pagiola 2002b). These contracts nonetheless are considered the earliest successful advances towards the development of eco-markets and monitoring in Latin America, and other versions have been subsequently tried in other Latin American countries. The Paraná state of Brazil is a great example where water sale taxes have been used to pay for the conservation of watersheds used for municipal drinking water (May et al. 2002). A less popular approach is the one developed in the Cauca Valley of Colombia, where

[12] The Regional Center for Studies in Ecological Economics (CRESEE) conducted a study of the effects of deforestation on water flows and water quality in the Province of Heredia and concluded that forest increased both when compared to grass cover. For more details of the study see (Castro 2001)

[13] Stefano Pagiola is the World Bank's economist who leads the bank's work on PES since 1994 and has published a volume of case studies on market-basement mechanism for forests conservation and selling forest for environmental services. http://info.worldbank.org/etools/docs/library/106763/eedp/eedp/speakers/pagiola.html .

agricultural water users pay a voluntary fee for the protection of upper watersheds (Echavarria 1999).

Besides hyodrological projects, Costa Rica (and later Colombia and Nicaragua) has applied PES to the creation of sustainable forestry-grazing systems. According to the World Bank, PES for forestry-grazing systems implemented with the help of local NGO's and GEF funding have induced positive changes in land-use,improved biodiversity, and significantly sequestered carbon (Pagiola et al. 2005). These PES programs developed a biodiversity and carbon sequestration index that identifies the degree of services provided by different land uses, grading 0 points for annual crops to 1 point for primary forest (bis). The implementation of such indices is now considered a best practice, but, depending on the available data and resources, they are usually too expensive in many developing countries. Carbon sequestration programs are still in the developing stages but are one of the main objectives of the UN-REDD, which includes 13 Latin America partner countries in the calculation of the financial value of storing carbon in forests (UN-REDD 2009).

Costa Rica's experiences with PES have certainly set a starting point for a variety of other Latin American programs, but the extent of their success is disputed. Sánchez-Azofeifa (2007) concluded that the Costa Rican deforestation rates in areas with PES were not significantly lower than other areas with no PES, adding that it is hard to attribute the overall decrease of deforestation to the PES program because the rate was already falling before implementation. Instead, he credits the forest conservation policies and the elaborated system of payments for reforestation prior to the PES. Wunder (2005) concurs, explaining that the deforestation problem was already "improving" in the early 1990's before the onset of the PES program. On another level, it continues to be difficult ascertaining and thereby negotiating the values of forests for eco-markets, especially for hydrological and carbon sequestration services. This is critical because the long-term sustainability of PES forest conservation projects depends on contracts with public and private enterprises (i.e., the eco-markets). Since 2009 REDD has urged its participant countries to develop a standardized measuring, reporting and verification process, but this is still in development.

The Implementation of PES in Mexico

For Mexico a federal PES program was modeled largely after the Costa Rica one. The original goals of preventing deforestation under PES were to reduce soil erosion, maintain biodiversity, improve air quality, and restore overexploited aquifers, but eventually other social elements like the reduction of poverty were included. The first pilot experience in PES involved a hydrological services project in the Pixquiac watershed of Coatepec, Veracruz in 2002, with the development of a trust fund for its protection. The project was spurred by a drought in 1998 that reduced the supply of drinking water in the entire municipality (SENDAS 2010) and has since then been maintained under the guidance of the National Institute of Ecology (INE).

The implementation of the PES program began at the national level in 2003 with a focus on hydrological services because of the country's growing concerns about overexploited watersheds, especially those linked to cloud forests and their provision of water quantity and quality (Muñoz-Piña et al. 2008). Originally, eligibility to enter the program included areas of at least 50 ha. and 80% forest cover in over-exploited aquifers near populations of 5,000 people or more (Muñoz-Piña et al. 2008), with payments of $400 pesos/ha for cloud forest and $300/ha for other type of forest and a maximum payout of 4,000 ha per landowner (Alix-Garcia, De Janvry, and Sadoulet 2008). Favoring cloud forest turned out to have little impact on the protection of watersheds since only 3% of forests in Mexico are cloud forests (INEGI 2005) and the most threatened ecosystems in Mexico are tropical forests.[14] In addition, while scientific studies on the benefits of forest protection-water supply are lacking, thus creating fodder for competing discourses (Mathews 2009), studies do show little overlap between the distribution of forests and overexploited aquifers (Muñoz-Piña et al. 2008). Since then, the criteria and operational rules of the program have been constantly modified. In 2004 a new set of categories that included carbon sequestration, protection of biodiversity and the recovery of agroforestry systems were added. Between 2005 and 2010 the criteria for eligible areas became more inclusive, accepting areas with 50% of forest cover and adding other environmental priority areas like the National Forest Commission (CONAFOR) 60 priority mountains, a risk of deforestation index, regions with

[14] The estimated rate deforestation of the country is 1.2% per year, but across forest type a remarkable increased rate of deforestation is seen in tropical forest, which present a 2.4% rate (Velázquez, Durán-Medina, and Jean-Francois 2003)

runoff water shortage, and the aforementioned regions with very high and high poverty (CONAFOR 2009).

Since fifty percent of the country is still forested and is among the most biologically diverse in the world, the type of services particularly important for its international markets are carbon sequestration and biodiversity (Alix-Garcia et al. 2009). As the majority of the forest (75-80%) is hold in common by rural communities and *ejidos* (Bray et al. 2003) and 86% of the localities inside these communities (with more than 100 ha of forest) have high or very high rates of marginalization (INE-SEMARNAT 2002), the PES program target of areas with very high marginality on overexploited watersheds covered vast swathes of the country. When CONAFOR took over the project as a subsidized federal program in 2003, it prioritized these elements.

The pioneering program did not have well defined policies and was launched the same year as most agricultural products were liberalized under the North American Free Trade Agreement (NAFTA), a situation that gained it the opposition of various anti-neoliberal rural groups (McAfee and Shapiro 2010, Alix-Garcia et al. 2009). Unlike the National Forestry Financing Fund of Costa Rica (FONAFIFO)'s long and gradual experience of forest programs, Mexico's CONAFOR was a recent creation and had to hire most of the staff for the PES program the same year it began to be implemented (Alix-Garcia et al. 2009). Previous reforestation programs were managed by the National Department of Environment and Natural Resources (SEMARNAT), but the newly created CONAFOR was designated to implement the program. After several criteria adjustments in 2006, CONAFOR integrated the PES into a broader program called *Proarbol* with the technical assistance and financial support of congress, the World Bank, and the Global Environmental Facility (GEF) (Ibid.). During the period of 2003 -2009 CONAFOR assigned US$325 millions for environmental services, covering 2,244,000 hectares that included 3,933 projects and benefitted more than 4,600 forest owners, including ejidos, communities, and small private owners (Conafor, 2009). Payments last for five years in exchange for "custodianship" of forests, after which the owners can reapply for another five years or participate in one of the eco-market programs, in which they are first trained in selling their environmental services to private companies or other entities dependent on forest preservation (Medina 2007). Until now, the federal government is the main client and therefore the one who chooses which forests are eligible to be paid, which types of actions should be rewarded, and what amounts paid according to location and forest type.

A national evaluation of the the design, implementation, and the long-term sustainability of the program made by the Postgraduate College (COLPOS)[15] of over 300 randomly selected PES participants in 2003 showed that 75 percent of the lands were in common property and much of the areas under contract were in low risk of deforestation.In other words, much of the money was expended on the protection of forests that were never at risk (González-Guillén 2008). Many contracts went to communities practicing commercial forestry, which obviously did not need PES incentives, but since they were previous participants in CONAFOR programs, it was easier for them to enroll (Alix-Garcia et al. 2009, González-Guillén 2008). Other discouraging pitfalls included misunderstanding of the program by participants, corruption by intermediaries and technicians, and failure to actually protect forests (Alix-Garcia et al. 2009). By 2007, the program restructured its hydrological priority areas to include vulnerability for overexploitation, water scarcity, and floods associated with the lost of forest (Muñoz-Piña et al. 2008). Like the silvopastoral PES implemented in Central America, a differential value index for land use was created based on the type of forest: cloud forest payments per hectare receive 25 percent more than other type (US$36.4 and other types US$27.3) because of cloud forests' ability to hold water (bis). Also, biodiversity priority areas were created based on the analysis of areas with high biodiversity that had not been protected whatsoever, the called GAP analysis (Urquiza-Haas et al. 2009). These additions to the eligibility criteria demonstrate the impact that studies by universities and international institutions have had; however, the performance, fair distribution of money, and the monitoring outcomes of PES have a long way to go before eco-markets can be implemented.

As in Costa Rica, the second stage of the PES in Mexico seeks to devolve control to local governments so they can sell environmental services for profit. This requires a more detailed knowledge of forest benefits and costs of environmental services to know where eco-markets can truly be developed and where they require either a change in forest policy, mandated protection or continuous payments from federal or international funding (Alix-Garcia et al. 2009). On top of this data, potential buyers must be researched as well as traditional rules and institutions by which local people have managed lands in order to structure compatible and environmentally sustainable services projects.

[15] COLPOS is a decentralized institution of the federal government that focuses on agricultural sciences and had seven branches around the different agro-ecological regions of the country.

Lessons L*earned from* PES *for the* D*evelopment of* E*co-markets.*

Since the mid 1990s there has been a great variety of PES initiatives and outcomes among Latin American countries; different land tenure systems, government regulations, environmental conservation efforts prior to PES, different institutional capacities and economies among other factors that have driven their scale and scope. Regardless of their differences, most countries have relied deeply on international funders like the World Bank, GEF, The Nature Conservancy, and ultimately UN-REDD for the development of PES and related programs. These conservation funders have united their strengths with other multinational institutions like FAO, UNEP, UNDP and the USA International Development (USAID) for the development of eco-markets using the past experiences of PES for the development of a more standardized market of environmental services. From 1992-2000, forest services in Latin America received 43 percent of the total funding that the GEF used to support conservation (Landell-Mills and Ina T. 2002), and a decade later 98.5 percent (US$171 million) have been allocated to the UN-REDD program (UN-REDD 2009), marking the transition from PES subsidies to eco-markets. As eco-markets and PES have become trendy amongst concerns of climate change, more and more land has come under neoliberal regulatory control (Pagiola et al. 2005, Sánchez-Azofeifa et al. 2007, Arriagada 2008, Larson et al. 2013, Rothe and Munro-Faure 2013), especially for the new phase of eco-markets. The marketing of ecosystem or environmental services started to be institutionalized in 2007, during the Intergovernmental Panel on Climate Change (IPCC) when it was concluded that reducing deforestation would have larger and more rapid effects on reducing global carbon emissions than any regulation of emission policy. Soon thereafter, the United Nations Framework Convention of Climate Change launched the REDD initiative in its 13^{th} conference in Bali (Springate-Baginski and Wollenberg 2010). By 2009, there were already 144 diverse REDD initiatives worldwide (bis). The intent is to have more globally standardized methods for measuring and monitoring forest carbon sequestration for the creation of a global market of CO2, but the program is still in the testing phase worldwide.

National programs like those of Costa Rica, Guatemala and Mexico are actually both federal and international in their reliance on support from agencies like the World bank, the GEF, and more recently the UN-REDD in providing funding for payments of environmental services (Wunder 2005) and their evolution into eco-markets. Other countries like Ecuador, Colombia and Bolivia began with private schemes but since 2010 joined the UN-REDD and now also receive millions of dollars in funding for their expansion (UN-REDD, 2009). The national PES programs have had more success to date than the private eco-market schemes because of their greater scope and aura of legitimacy. The disadvantage of national programs is that they tend to be more bureaucratic and loaded with political objectives to cater voters or other supporters, elements that increase the costs of implementation and veer away from local needs (Echavarria 2002).

Communally or locally driven conservation initiatives are considered the opposite of state-driven ones, but since NGOs and other large institutions tend to play a key role guiding them, locals do little in the way of self-management. Nonetheless, studies have found that community-managed forests have lower and less variable deforestation rates than state-managed ones (Porter-Bolland et al. 2012). In terms of inclusiveness of community members, there seems to be little difference between community- and state-driven projects. An analysis of local perceptions of community-based conservation initiatives versus the state-based ones in southeastern Mexico (Quintana Roo, Campeche, Oaxaca and Veracruz) found that the major difference revolved around land ownership (Reyes-García et al. 2012). Landless members usually did not appear to recognize the conservation initiatives in their own communities despite over a decade of implementation, whereas individuals with land rights were much more aware and knowledgeable (ibid.). This highlights the fact that locally based conservation initiatives does not always imply equal inclusion and knowledge of all community members, much less equal management, but they do include more active participation by locals in the management of protected areas and thus more sustainability, especially when payments are involved.

In general, community-based and regional scale PES projects target threatened areas that provide greater environmental services, while nationwide PES programs emphasize poverty reduction because of their political agendas. Likewise, the UN, World Bank, and the GEF also stress poverty reduction with their market-based approach. However, opponents allege that payments for environmental conservation are an inefficient means of alleviating poverty (Lipper, McCarthy, and David 2009). On the flip side, in the pragmatic view of economists, who are by far the more prolific writers in the environmental services literature, targeting areas on the basis of poverty reduction can rapidly alienate the potential buyers of environmental services, thus drying up funding and failing to alleviate poverty anyway (Pagiola 2002b, Pagiola, Landell-Mills, and Bishop 2002a, May et al. 2002, Echavarria 2002). They suggest that a more direct approach to poverty alleviation should be applied in addition to identifying areas of poverty that can be ameliorated by PES. Another contradiction is that the poorest people are often the landless and thus unable to participate and benefit from this kind of in programs. A PES program with dual objectives needs to take into account the spatial distribution of poverty and quality of lands, concentrate on areas where the returns from agriculture or resource extraction are low but the environmental services are high (Lipper, McCarthy, and David 2009), but even then it will exclude the landless. Wunder's (2005) analysis of PES in Latin America and Asia reported that people facing medium-sized environmental degradation are more likely to become PES recipients than the poorest who lived in relative harmony with nature because of a range of barriers that they had to overcome in order to switch land uses. Nevertheless, in the Costa Rica case, although the program's primary intention was the protection of watersheds, it helped the poorest in the country because they were the ones most willing to participate (Pagiola 2002b). This highlights importance of relative profitability and fairness as the poor will gladly accept payments that may match or exceed their productive output for particular patch of land or forest that they didn't intend to clear anyway, while purchasers of services in eco-markets find it unprofitable to pay for services in such situations until they realize that investing in the status quo is ultimately a wise decision and that environmental services is being provided.

The market approach to conservation has been controversial especially as opposed to the respectful nature-human relationship emphasized (but not always practiced) by indigenous people. McAfee and Shapiro's (2010) study of the PES in Mexico found that main criticism of PES by activists was the neoliberal failure to acknowledge the values of ecosystems other than money, including the quality of peasant life, biodiversity, and social benefits that are arguably priceless (McAfee and Shapiro 2010). Support from international and national elites is another reason for distrust by several anti-globalization and anti-neoliberal groups. The need for continual financing from transnational institutions and developed countries for the environmental conservation of the south could fall into what some analyst call the dependency trap (Perfecto, Vandermeer, and Wright 2009) or the development game of "aid" transfer from northern to southern countries. Even if part of the eco-markets' plan is to reach local self-sufficiency, the fact that the main buyers of ES come from developed countries is seen as a threat for local autonomy. Latin American countries, however, are not powerless in this matter, and the development of stronger institutions and protective policies can prevent previous dependency mistakes. Besides, environmental problems are now global, so solutions must be as well.

Since eco-markets are still in their initial stage, there are no robust technical and social evaluations of their impacts and considerable research is needed as to the demand and willingness to pay for the environmental services. Regardless, climate change has certainly driven the approach forward. So far, the two major approaches to measure and estimate the reduction of carbon emission from forest for REDD are stock-based and profit-based approaches.

Mexico was one of the six countries that participated in the designing of REDD initiatives, together with Brazil, Nepal, Indonesia, Tanzania and Madagascar (Corbera and Estrada 2010). As previously mentioned, REDD intends different approaches to forest conservation, from payments and more secure land tenure for forest dwellers to alternative livelihood options that even include the possibility of resettling forest dwellers and intensifying agricultural production on non-forested lands. One problem that remains unresolved is the negative impacts that the formalization of land rights could bring for participants since they can marginalize the poor and disenfranchise customary authority structures that in many cases enable the poorest access to resources under local rules.

While Mexico is just beginning to experiment with REDD under community forest partnerships in voluntary carbon markets and funds, it does has experience with earlier initiatives in Chiapas and Oaxaca in 1997 under the Scolel Te Plan Vivo Project. In this project forest holders in conjunction with a technician elaborated a project that is then registered in a carbon market database for potential world-wide buyers. So far, carbon offsets have been sold to international investors like The International Automobile Federal Foundation (http://www.planvivo.org/projects/registeredprojects/scolel-te-mexico/). The program was initially supported by the World Bank Bio-Carbon Fund, international research institutes like the Center of Carbon Management of Edinburg (ECCM), the Plan Vivo Foundation, researchers from El Colegio de la Frontera Sur (ECOSUR), and the coordination of AMBIO NGO (Corbera and Estrada 2010). The project sought to find the forest and agroforestry uses by indigenous communities and how carbon sequestration benefits can be administered to support them (De Jong, Tipper, and Montoya-Gómez 2000).

REDD plans to build from these ongoing initiatives and government ministries, agencies and commissions, such that for Mexico its national program would be administered through the existing PROÁRBOL program and think tanks like INE (The National Ecology Institute) now INECC, INEGI (National Institute of Statistics, Geography and Informatics), and various NGO's (Corbera, Soberanis, and Brown 2009). Current funders include: Fondo Forestal Mexicano, Mexican Carbon Fund (FOMECAR), Financiera Rural, World Bank, Ford and The Rockefeller Foundation.

To conclude, history has shown environmental degradation and increasing poverty to be negative impacts of unsustainable development and industrialization as well as successes in different natural resource conservation efforts from which lessons should be learned. Neoliberalism offers a new market-oriented approach to conservation, which fundamentally involves formalizing property rights, putting a price on the environment, and creating markets for environmental services.

Many Latin American countries have dutifully followed suit, but as Igoe (2007) warns, global programs are always digested at the local level: "neoliberalism has not automatically benefited local people and the environment, particular conditions are the ones that can open new spaces and opportunities to help or to make things worse." Titling lands as a way to reinforce local people's rights and capacity to negotiate with investors have potential threats as well as opportunities. Land rights do not automatically benefit local people or the environment. Much depends on the causes of deforestation and degradation, which may have been, and often were, promoted by the state in the firstplace for economic growth. This is not to say, however, that neoliberal conservation projects by definition harm and do not help local communities.

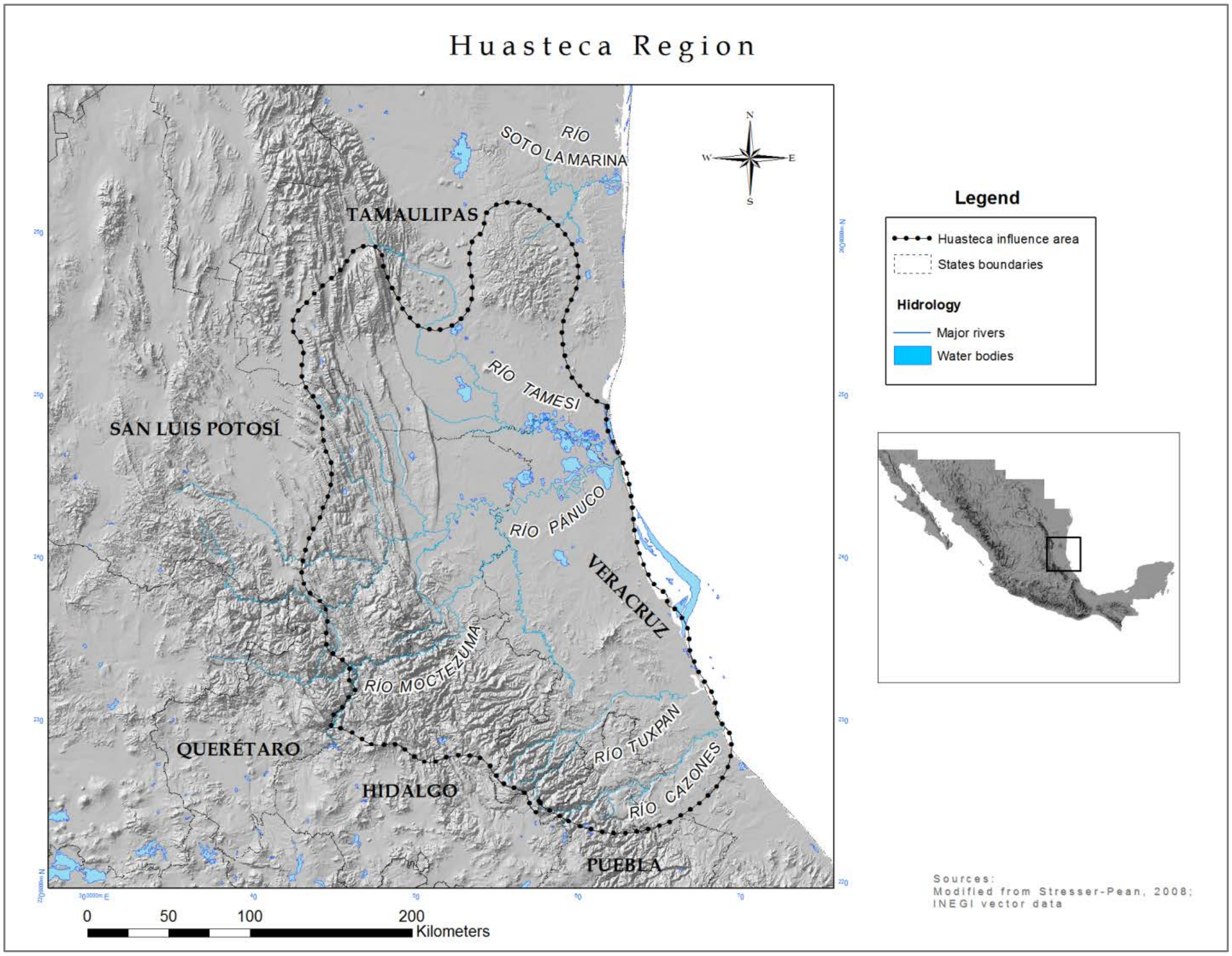
Since land reforms and market-driven conservation approaches are already embedded in conservation policies, it is critical to identify the conditions – global, national, regional, and local – in which the outcomes benefit the local people and their environment. So far, positive outcomes like reversed deforestation in Costa Rica have been tied to its strong internal institutions and regulations that recognize the value of environmental services and adequately rewards land owners with a diversity of financial funds from international donors, national taxes, and private enterprises. The Costa Rica case, however, also shows these ingredients to be costly and possibly unsustainable in the long run if better targeting schemes are not developed.

The development of PES and eco-markets has had a very high implementation cost and almost prohibitive for low income countries, requiring multidisciplinary, international collaborations, strong institutions, and advanced technology to generate reliable data for the implementation and evaluation of these projects. Despite the barriers, Latin American countries are barreling ahead with the market approach, no doubt in part because projects are substantially financed by international agencies. The ultimate success must be measured by whether markets can be sustained and local people and the environment, at both the local and global levels, benefit.

One aspect that has received little research attention is its cultural impact on vulnerable groups like indigenous peoples. The evaluations of PES in Costa Rica, for example, did not address this issue and neither have they in Mexico, where 62 indigenous groups manage lands where most of these programs have been implemented. This oversight is especially egregious for Latin America, where ninety percent of its roughly 40 million indigenous people (http://www.iwgia.org/regions/latin-america/indigenous-peoples-in-latin-america) are subsistence farmers and depend directly on their environment for their survival (Gorman 2003) using diverse worldviews and traditional management strategies. While isolating these vulnerable groups from neoliberal trends is naïve, a better understanding of their lives before plowing ahead with Western economic policies is not. If all agree that conservation needs to start from the bottom up, traditional rules and institutions that local people have been using to control and manage lands should not be ignored but given special attention for the creation of sustainable conservation projects.

III. The Huasteca region, environmental and cultural conditions

What is commonly known as the Huasteca region, which spans from northern Veracruz to eastern San Luis Potosí, northern Hidalgo, southern Tamaulipas, and small portions of Puebla and Querétaro, is based on shared ecology, sociocultural traditions, and history going back for thousands of years[16] (Meade 1942, Stresser-Péan 2008, Ochoa 1979, MacNeish 1947). By the late classic period (600-900 A.D.), the region shared core cultural features with the rest of Mesoamerica (Ochoa 1979).



Map 2. The Huasteca region, area of influence

[16] According to Meade (1942), the Huaxteca region experienced its greatest extension during the Moctezuma Ilhuicamina period (1440-1469), extending west to the goldmines of Guadalcazar and the valley of Tangamanga (today's city of San Luis Potosí).

The Physical Environment

The rugged landscape of the Huasteca began to form during the Mesozoic era from limestone deposits of calcareous and clay sedimentations, when the entire region was still covered by the Atlantic sea (Tamayo 2004). During the Cretaceous period the region surfaced as the Sierra Madre Oriental mountain range emerged. During the Cenozoic its central low mountains zone took shape, followed by the formation of flood plain on the Gulf coast in the Quaternary (bis). The Sierra Madre Oriental ended its formation at the end of the Neogene period (Meade 1942). The central part of the Sierra consists of tectonic, folded, eroded, anticline and syncline layers of limestone, intrusive and extrusive igneous materials from subsequent volcanic activity, and sedimentation. In the foothills of the Sierra and the adjacent valleys, there are reservoir structures with low permeability and folding without faults that explain the importance of the region as an oil reservoir (Tamayo 2004).

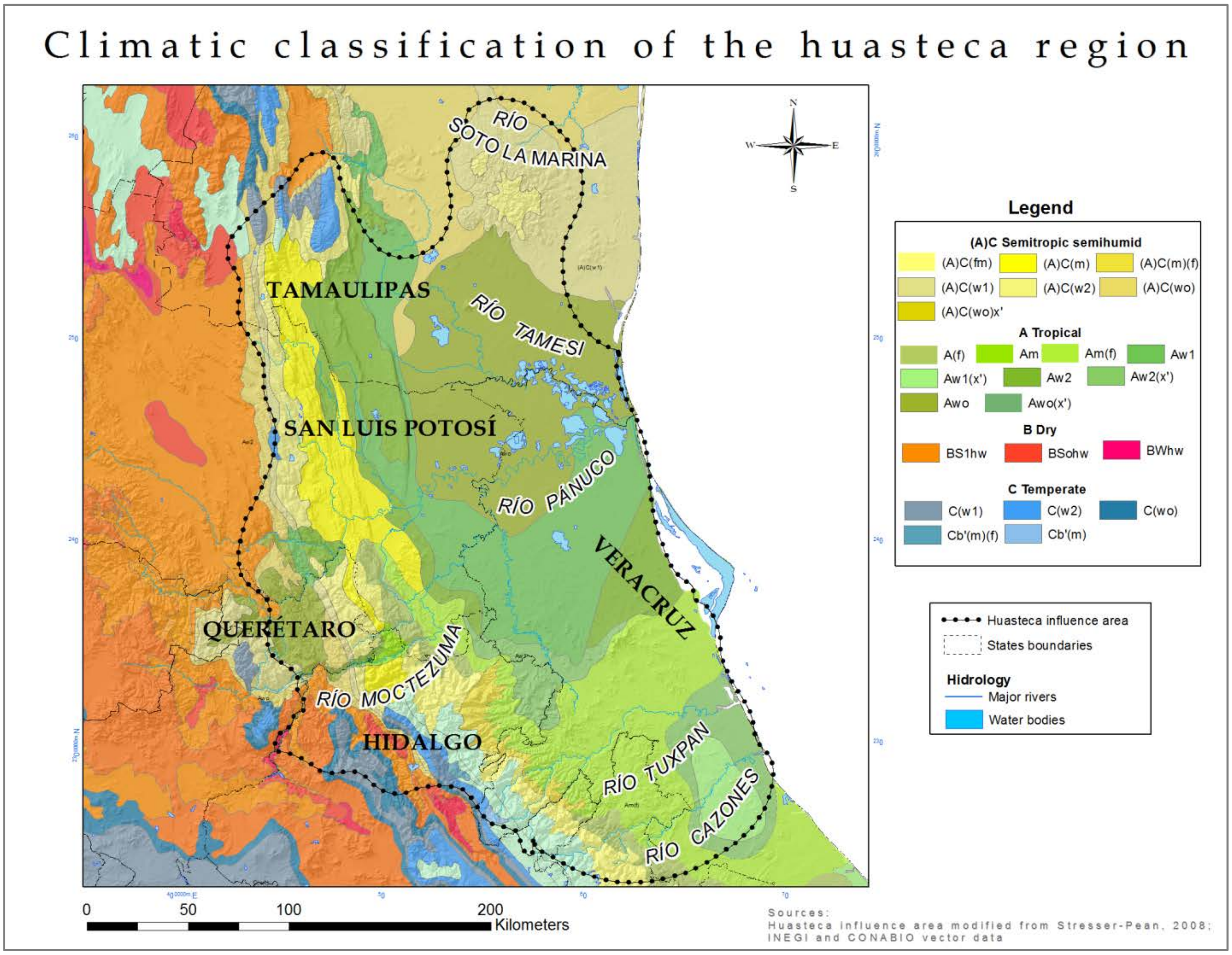
The principal soils of the region are from three groups: rendzinas, which dominate the landscape developed from limestone's residues; chernozems or black soils, found at alluvial flood plains and steppes; and podzolic soils, usually found in cloud and pine forest areas (INEGI, 2005).

The region, as seen in the map above, is fed by a great number of rivers that emerge from the Sierra on their way to the Gulf coast, including the Soto la Marina, Tamesi, Moctezuma, Panuco, Tuxpan and the Cazones. The region has very marked dry and wet seasons, such that creeks vary from trickles to raging torrents according to period, however, the mentioned major rivers always carry water. The great volume of water flowing though the network of rivers and waterfalls in the sierra has drawn the attention of hydroelectric plants and tourism. Other important water sources in the region are the several lagoons spread throughout the coastal plains, the largest ones in north near Tampico, where flooding is common.

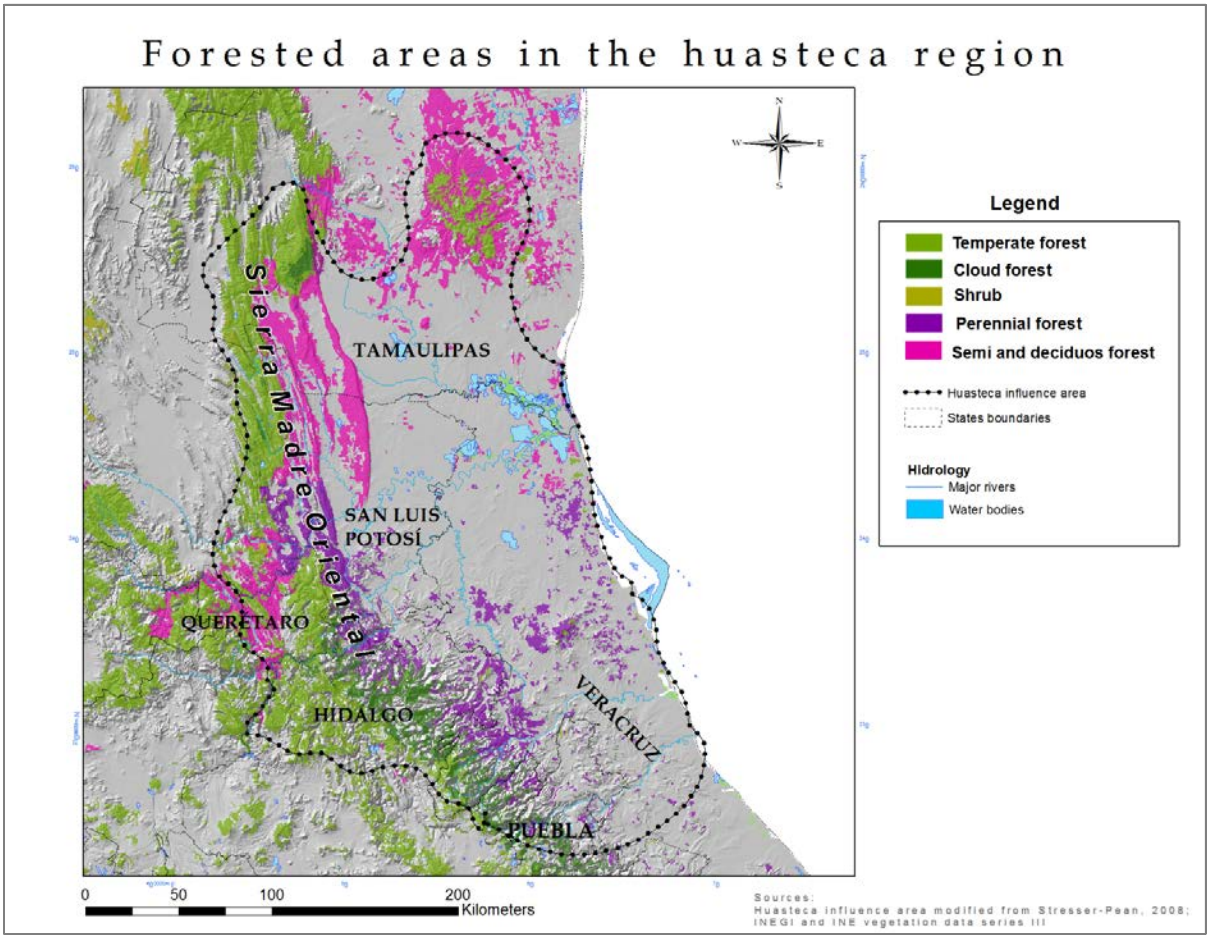
The region mostly falls below the Tropic of Cancer, which combined with its low elevation results in a hot climate, known as *tierra caliente*. According to Koeppen classification, the region as a whole falls into the Aw regime (tropical savanna), for its pronounced dry period during the winter. The more detailed climatic classification for Mexico made by Enriqueta García (1964) divides the region according to precipitation regimes, from tropical monsoon (Amgw) to sub-humid with summer rains (Aw0), to semi-humid climate (Bs) as one goes northwest into the drier steppe mountain ranges of Tamaulipas (see map below).

Climatologically, the region can be divided in two general zones: the dry huasteca near and above the tropic of cancer with an annual rainfall between 800 to 1000 mm; and the wet huasteca in the south, with 1100 to 1700 mm of annual rainfall.

Map 3. Climatic conditions of the Huasteca region



The variation of climatic conditions within the region is mainly responsible for the development of two floristic areas: the Golf Cost of México, which includes savanna grasslands, mangrove swamps, deciduous tropical forest, and thorn forest; and the Sierra Madre Oriental, with major remnants of different kinds of forest, including tropical forest in the south to temperate forests and cloud forest in the interior higher altitudes. The major remnants of forest in the region are located in the states of Tamaulipas, San Luis Potosí, Querétaro and Hidalgo, which serve as biological corridors allowing the movement and survival of wildlife between the agricultural matrices of the region.



Map 4. Types of forest in the Huasteca region

There are two tropical zoographic zones, an upper one that extends from the state of San Luis Potosíinto the humid curve of the Sierra Madre Oriental, and a lower tropical one that covers the drier eastern lowlands. Among the key charismatic species that traverse the region are major wildcats such as jaguar (*Pantera Onca*), puma (*Puma concolor*), margay (*Leopardus* wiedii), and ocelot (*Leopardus pardalis*) (Loa-Loza et al. 2009). Other charismatic species important to include are black bear (*Ursus americanus eremicus)*, deer (*Mazama americana*), the collared peccary (*Pecary tajacu*), and the monarch butterfly (*Dannaus plexipus*) in the temperate and the cloud forest peaks (ibid.). The region is also famous for its tropical birds, such as the emblematic Red Crowned Amazon (*Amazona viridigenalis*), White Crowned Parrot (*Pionus senilis*), and parakeets, including the Green parakeet (*Aratinga holochlora*), and other migratory species that seasonally visit the swamps (Sahagún Sánchez, Navarro, and Reyes Hernández 2013).

The rivers, wetlands and mangrove swamps are homes to amphibians and reptiles like the now legally protected Morelte's crocodile (*Crocodylus moreletti*) and endemic fishes like *Xiphophorus sp.* and *Astyanax sp*. The coastline of Tamaulipas and Veracruz covers a 20,100 km² of sea shore intersected by large rivers and lagoons where a variety of shrimp – (white (*Litopenaeus setiferus*), pink (*Farfantepenaeus dourarum*), brown (Farfante*peneaeus aztecus*) — and oysters abound (Ruvalcaba-Mercado 2005).

The cultural geography of the region

Ethno-history: The first settlers

The earliest signs of agriculture in the region appeared in the floodplains of the Pánuco basin along the gulf coast of Veracruz and the slopes of the Sierra Madre Oriental around 7500 to 7600 BCE, according to scholars' estimations. Full development of sedentary agriculture in the Huasteca appeared later between 3400 and 2500 BCE (Meade 1942, Ochoa 1979, Hudson 2004, Saka 2013b, 3). The first settlers derived from a branch of the Maya language family that separated before the rise of Maya civilization around 2000 BCE (Stresser-Péan 2008). Meade (1942) categorizes these first settlers of the region as the Olmeca-Vixtoti who later became the Cuextecas, a people loosely integrated in the Mesoamerican interaction zone due to their early isolation. As communities grew and agriculture extended within the river valleys during the late formative period (between 1600 and 1100 BCE), a more distinctive Huasteca society called the Teenek began to expand from the north of Veracruz through the coastal lowlands of San Luis Potosíand southern Tamaulipas (Hudson 2004, 654). The Teeneks formed numerous autonomous provinces, each with its own governor (Ochoa 1979, 145). One of its most important centers was Tamtok, which emerged at the banks of the Tamuín River of the Huasteca Potosina around 1000 BCE, until its demise between 900 and 1300 AD (Stresser-Péan 2008, 172-86). By 500 to 200 BCE, the Teenek or Huastec had ceremonial centers at Pánuco, Tamuín, Tancanhuitz and Ébano among other coastal and mountain sites, as evidenced by *cues*, or small mounds characteristic of Huastec sites (Saka 2013b), and by the Classic Period, the population had expanded north to the mountain range of Tamaulipas (Ochoa 1979). The most complex degree of Teenek social organization occurred between the 200 BCE and 800 ACE, when decentralized villages formed independent states with an ascribed chiefly elite that resembled other social organizaitons in the rest of Mesoamerica (Ochoa 1979). In the late classic period, Huastec territory was shrinking, perhaps due to droughts or flooding, particularly between 500 and 700 CE (Hudson 2004, Santiago 2011, 37), yet, between 800 and 1200 AD, the Teenek expanded again northward to modern state of Tamaulipas near Soto La Marina River and to the south at the Tuxpan and Cazones River (bis), and from about 850 to 950 ACE they were involved in maritime trade networks that extended south across the Yucatan peninsula to the Honduras coast line of Central America and north to Tamaulipas (Andrews 1983). The Soto la Marina region is actually considered the northern frontier of Mesoamerican civilization and has strong linkages to both the Huastec civilization and that of the Mississippi basin[17] (Stresser-Péan 2008). Unfortunately all these northern Mesoamerica towns disappeared by the end of the XIV century due to constant wars with nomadic Chichimeca groups (bis). By the post classic period (900-1500 AD), the Huastec civilization extended their connections as far north as the southeast of United States and as far south as the Yucatan peninsula, as according to MacNeish (1947) the Gulf coast shared art, artifacts and settlement types[18], all facilitated by maritime currents (Ochoa 1979).

After the Teeneks' arrival, several other groups eventually migrated into the region, including Nahua, Otomí, Tepehuas, Totonaca, Pame, and in the colonial period Afro-descendants and Mestizos[19]. A brief description of the ethno-history of the region is explained below.

There are several theories for the origin of the region's name, the most popular is the Nahua word *Huaxtlan*, meaning the land (*tlan*) of the bottle gourd (*huaxi*). The missionary and ethnographer Sahagún wrote in his "General history of the Things of New Spain" that the Nahua people named the region "Cuexteca" and the people "*Cuextecos*" after their first encounter with the chief Cuextecatl, and the name later evolved to the hispanized word Huasteca that may have a connection to the Teenek word *cuexhté*, a cotton head band still used by the Teenek women (Meade 1942). Another theory for the origin for the name comes from "*cue*", which means "house of gods" and refers at the pre-hispanic mounds found in the region, such that Cuextlan would mean "the land of temples" (Noguera 1946). As for the first inhabitants of the core region,

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[17] The straight pipes found in the archeological site of Antonio Nogalar are very unusual in Mesoamerica and its relative antiquity suggest that the first pipes that were introduced in Mexico were straight because of the influences of the Mississippi valley (Stresser-Peán 2008). For the huastec civilization, the remains of circular houses, the form of the platforms, certain forms of ceramics, ball games and idols figurines of Huehuetéotl and Xochipili have found here its most northern extreme.

[18] *Cues* (rounded platforms used under their structures) that are found in the lowlands valleys, never above 1000 m. high.

[19] Mixed race between European and Native American.

the people themselves self-identify as *Teenek*, which is a contraction of *Te' Inik* (*Te'* for here and *Inik* for man) meaning "the man from here", and call their territory *Teenek bichou*, as bichou means country or nation. Another name given to the region by Nahua-speaking Mexicas was "Huaxtecapan".

Another group of people that invaded the region were the Totonacos and Tepehuas, probably before the time of Christ, with whom the huastecos would eventually form alliances to defend against the Mexica empire in the post classic period, but eventually all became subjugated and forced to pay tribute to the Aztecs by 1454[20] (Meade 1942). The Aztecs demanded tribute in exotic items like birds (parrots and macaws), shrimp, honey, turkeys, fruits, textiles, tree bark for paper, pigments, animal skins, and above all human sacrificial victims (Santiago 2011, 38). During the early sixteenth century thousands of huastecos from the Panuco's flood plains were captured by the Aztecs as slaves or for human sacrifice to their god of war Huitzilopochtli (Saka 2013b, 7).

The social and environmental impacts of the Spanish arrival at the huasteca region

The Spanish introduced a new variety of plants, animals, epidemic diseases, cultural, social organization, and human genes to the American continent that forever changed the trajectory of history, including that of the Huasteca. When they made their first explorations into to the north of Veracruz in 1517, the Huastecs were already subjugated by the Aztecs; much of Veracruz and the Huasteca Potosina were paying tribute to the empire (Stresser-Péan 2008). The population was disaggregated in self-governing provinces that the Spanish named *señoríos* or *casicázgos* (chiefdoms), the most important being Tziuhcoac, Huexotla and Oxitipa (Pérez-Zevallos 2005). Besides the chiefly centers, there were villages scattered in the sierra and the coastal lagoon of Tamiahua (now Tampico) where population density reached seventy to hundred people per square kilometer; Chicontepec and Ixhuatlán (now Veracrúz), Tamuín (San Luis Potosi), Yahualica and Huejutla (Hidalgo) were among the most important ones (Aguilar-Robledo 1999, Meade 1955).

[20] In 1454, during Netzahualcoyotl's rule, four Huastec tributary towns paid tribute to Texcoco, part of the Aztec Triple Alliance. The Huastecs also allied the people of Metztitlán (in contemporary Hidalgo) to fight the payments of tribute but after several riots Pánuco was completely conquered in 1506 (the Chimalpopoca codex in Meade, 1942).

Hernán Cortés first invaded the Huasteca in 1522 but abruptly left the area to suppress a Cuauhtemoc revolt in Tenochtitlán. He later returned with 40,000 Tlaxcalan allies via the Moctezuma river into the hinterland of the Huasteca Potosina (Saka 2013b, 7). Teenek villages formed unsuccessful alliances to repel the Spanish in Coxcatlán, and throughout the colonial period the area remained a stubborn center of cultural resistance (bis).

Cortés marked the conquered region from the Tuxpan River of northern Veracruz to Huejutla in Hidalgo in the west and the Huasteca Potosina in the north as "Pánuco", where among his first actions was the depopulation of several villages. The major towns of the Huasteca Potosina, like Tamazunchale, Tampaxal, Xilitla, Tancanhuitz and Valles, all fell under Spanish political jurisdiction, but several revolts incited Cortés to destroy dozens of villages and burn four hundred villagers alive (Chipman 1967, 20-21). According to the letters of Fray Nicolas Witte, many Indians were tied up and burned *"so that is how all that land is lost, although it was the most populated land that covers the sun, based on the old edifications that we found on it"* (unedited documents of Mariano Cuevas, 1914 in Meade, 1942). Pánuco's agricultural potential and easy access to the coast became its inhabitants' curse during the colonial period, as Cortés and Francisco de Garay's desire to control the area and turned it into a battlefield. Cortés claimed the region and divided it into *encomiendas* (land grants) for his supporters, but in 1525 the Spanish crown installed Nuño Guzmán (part of the Garay faction) as governor of Pánuco, and Cortés was completely ejected from the region by 1527 (Ruvalcaba-Mercado 2005).

With Nuño Guzmán as the governor the fortune of the native people did not improve, as he specialized in deportating natives slaves to the Antilles. Towns especially suffered dramatic depopulation due to slavery, deportation and epidemic diseases; in six years Nuño shipped four thousand Huastecs to Mexico City and deported another eight thousand to the Antilles in exchange for a thousand head of cattle (Chipman 1966). In Mexico City; most of them died shortly after their arrival due to their low resilience to colder conditions and the harshness of forced labor, while many shipments of slaves to the Antilles sank from being overloaded[21] (bis). After five years, Nuño managed to depopulate 90 percent of the Huasteca-Totonaca region and in areas such as Pánuco only two percent of the pre-contact population remained (Saka 2013b,

[21] The Spanish shipped as many as four hundred huastec slaves per boat, many of which sank in the Gulf full of chained Huastecs (Chipman 1966).

9). Some Nahua and Teenek groups were able to escape to the highlands, where they managed to survive and recover demographically. The main hinterlands of recovery were Tantoyuca, Ozulama, and the west and southwest the Huasteca mountain range (Stresser-Péan 2008, 415), regions that since have become important indigenous cores.

In addition to their isolation, indigenous groups were able to survive with the help of the early religious orders (Franciscan and Agustino) that fought against the brutality of Nuño and other governors. Fray Juan de Zumárraga, the first archbishop of Mexico, also known as a protector of native people and enemy of Nuño, denounced him in 1528 for "*leaving Pánuco destroyed and desolated.*" He estimated that the total number of humans exchanged for cattle and horses surpassed fifteen thousand (Pérez-Zevallos 2005).

The introduction of livestock and new crops from the Old World brought drastic changes to the landscape. The Spaniards exploited the resources available in each region, and Pánuco offered little precious metals but had vast prairies that resembled those of southern Spain, where cattle could graze freely.

Although Nuño Guzman governed Pánuco province for only six years, his trade in slaves for cattle was so massive that the Huasteca became one the most important centers for cattle herding in the viceroyalty of New Spain (Aguilar-Robledo 2001). Pánuco province had its own *Mesta*[22] that represented around 150,000 head of cattle between 1530-70 (Butzer 1991), and by the end of this period herding expanded from the jurisdiction of Ciudad Valles to Chicontepec, as cattle, horses and mules supplied meat and beasts of burden for the silver mining centers of Pachuca, Zacatecas and San Luis Potosí (Pérez-Zevallos 2005). As Aguilar-Robledo (2001) explains, the environmental conditions of the region, the niche left empty by the indigenous people, and the explosive growth of livestock (cows, horses and mules) set the stage for the later development of the *ejidos* and indigenous communities' land tenure system that we know today.

Religious orders also played an important role in founding the agrarian ideology of communal lands now associated with indigenous groups. The Augustinians entered to evangelize the Huasteca between 1538 and 1557[23] and started advocating communal lands for indigenous

[22] A cattle registry post for long distance transhumance. The word comes from the Latin *animalia mixta,* referring to the beasts of diverse owners, nobles and church that hired shepherds. The concentration of herds was accompanied by a meeting of their shepherds. A formal council of powerful cattle holders was eventually established and was called a *mesta.*

[23] Their convent in the Nahua pueblo of Xilitla remains the oldest functioning church in the state of San Luis Potosí(Meade 1955, Saka 2013b, 9)

people (Saka 2013b, 10). Since the Spaniards and Creoles took advantage of the land left unoccupied by the indigenous depopulation by claiming them in the form of *mercedes* to the Spanish viceroy, the only fertile lands left to the Indians were the communal lands provided by the local friars. During the next four hundred years, the *mercedes* evolved into private estates while Indians were concentrated into small territories called *repúblicas de indios*.

Indian populations were originally granted to Spaniards as *encomiendas* and were eventually subdivided in a system called *cabecera-sujeto* (head town–subject town) that enabled the *encomendero* (owner) to extract tribute and forced labor. The *encomenderos* practiced a system of indirect rule, with local Indian governments electing their own representatives but supervised by the Spanish authorities and a parish priest (Ducey 2001, 527), which allowed reciprocity and redistribution among the Indians and in turn strengthened alliances for the upcoming rebellions (Pérez-Zevallos 2005). Both the resistance and demographic collapse of the Teenek population motivated the Spaniards to move large numbers of other ethnic groups like Otomies, Tlaxcalans, and Nahuas to pacify and settle Pánuco, for which they received land grants in gratitude for their services (Saka 2013b, 11). Even after the establishment of colonial rule, more Nahuas from the central valley and Tarascans from Michoacan were imported as laborers to replace the intractable Teenek population (Saka 2013b, 12). Gradually, all of these groups integrated into the Nahua and Teenek societies.

The Indian communities dominated the sierra agricultural production through the swidden agriculture of food staples like maize, beans, squash and few cash crops like sugar cane for the production of *pilloncillo,*[24] cane liquor, vanilla, cotton and tobacco (Ducey 2004, 18). The shifting agriculture in the rugged sierra was sustainable despite the fragile rainforest' soils as long as the population size remained small and the plowed plots were allowed to long periods of fallow. Variably known as swidden, shifting, slash-and-burn, and extensive agriculture it entails chopping down trees, setting them ablaze to kill weeds and use the ash for organic fertilizer, and planting and harvesting until weeds take over or the soil loses its fertility, usually within 10 years or less (Santiago 2011). At that point, the land is left to fallow for at least a dozen years (Vandermeer and Perfecto 2005, 41-43). While Indian communal lands tended to be the least arable, they were sufficient for subsistence while the population was in recovery, but eventually the increasing population together with the colonial demands for tribute, taxes, and the

[24] The rough brown sugar, it was used as an exchange owing to its ease of transport and high value.

corruption of colonial officials sparked pressure on the land, environmental degradation, and social unrest all over New Spain.

Throughout the colonial period Indian communities continued to experience pressure from *estancias* or private cattle ranches (Aguilar-Robledo 2003). As concerns over overgrazing emerged, herds began to be moved seasonally (transhumance) as had been done in the Antilles. To expand their options for pasture, private ranchers often united in *condueñazgos* (co-ownerships), also called *haciendas* (Perramond 2010, 35, Aguilar-Robledo 2003). With this system, multiple co-owners registered with the state to regulate land access by custom (Ducey 2004, 18, Perramond 2010, 33). Another mechanism to accumulate lands for the *haciendas* included inheritances, purchases or straight invasions of Indians' holdings. In this way cattle ranchers' territories became enormous and the concentration of lands continued through the seventeenth and eighteenth century (Pérez-Zevallos 2005, 85). Religious orders and priests held the biggest latifundia in the region. For example, in the Valles jurisdiction, the priest Juan Caballero's hacienda San Ignacio del Buey was 600,000 hectares, and Diego Barrientos y Rivera and Domingo Hernandez Prieto's hacienda San Juan Evangelista del Mesquite y anexas encompassed 450,000 hectares in 1643 (Aguilar-Robledo 1999, 214). Although the environmental impact of cattle has been considered moderate, it certainly strongly influenced social organization and land tenure throughout the region, as the best valley lands were devoted to cattle and sugarcane while the worst mountainous lands were left to indigenous farming.

By the middle of the eighteenth century, when indigenous population numbers had recovered, land displacement, high taxation, and forced labor under the Bourbon Reforms slowly caused resentment that contributed to the rebellion for independence. Especially in Yahualica, Huejutla, Pánuco, and Valles, most Indians lived on *haciendas* as servants or worked in the houses of priests, while those still in Indian communities worked without pay in construction projects and other agricultural tasks[25] (Ducey 2001) and paid tribute in produce cotton blankets (Pérez-Zevallos 2005). After three hundred years of colonial rule, local elites largely lost their legitimacy and ability to keep the indigenous populations in order.

[25] For the huasteca region, Michael Ducey (1994) extensive research for the period of 1750 to 1850 describe the local interactions among the different castes, their evolution and its important role throughout the creation of the independent Mexico.

Indigenous groups started to recover as early as the late 1560s in the Chicontepec jurisdiction, gradually followed by other communities of the sierra. The demands for agricultural lands caused native revolts by 1750 and invasions of ranches throughout the region (Valle-Esquivel 2003). The growth of *mestizo* or Creole population was also a key factor in the uprisings, as they neither belonged to the *repúblicas* nor the Spanish ruling caste and thus occupied interstices of the land tenancy system and the colonial bureaucracy, usually at the expense of the weaker Indian communities partly due to their Spanish-speaking skills (Ducey 2004). They appropriated indigenous lands either by permission or by force (ibid.). In addition to the growth of these mixed populations, Blacks were imported to work the sugarcane in the valleys and eventually intermarried with the Mestizo population as well. Some escaped the plantations and settled in the sierra, married indigenous women, and thereby formed a new ethnic group: the Mulatos, another marginalized group that in only a few cases were able to obtain land grants.[26] The combination of the forced labor, the growth of a multiethnic population, the establishment of a caste-based racial order, and the missionaries' communalistic ideology set the foundations for agrarian violence in the nineteenth century.

As hopes of rescinding Bourbon taxes and monopolies over tobacco increased in the Napoleonic period,[27] several indigenous riots broke out that merged with the independence movement in 1812 (Ducey 2004). The insurgents challenged the extractive economy and government at the local level, rebelling first against local officials, the royal tobacco agents, and commercial elites (bis). The chaos of rebellion was such that villagers believed that the insurgent army was defending the Crown by attacking abusive local officials. Perhaps as early as the Crown's actions against Nuño Guzman, the Indians saw the King as a paternalistic protector against abuses of corrupt local officials (ibid.).

The decline of the cattle industry due to the impact on the ecosystem also added fuel to the fire. Documentation of the deteriorating environment was cited in the ordinances of 1819, which stipulated that on pastures under stress cattle were productive at three or four years old rather than two in fertile grasses (Aguilar-Robledo 2001). Aguilar-Robledo (1999, 2001) argues that

[26] San Lorenzo de los Negros's is one town of the few Mulato settlements to which the Crown granted legal recognition in the middle of the seventeenth century. Lacking agricultural lands, some lived as fishermen along the rivers (Herrera-Casasús 1989).

[27] Tobacco was the principal monopoly that challenged the long-standing traditions of the Indigenous towns, the royal government restricted its production and then bought it all to market it through the colony (Ducey 2004).

due to transhumance and evolutionary checks on cattle such as climatic disasters and diseases, herds inflicted a low environmental impact in the region.[28] Santiago (2011) agrees that despite the importance of herding in the Huasteca, it did not dramatically deplete the forest. On the other hand, the social inequalities of the colonial era left its mark on the cultural landscape of the region and continue to this day.

The peasants' struggles to maintain their lands after the Mexican independence

The war of independence in the Huasteca as in most of Mexico was a matter of regional affairs, rooted in the social tensions of local societies. In San Luis Potosi, for example, the call for independence war by Miguel Hidalgo in 1810 did not attract peasants from the large estates in El Bajio (the most productive lowlands in central Mexico) where they were provided permanent employment, insurance, and a social safety net, but the peasants of the Huasteca immediately responded to the call (Tutino 1998, 404). The peasant towns of Tamazunchale, Cd. Valles, Cd. Del Maiz, Rioverde and Xilitla formed a strong insurgent line that was eventually joined by other hinterland towns in the Huasteca Veracruzana (Ducey 2004, 60-76). The insurgence experience awoke the peasant population and gave them the skills, tactics, and unification of warfare for addressing political and social conflicts as well as confronting the several invasions that followed independence, like the U.S. invasion in 1847 and the French invasions in 1857.

At the final stage of the Mexican independence, the *Plan de Iguala* also known as "the three guaranties" (religion, independence and unity) called for the creation of town councils, or *municipalities*, supposedly in the search of equality for all the inhabitants of the country. Following the plan, several municipal councils were created in the region from 1813 to 1821, and challenging the existing limited indigenous autonomy and traditions, non-indigenous people were allowed to participate (Ducey 2004, 97-9, Ducey 2001, 530). Although the plan included democratic elements, it also ensured that local elites, many of whom became militia officers during the independence war, remained in power.

By 1824, the new constitution expanded suffrage to all males regardless of their ethnicity, which increased the indigenous social awareness and empowerment; unfortunately, however, they failed to foresee that liberalism would also threaten their communal lands. Their demands

[28] The two major hurricanes that lashed the region in 1818, in addition to the constant grasshoppers' plagues and wild predators, slowly contributed to the reduction of herds throughout the colony, allowing the recovery of the ecosystems.

for lower taxes and fees, regional autonomy, and protection of their communal lands from commercialization were what they thought liberalism entailed (Ducey 2001, 528). Unfortunately, the elites understood liberalism quite differently as free markets, foreign capital infusion, and especially the dismantlement of communal ownership (bis p. 58-60). Consequently, many communal lands were privatized during the independence period, as described below.

The rapid succession of presidents, political demands and expectations, swinging municipal autonomy (radical federalism) at one extreme to conservative centralism at the other caused local insecurity and violence, and ultimately a civil war in 1832 (Ducey 2004, 172), and also led to a Huastec insurrection in 1845-49 called the "caste war," which contrary to what the name suggests, was quite heterogeneous and had nothing to do with castes. The peasant demands for local political changes and autonomy was also enjoined by local elites who had lost control over offices and national politics. Insurgent peasants and elite conspirators believed that their economic wellbeing depended on dominating local political offices and that a military rebellion or *pronunciamiento* was the only way to achieve their objectives (Ducey 2004, 169, Ducey 2001). The rebellion started in Huejutla, Hidalgo and quickly spread to the indigenous towns of Tamazunchale, Xilitla and Chapulhuacán despite opposition from their own prefects, then across the state boundaries to San Luis Potosí, Veracruz, Puebla and México (Ducey 2004, 112-17). This kind of *pronunciamientos* began to be used by the rebels as a way to win control over municipalities, install their own judges, local military commanders and district prefects. Because the new Mexican republic dispersed its power to the states and ultimately to the municipalities, the Huastec state was now within reach of the rural majority, allowing peasants to become actors in its formation (Ducey 2004, 171). In this way indigenous people rejected several of the land privatizing legislations (in 1826, 1856, and 1883) that threatened to displace them from their collectively owned lands (Ohmstede 1996). Nevertheless, the dream of a nation of autonomous peasant villages never materialized, although the establishment of a new colonial order was thwarted. Unfortunately for the peasant populations, as Ohmstede (1996) has stated, the creation of municipal councils eventually evolved into a new system for dominating the rural population.

While the peasant population, both indigenous and non-indigenous, proved to be a capable resistance force to the U.S invasion between 1846 and 1848, it could not prevent the state confiscation of communal lands. During the U.S invasion, peasants of the Huasteca with the support of some local elites[29] not only blocked the U.S. invasion of Mexico City via San Luis Potosí(from the Huejutla in Hidalgo through the Huasteca Potosina and the Pánuco River),[30] but left the region to confront U.S forces at Tuxpan, Veracruz, Tampico and Tamaulipas. With this flexing of muscle and national respect, the peasants returned to their villages armed in case of more U.S. attacks, with the intention to reclaim communal lands and end tobacco monopolies (Saka 2013b, 21). Local priests led them in their defense of their lands and the occupation of several *haciendas* of the region, especially in the Sierra Gorda of Queretaro and the Huasteca region of San Luis Potosíand Veracruz (bis). The Mexican army managed to suppress most of these invasions, but the peasants continued to be a force to be reckoned with in a new era of agrarian uprisings against municipal governments and *haciendas*.

Throughout the social unrest, liberal power waned, and the government's inability to pay off foreign debt encouraged Britain, France and Spain to invade the country to collect their claims. France sought to dismantle the liberal government with the help of the Conservative party, and once Spain and Britain noted France's intentions withdrew. President Benito Juarez retreated to San Luis Potosi, the provisional capital, and once again the Huasteca provided a solid defense against the French with hundreds of indigenous guards from the Huasteca Potosina and Veracruzana, as well as the provision of food supplies (Saka 2013c, 22). Although the peasant troops were paid a salary, due to the prolonged time of the war (1861-1864), food supplies failed to be sufficient, such that both the army and citizen militia began to occupy unused hacienda lands as payments for their services (bis). When the French invasion was finally suppressed, the liberal government expressed its gratitude towards the peasants of the Huasteca but continued to their plan of dismantling communal lands.

Lands were confiscated from indigenous communities through several laws called *Leyes de desamortización*, which abolished the communal land tenure system and made them an easy target for *hacendados* always looking for ways to expand their properties. After participating in two wars, the Huastecan peasantry found themselves economically depleted and demoralized with the increasing racist ideology developing among elites, especially towards indigenous

[29] Besides independent peasants from villages, *hacienda* owners also sent their workers and supplies to the civilian militias like grains, mules and corn (Saka 2013b, 22).
[30] The huasteca regions of San Luis sent three hundred men from Tancanhuitz, Xilitla, Tamazunchale, Axtla, San Martin, Aquismón, San Antonio Huichimal and Coxcatlán and thirteen from Rio Verde to form part of the artillery and infantry forces (ibid).

population. The clash between the elites and the indigenous peasantry continued from late 1870 to the revolution in 1910 (Saka 2013a, 59). The Liberal Party split as a result of a general discontent with the government and the general Porfirio Diaz's rebellion of Tuxtepec in 1876, which led to his occupation of the presidency for over three decades. Peasants supported the Tuxtepec revolt in hopes of recovering their communal lands, as Díaz had proclaimed to be on the side of the masses, but local elites also supported him in the promises of economic growth and development via more privatization of communal lands and the construction of a railroad from San Luis Potosíto the port of Tampico, which would greatly benefit the sugar and tobacco industries (ibid. p 61). These dreams of exploitation were fulfilled, and once again the peasants' loyalty was taken for granted.

The effects of the Porfiriato on the huasteca land tenure systems and forest

A lot has been said about the economic growth, progress, and the even internal stability that the thirty years (1876-1911) of Porfirio Diaz' dictatorship brought to the country, but a different story of slavery and peasant's land dispossessions must be told about rural Mexico during this period. As the journalist John K. Turner (1908) testified in his *Barbarous Mexico*, many peasants and especially indigenous people were exiled, enslaved and forced to work in inhuman conditions in the name of progress.

For the Huasteca region, progress was found in the form of petroleum. The extraction of the black fossil liquid caused major social and environmental upheaval that translated into more privatization of communal lands, indigenous land dispossessions, and the clearing of large forests. According to Santiago (2006), the shift in land tenure during this period was without precedent in the Huasteca, even when compared to the Aztec or the Spanish invasions (p.70). The infrastructure necessary to extract the fossil liquid – roads, telegraph lines, a single-gauge railroad, ship terminals, and port facilities – was built all the way from Tuxpan to Tampico and was called "Golden Line".[31] Three oilmen were crucial in these endeavors: the Mexican engineer Ezequiel Ordoñez, the American Edward L. Doheny, and the English engineer Weetman Pearson. Together they initialized the process of oil exploration and the

[31] It was the most rich oil portion (eighty five kilometers long and forty five kilometers wide) that began in the middle of the Tamiahua lagoon, curved inline trough Tantoyuca and ended on the banks of Tuxpan River.

industrialization of the Huasteca's coastal plains in 1901 (Santiago 2011, 45). The Golden Line brought a wave of immigration of all social classes[32] from all over Mexico, the United States, and Europe, adding to the region's social complexity via new labor hierarchies, social divisions, and marginalization of several indigenous communities. In two decades, 1900-1920, foreign oilmen alienated indigenous lands through misleading contracts while cattle ranchers, eager to get rid of the tar puddles known as *chapopoteras*, benefitted from the extraction contracts. Ranchers also sold their rainforest properties quickly and cheaply in fear of another indigenous insurrection (Santiago 2006, 74). The unstable social environment of the region made the oil agents work easier, rapidly supplanting local land tenure systems with monopolistic oil landholding. As Santiago (2006) describes in *The Ecology of Oil, Environment, Labor and the Mexican Revolution, 1900-1938,* oil extraction proved to be especially harmful for the coastal plains of Veracruz: "a scale without precedents in its history of human occupation, with degradation spreading as fast, far, and wide like never before." Along with the oil industry, came diseases due to the human confinement and unhealthy working conditions in labor camps.

The privatization of communal lands reappeared again in the main agenda of the Porfirian period in order to facilitate oil extraction. According to Díaz's administration, lands were not "productive" under the indigenous system, therefore new legislations and reforms for privatization and exploitation of natural resources beneath them were created in the name of progress. The petroleum legislation of 1909 declared oil the exclusive property of the surface owner (Santiago 2006, 63), attracting more foreign oil companies into the region. By 1922 four companies held the petroleum rights along the Pánuco River: Doheny's huasteca, Pearson's El Aguila, the American PennMex, and a smaller subsidiary of Royal Dutch Shell called La Corona. After a decade, these companies came to own eighty percent of the Huasteca subsoil, naming the region the "oil country" (Santiago 2006, 67-70, 78, 103).

Indigenous people were easy targets for land dispossession by the oil agents who offered to rent subsoil rights to their lands in the search for oil while owners could continue farming as

[32] After the local indigenous and mestizo men open the oil camps, companies recruited Mexican laborers outside the state and once the business was known worldwide, people from outside the country arrived looking for work. Mexican labors were recruited in mass for physical labor; many were escaping from the revolutionary environment of the northern states of country. Later the Chinese arrived to the country and where recruited for service work in kitchens, cafeterias and hotels, with salaries higher than the Mexicans. Above them where the literate Europeans: Catalans, Irish, Russians and Spaniards that fled from WWI, they were hired as master mechanics, carpenters and machinist (Santiago 2006, 152-3).

usual. Unfortunately, once oil was found, the drilling of wells brought fires, pollution, permanent land degradation to their lands, and even death. Once indigenous people realized the danger involved in oil exploitation for themselves and their crops, they increased the price of their lands' subsoil rights, to which oil agents either accepted or responded with violence (ibid, 74-79, 86).

Cattle ranches, as usual, held a more advantaged position compared to the poor peasants, as they realized early on the royalties that could be demanded as well as the renting of their lands (Santiago 2006, 70-73). By breakout of the revolution in 1910, the cattle ranchers with the oil companies' financial support created their own army to protect against rebellions like the one that would happen in Tampico in 1913 (Santiago 2006, 100, 212).[33] The ranchers, however, also organized a long revolt (1914-1920) to protest the companies' reticence to their demands for higher prices offered for rainforest real estate on the coast, the culmination of which ended with an increase in the price of the rainforest and the conversion of the Huasteca Veracruzana into camps of oil wells.

The environmental degradation of the period was enabled by the complete lack of regulations so as to reap maximum profits in at minimal time and expense. The ecosystems where oil wells were drilled were completely destroyed: first, fires were set to deforest the land; once the oil was gushing, enormous pits were dug to catch the pouring oil (Santiago 2006, 104). Swamps, mangroves and sand dunes were converted into refineries and the Pánuco river was transformed into the refineries drainpipe, receiving an overwhelming quantity of around 50,000,000 m^3 of oil waste per year by 1918 (Santiago 2006, 125). In addition, the overcrowding conditions for workers also facilitated the constant spread of epidemics and diseases like yellow fever and tuberculosis all over Tuxpan to the port of Tampico during 1903 and 1922, and with period breakouts of malaria until 1940 (Santiago 2006, 118, 188). The reckless economic development of the region after independence was devastating for the majority of peasants and indigenous people of the region. The fall of the Porfirian regime and rise the revolution were again triggered by the peasantry demands of land, and better living and work conditions.

[33] While Carranza's constitutionalists advanced to Tampico, the then President of United States Woodrow Wilson ordered the evacuation of all U.S. citizens from Mexico, and many did, leaving Mexicans to protect and run the oil operations for months until the Americans returned with the protection of the U.S. government (Santiago 2006)

Land reforms after the revolution and the capitalist assault

The environmental degradation, especially deforestation all over the country during the Porfirian era, awakened revolutionary consciousness on the need to reduce the rate of environmental destruction. The first attempt to moderate the exploitation of natural resources and protect for the first time agriculture and water resources emerged in 1915 when Carranza decreed a suspension of oil exploitation until the new government established regulatory laws (Santiago 2006, 258). By then, however, Mexico's economy was already dependent on "rapid progress." Despite the revolution and the several oil worker strikes (29 between 1911 to 1921), by 1921 Mexico became the third world's largest producer of oil (Santiago 2006, 216).

With the Constitution of 1917 and its agrarian reform in Article 27, the subsoil private property rights were not eliminated, but owners had to be a Mexican citizen or a naturalized citizen and thereby subject to the state regulatory powers. This restriction in property rights, however, was enough to force the backup of foreign oil companies, leaving many migrant workers of oils camp in the Huasteca jobless and many native people in fear of never recovering their lands (ibid. p, 260). With all the jobless migrants on their territories, the indigenous population saw the urgency to organize and reclaim their alienated lands from the oil companies under Article 27's "restitution of lost lands." The agrarian reform also included a legislation for "idle lands," the purpose of which was to pressure landowners to release uncultivated properties to those who lacked land. These reforms had a great impact on the Huasteca region because of the great amount of "unused" lands that *hacendados* kept in reserve for oil discoveries, and it was no surprise that Veracruz was the first state to implement it. Land barons tried different ways to avoid the expropriation, such as a French *hacendado* in Veracruz who in 1928 presented a provisional plan for timber exploitation on his lands to be exempt of the law (Aguilar-Robledo and Flores-Pacheco 2004). On the peasant side, some revolts emerged after indigenous people tried to sue the oil companies individually or formed organizations to request the Agrarian Commission land (*ejido)* grants to get their communal lands back (Santiago 2006, 274-276). Although several succeeded, they found their lands to be already severely damaged by deforestation, erosion, and oil contamination, especially in northern Veracruz (Santiago 2011). *Hacendados* on the contrary, found it easier to convert their recovered lands into pasture (Santiago 2006, 275). Although land reforms in the new constitution re-opened legal channels for peasants to reclaim their lands, the ranchers maintained the political advantage when it came to the most productive valley lands.

The early government approaches to forest conservation and the scapegoating of peasants

After the revolution, the country stabilized under Álvaro Obregón's presidency (1920-1924). Although known mainly for major educational and labor reforms, he also developed environmental conservation reforms. Perhaps the most influential academic group on the development of this reform was the Mexican Society of Forestry, founded in 1922 under the leadership of Miguel Angel de Quevedo and concerned with peasant deforestation of recovered lands (Klooster 2003, Boyer 2007). Quevedo's approach to rapid deforestation focused on the practices of rural communities, instead of the foreign timber and oil industries that overexploited them. The forestry society calculated that eighty percent of the country's deforestation was attributed to the peasants' unsustainable practices, which the agrarian reform supposedly exacerbated (Boyer 2007, 93). As part the solution, land grantees (*ejidatarios*) were conditioned to conserve, restore and expand their forests (Santiago 2006, 276). This policy, however, was largely disregarded by the next administration of Plutarco E. Calles (1924-28), who reneged on campaign promises of land redistribution, equal justice, and labor rights to once again favor the oil industry. He nonetheless decreed in 1926 regularization of the exploitation, restoration and expansion natural resources, but its main focus were limiting peasants and forcing *ejidos* with forested lands to form state-regulated cooperatives of producers (Boyer 2007, 121, Klooster 2003). Following the Buccareli Agreement of 1923 with the United States, foreign companies were exempted from the land nationalization policies of Article 27 if they had performed "positive acts," or material investments, to their properties, but the Great Depression slowed the oil industry's recovery (Santiago 2006, 285). With less oil being exported from the country, national oil consumption was encouraged and the idea of moderating natural resources exploitation was officially forgotten again (ibid).

Labor conditions also decayed in the Great Depression. In Tampico and northern Veracruz Rockefeller cut fifty percent of Huasteca petroleum's workforce by 1927, and the Royal Dutch Shell "La Corona" closed in 1931, leaving only one third of oil workers employed throughout the country (Santiago 2006, 310-11). Worse still, several hurricanes whipped the region from 1927 to

1933, contributing to a drop in Huasteca population from its peak high of 120,000 in the 1920's to 70,000 in 1930 (ibid. p. 312).

It was not until the next presidential period of Lázaro Cárdenas that protective regulations for natural resources and workers returned. In a conservationist tone, Cárdenas created the "Department of Forestry, Fish, and Game," again under the command of Quevedo, although he did not last long (Boyer 2007, 97). As Boyer (2007) explains, Quevedo was a proponent of scientific paternalism, which clashed with Cárdenas' policy of giving the rural communities control over their natural resources. During its duration, 300 rural cooperatives were established to develop the peasant economy and regulate *ejido* timber exploitation (Boyer 2005, 31). Boyer (2007) argues that Quevedo's conservationist discourse and his heavy-handed cooperative regulations may have actually speeded up deforestation as communities raced to turn forests into fields before the new regulations limited their maneuverability. The department was ultimately dissolved at the end of his presidency in 1940.

Despite Quevedo, the Cárdenas administration implemented important regulatory changes to protect natural resources, especially regarding oil, ending the era of massively destructive oil exploitation in the Huasteca region. The oil industry migrated to southern Veracruz to what is now known as Poza Rica (Rich Well), referring to its oil wealth. In the Huasteca Potosina only Cerro Azul and Ebano remained as a sites of oil extraction until 1978, with Tampico as their major refinery center and port (Santiago 2011, 46, Aguilar-Robledo 1995). The Cardenas' period was especially important for the rural Mexico because it boosted rural education, agricultural development, and redistributed lands to peasants in earnest for the first time. Eighteen million hectares of arable lands were distributed as *ejidos* (Klooster 2003, 98). Cárdenas also improved cattle ranching with the introduction of fencing to replace open range pasturing, exotic guinea grass, and Zebu cattle, a breed well-adapted to the Huasteca (Harnapp 1972).

For the next three decades after Cárdenas, Mexican leaders set forest policies that favored the commercial and state-owned timber interests that received exclusive rights to exploit even community timber lands. A forest law in 1952 allowed the establishment of semi-public corporations known as Industrial Forest Production Units (Unidades Industriales de Explotación Forestal, or UIEF's), created for managing the regional timber extraction in place of community-based producers' cooperatives (Boyer 2005, 35). The law conceded to the UIEF jurisdiction over one sixth of the nation's forests (5.8 million hectares) for 25 years and disregarded whether land tenure was communal or private (ibid). The restrictions imposed by the program blocked the communities from direct access to timber market and forced the peasants to clear new spaces for other activities like cattle grazing. Thus, such "approaches to conservation" only translated into forest exploitation by the powerful and the peasants' inability to manage their own natural resources.

The period of major land redistributions and the modernization clash between mechanized agriculture and the long-established cattle ranching

Land grants from expropriated properties accelerated during the Cárdenas presidential period and many peasants experienced economic improvement. In fact, agricultural production increased 325 percent nationally from 1934 to 1965 due to his agrarian reform and investment in agricultural development (Kay 2002, 44). On the other hand, the agricultural reform caused great insecurity for investors, especially cattle ranchers, who were not sure if and when their "idle lands" would be redistributed. To improve agricultural productivity and ease the social tensions, President Avila Camacho (1940-46) threw the Huasteca into another environmental crisis with his infamous "the march to sea" project. Camacho planned massive tropical agricultural development largely by way of irrigation projects to decongest the plateau region. For the Huasteca, the plan involved the Pujal-Coy irrigation project, which began in 1950 but took the state twenty nine years to finally complete its first phase due to the slow expropriation of 238,000 hectares from the cattle-ranching elites (Aguilar-Robledo 1995, 24). The project absorbed ranching lands of San Luis Potosí, Veracruz and Tamaulipas and it was considered the biggest irrigation district in Latin America. The project did indeed achieve success in terms of reversing the immigration flow, as peasants from states like Nuevo León, Guanajuato, Michoacán, Veracruz and Tlaxcala flocked to the low-populated areas of the region during the first phase of the Pujal-Coy project.[34] The first phase of project included mainly private properties, although the original plan intended to include social properties - *ejidos* and communities- in order to redistribute the land that was still concentrated in few hands. The

[34] It included the municipalities of Ébano, Tamuín and San Vicente Tancuayalab; all located in the state of San Luis Potosí (Hernández et al. 2008).

project intended for the conversion of range cattle into intensive agriculture, but also the clearing of 100,000 hectares of tropical forest in addition to the drainage of several lagoon. This was followed by contamination of soils and water due to the heavy use of agrochemicals (Hernández et al. 2008, 384, Aguilar-Robledo 1995). This project, deeply studied by Aguilar-Robledo (1995) and Hernández *et al* (2008), is a prime example of failure of the technological approach, as it did nothing to dismantle the power of the cattle ranching elite in the region.

With the increasing demand of beef from cities, the inputs made by the Cárdenas administration, and the construction of two highways – one from Mexico City to Tampico via San Luis and another one from the capital to Pánuco via Poza Rica and Pachuca – cattle production was booming by the 1950s. The ongoing demand for beef led the government to implement a regional livestock development project in 1968, facilitated by loans from private banks (Harnapp 1972, 46). The federal government secured money from the World Bank, the International Bank of Reconstruction and Development, and the Alliance for Progress, and channeled the funds through the federal banking system to various private banks (ibid). The program, as Harnapp (1972) discovered, encouraged the replacement of *monte* or “idle” lands for improved pastures with the exotic Guinea and Pangola grasses especially in Pánuco, Tamuin and Tempoal districts. With the transportation improvements, by 1970 the Huasteca provided forty percent of the capital’s beef supply (Harnapp 1972). For the peasants, however, the strength of the cattle industry marginalized them further and diminished the availability of agricultural lands while providing little employment, forcing many to emigrate to find work.

A more drastic option for indigenous communities was land “invasions”, which increased considerably in the 1970s (for Huejutla, Hidalgo see (Schryer 1986). In the end, so-called land reforms did not result in any substantial changes in the patterns of landholdings for most of region, although its failure sparked peasant migration in search of seasonal employment where they were exposed to Spanish and subsequently became more aware of their legal rights in regards to the land (Schryer 1986, 299). When those rights were not legally attainable, the invasions of largely indigenous peasants increased.

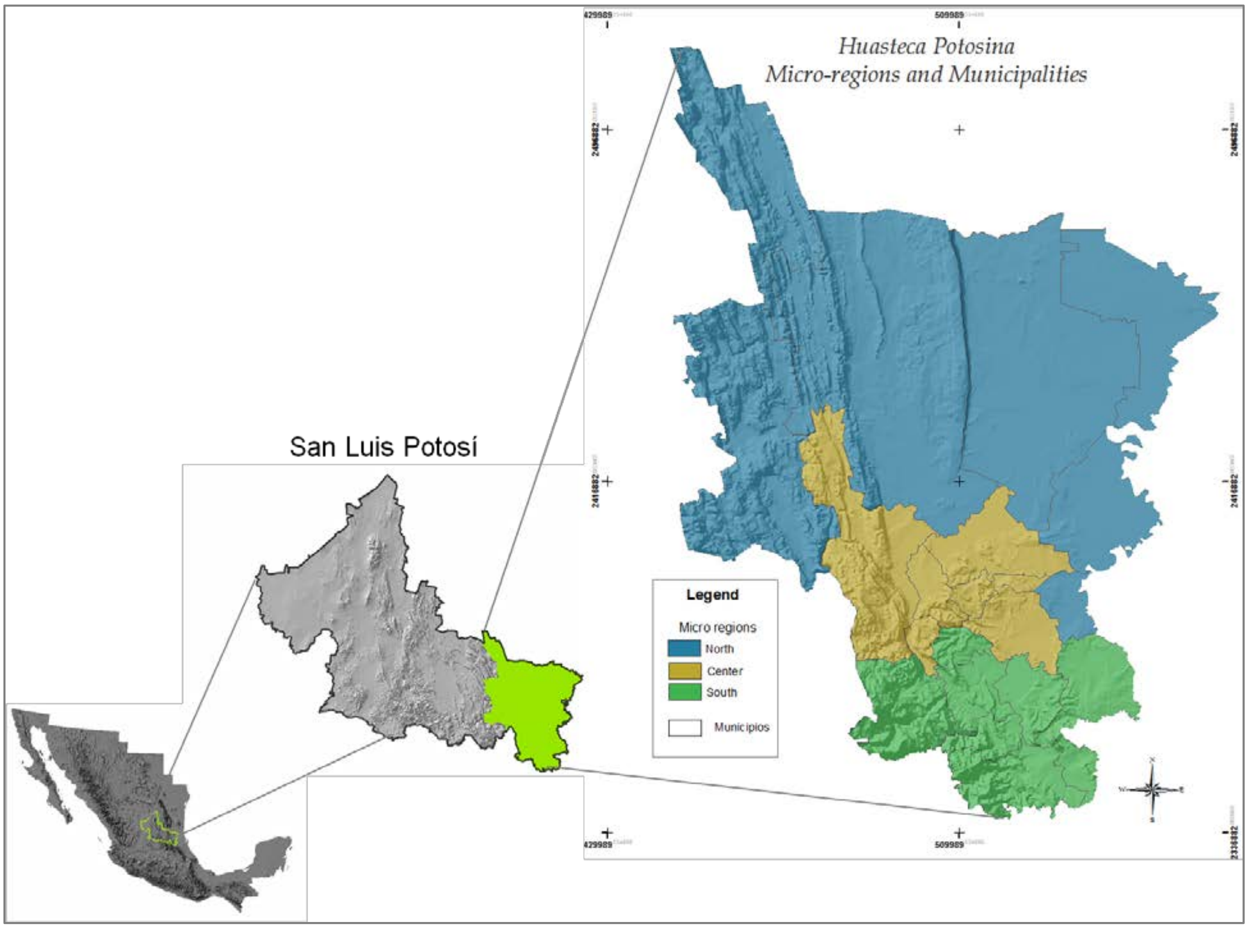
The other major monopolizer of fertile valley lands was the sugar industry, and after the closure of Cuban sugar to the U.S. market in 1960, Mexico expanded its sugar industry to fill the void amidst rising prices (Stresser-Péan 2008, 439). Although the Huasteca had been producing sugar since the colonial period, it substantially increased production such that by 1973, there was a monopoly on sugar cane production in the mills of Pánuco, El Higo, Tamasopo, Ciudad Valles and El Naranjo due to their heavy use of fertilizers, agrochemicals, and improved varieties of sugar cane (Bassols-Batalla 1977b, 133-41). In the Huasteca Potosina the land devoted to sugarcane increased from 2,000 hectares in 1960 to 15,000 in 1970 (Bassols-Batalla 1977a, 247). Along with sugar came diversification in tobacco, maiz, coffee, sesame, cotton, plantain, and industrialized citrus especially in the municipalities of Ciudad Valles, Tamasopo, San Antonio, Tanlajás, Aquismón, Ciudad Santos, Tamazunchale, San Martin Chalchicuautla, Xilitla and Tamuín of the state of San Luis Potosi. The other state experiencing the industrialization of its agriculture was Veracruz, especially in the municipalities of Chicontepec, Papantla, Temapache, Pánuco, Ixtlahuatlán de Madero, Tuxpan, Tihuatlán, Tantoyuca, Tempoal and Gutiérrez Zamora (ibid). In both states, industrialization meant the use of tractors, tillers, pesticides, and fertilizers and ultimately the establishment of juice extraction and processers industries. The majority of the irrigated lands were managed by private owners, but a few ejidos were also granted good agricultural lands to participate. Industrialization brought job opportunities for peasants as *jornaleros* (day laborers) during the harvests but wages were never sufficient to take them out of poverty. Technological modernization efforts of the 1960's also came in the form of big electric plants, cement plants, a rum distillery into Cd. Valles, and the development of the petrochemical industry in Poza Rica and Ciudad Madero-Altamira (ibid.).

To conclude, the history of interactions between the physical environment, social divisions, and cultural conditions have created the landscape that now defines the modern Huasteca region. The purpose of describing some of the major events that have led to the present conditions was to provide a better understanding of the social and environmental conflicts as well as the actors addressed in this research project. In the next chapter on modern neoliberal reforms, the age-old debate between the land privatization and the preservation of communal lands comes to the fore again and has everything to do with how the environment is perceived, defined, and treated.

IV. Study Area: the Huasteca Potosina Region

Political Division

The definition of the Huasteca Potosina region varies, but the most commonly used reference is by the state administration, which includes twenty *municipios*[35] covering 11,292.21 km². For development planning and government programs, the State of San Luis subdivides the region into three micro-regions: north, center and south (see the map below) based on natural resources, economy, level of development, and cultural patterns.



Map 5: Location of the Huasteca Potosina Region

[35] The Mexican administrative unit comparable to a county in the Unites States, it is its own political and legal entity with a county seat.

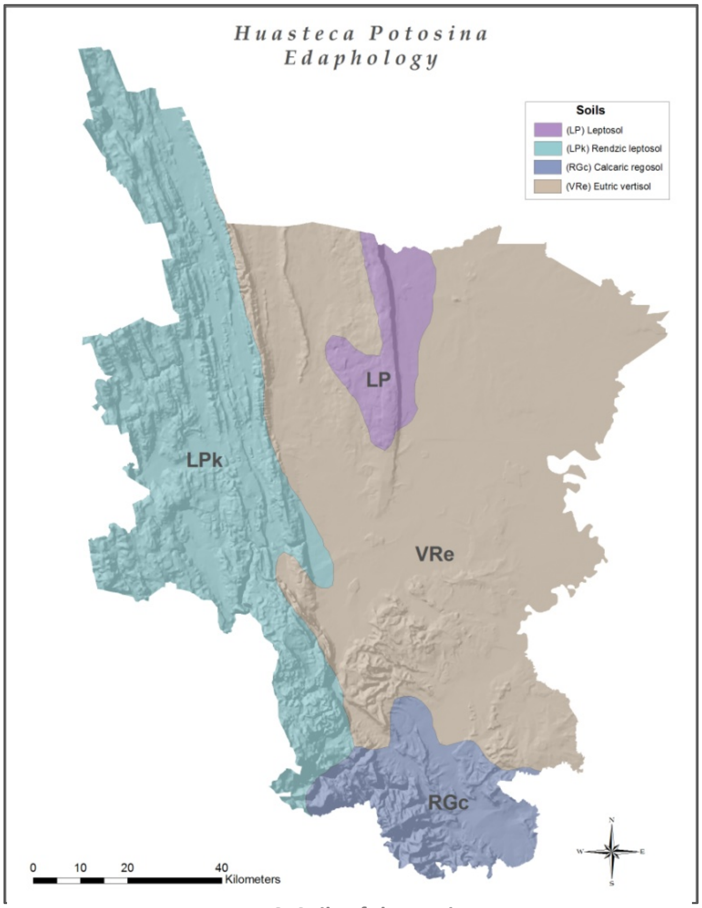
The municipio administration

The *municipios'* political and administrative organization is concentrated in head towns, or *cabeceras*, where the city council is located; each city council has a governor, a municipal manager, and a trustee. Depending on the size and population density of the *municipio*, it can have up to eleven councilmen that represent the political parties not currently in power, called *regidores de representacion proporcional.* The city council has the obligation to reinforce, formulate, and update the development programs of the *municipio*. [36] In the Huasteca Potosina these programs mostly revolve around the cattle industry and agriculture. The prevailing political party of the region over the last 30 years have been the Intitutional Revolutionary Party (PRI), only since 2000 the National Action Party (PAN) has gained some municipal elections in the south.

The Geographical and Ecological Characteristics of the Huasteca Potosina

As mentioned in the introduction to the regional context, the Huasteca Potosina is comprised by two geomorphologic units: the mountain ranges of the Sierra Madre Oriental and the lowland valleys. Except for some high peaks of the southwest mountain range of Xilitla that reach 4000 meters, the overall elevation of the region lies below 500 meters for the most part and is designated *tierra caliente* (hot lands).

[36] From the state constitution "Ley orgánica del municipio libre el estado de San Luis Potosí"

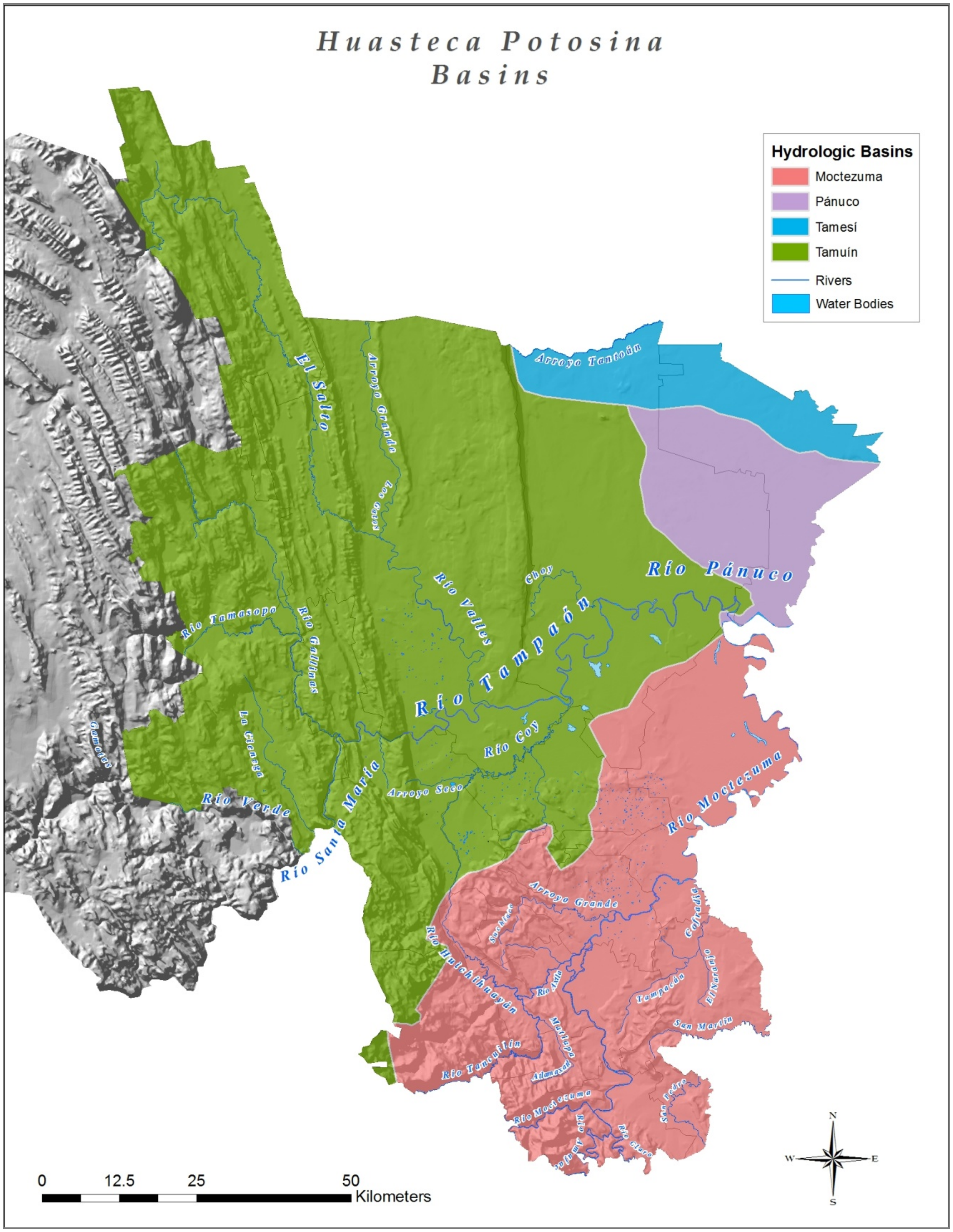


Map 6: Soils of the Region

The karst topography of the Sierra Madre Oriental was formed of limestone during the Cretaceous Period. The eastern valley formed during the Tertiary Period from limestone deposits at the sea level.

Three types of soils predominate: Calcic Leptosol (LP) in the mountains, Eutric Vertisol (VRe) in the lowlands, and Calcaric Regosol (RGe) in the southern mountains. Another type of Leptosol (LP) is found only in isolated low mountains of the Sierra Abra Tanchimpa and La Colmena (see map 2). Leptosols and Regosols are common on mountain regions; they are very shallow and unconsolidated soils that are best left under forest use (FAO). On the contrary, lowland Vertisol soils are blacker, deeper and richer in clay, which makes them more fertile than the sierra soils but still not as much as alluvial soils (Harnapp 1972, 14).

The region is fed by the Pánuco river system which forms four sub-basins of the major rivers: Moctezuma, Pánuco, Tamesí and Tamuín. The Pánuco river together with the Tamesí river are considered, according to Sanders (1978), the second largest system in Mesoamerica after the Usumacinta in terms of the volume of water it carries and the third in length (Alcorn 1984).

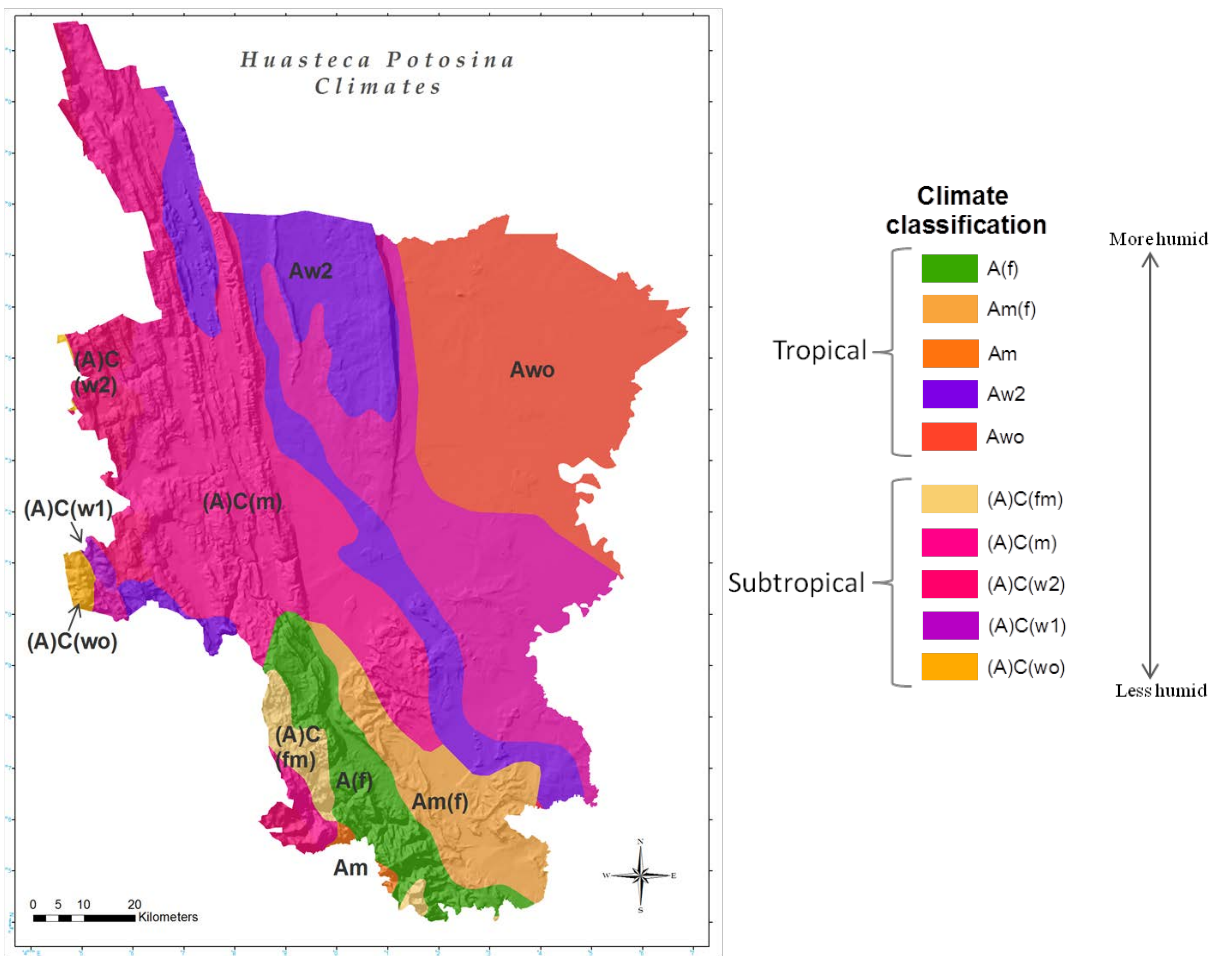


Map 7: Hydrology of the Huasteca Potosina Region

The climatic conditions vary according to latitude, the openness to the northern winds, and openness to the moisture laden winds and hurricanes from the Gulf Coast (Rzedowski 1966a). According to Koeppen's classification, the Huasteca as a whole falls almost entirely within the AW climate type, "tropical wet and dry or savanna regime." However, a modified classification by E. García (1972) differentiates sub-climates and sub-zones within the region (see table1 and map below).

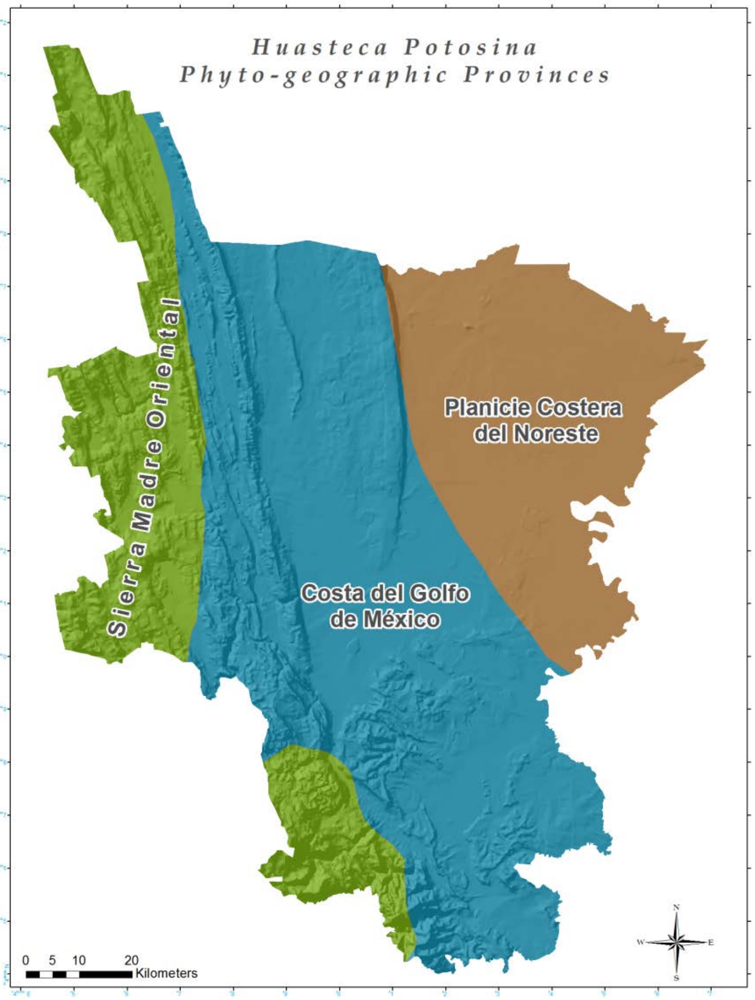
Climate Type	Rainy Season	Dry Season
(A)C(fm), (A)C(m), (A)C(w1), (A)C(w2),(A)C(wo)	May-September	December-April
A(f)	May-September	There is no dry season
Am, Am(f)	May-September	There is no dry season
Aw1, Aw2, Awo	July-September	November-March

Table 5. Principal climates in the Huasteca Potosina Region according to CONABIO



Map 8: Main Climates Distribution in the huasteca region

The physiographical elements and variety of climatic conditions conjoined in the Huasteca Potosina have defined three floristic provinces: The Sierra Madre Oriental, The Golf Coastal Plain, and The Northeastern Coastal Plain province.



Map 9: Phyto-geographic Provinces

The rocky soils of the Sierra Madre Oriental sustain a forest community dominant on *Quercus* in the mountains and *Pinus* in the highest ranges along with other flora associated with cloud forest (Rzedowski 1986).

The pine-oak forest, found in the western extreme between 600 to 2000 meters above the sea level has affinities with southern Mexican, Central American, and the Southern U.S. forests. The most common species are: *Quercus oleoides, Q. polymorpha, Q. sartorii, Q. germane, Pinus teocote and Pinus arizona.* This type of forest is especially under risk of deforestation because of its commercial value, as the woods are considered precious for the manufacture of luxury furniture. Small patches of cloud forest are found in the highest peaks and in those parts of southern Sierra exposed to the cold northern winds during winter. The most dominant species are: *Quercus, Juglans, Dalbergia, Podocarpus* and *Liquidambar.* The majority of these are considered good quality woods for construction. As altitude decreases, four mayor forest ecosystems can be identified: oak-pine forest, rainforest, semi-deciduous tropical forest, and deciduous tropical forest (Flores Mata et al. 1971; Puig 1976; Rzedowski 1978).

Tropical perennial forest or rainforest expands along the warm humid eastern slopes of the Sierra Madre Oriental between 50 and 800 meters of altitude. It has affinities with the rain forest of the Atlantic slopes in southeastern Mexico and Central America but because of local condition related with soils, slope angle and sub-climates, its flora varies (Rzedowski 1963). The dominant species in general are: *Brosimum alicastrum, Bursera simaruba, Celtis monoica, Carpodiptera ameliae, Ceiba pentandra, Dendropanax arboreus, Diospyros digynia, Ficus sp., Garcia nutans, Helliocarpus donnell-smithii, Manilkara achras, Pithecellobium arboretum, Pouteria hypoglauca, Protium copal, Mastichodemdrum capiri, Spondias mombi, Tabebuia roseae, and Trichillia.* This type of forest is especially rich because of the variety of precious woods and biodiversity that it contains. Although many of the tree species are not prized for their timber, most are locally used for construction, medicine, ornamentals, and food.

The following list of arboreal species shows the most commonly used by the Teenek people of the region that J. Alcorn (1984) registered in her book “The Huastec Mayan Ethnobotany.” (They are also commonly known and used by Nahua and Pame groups that live in the sierra.) Their scientific name appears in italics, followed by Spanish common name in parenthesis and then the Teenek name in bold.

- *Brosimum alicastrum* (*ramón* or *capomo*, **ohosh**) is debatably one of the most important species in the Maya cultures for its dominance in perennial and semi-deciduous forests located near their prehistoric settlements. Scholars have suggested that the early Maya cultures encouraged the growth of this particular species in their ancient orchards (Alcorn 1984b, Lundell 1937); however, others suggest that their high density near ancient sites is mainly due to the natural onset of secondary forests once cleared areas are abandoned (Miksicek et al. 1981). Regardless, the tree is considered sacred among Mayas, and its seeds are commonly found in sacred caves as offerings. In addition, the seeds have a high nutritional value and used to be consumed as a replacement for corn in times of scarcity, according to Teenek elders (Gillespie, Bocanegra-Ferguson, and Jimenez-Osornio 2004), although today only a few traditional communities now collect and process the seeds and they are used mainly as forage for livestock .
- *Ceiba pentandra* is considered a precious wood, but beliefs about its being associated with subterranean world attracting water protects it from been over exploited. Another local belief is that if you sleep under this tree, it will suck or thin you blood, making you

weak. It usually blooms in March and is considered a good prognosticator of the coming rainy season and time to prepare for planting. Medicinally, its bark and thorns are used as a cold infusion for measles, pox, and sores and they are frequently sold in local markets.

- *Spondias mombin* (*Jobo,* **k'inim**) is a tree used to manufacture handles. Its fruits are edible and used in the production of local liquor sold mainly to tourists.
- *Pithecellobium arboreo* (*frijolillo* or *coralillo*, **ítil**) wood is also used to manufacture hand tools and is widely abundant in shade grown coffee plantations.
- *Dendropanax arboreus* (*mulumento*, **multe'**) has relieves the symptoms of colds, malaise, and achiness when its leaf's are drunk in an infusion.
- *Heliocarpus donnell-smithii* (*jonote*, **baat**) has many properties attributed to it, but the most commonly mentioned are during childbirths, gastrointestinal pain, and the healing of wounds.
- *Tabebuia rosea* (*palo de rosa*, **k'uul**) is also used to heal wounds, sores, malaise, and uterine and vaginal problems, and its fruit is also edible.
- *Cedrela odorata* (*cedro rojo,* **ikte'**) wood is highly appreciated for the elaboration of fine musical instruments, fine furniture, and house posts. For the indigenous people it is also precious for the bark's and leaves' medicinal qualities in treating headaches, malaise, and even sorcery.

Deciduous forests shares ecotone species with rainforests but the increased abundance of the following species marks the full transition into this forest: *Acacia coulteri, Bursera simaruba, Beaucarnea inermis, Cedrela odorata, Lysiloma acapulcensis, L. divaricata, Phoebe tampicensis, Piscidia piscipula, Sabal Mexicana, and Zuelania guidonia.* The most commonly used species in the region are:

- *Sabal Mexicana* (*palma real* or *de mícheros*, **áptaz**) is an indicator of disturbance in areas where semi-deciduous forests predominated by *Brosimum alicastrum* use to be. The palm is valued by local people for its leaves and trunk used in house construction and the 'hearts' of young trunks (*palmito*), a highly appreciated delicacy.
- *Aphananthe monoica* (*palo barranco* or *quebrancho*, **tza**) has a flexible and hard to break wood that is commonly used for the fabrication of handle tools.

- *Pithecellobium flexicaule* or *Ebanopsis ebano* (*Ebano*, **acte, ajcte**) wood produces high quality charcoal and is also widely used as fence posts and rural construction.

In terms of biodiversity, the patches of tropical and deciduous forest are considered key elements of the biological corridors needed for the mobility of umbrella species like *Panthera onca* (mountain lion), *Ursus americanus eremicus* (black beer), *Leopardus wiedii* (margay) and *Leopardus pardalis* (ocelot) (Loza *et. al.* 2009). Recent surveys of the Sierra Madre Oriental of San Luis have registered 359 bird species from which 71 percent are permanent residents and where the most variety is found in oak, cloud and perennial forests in the central and southern parts of the sierra (Sahagún-Sánchez et al. 2011). Bird species like *Strix occidentalis* (spotted owl), *Amazona viridigenalis* (red-crowned parrot), *Amazona holochlora* (Mexican green parrot), *Aratinga holochlora* (green parakeet), and *Cocodylus moreletii* (Mexican crocodile) are among the umbrella species.

Some of the threatened Sierra vegetation species according to the UICN red book list are: *Magnolia schiedeana* (endemic to Mexico and "endangered"), *Clethra pringlei, C. maerophyla, Carya ovata* (shagbark hickory), *Quercus germana* (Mexican royal oak, endemic to Mexico and "vulnerable"), *Stirax glabrescens*, *Bauhinnia chapulhuacania*, the arborescent fern *Cyathea Mexicana* (endemic to Mexico and "vulnerable"), and the orchids *Stanhopea hernandezii* (endemic), *Prosthechea mariae*, and *P. cicheleata* (Loza *et. al.* 2009).

The last estimation of forest cover in the Sierra Madre Oriental of San Luis Potosí made in 2009 shows the predominance of oak, deciduous, and semi-deciduous forest (see table below). The southern range refers to the mountain appendix of Xilitla, dominated by rainforest and semi-deciduous forest.

Type of vegetation	Major range (Ha.)	South range (Ha.)	Total percentage
Oak forest	172,461.42	3,739.91	41.52
Oak-Pine forest	0.18	4,653.75	1.10
Pine	0.08	15.27	0.00
Pine-Oak forest		4,299.72	1.01
Cloud forest	2,526.21	1,606.12	0.97
Rainforest	0.01	25,954.35	6.12
Semi-deciduous tropical forest	45,579.59	19,197.42	15.26

Deciduous tropical forest	84,928.32		20.01
Seasonal agriculture	21,609.22	14,214	8.44
Palm grove	2,399.32		0.57

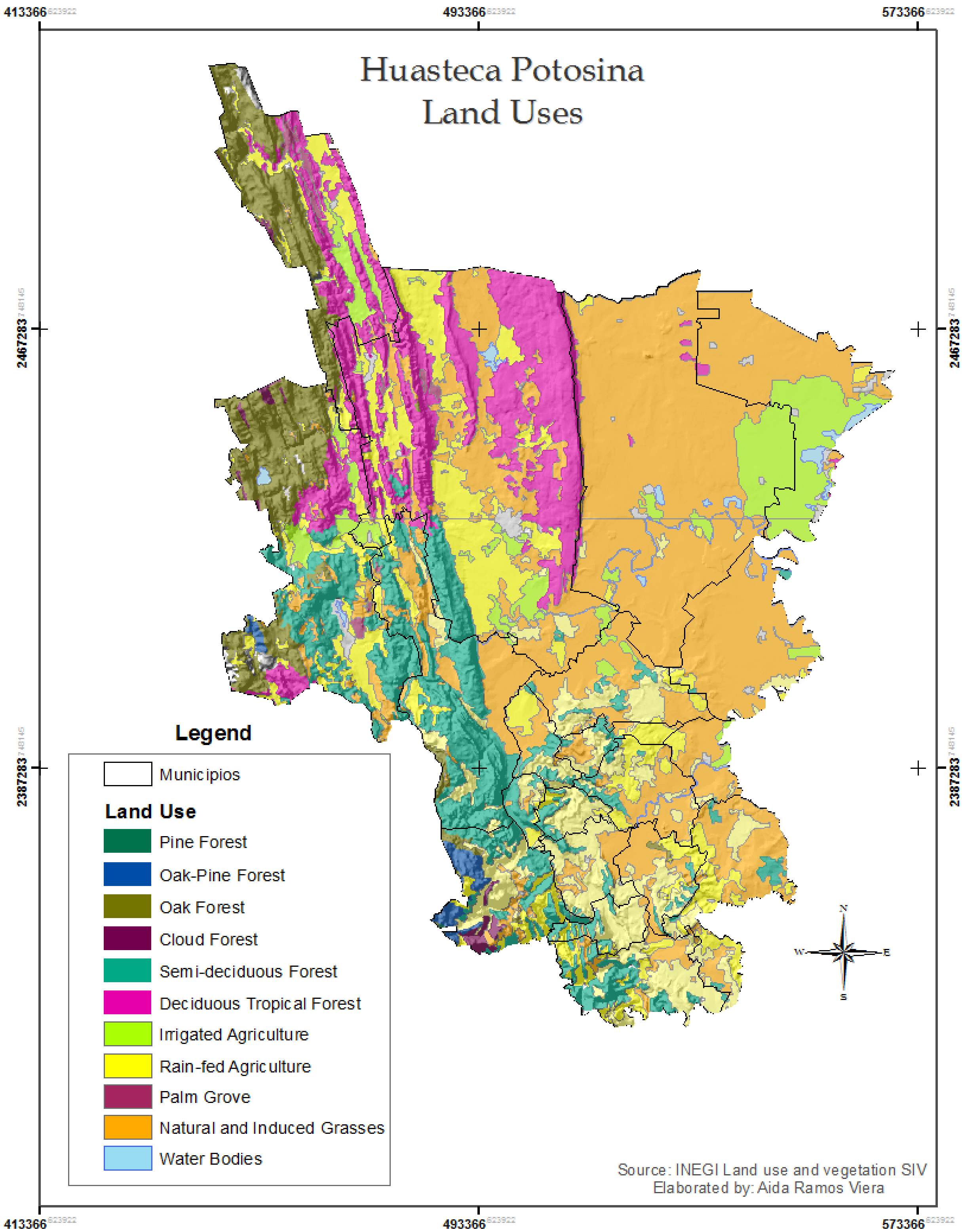
Table 6. Major Types of Vegetation on the Sierra Madre Oriental
Source: Loa Loza E. *et al.* 2009. *Áreas Prioritarias para el Manejo y Conservación del Estado de San Luis Potosí.*

Having the northernmost extension of rainforest in the Americas makes the region a transitional zone and thus richer in species (Rzedowski 1968, 1978). Studies have shown the forests of San Luis Potosíto be richer in vegetative species than those of the Huasteca Veracruzana adjacent to the south (Puig 1967; Flores Mata 1971).

The Gulf Coastal is one of the richest floristic provinces, especially farther south in Veracruz and Tabasco. The strip within the Huasteca Potosina constitutes, together with the small portion of Tamaulipas, the most northernmost extension and is dominated by deciduous and thorn forests. Common elements in this, hotter, dryer tropical forest are: *Acacia coultery, Bursera simaruba, Beaucarnea inermis, Cedrela odorata, Lysiloma acapulquensis, Lysiloma divaricata, Phoebe tampicensis, Pscidia piscipula, Sabal Mexicana,* and *Zuelania guidonia.*

The Northeastern Coastal Province maintains only few remnants of its previous deciduous forest, as most of it (78%) has been converted into grasses for cattle ranching. The small patches of thorn forest remaining are considered a dryer version of the deciduous forest of the northeastern limits of Huasteca Potosina and are predominated by the species: *Pithecellobium flexicaule*, *Phylostylon brasiliense,* and *Acacia unijuga.* The wood found in this region is mainly used as fuel, construction, and medicine sold in local markets.

The map of land uses shows the distribution of the major vegetation types described above.



Map 10: Major Land Uses and Vegetation Types of the Huasteca Potosina

Cultural Conditions

Surrounded and penetrated by human activity, the remaining forests are constantly being reshaped and transformed.[37] As seen in the previous chapter, the region shares similar cultural conditions to other forested areas in the countries where there are high concentrations of indigenous groups, in this case the Teenek (Huastecos), Nahuas, and Pames (Xi Ui). The northern part of the Sierra, however, is mainly inhabited almost entirely by *mestizos*. The different populations have had different interactions with the forest, making both environment and cultures unique[38] and worthy of research in this dissertation.

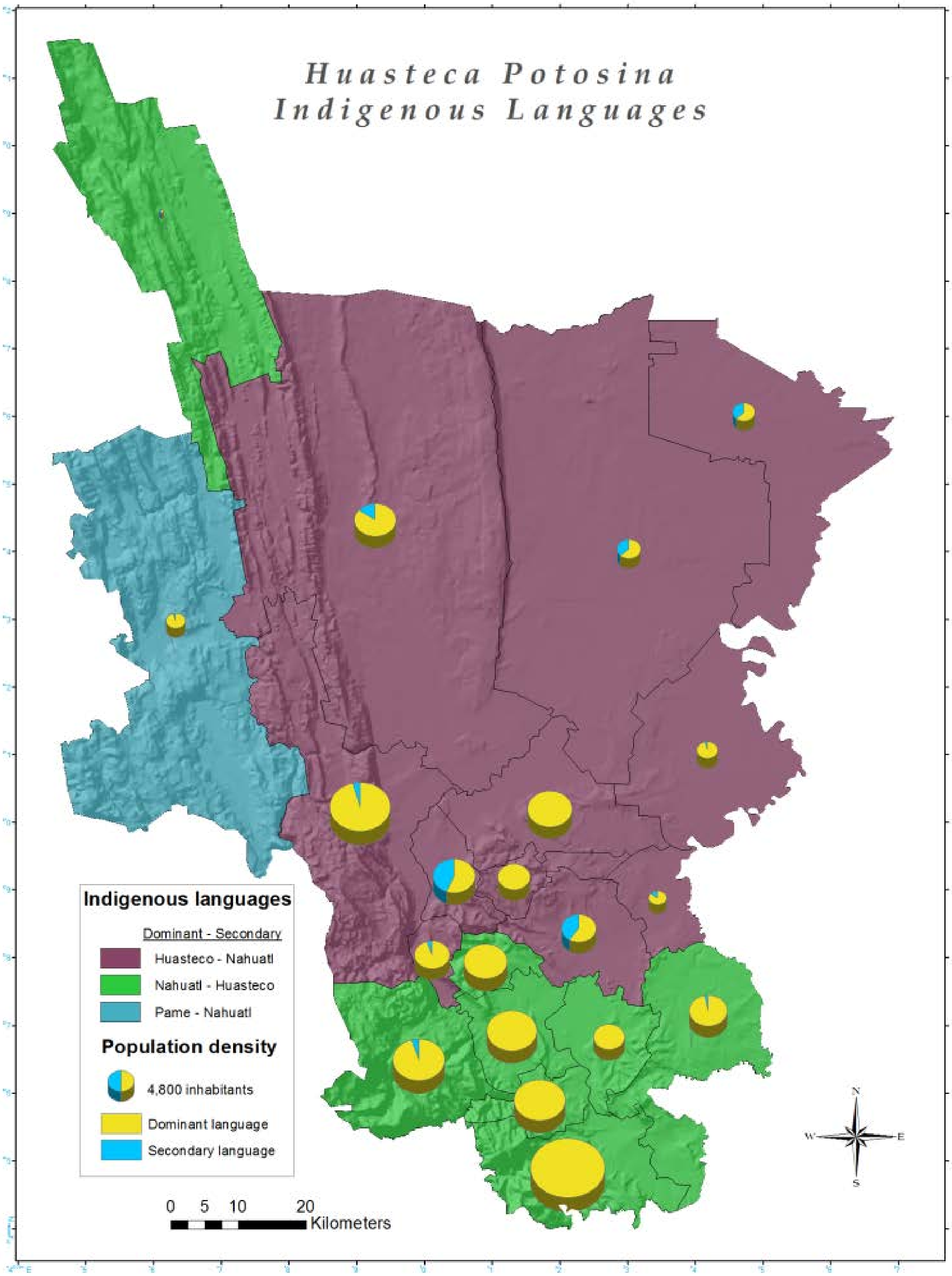
As explained above, the Huasteca Potosina region was originally inhabited by the Teenek people in the lowlands around 1600 to 1100 BCE (Hudson 2004). Cities like Tamtok emerged on the banks of the Tamuín River around 1000 BCE and remained as the most important centers until their demise between 900 and 1300 A.D. (Stresser-Péan 2008, 172-86). However, it was not until around 900-1200 A.D., that a consolidated civilization was formed in the new center of Tamul.

The Nahua population, now bigger than the Teenek in the region, arrived at two different moments in the pre-Hispanic period: the first around 800 BCE and the second during the Aztec expansion around 1400 C.E. (Valle-Esquivel 2003). They constitute 59 percent of the indigenous speakers in the region, followed by the Teenek with 37 percent, and the Pame at 3.4 percent.

The Huasteca Potosina is home to 95 percent of the 348,551 indigenous people of the State of San Luis Potosi, which places the state at the number nine of the country for indigenous population (Serrano, Embriz, and Fernández-Ham 2002). As seen in the map of indigenous languages distribution, ethnicity shows a strong geographical pattern, with the Nahuas concentrated in the south and the Teenek in the central sierra region and lowlands.

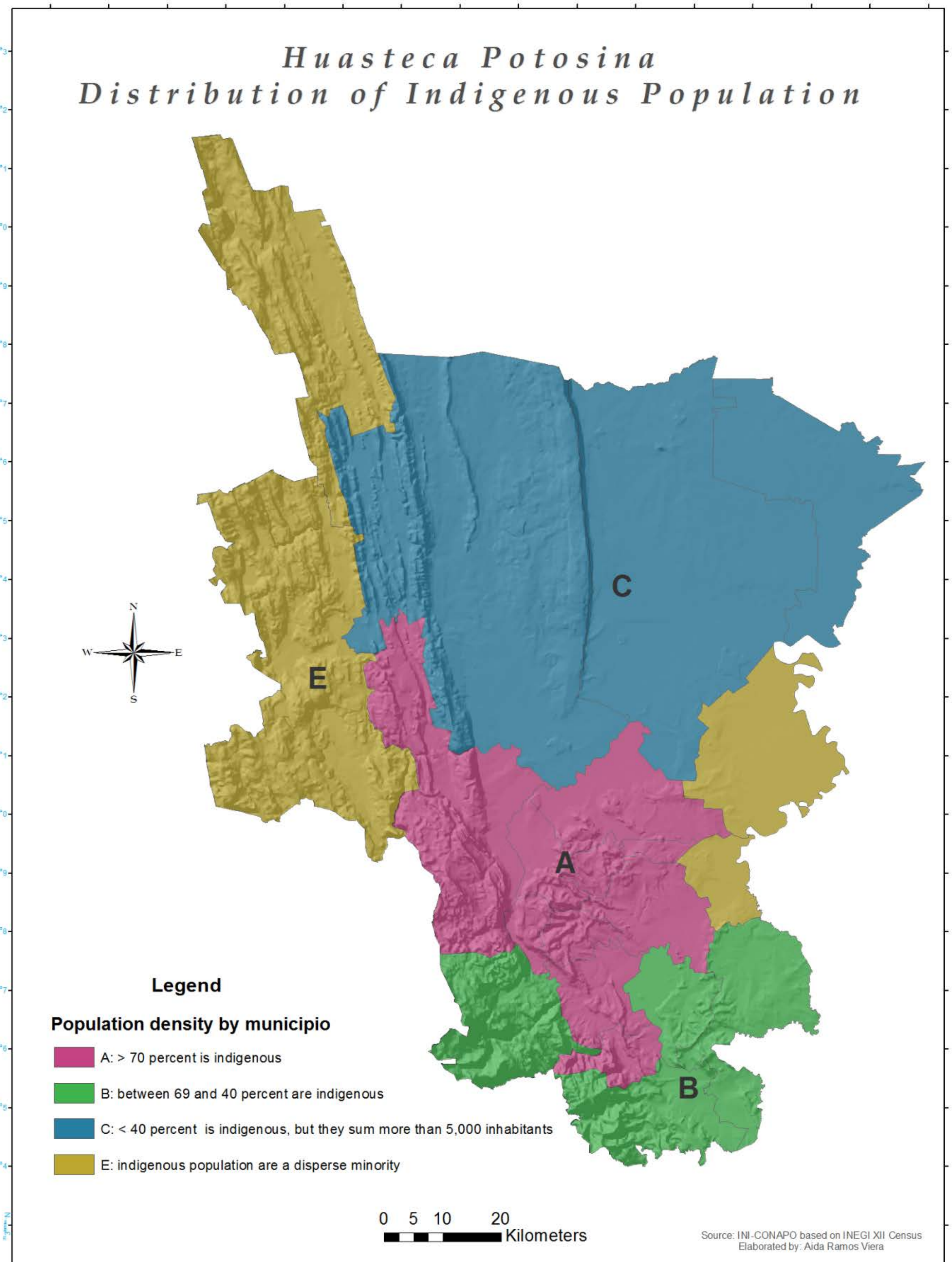
[37] The dynamic nature of tropical forest and the human interventions over thousands of years have made the term "climax vegetation" difficult to describe, rather dynamic mosaic of forest patches in different stages of successions that reach its mature cycle between every 60 or 140 years are identified as primary vegetation (Martinez-Ramos, 1985). Its composition then, reflects the combined impact of climate and human activities since ancient occupancy (Myers 1980).

[38] The te'lom, described by Alcorn (1984) is part of these unique anthropogenic vegetation zones that appear to be "undisturbed" forest from the distance but its species composition and distribution reflects a conscious management.



Map 11: Indigenous Languages Distribution in the Huasteca Potosina

As for population distribution by *municipios*, The National Council of Population and Livelihood (CONAPO) together with the National Indigenous Institute (INI) have created a categorization of indigenous people, which along with the INEGI XII census data of 2002, allows the map shown below for the huasteca potosina by *municipio*: Area A designates more than 70 percent indigenous population; B marks between 69 and 40 percent of the total population are indigenous; C represents less than 40 percent when more than 5,000 inhabitants; and E denotes a dispersed minority of indigenous throughout the *municipio.*



Map 12: Distribution of Indigenous Population by *Municipio* in the Huasteca Potosina

Land tenure systems and the impacts of the neoliberal land reform

As described above, since of end of the Spanish colonial period in 1821 several changes in land tenure have occurred. Following the independence period several campaigns of corporate land privatization occurred, forcing the inhabitants of rural regions (indigenous as well as *mestizo*) to resorted to different strategies to protect, recover, and acquire lands. After the Revolution, the federal government recognized indigenous communities and granted hacienda lands to landless peasants as communal *ejidos* for more than seven decades (from 1920 to 1990).

The first mention of ejidos and the recovery of indigenous communal lands structures[39] came in the midst of the Mexican Revolution during the first agrarian law of 1915 in which lands expropriated from large estates were to be managed communaly by landless peasants. Article 27 of the 1917 Constitution created the legal foundation for the agrarian reform and land redistribution of such *ejidos* lands, after which petitions for *ejido* lands could be requested by organized groups of peasants with demonstrated need. Once the grant was approved, technicians surveyed and measured the land to deliver title and develop an official management plan. The size of the ejidos depended on the number of solicitants, the availability of land, and the quality thereof. Whether ejidos or indigenous communal lands, these "social properties" were prohibited from being privatized and sold, which was intended to prevent the re-concentration of land in the hands of a few owners; however, internally, unequal concentrations due renting or purchasing arrangements were not unusual.

The first distribution of *ejido* lands in the Huasteca Potosina involved the expropriation of land from the *haciendas* where the petitioners had worked before. During Cardenas presidency (1934-1940) the deliverery of land grants sped up, as it did in the rest of the country, but slow down thereafter until the 1970's under the Echeverria administration. By then, however, land scarcity led to a new type of *ejido* called *Nuevos Centros de Poblacion Ejidal* (N.C.P.E), in which peasants were relocated and settlements were often established outside of the *ejido* lands per se, sometimes by more than seven kilometers. The N.C.P.E were the last government efforts of lands grants to peasants and officially ended in the late 1990s. Over a period of 70 years the revolutionary agrarian reform redistributed about 50 percent of the agricultural, forestry and

[39] The concept comes from the latin word *exitum* and was brought by the Spaniards' colonization laws (*leyes de Indias*) in 1523, as the designated communal lands of a village that were located in the outskirts (Magaña 1985).

livestock grazing lands of the country to peasantry, and for the Huasteca Potosina region it created 454 *ejidos.*

In the meantime, indigenous communities have far preceded ejido grants and can have their titles traced back to the early colonial period, if not earlier. Most in the Huasteca Potosina lost their ancestral lands after Independence and regained part of them after the Revolution using colonial documents like maps and taxation records to establish ancestral rights, as well as purchasing other former lands. The granting of ancestral community lands are considered “of restituted origin” by the agrarian registry. Initially, the state was slow to recognize indigenous communities as social properties, such that in the early 1920s six Huasteca Potosina communities opted for *ejidos* lands instead, including four Pame communities that received lands from a large hacienda in the *municipio* of Tamasopo and the Teenek community of Tampaxal in the *municipio* of Aquismón (Tiedje 2005). These early indigenous-based ejidos tend to be bigger than other *ejidos*. The process of formally recognizing indigenous communities per se started during Cardenas’ presidency in the 1930s and continued until the 1990s, with most occurring in the 1980s.

The agrarian counter-reform of 1992 ended the distribution of social properties and facilitated their certification, land titling, and privatization if their members so choose, although many indigenous communities and *ejidos* have chosen to keep collective ownership of their lands under. Today, the National Registry of Agrarian Properties (RAN) refers to indigenous communities and *ejidos* as *nucleos agrarios* (agrarian units), regardless of their certification status. For the Huasteca Potosina 613 *nucleos agrarios* of varying sizes and backgrounds that cover 59 percent of the region, as will be discussed later.

The counter-reform of 1992 reinforced the perception that ejidos are advantageous over indigenous community titles, due to the formers’ improved land measurements techniques used by surveyors and the privatization of a property title, causing more communities to convert and certify their land as *ejido*s. Of 159 indigenous communities in the Huasteca Potosina, covering seven percent (763.40 km^2) of the territory and located predominantly in the southern *municipios* of Aquismón, Axtla de Terrazas, Coxcatlán, Huehuetlán, Matlapa, San Antonio, San Martín Chalchicuautla, Tamazunchale, Tancanhuitz de Santos, Tampacán, Tampolón Corona, Tanlajas, and Xilitla, only 15 have not certified their lands under the counter-reform.

The Neoliberal Counter-Reform

In Mexico, a series of neoliberal reforms were introduced in the mid 1980s as a strategy to cut the government deficit by the elimination of a great amount of subsidies, the privatization of state-run firms, and the promotion of foreign products and capital investments.

The agrarian land counter-reform of 1992 was a center piece of the neoliberal restructuring. This counter-reform intended to reinvigorate productivity and inversions in rural areas as well as jumpstart the urban financial system by enabling the buying and selling of land through titling , a solution of the Peruvian economist Hernando De Soto (Fernandes 2002, Johnson 2001). The World Bank and International Monetary Fund (IMF) included his ideas in Structural Adjustment Programs for indebted Latin American countries. These social properties, however, are home to a great amount of the natural resources, which led to environmental concerns such as that for biodiversity to be integrated into the privatization schemes. As mentioned above, it was thought that legal property ownership would stop land invasions, overexploitation of natural resources, and create incentives for external investments (Igoe and Brockington 2007). Privatization schemes included assistance for sustainable agriculture now that farmers, it was assumed, could invest in the long-term on their own private lands.

The national land certification and property titling of the counter-reform was implementated by a program called PROCEDE, with whom *ejidos* and communities could "voluntarily" certify, title, and privatize their lands to varying degrees. The degrees of privatization can be classified in five broad categories:

1) The lowest degree is for communities and *ejidos* to keep all their lands communally owned and certify only the external perimeter of their community. Internal organization is kept almost intact, and although each owner has their own parcels, they do not receive individual titles and internal sales can only be made through communal processes. One advantage of this certification is that owners do not have to pay individual taxes for their parcels or house plot titles. For communities and *ejidos* with common use lands, which are usually forested areas unsuitable for agriculture, the certification process gives each property owner (*ejidatarios* and *comuneros*) a title of an equal percentage of the common area, which gives them an equal right to use the lands but not claim any specific area.

2) The second degree of certification is when communities and *ejidos* request individual certificates for their parcels. Here, landowners usually acquire individual house plot titles in addition to certification of communal areas. The certification of parcels and house plot titles entails that the owner must pay property taxes; the individual or communal of payment of taxes is decided by a communal general assembly. The most common decision is to set a rate for each certification of property no matter its size. Although the decision to certify parcels and obtain titles is made by the majority of the community or *ejido* assembly, not all owners are obligated to certify their lands. Many poor owners do not certify or chose only their parcels or house plots, which inhibits them from accessing government programs and other types of aid. In fact, the decision to certify only the perimeter of their lands (category 1 above) is made mainly by the poorest communities and *ejidos* afraid of not being able to pay taxes and thus losing their land.
3) Collective ownership is another land tenure system maintained in some *ejidos* and communities, in which a group of property owners organizes to manage the land in a collective way, usually for agricultural or cattle production. In the Huasteca Potosina, the most common collective land uses are for sugar cane and cattle ranching. The presence of communal and collective properties helps preserve the internal organization of agrarian *nucleos*, even if individual parcels have been certified, because such areas require group maintenance.
4) Another step towards greater privatization involves a community's decision to certify their parceled lands under the title of *dominio pleno*, meaning total domain. This title gives each owner full domain over his or her property to be rented or sold without the community's consent. Such titling highly threatens the internal organization of *ejidos* and communities, and unless communal lands are maintained, members might not feel obligated to any communal work (*tequio*) or contribute to other collective benefits. So far, 25 *ejidos* in the region have chosen this title in different proportions of their territory: 18 *ejidos* have less than 10 percent of their lands under *dominio pleno,* three have between 20-30 percent, three have 50-60 percent, and only one has almost all its territory (85 percent) under *dominio pleno*. In fact, almost all of the *ejidos* that have chosen *dominio pleno* do not have communal use areas or have very few hectares in a communitarian parcel. Significantly, these *ejidos* are located in lowlands where almost all the land is arable. The only exception is the *ejido* "El Sabinito" located in the northern mountain range of Sierra, where 64 percent of its territory

(forested) is communal and only four percent of their parceled arable lands have been certified under *domino pleno.*

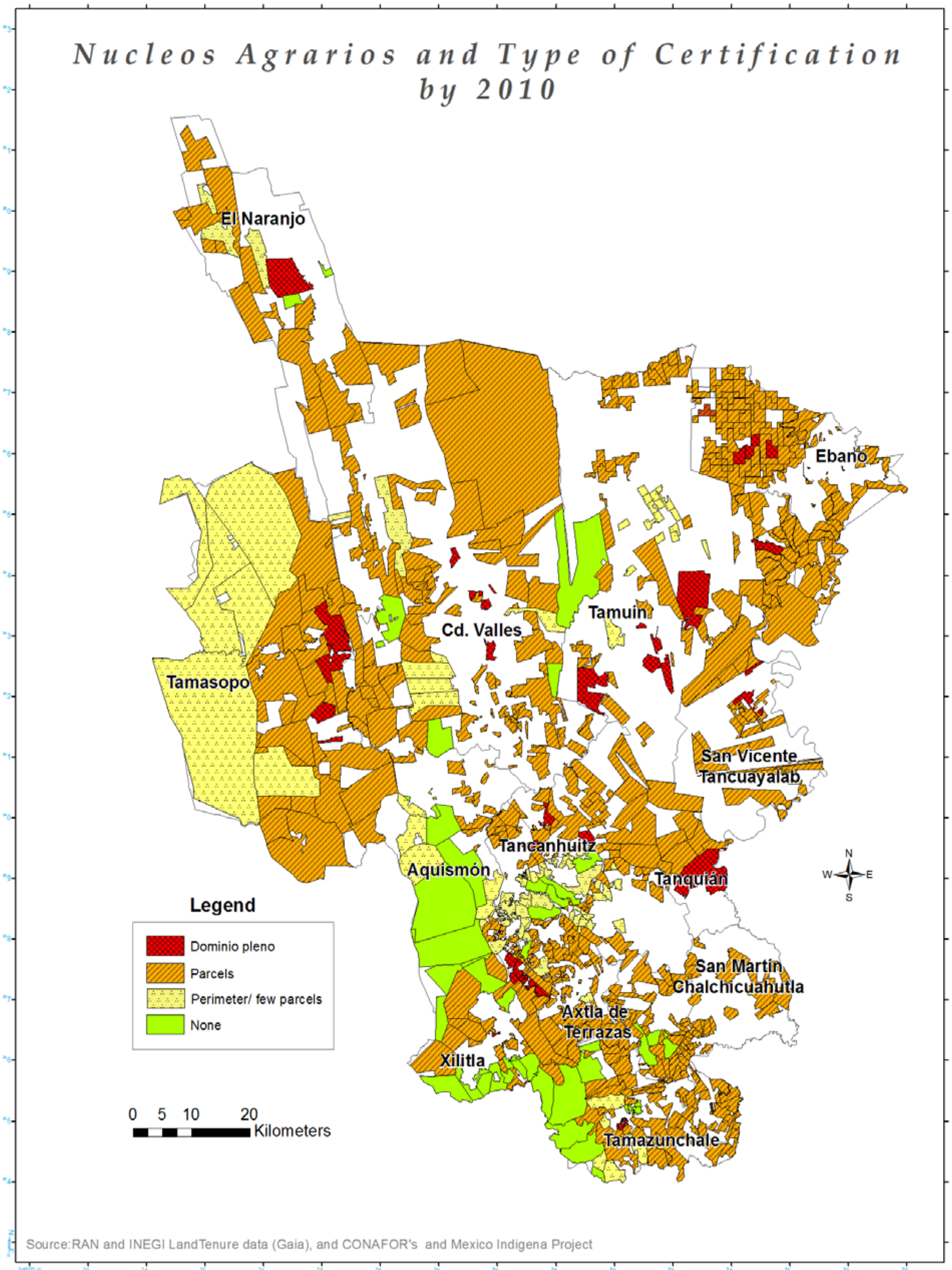
5) Finally, the total privatization of a social property occurs when the majority of the members decide to entirely disintegrate their social system. In this case communal lands can be kept as areas as such or divided among the owners as individual private plots, but only if no forests are in play.

In reality, communities and ejidos combine a variety of these ideal types as negotiated and arranged with the agrarian attorney (*Procuraduria Agraria*). Decisions to use combine or disregard some certifications over others depends largely on geographical location, local economy, and culture, as we will see below.

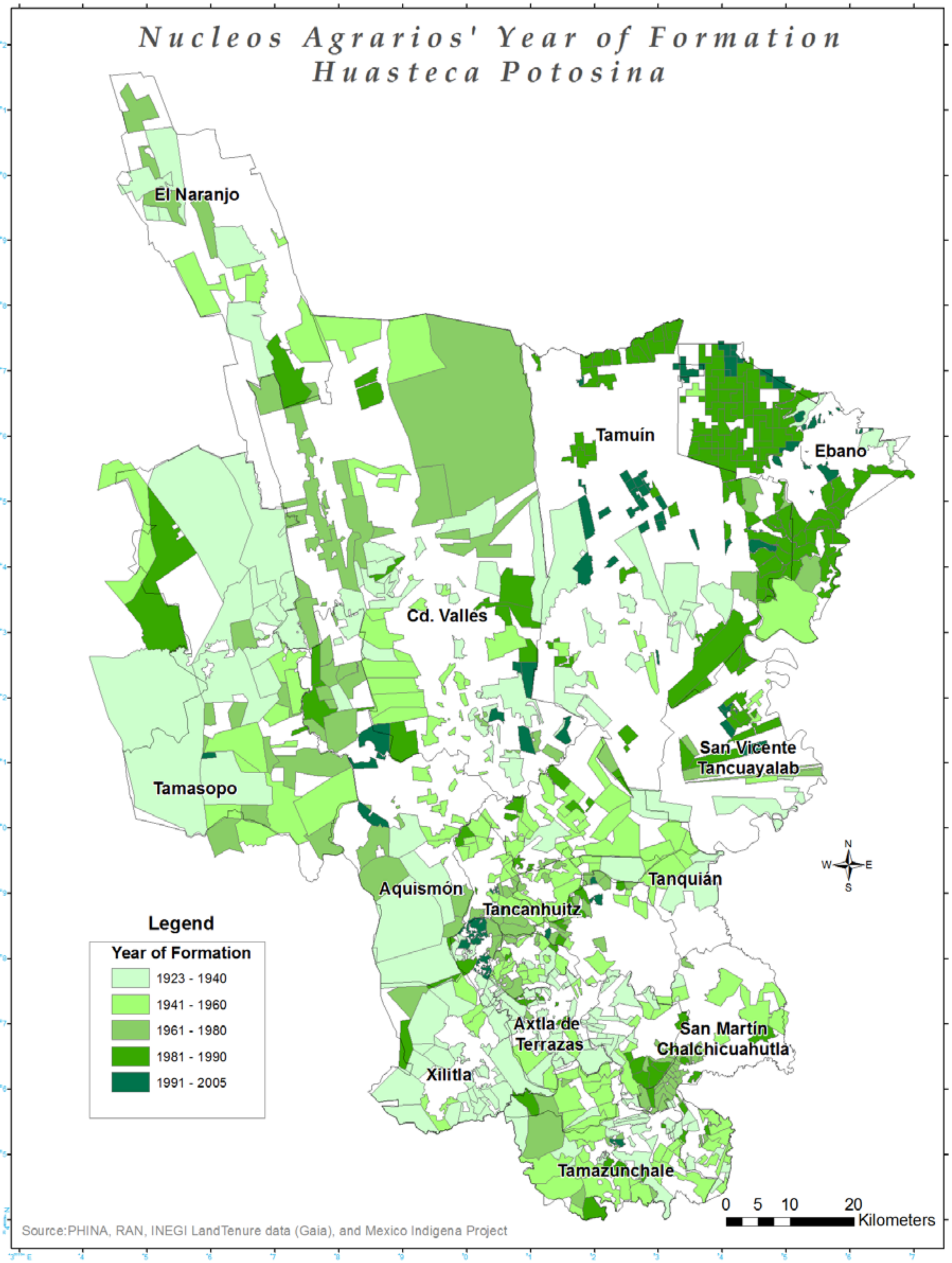
After over twenty years since the certification program started, at least 91 percent (907455.88 km²) of all the social property nationally has been certified. Livestock raising (46%) and forests (17.5%) constitute the majority of certified common use areas and cover 623,186 km² of the national territory (INEGI 2007). If all forested lands in social properties are considered, both the certified and uncertified, scholars estimate that they represents between 70 (Bray et al. 2003) to 85 percent (Yates 1981) of the total forest in the country. Therefore, the potential effects of division and/or privatization of the forest under the land reform has become a matter of serious concern in Mexico for years to come (Sunderlin, Hatcher, and Liddle 2008, Yetman and Burquez 1998, Durán et al. 2011, Merino and Martínez 2009, Perez-Verdin et al. 2009, Larson et al. 2013, Robinson, Holland, and Naughton-Treves 2003, Thoms C. 1998, Landell-Mills and Ford 1999, Angelsen and Kaimowitz 1999). Although most social property was certified under the PROCEDE program by 2006, a second program called FANAR has continued the certification process for remaining properties with delimitation conflicts.

Although the government stopped granting ejidos and communal lands in the Huasteca by 1996, it has continued to encourage the formation of new "private" version *ejidos* for private owners who wish to merge their properties to obtain an *ejido* title. These are called constituted *ejidos*, and although the government does not provide them any additional lands, it recognizes their collective property as a legal institution with its own patrimony. These constituted properties emerged at the beginning of the year 2000, and so far 16 have registered for the region, all in the *municipio* of Tamuin. The constituted *ejidos* have restrictions on their size depending on the amount of property owners and the quality of lands; in the Huasteca Potosina usually between 20 to 30 property owners hold around 200 hectares of land, an amount that according to the article Article 9 of the state constitution is accredited for seasonal cultivation.[40] The map below shows the type of certification that *nucleos agrarios* have adopted in the Huasteca.

[40] **for the constitution of new ejidos, see http://www.pa.gob.mx/publica/pa07fb.htm**



Map 13. Nucleos agrarios' type of land certification



Map 14. Nucleos agrarios' formation date

As the map above shows, most of the biggest *nucleos* in the region were granted by the 1960s, after which mostly smaller properties were granted. The empty spaces indicate mainly private properties and some state or federal properties. Especially during the 1980s, the decade before the neoliberal reform, there was a rise of small landgrants (see table 5) in the form of *NCPE* throughout the region.

Date of formation	Number of nucleos
1923 - 1940	132
1941 - 1960	137
1961 - 1980	105
1981 - 1992	171
1993 - 2005	66

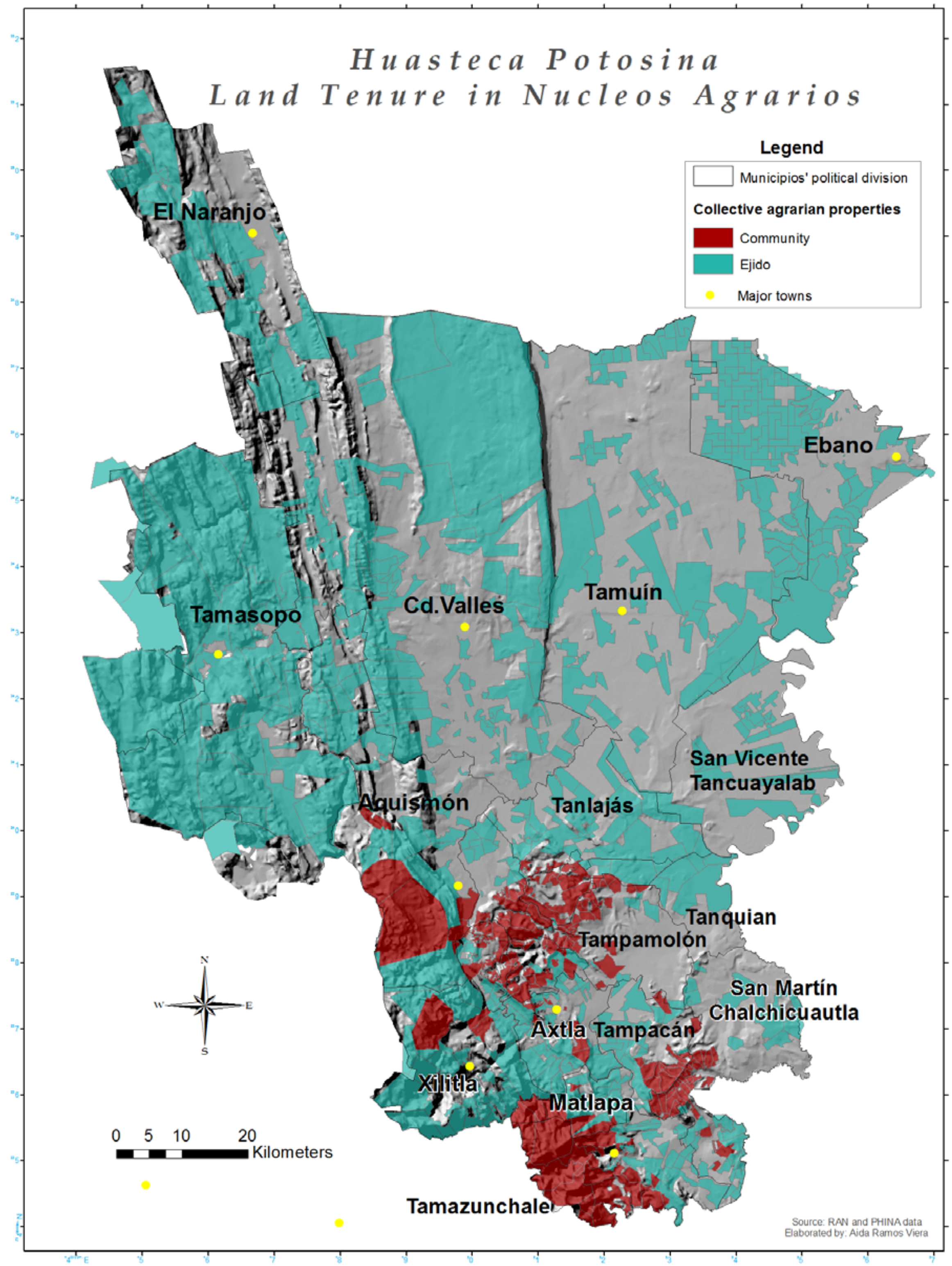
Table 7. Distribution of agrarian nucleos by date of formation

Regarding the type of *nucleo* origin, as seen in the table below there were five ways in which they could be formed.

Type of origin	Type of social property	# of lands	Hectares
Division Suma	Ejidos	26	24,148.16
Dotacion (grant)	Ejidos	267	362,629.76
Restitución	Communities and some Ejidos	159	143,749.64
NCPE	Ejidos	133	121,855.48
Constitucion	Ejidos	16	3,194.93

Division Suma refers to the *ejidos* that resulted from the distribution of *hacienda* lands, usually to groups of peasants that already lived and worked there. *Dotaciones* were grants of available or idle arable lands given to landless peasant. *Restitución*, as its names indicates, were lands returned to their original owners, who were usually indigenous communities, although some of them decided to convert into *ejidos* at the time of the restitution. The NCPE, as previously mentioned, were the last land granting efforts to landless peasants prior to the agrarian reform of 1992. *Constitución* are the new *ejidos* formed after the aforementioned land reform, where a group of landowners united their lands to constitute an *ejido*.

The *ejido* system dominates the region, covering approximately 52 percent of the territory (around 5,891 km²). The distribution of the two types of social property showN on the following map reveals how indigenous communities in the southern region cluster together, while *ejidos* are spread throughout the region. Both types of social properties vary greatly in size, economic conditions, and cultures, for example, the smallest is the community of Mexcala with only 12 hectares, while the biggest the N.C.P.E of Laguna del Mante with 46,219.58 hectares. On average, the size fluctuates from 500 to 4,000 hectares, and population densities closely correlate to the indigenous percentage of their populations.



Map 15: The Social Land Tenure System of the Huasteca Potosina

Fifty-nine percent of the territory is under a social property system while the empty spaces are the best arable lands that have prevailed as private properties. The situation dates back to the land expropriation and redistribution period, when cattle ranchers managed to maintain their lands by soliciting government protection licenses against expropriation. The government provided many of these licenses for up to fifty years in favor of the economic development of the country (Schryer 1986), but thereby reinforcing the unequal distribution of arable lands.

Governance and social organization of communities and *ejidos*

Neoliberal reforms have also changed the level of state and municipal involvement in the affairs of social properties. Federal constitutional reforms in 2001 gave states the freedom to establish the characteristics of auto-denomination and autonomy of their indigenous people. Thereafter, the states of Oaxaca, Campeche, Chiapas, Mexico, San Luis Potosi, Nayarit, Tlaxcala, Durango, Querétaro and Baja California have created regulatory indigenous laws, but only San Luis recognizes auto-regulation at the community level (*personalidad juridica*). The 2003 State Constitution of San Luis Potosí (revised in 2010) describes indigenous communities as those with a) a political, economic, social, and cultural unity, b) settled in a defined territory, and c) who recognize their own governance and authorities as part of their traditional costums.[41] In its Article 9 it is declared that such communities are for the first time *sujetos de derecho publico*[42] (legal entities with public power), which means that they are recognized as an institution, with rights, obligations and their own patrimony. It also recognizes the legal power of its indigenous authorities, general assembly, internal body of police and their acts, meaning that their overall structure of internal governance, decision-making, and leadership structures are legal (Article 9. State legislation of San Luis Potosi, 2003).

The decision of the state to recognize the indigenous communities' legal authority was based on an internal analysis of 28 indigenous communities, which demonstrated a history of their solid and efficient organization and auto-regulation (Ávila 2009). Communities can now use the new legislation to demand respect from other outside authorities such as the city council at the *municipio* level (Cisneros 2011b). Although this legislation was originally created for indigenous communities, the state also recognizes that *mestizo* communities or *ejidos* can benefit from it as

[41] Article nine of the State Constitution "Constitución Política del estado libre y soberano de San Luis Potosí" 2010.
[42] State legislation of San Luis Potosi, 2003.

long as they have a comparable organization (Article 9. State legislation of San Luis Potosi, 2003). This is an important step reinforcing community organization, and the next step is to make the beneficiaries aware of their rights and put them to practice.

The internal organization of indigenous communities is quite complex and varies from community to community, but generally it directly involves at least ten to fifteen percent of members in core governance.

The table below shows the basic authority structure from most to least powerful:

Level	Authority
1	General Assembly, Agrarian Assembly, Assembly of authorities, Assembly of neighbors
2	The Commission (president, secretary, treasury and substitutes) Security council (president, secretary, treasury and substitutes)
3	Auxiliary judge (1st, 2nd ,3rd judge) Municipal delegate, its substitute and secretary
4	Major, sub-major and corporal
5	Police man and rural guards
6	Vocal members, or representatives
7	Committees

Some positions, however, are not recognized by external (state or federal) laws. One important one is the Municipal Delegate or Auxiliary Judge, who tend to all legal disputes, conflicts, controversies, and offenses that occur inside the community, whether administrative, criminal, civil, or family, if the problem is not so major that it must be treated by an extended group of authorities like the assembly of neighbors or the general assembly. They tend to be present in Nahua communities, and also perform the important functions of planning and organizing the communitarian work called *faenas* or *tequio,* the coordination of committees, and the protection of natural resources (Cisneros 2011a, Ávila 2009).

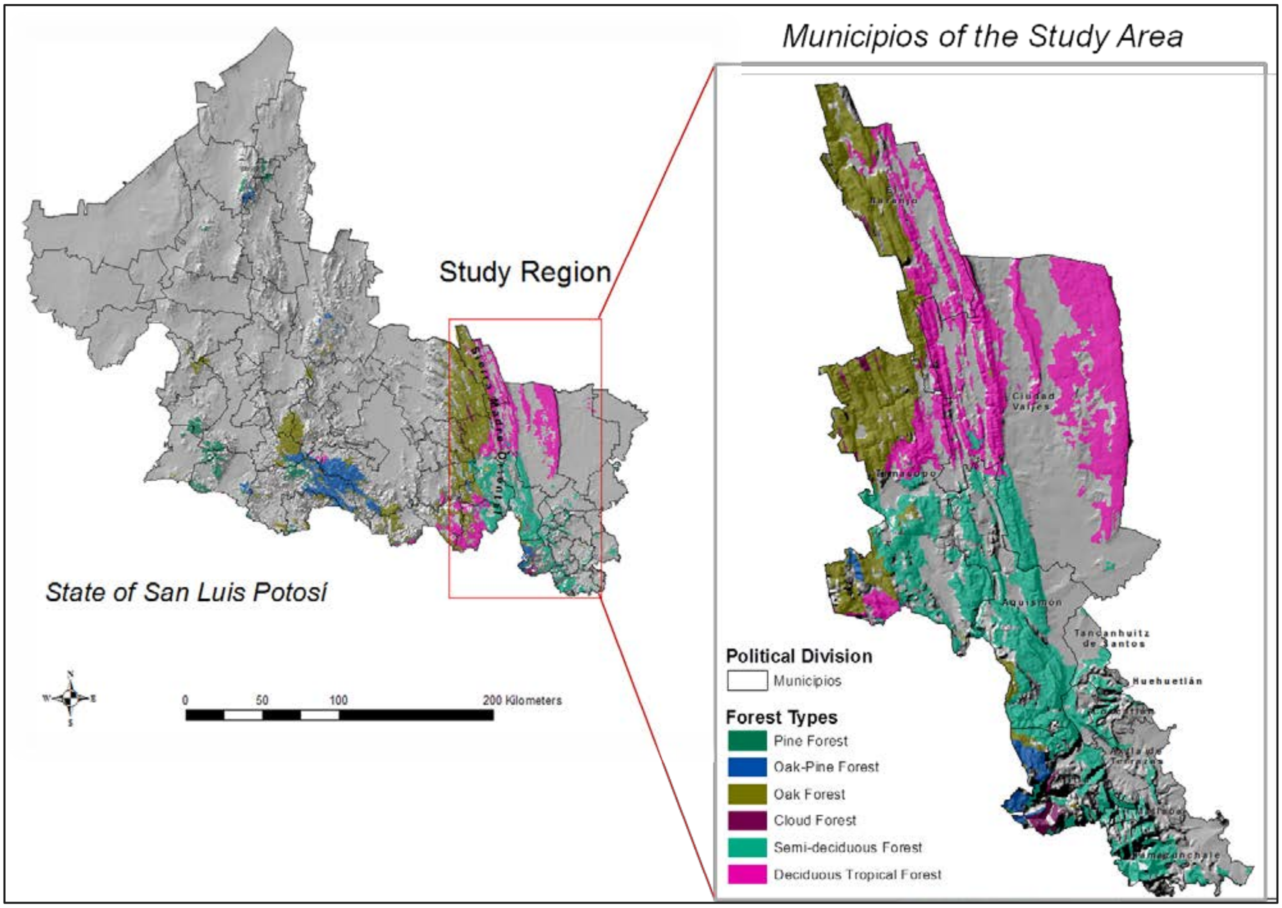
Communication between the city council and communities is made through committees that attend official public meetings. Committees are constantly created and dissolved according to the ebb and flow of programs, but some committees endure indefinitely, like dealing with health clinics and aid, senior citizens, utilities like energy (electrification), the Integral Development of Families' program (DIF), nursery school, primary school, *Telesecundaria* (lower secondary school taught through television programs), PROCAMPO, which gives official economic support to rural producers, and *Oportunidades*, which provides cash payments to families in exchange of school attendance. Last but not least are committees dealing with natural resources management, such as forested social properties, especially for the ones that participate in one of the PROARBOL programs.

The complexity and extension of community governance varies according to factors like the size of the *nucleo*, origins (if they were recently created or date back to the colonial period), settlement pattern, and the level of assimilation or penetration of the Western culture. The biggest communities, for example, are structured into neighborhoods called *barrios* or *anexos*, each with a mayor and committee representatives, while smaller communities might have some settlements dispersed from the center with no official representatives. The following section examines forest management, policies and the neoliberal land reform at *municipio* and community levels where forests represent more than 30 percent of the territory.

vi. *Municipios* of the study area

As mentioned in the ethno-history section, the forest of the Huasteca region has been severely threatened by agriculture and cattle ranching expansion. Among the several social, political, economic and ecological factors that scholars have found to influence deforestation in Mexico, the most commonly mentioned are: population growth, uncertainty in land tenure, capitalism, poverty and unsuitable government policies (Vandermeer and Perfecto 2005, Lambin et al. 2001, Boyer 2007, Merino and Martínez 2009, Kepleis and Vance 2003). Lately, national and international efforts to protect the remnants of forest have focused on payments for environmental services (PES) to forest owners as an incentive to keep, revert, and use their land as forest. As mentioned above, PES has been applied throughout Latin America, including Mexico, with a wide variety of outcomes.

My focus on the application of PES to forest conservation in the Huasteca Potosina has broader implications for neoliberal ideologies, assumptions, and strategies regarding forest conservation. In this section, I introduce the two study zones composed of eleven *municipios* in the Sierra Madre Oriental of the Huasteca Potosina where the PES program has focused its efforts over the past decade on last remaining major remnants of forest (see map below).



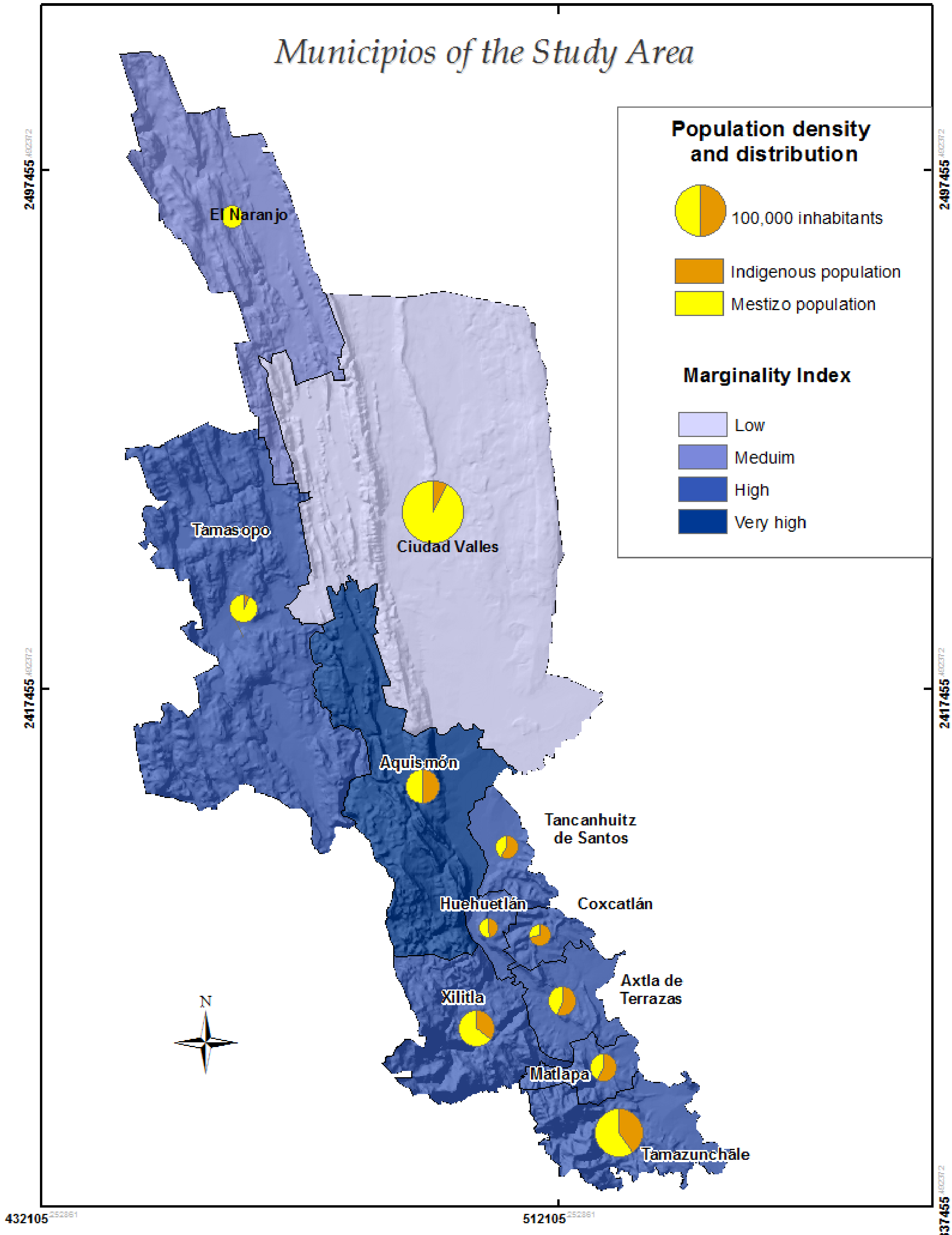
Map 16: ***Municipios*** **of the Study Area**

Based on economic and cultural characteristics, the selected *municipios* were divided into the northern *mestizo* area and the southern more indigenous area. The more developed northern mestizo region includes the *municipios* of El Naranjo, Ciudad Valles and Tamasopo, where sugarcane and cattle ranching are principal endeavors. The southern area, on the contrary, stands out for its high concentration of indigenous population, less arable and more rugged land, and dedication to shade grown coffee. The differences in topography and the possibilities they offer for agricultural activities have influenced the economic strategies, as seen in the map below.

The National Population Commission (CONAPO) has developed and recorded a national marginalization index at the local and municipal levels since 1980. This index which I used as a reference for poverty levels at both scales considers the overall impact of different kinds of disadvantages that a population can suffer, the purpose of which is to identify when a sector of the society lacks the opportunities to develop to its full capacity (Ávila 1995). Depending on the scale of analysis (*municipio* or locality level), different factors are considered; at the municipal level three dimensions are examined:

a) Education, measured by the percentage of people at 15 years old or more that are illiterate and have not completed primary school.
b) Housing, evaluated by the percentage of population i) without basic utilities like sewage and sanitation, electricity, and tap water, ii) overcrowding, and iii) the percentage of population living in houses with dirt floors.
c) Income, based on the percentage of working population living in households with inhabitants earning no more than two minimum wages.

The map below shows the municipal level of marginalization in study area based on the CONAPO index and its association with population's densities. Overall, the Huasteca is considered highly marginalized, but important differences endure between poor southern *municipios* with higher population densities and the northern ones with less population and marginality.



Map 17. Municipios of study, marginality index and population densities

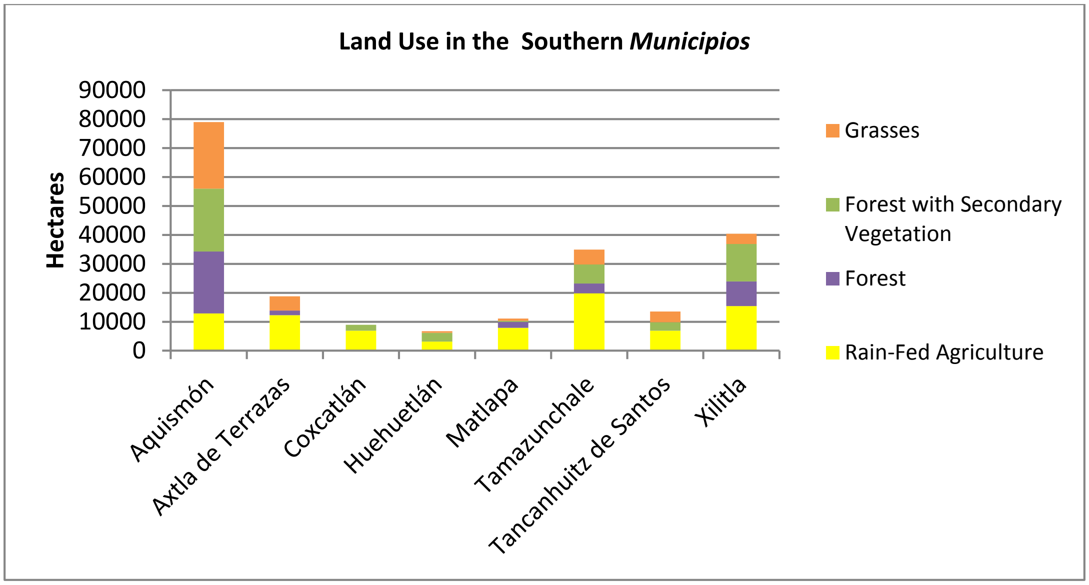
The Southern Indigenous Area

This area comprehends eight *municipios*: Aquismón, Tancanhuitz de Santos, Coxcatlán, Huehuetlán, Xilitla, Axtla de Terrazas, Matlapa and Tamazunchale. All have been catalogued with high and very high marginality and contain the highest proportion of indigenous people of the Huasteca Potosina. They are considered a multi-culturally integrated area where ejidos and communities of Nahuas, Teenek, and *mestizos* coexist even within communities.

Land uses and Economy

The communities and *ejidos* that populate this portion of the sierra have less capital-intensive agricultural production compared to their northern counterparts; according to the national agricultural, stockbreeding and forestry census, self-subsistence and extensive agriculture dominates production in most of the region. Coffee is the main cash crop for indigenous people and was introduced during the early nineteenth century (Stresser-Péan 2008). Coffee plantations have been integrated into forest management, and during the 1980s, when social properties were still being federally granted, ranchers would refer to their unused forested areas as *cafetales* (coffee plantations) to avoid expropriation (Alcorn 1984b). Overall, the amount of forest in the southern region covers 86,587 hectares, from which 59 percent (51,260 hectares) has been categorized as secondary vegetation.

More area is covered by secondary vegetation (locally known as *monte*) than agricultural areas. Secondary vegetation essentially refers to areas of fallowing of previously cleared agricultural fields or primary vegetation that has been partially disturbed. For the *municipios* of Xilitla, Tamazunchale and Aquismón, areas of secondary vegetation are at different stages of managed regrowth usually in orchards or shade grown coffee plantations with a wide variety of species of timber and non-timber products. The graphic below shows the proportion of land uses in each *municipio* of the southern region according to the vegetation series IV (SIV) data made by INEGI. The *municipio* of Aquismón is the only one with a high percentage of land devoted to grazing due to its large valley.

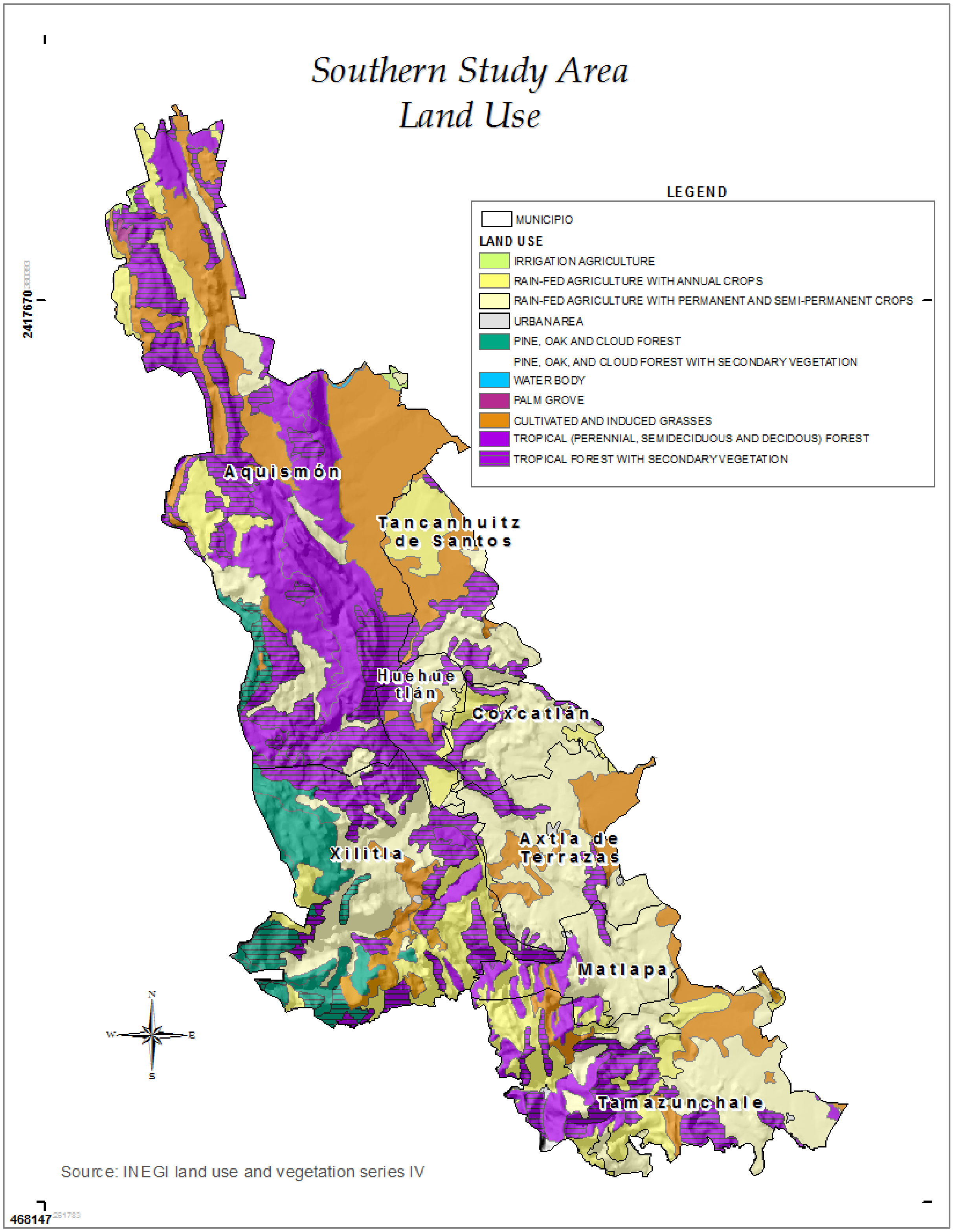


Graphic 5. Land uses by municipality in the southern region

According to these data Aquismón possesses the most natural resources, with a forested area of 21,408 hectares, yet it is also one of the most marginalized in the state. The cultivated pastures (17,616 hectares aprox.) in Aquismón are privately owned and contain sedges and forbs intermixed with natural shrubs to feed cattle for milk and meat, and secondarily pasture horses, sheep, and goats (INEGI, 2007). The pastures on the best valley lands are monopolized by a few ranchers, which has exacerbated inequality and especially increased the marginalization of the indigenous populations, who cultivate small cornfields and perennial crops like coffee on the ridges and slopes of the sierra. The uneven land distribution and accompanying pressures on the people of the sierra have motivated the introduction of PES for them.

The rest of the *municipios* have similar agricultural practices; most of the inhabitants make a living from self subsistence cornfields along with cash crops of coffee, *palmilla*, and sugarcane for the production of *piloncillo*[43] or to sell it to sugar mills. Another common source of income is the rental of pasture to private owners since very few members of social properties possess their own cattle. Some low-lying *municipios* like Coxcatlán and Huehuetlán near the Pan-American Highway capitalize on the strategic location to specialize in orange orchards, with secondarily production in mangos, bananas, and avocados. The map below shows the distribution of these main land uses according to INEGI land use and vegetation data for 2010.

[43]It is a solid piece of unrefined whole cane sugar obtained by heating and evaporating sugarcane juice.



Map 16. Land uses of the southern study area

Religion

Religion has played a fundamental role in both indigenous and *mestizo* people's daily lives. Catolicism is the dominant religion, but for the indigenous it is often a syncretic veneer for Mesoamerican beliefs and practices, such as merging the sun god, the moon goddess and other nature spirits with Jesus, the Virgin Mary, and other saints. Religion is enmeshed in peasant life and gives meaning to the agricultural cycle, particularly regarding rituals at the sowing and harvest times (Avila et al. 2008). For the Teenek, for example, Dhipaak is the mythical heroe who defied the supreme God who jealously hided corn in the 'stomach' of the *sierra* and brought it to people (Alcorn 1984; Ariel de Vidas 2003). The introduction of Protestant religions (e.g., Evangelicals, The Light of the World, and Jehova's Witnesses) came in the 1960s but have only a minor presence. Overall, 10 to 15 percent of people in the Huasteca is afilliated with these religions (Avila et al. 2008). While no major conflicts between the religions have been reported for the Huasteca, unlike other areas of Mexico, the introduction of Protestantism has undermined the traditional civil-religious *cargo* or "duty" system and has influenced a separation from religious and civic duties among communities' organization (ibid).

Organizations and Political Parties

A wide variety of organizations operate in the region at multiple levels, from the national, the regional, and communal. In 2008 74 peasants' national organizations, *ejido* unions, regional organizations, groups of women and cultural groups were in operation (Avila et al. 2008). Some of the most influential were the National Peasant Confederation (CNC), the Democratic Peasant Union (UCD), and the National Union of Coffee Organization (CNOC), the latter of which has 12 local branches in the southern *municipios* and is linked to the Union of Indigenous and Peasant Organizations (COCIHP) (ibid). In adition to uniting coffee growers, COCIHP also organizes *piloncillo* makers (unprocessed brown sugar), orange growers, and women producers, giving it a strong presence in the southern region.[44] Cultural organizations include traditional doctors, dancers, musicians, artisans, and community radio stations. Overall, the Huasteca Potosina is well organized, cohesive, and autonomous compared to other Mexican regions (Avila et al. 2008). Other organizations with more political character are the ones associated with the

[44] See http://www.redindigena.net/organinteg/cocihp.html. for more information about their affiliated organizations and their projects.

indigenous and peasant struggles to obtain or recover land, including the Democratic Huasteco (MHD) Movement and the Citizen Front (*Frente Ciudadano*), which still have great ability to mobilize people despite the end of the land grants (ibid).

The strongest political party in the region is the Intitutional Revolutionary Party (PRI), the one that dominanted the country in various permutations for 70 consecutive years after the Revolution. Other parties like the National Action Party (PAN) and coalitions like New Aliance (PNA) have occupied municipal presidential chairs in the southern region but only for brief periods, except for Aquismon, where the right wing party PAN has held power since 2000[45].

The Development of Payments of Environmental Services (PES) in the Southern Region

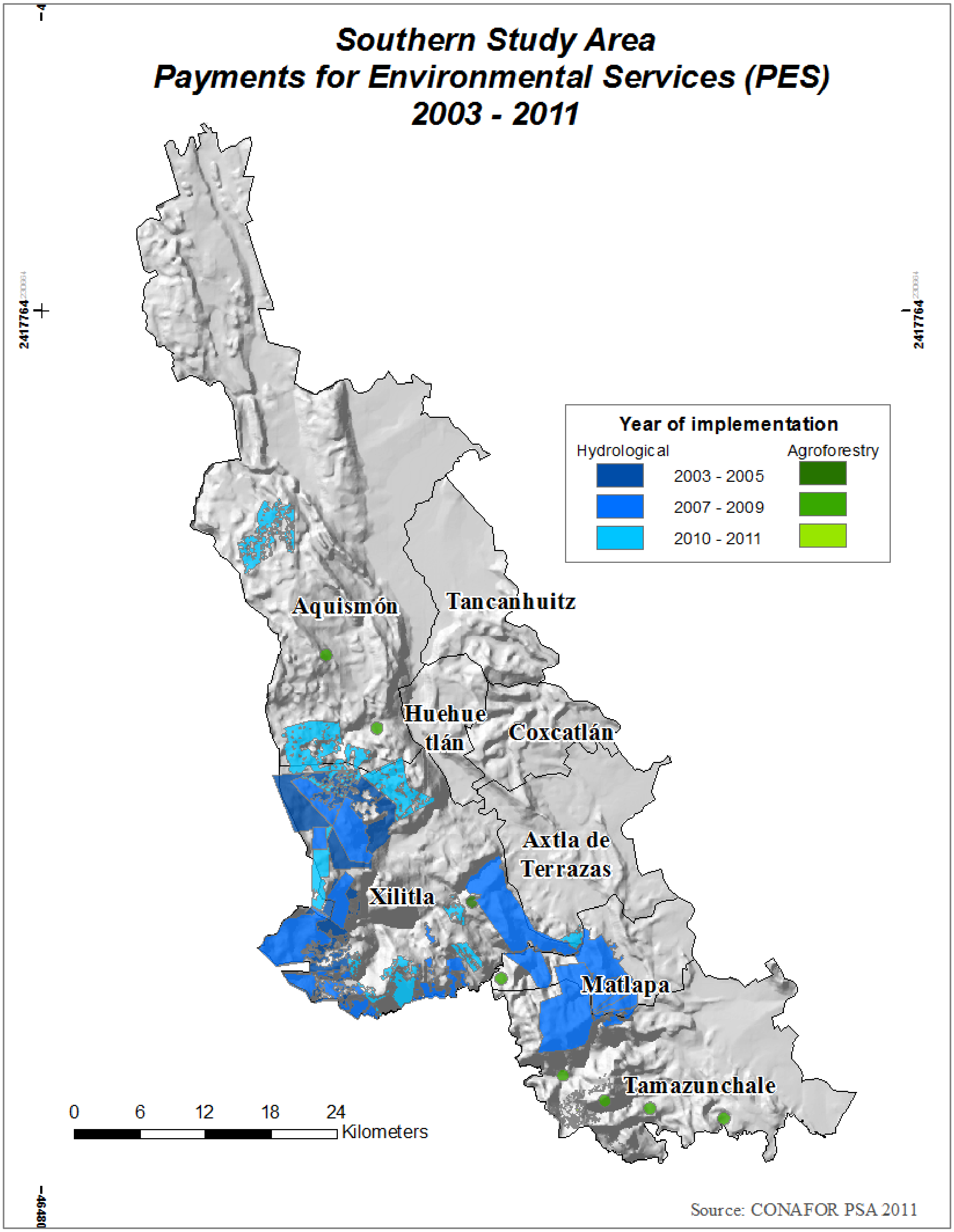
The PES program in the State of San Luis Potosí started precisely in this southern region in 2003, first in Xilitla, which still has the most PES projects in the region. A pilot project started with seven communities participating in the Payments for Hydrological Services Program (PSAH), the first nation-wide PES created and implemented by the forest commission, CONAFOR. The advantage the region offered for PSAH was that many communities share boundaries with the Sierra Gorda biosphere reserve and nine communities constituting 800 hectares in the Sierra of Xilitla known as *La Silleta* were already part of another forest conservation program (Lands for Conservation and Environmental Services pilot project), that managed the NGO of Sierra Gorda. This program worked in collaboration with CONAFOR to establish the federal PES program in the region. As the national priority was hydrological conservation, communities PES was ultimately an exchange for case water collection and infiltration.

The next year in 2004 carbon sequestration and the improvement of agroforestry systems (the PSA-CABSA category) were added to the program in Xilitla and still today it has the biggest concentration of PES projects under this category; 26 of the 44 PSA-CABSA projects in the state in 2011 were implemented here. Until now, however, funding for carbon sequestration has only been for project design not for the implementation of PES. As the map of PES shows below, from the four categories available in the program (Hydrological, Agroforestry, Carbon

[45] According to National Sistem of Municipal Information (SNIM), available at http://www.snim.rami.gob.mx/

sequestration and Biodiversity), only hydrological and agroforestry services have been implemented in the region for actual payments.

Until 2010, agroforestry projects did not have a demarcated area, only circles to indicate the community or *ejido* that was participating. More recent projects are accurately represented by polygons of participating coffee-parcels made by the federal Subsidies and Services for the Commercialization of Agriculture and Livestock (ASERCA) for monitoring. Without delimitated areas for the early years of implementation, it is difficult to estimate the areas under agroforestry services at the regional scale, however, at the community level; participants in the program have detailed censuses of the individual parcels in the program. For the hydrological PES there are more detailed polygons totaling 35,488 hectares in the southern region since 2011. In total, agroforestry and hydrological PES programs include 33 *nucleos agrarios*; agroforestry projects are predominant in indigenous communities (six out of seven have them), while hydrological projects are more common in *ejidos*. Some examples of how these programs have been implemented and managed will be described in the results chapter.



Map 18. PES projects within the southern region, from 2003 to 2011

The Northern *Mestizo* Area

The northern study area comprises three *municipios*: Ciudad Valles, El Naranjo and Tamasopo, covering 241,956 hectares. With its fertile valleys, the region has been the focus of major irrigation projects, especially for the development of sugarcane and cattle. With the introduction of improved varieties and industrialized sugarcane, production has increased dramatically. Ciudad Valles, El Naranjo and Tamasopo in that order are the major sugarcane producers of the state, covering 84 percent of the overall production (4,820,359 ton per year)[46]. As mentioned, in contrast with the southern region the majority of the population is *mestizo*, and the indigenous population of Tamasopo and Ciudad Valles is only seven percent while in El Naranjo the percentage is not statistically significant. The disappearance of indigenous population, as mentioned in the ethno-history chapter, dates back to the Spanish arrival, when all the indigenous settlements were completely destroyed and suitable lands quickly occupied for cattle ranching.

Land use and Economy

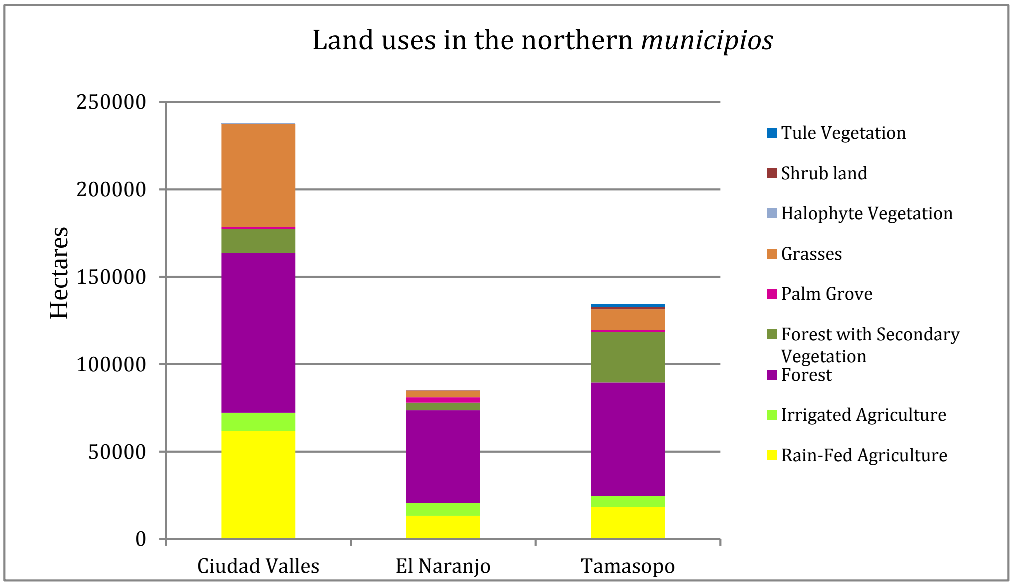
According to Butzer and Butzer (1992:20) and Aguilar-Robledo (2001), this northern zone was the site of many granted livestock ranches before 1575. The landscape predominated by *coyol* palms, grasses, cactus, and agaves was quickly transformed into pastures (Aguilar-Robledo 2002). The rapid growth of cattle during the early years of colonization (1530-1570) was facilitated by the availability of lands left after the native depopulation, as well as the pre-existence of grasses and the lack of grazing competitors for livestock (Aguilar-Robledo 2001, Butzer 1992). As in the southern region, cattle ranchers managed to maintain their domain over the lowlands despite the land expropriations, Ciudad Valles is still one of the main cattle producing *municipios* in the entire state, with over 70,000 units[47].

Although cattle ranching and sugar cane production are the leading economic activities of the region, forestry (see graphic below) and lumber have been important parts of the economy since the colonial period. According to the National Agriculture, Stockbreeding and Forestry Census

[46] *Censo Agropecuario 2007. Tabulados por municipio No. 10,* INEGI.

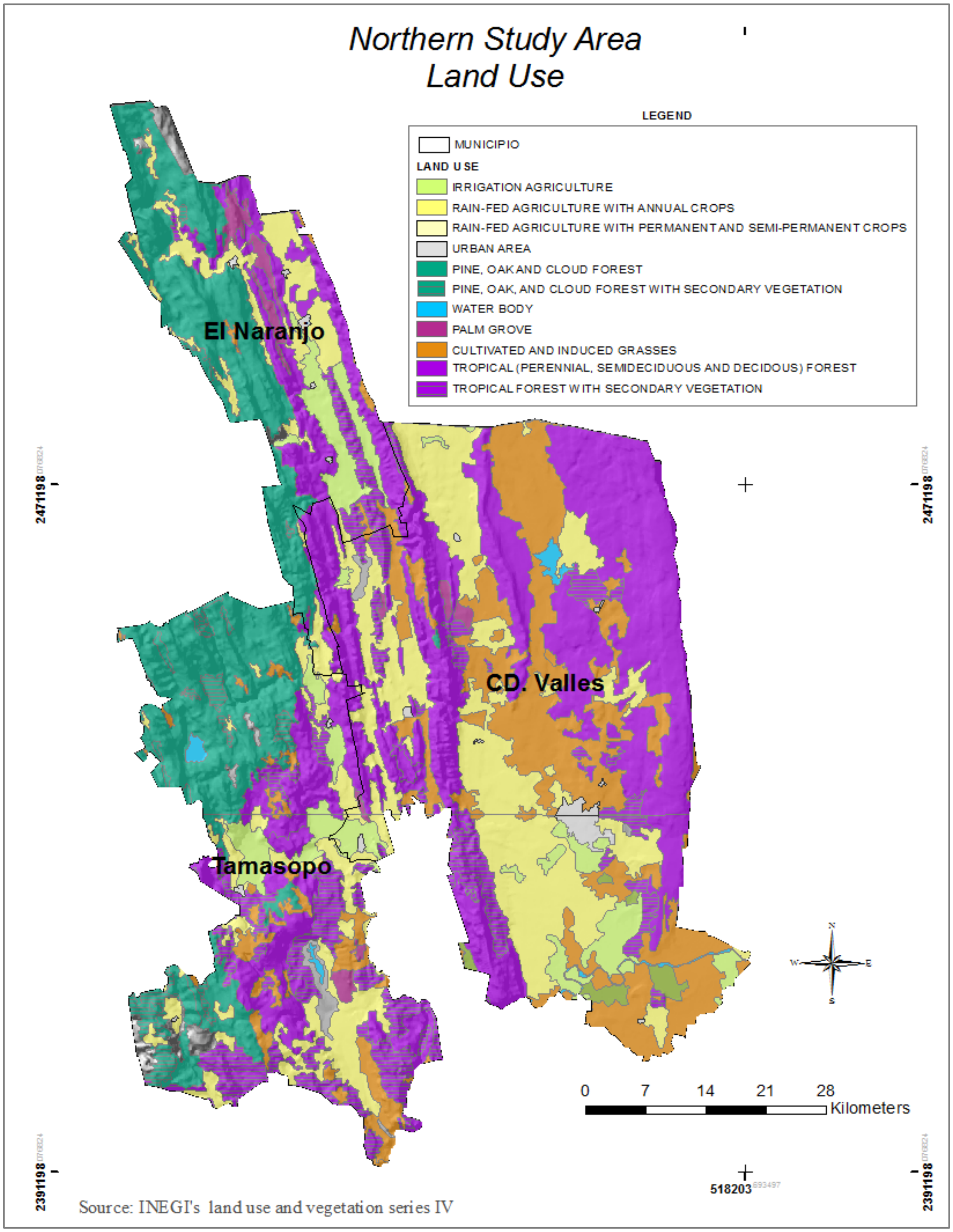
[47] *Censo Agropecuario 2007. Tabulados por municipio No. 32,* INEGI.

of 2007, Ciudad Valles reports the most timber extraction in the state, with 74 registered sawmills and approximately 5,550 m^3 of tropical woods cut yearly. Tamasopo, in contrast, cuts only 116 m^3 of oak and 165 m^3 of other tropical woods with its 73 sawmills, and El Naranjo cuts 348 m^3 of mainly oak with 32 registered sawmills.



Graphic 6. Land uses by municipality in the northern region

As with the land use distribution patterns of the southern region, most of the forested areas are owned by social properties, namely, 89 *nucleos agrarios* with 287,043 hectares. Of the total 209,137 hectares of "primary" forest in the region, 80 percent (169,341 hectares) are within social properties. The maps of land use below show their spatial distribution.



Map 18. Land uses of the northern study area

Religion

As in the south, the northern population here is predominantly Catholic, although more orthodox. Evangelicals and other Protestant religions are present in small percentages, but there are no major communal conflicts based on religion.

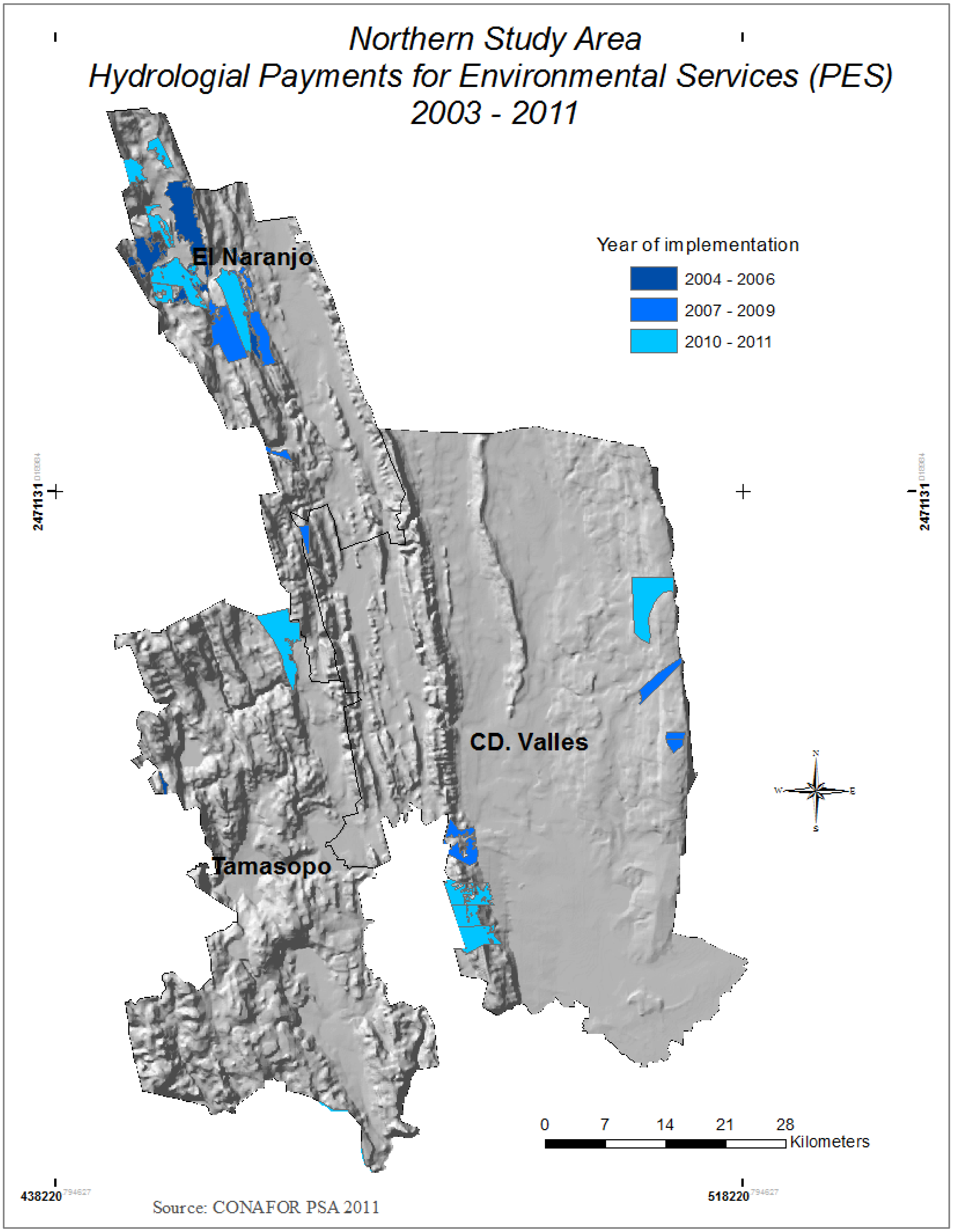
Organizations and Political Parties

The north is also organized in national peasant unions, regional organizations, *ejido* unions, and other social cooperatives and nonpropfit organizations. The Pujal Coy project and the agrarian conflicts that emerged with it incited the creation of numerous peasant organizations (Avila et al. 2008). Now corn growers, cattle ranchers, sugar-cane growers among others form a wide variety of trade organizations.

Regading political parties, like in the south, the PRI has maintained control, except in the *municipio* of CD. Valles (the biggest and wealthiest among the region), which has seen constant shifting of power between the PRI, PAN, and the Workers' Party (PT). Between 2007 to 2009 PAN won control over the region gaining the elections in the three *municipios.* The PRI, however, has recovered power thereafter.

The Development of the Payments of Environmental Services (PES) in the Northern Region

The PES program in this region started in 2004 with the *ejido* of San Jose de Corito and El Durazno in Tamasopo. From the 129 projects that have been implemented in the state of San Luis since 2003, 42 are located in this region. Although the territory presents several eligible areas for bio-diversity projects, most of the projects have been for hydrological services, with the northern *municipio* of El Naranjo hosting the majority of these projects (see map below).



Map 19. PES projects within the northern study area, from 2003 to 2011

V. The Correlation between Deforestation and Poverty in the Huasteca Potosina Region.

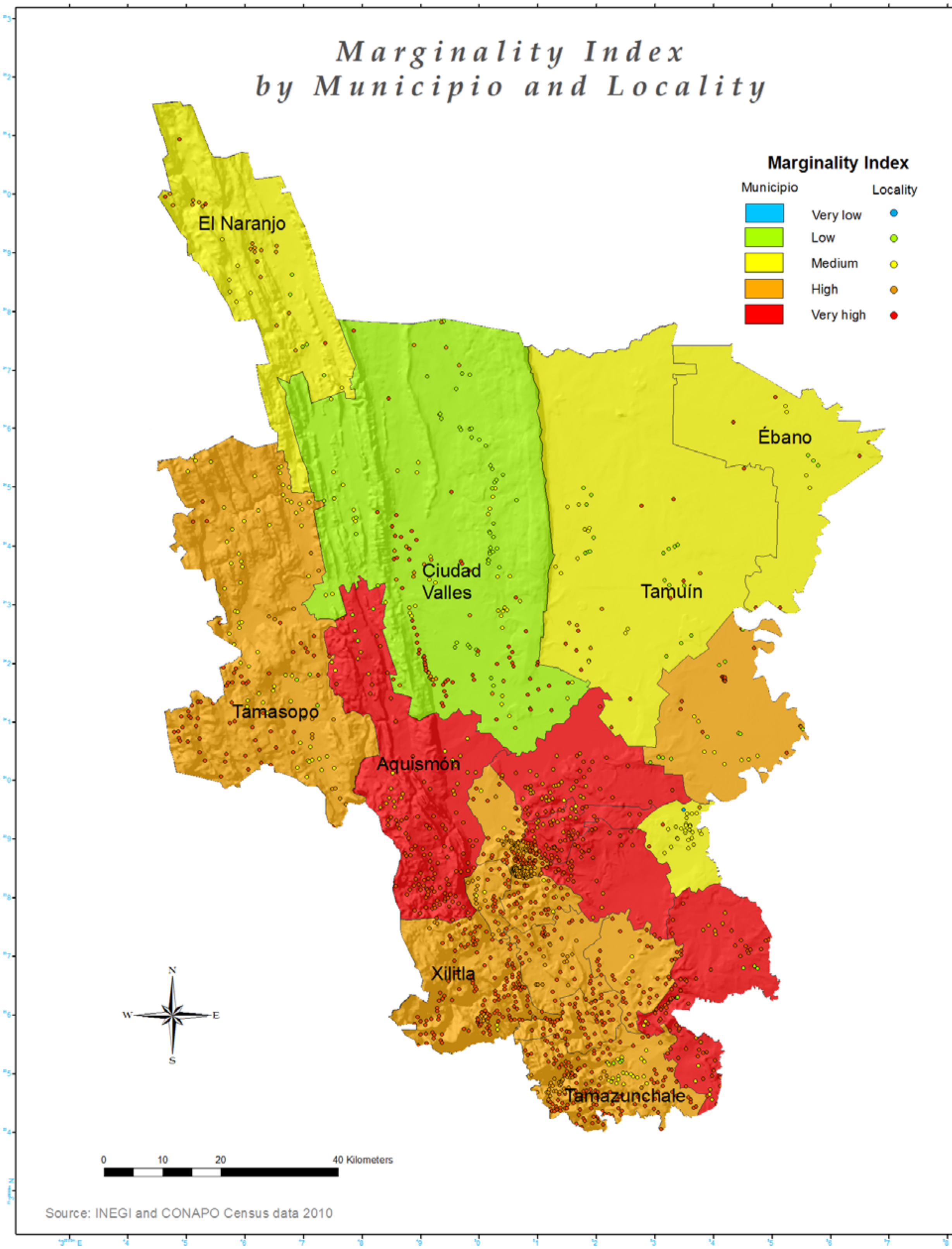
The presumed connection between deforestation and poverty has been one of the main justifications for the PES program in impoverished areas worldwide, and Mexico is no different. This study examines the deforestation-poverty relationship at a regional and community levels, using spatial correspondence analysis between marginality, risk of deforestation, and total deforestation.

Using a marginality index to measure poverty.

Following the CONEVAL poverty guidelines, the National Council of Population (CONAPO) has created a marginality index based on eight variables that represent the multidimensionality of poverty. Since 1990 the index has been used to designate when a sector of a society – be it at the municipio, *nucleos agrarios* and localities (settlements) level – falls under the poverty line. While a general description of the index was discussed in the methodology chapter, here the variables considered for each scale will be explained.

At the *municipio* level

The eight variables applied to the 2010 population census include the percentage of the population: 1) 15 years or older who are illiterate; 2) 15 years or older who have not completed primary school; 3) without sewage or sanitations services, 4) without electricity, 5) without tap water, 6) living in a single room dwelling; 7) living in houses with dirt floors; and 8) living in households with no more than two minimum wages. The index ranks poverty in six grades from zero to five, with five representing the highest degree of marginality. Map 18, “Marginality Index by *Municipio* and Locality,” shows how the entire Huasteca Potosina is classified marginal, but with varying degrees. Forty-one percent of the *municipios* have low marginality, 14 percent medium, 30 percent high, and 14 percent very high marginality. Four of the five *municipios* with very high marginality coincide with higher concentrations of the Teenek population, where as the urban municipality of Cd. Valles, with more than 100,700 habitants, is rated with low marginality.



Map 20. The Huasteca Potosina's marginality index by municipio and locality

The locality level

A "locality" in the national census refers to any inhabited area, from only one to hundreds of houses. Although the information is gathered at the household level, the data is only available in its aggregated form to protect householder's privacy. The marginality index at the localities' scale uses the same variables as the municipal level except in the economic dimension, in which income is replaced by the percentage of houses living without refrigerators. According to CONAPO, this proved to correspond better with the other variables than income at the localities scale (CONAPO 2012)

As mentioned, the State of San Luis Potosí occupies the 9th place on poverty according to the number of municipios with very high and high marginality, but in terms of the proportion of marginal population living in localities the state occupies 7th place. The marginality index of the 2010 census showed that of the 4,203 localities in the state, 89 percent had high or very high marginality; however, these localities represent only 35 percent of the total population. These data correspond to higher poverty levels in rural areas compared to cities where population tends to be concentrated. The distribution of the marginality index among localities and population in the state is shown on the table below.

Marginality index	**Localities**	**Population**
Total	**4203**	**2572173**
Very High	781	55404
High	3001	846750
Medium	302	260612
Low	95	351006
Very low	24	1058401

Table 8. Distribution of the marginality index in San Luis Potosi

Within the Huasteca Potosina region, as seen in the previous map of "Marginality index by *municipio* and locality", localities are concentrated in the southern most indigenous region. In the 2010 census, the Huasteca Potosina had 1,908 localities with some degree of marginality, and the majority (71 percent) had high marginality (see Table 9).

Localities' marginalization index within the Huasteca Potosina region		
Index Value	Frequency	Percent
High	1356	71.1
Very high	410	21.5
Medium	103	5.4
Low	31	1.6
Very low	8	.4
Total	1908	100.0

Table 9. Marginalization of localities at the regional level

Within the 11 forested *municipios* in the study area lie 1,662 localities, with populations varying from just one to 3,614 houses. From these, 327 localities, which usually were isolated households, did not have the data to evaluate their marginality levels, and although they were very likely to have marginalinity, without reliable data they had to be excluded from the marginality analysis here. The 1,336 localities with complete data presented a high mean marginality value (0.1485), very similar to the average value for the Huasteca Potosina region. The index seen on table 7 shows how 80 percent of the total population of the region also lives with high marginality.

Marginality of localities within the forested *municipios* in the Huasteca Potosina Region					
Marginality Ranks	**Marginality Index**	**# of localities**	**Percentage of localities**	**# of population**	**Percentage of population**
	0 (none)	5	0.374	1,749	0.473
(-1.83197-1.32309)	1 (very low)	1	0.074	9	0.002
(-1.32309-1.06870)	2 (low)	10	0.748	3,617	0.979
(-1.06870-0.81425)	3 (medium)	58	4.341	26,827	7.265
(-0.81425-0.71231)	4 (high)	1003	75.07	298,343	80.801
(0.71231- 8.34515)	5 (very high)	259	19.38	34,406	9.318
	Total	1336	100	369,229	100

Table 10. Marginality Index at the localities' level

There is a tendency to believe that smaller settlements or localities present higher indexes of marginalization because they are located in more remote places where basic services are harder to implement however no significant correlation was found between marginality and population density using Pearson at the 0.01 level. This is likely due to other impinging factors like geographical location, economic opportunities, and governance systems. Localities must be studied in their full spatial context, including in the agrarian *nucleos* of which they are part.

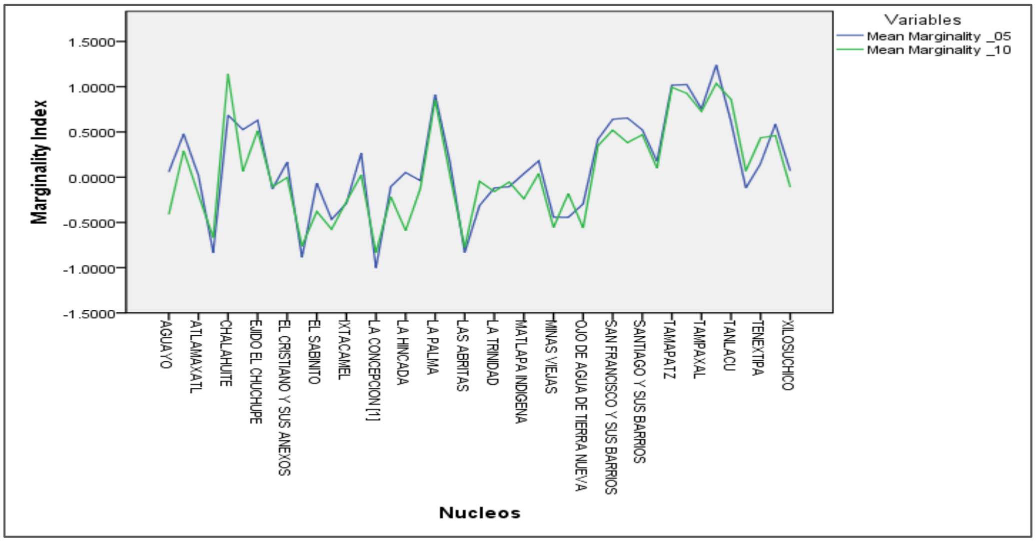
At the *nucleo agrario* level

An official marginality index at *nucleo agrario* scale does not exist and had to be calculated based on the localities' census data. Two calculations were made: one using the mean marginality value of all localities inside the *nucleos* and another by aggregating the total number of households. Using the former method, the *nucleos* of the sample presented an overall marginality value of 0.3606, higher than the mean for the region but still within the range of high marginality. Compared to the values of 2005, the mean marginality of the sample decreased by 2010 (see table 8), but not all nucleos showed improvement. The *ejido* Chalahuite, for example, experienced a big increase in marginalization by 2010 along with another 13 *nucleos*.

	Marginality 2005	Marginality 2010
N 43	43	43
Mean	.129132	.057437
Median	.068963	-.003503
Mode	-1.0015[a]	-.8350[a]
Std. Deviation	.5352534	.5314073
Variance	.286	.282
Minimum	-1.0015	-.8350
Maximum	1.2393	1.1408

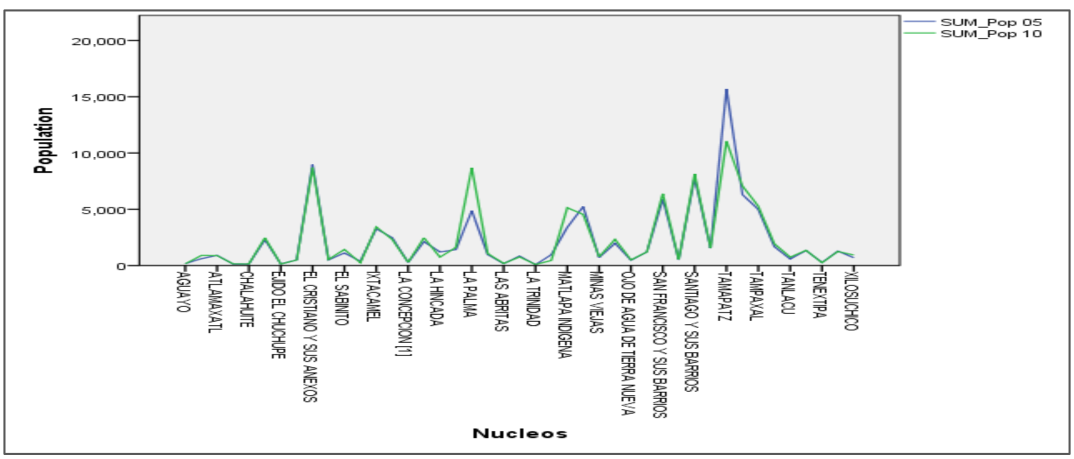
a. Multiple modes exist. The smallest value is shown

Table 11. Nucleos' marginality comparison between 2005 and 2010



Graphic 7. Nucleos' marginality index from 2005 to 2010

At the nucleo agrario level as with the locality level, the marginality value and population density did not significantly correlate (0.109 using Pearson at 0.01 level), neither did the population densities changed much during that five-year period[48] (see graphic below).



Graphic 8. Population density among agrarian nucleos from 2005 to 2010

[48] Only in two cases were there major changes in population: the *ejido* La Palma, with a significant increase, and Tampaxal, which experienced a major decrease. The major changes of those two *nucleos* suggested a re-assignation of localities as it is not uncommon in the region when the basic needs of a settlement can be better fulfilled by another *nucleo* or without one. Fieldwork confirmed that in Tampaxal, one of the biggest *nucleos,* some localities requested their re-assignation to another *nucleo* because they were located within the boundaries of the state of Queretaro; far from the head town and it was easier to obtain their basic services from this state. It is important to also notice that these two communities haven't certified their lands due to conflicts within their boundaries situation that seems to ease such internal arrangements.

Because the mean marginality values of *nucleos* showed little variation, a second marginality index was calculated using the total population of the *nucleos* instead of the localities. The new index was based on the same eight CONAPO variables. Here Pearson correlations can be seen between population and the percentage of houses with dirt floor, lacking tap water, lacking electricity, and illiteracy. The variables were weighted and the index constructed following CONAPO's "Principal Components and Dalenius' Stratification," detailed in the methodology chapter. One of the main differences between the marginality index at the localities level and the *nucleos'* level was the weight that each variable had on explaining or representing marginality; at the localities scale the percentage of houses without refrigerators have greater weight while at the *nucleos'* level the percentage of people living on dirt floors are more predictive, closely followed by the lack of electricity, tap water and the percentage of illiteracy (see the table of principal component matrix below).

Marginality Variables[49]	Component			
	1 ω	2	3	4
p15YM_AN	.632	-.446	.379	-.118
p15PRI_IN	.073	.008	.950	.170
PROM_OCUP	.124	-.755	-.016	.074
pVPH_S_EXCSA	.419	.375	-.095	.767
pVPH_S_ELEC	.855	.254	-.013	.196
pVPH_AGUAFV	.819	.172	-.085	-.420
pVPH_PISOTI	.907	-.021	-.155	-.171
pVPH_REFRI	-.168	.722	.276	-.370

Table 12. Principal components matrix of marginality index

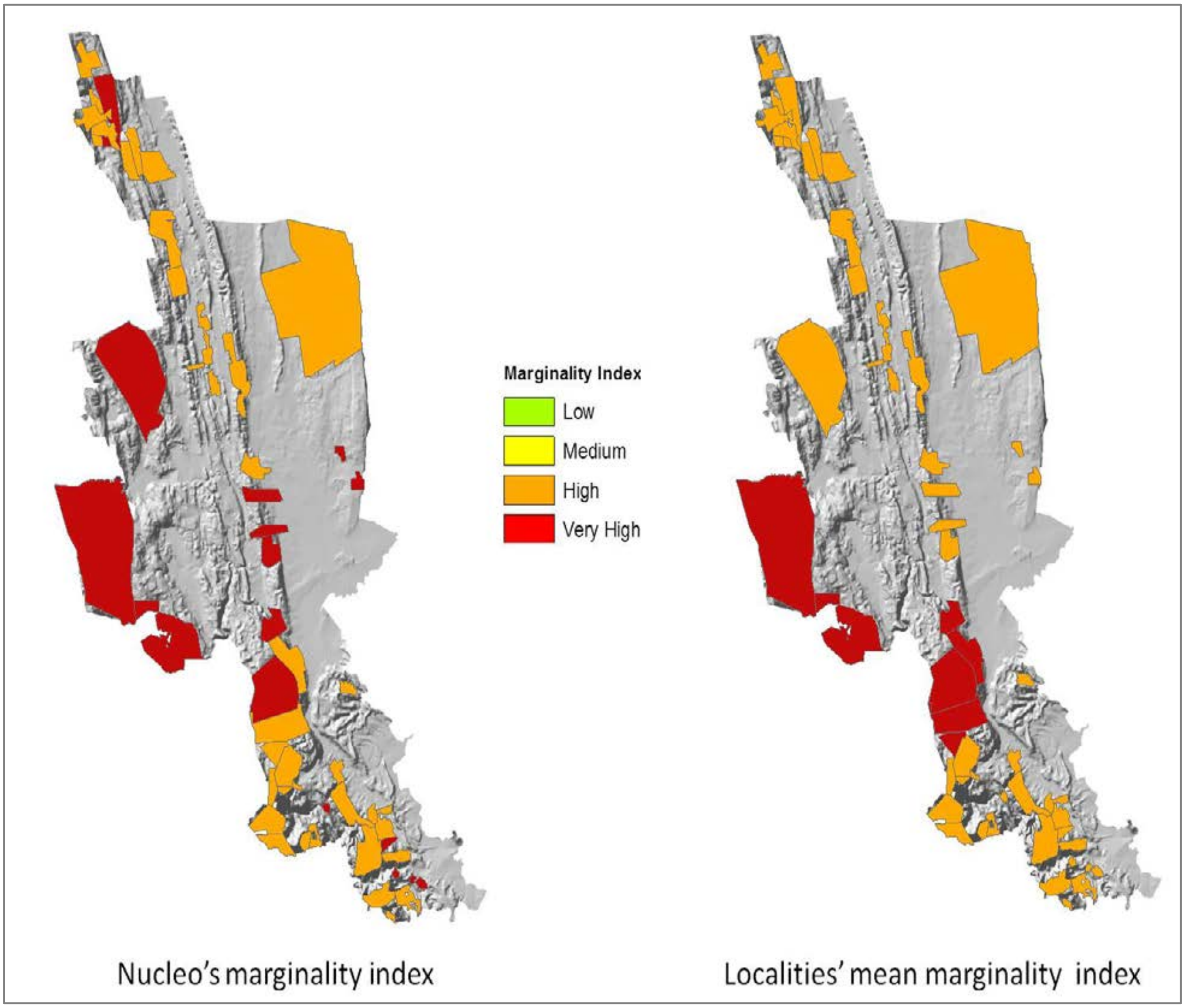
The percentage of people without refrigerators had the least weight at the *nucleos'* scale because the vast majority of the houses within them do not have one. The new index also presented a wider range between the minimum and maximum values among the *nucleos* as seen in the table 11. Marginality at the *nucleos'* scale coincides with commonly identified health threats in developing countries, like like lack of cement floors and running water, which can lead to slow growth and cognitive development in children (D.Cattaneo et al. 2009).

[49] See definition of variables in Table 1. Maginality variables, pg 8.

N	Valid	43
	Missing	0
Mean		.0000
Median		-.6055
Mode		-4.22[a]
Std. Deviation		3.25323
Variance		10.583
Skewness		1.494
Std. Error of Skewness		.361
Kurtosis		3.542
Std. Error of Kurtosis		.709
Minimum		-4.22
Maximum		12.07

Table 13. Statistics of the constructed marginality index among *nucleos*

The differences in marginality values obtained with the two methods are shown in the maps below; the one on the right was based on the localities' mean marginality while the map on the left shows the *nucleo* index based on households. Because of of its greater accuracy, the later index was chosen for the correlation analyses on deforestation.



Map 21. Marginality indexes at the *nucleos'* level

Evaluating risk of deforestation

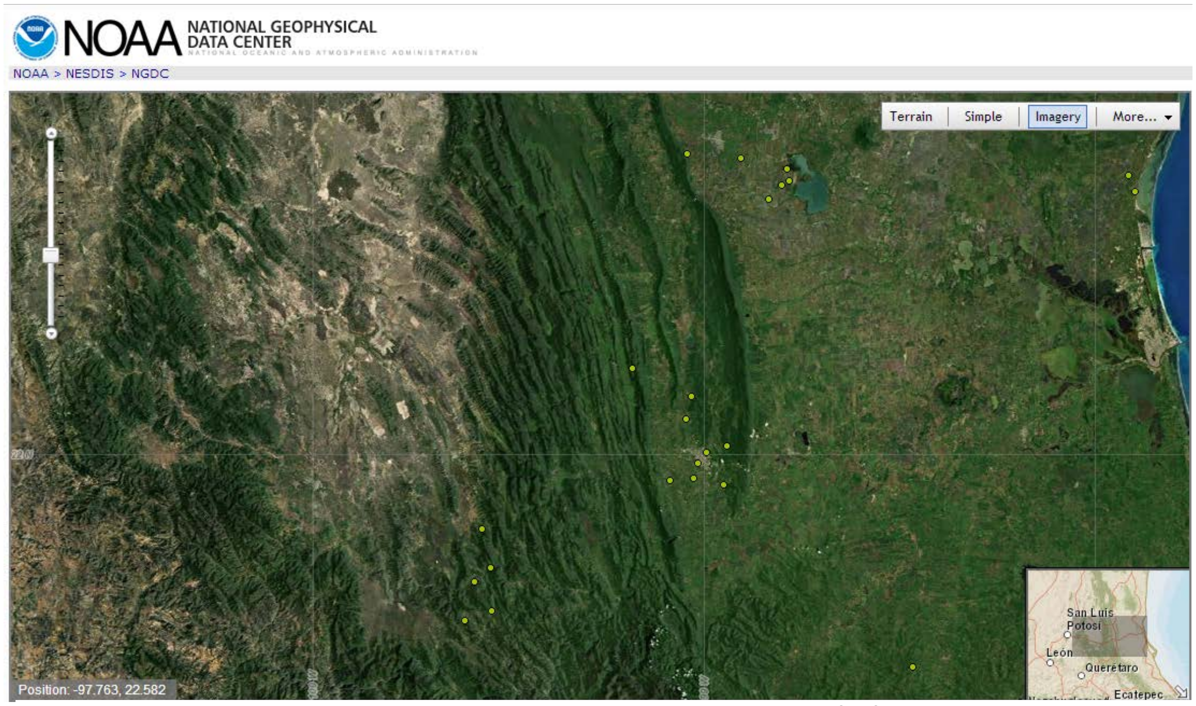
In order to analyze any potential correlation between deforestation and poverty, deforestation itself must be operationalized. Fortunately, deforestation risk models have been developed and used by environmental government agencies and policy makers for the allocation of forest conservation programs like the PES. Two models are specifically used by government agencies in Mexico to identify areas under risk of deforestation: 1) that of the Federal Prosecutor for the Protection of the Environment (PROFEPA), which designates areas where the natural vegetation has reached high rates of destruction due to factors like illegal timber, drug trafficking, burning, and agricultural expansion, and 2) the Risk of Deforestation Index IRDef 2.0.1, a raster data set that provides a more detailed classification of forests under risk.

The PROFEPA data set is mainly used by The Assistant Prosecutor of Natural Resources (*Subprocuraduria de Recursos Naturales*) to monitor areas where environmental violations are usually registered (see the map of “Municipios’ marginality index and critical areas subject to deforestation” below). Environmental violations here usually involve criminal mafias equipped with radio-communication systems and firearms, such that the national security forces are regularly involved in the monitoring (PROFEPA, 2011).

During the first part of my fieldwork season in 2011, the presence of military forces was quite prominent in the region; the northern zone of my study area became an openly contested territory between the Zetas and the Gulf drug cartels for the control of the eastern highway routes leading to United States’ border. Throughout the Huasteca Potosina spread incidents of violence, but the heavily forested northern *municipios* of El Naranjo, Cd. Valles, and Tamasopo were especially hard hit; kidnppings and battles between the municipal police, the army, and the cartels forced several of the wealthy families to flee while government ministries like PROFEPA and CONAFOR could not monitor the mountain forests. For at least six month, government programs like Payments for Environmental Services (PES) delayed their follow-up evaluations on participating areas, and technicians working for several communities fell behind in their visits. I visited a few communities in the northern region accompanied by a technician I already knew, but I followed up with a more in-depth investigation in 2012 when violence calmed down.

In addition to induced fires and deforestation associated with drug trafficking (see (Dueñas 2013) for Chihuahua and (Alatorre 2011) for Nuevo Leon, Coahuila, Zacatecas and San Luis Potosi), farmers in the Huasteca region also start forest fires. The extended dry season (February to June), the juxtaposition of forests with pastures and sugarcane plantations, and the practice of burning the latter (*zafra*), all exacerbate the spread of forest fires.

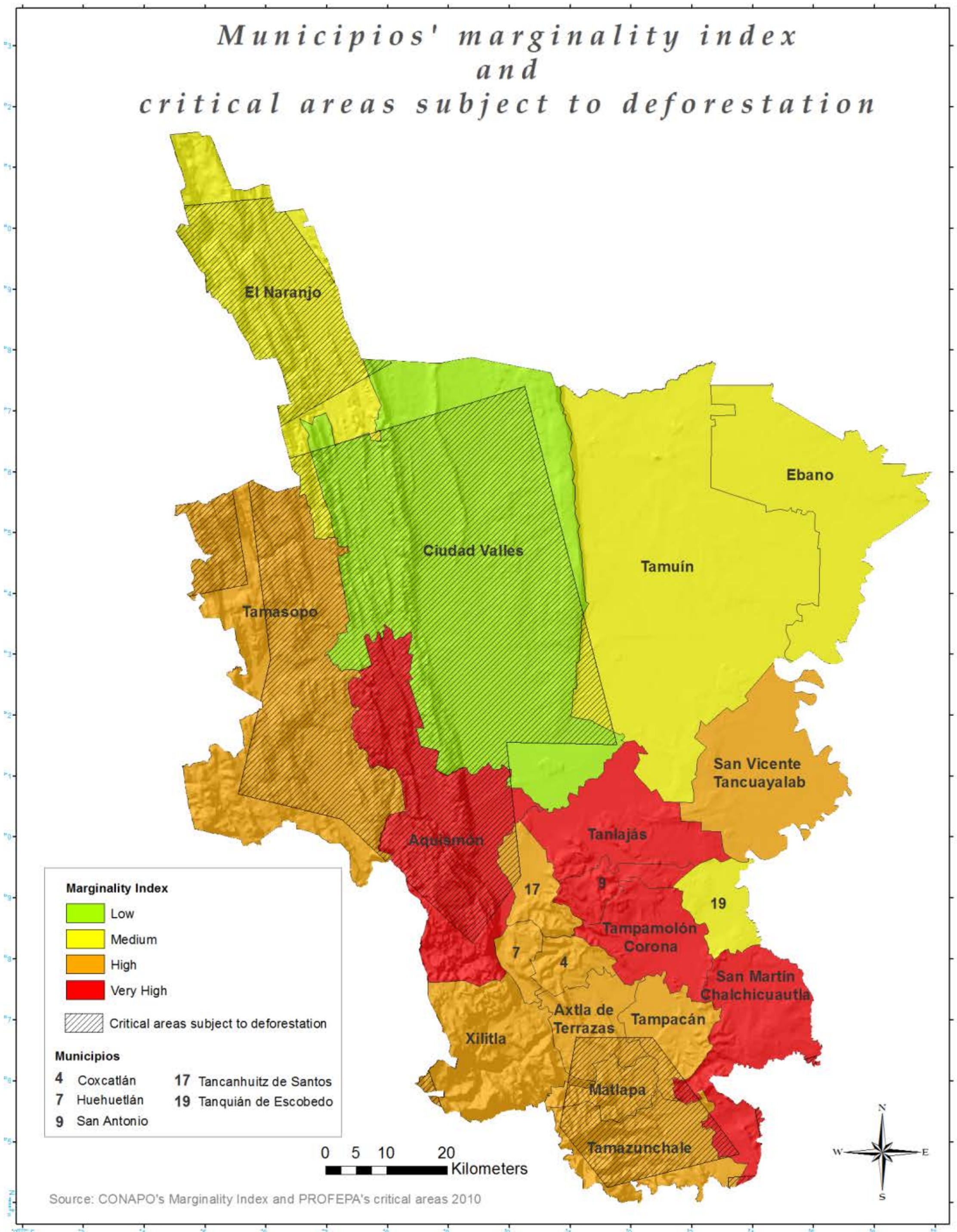
The people from the region distinguish between fires associated with criminal activities of drug cartels that create social disruption and those unintentionally spread by farmers. In 2013 criminal fires particularly were rampant, starting in the delimited critical areas at the end of March and rapidly spreading through pastures and deciduous forests via strong winds. On March 28 alone, around four thousand hectares of forest were burned in the Ciudad Valles, Tamasopo, Santa Catarina and Rio Verde municipios (Enciso 2013). SEMARNAT and local citizens argued that 129 fires seemed to have been intentionally set around Ciudad Valles, the biggest city of the region, the largest of which are represented by the yellow dots in following March 24 map by the



Map 22. Registered fires in the northern region of the Sierra Madre Oriental on 03/24/2013 by NOAA

U.S. National Geophysical data center (NOAA) fire detection satellite service.

PROFEPA's critical areas presented in Map 21 correspond with the areas related to organized crime as well as to social properties; 4,726 km² or 42 percent of the territory that has been classified as critical, covers most of the *Sierra Madre Oriental*. All the *municipios*, regardless of their level of marginalization, are subject to criminal activities, but easy access to forest resources and highways increases their risk. *Municipios* like Cd. Valles, El Naranjo, Aquismon, Matlapa and Tamazunchale, which are linked by highway directly to the US border and Mexico City, are among the most in danger of deforestation due to criminal activities.



Map 23. The Huasteca Potosina's Marginality Indexes and Critical Areas Subject to Deforestation

When considering the type of land tenure system in the areas under risk of deforestation as defined by PROFEPA, 62 percent (3,000 km²), representing 183 communities and *ejidos*, were social properties.

<u>Type of forest under risk of deforestation</u>

The PROFEPA data on critical areas subject to deforestation is broad and includes a variety of environments, including land other than forest (37 percent include agriculture and pasture lands). According to the last INEGI vegetation inventory in 2007-2011, the Huasteca region had 4,078 km^2 of forest, and 49 percent of it (1,989 km^2) was considered old-grown forest, mainly located in the northern parts of the *Sierra*. The other 51 percent was considered secondary, including scrub (1,032 km²), mixed arboreal stratum (969 km²), and herbaceous (88 km²).

The table below shows the predominance of tropical forest in the region and its high percentage under critical areas.

Vegetation types	**Critical areas in km²**	**% in critical area**	**% of the total study area**
Temperate Forest	546.6	11.8	26
Tropical forest	2,026.3	44.08	67

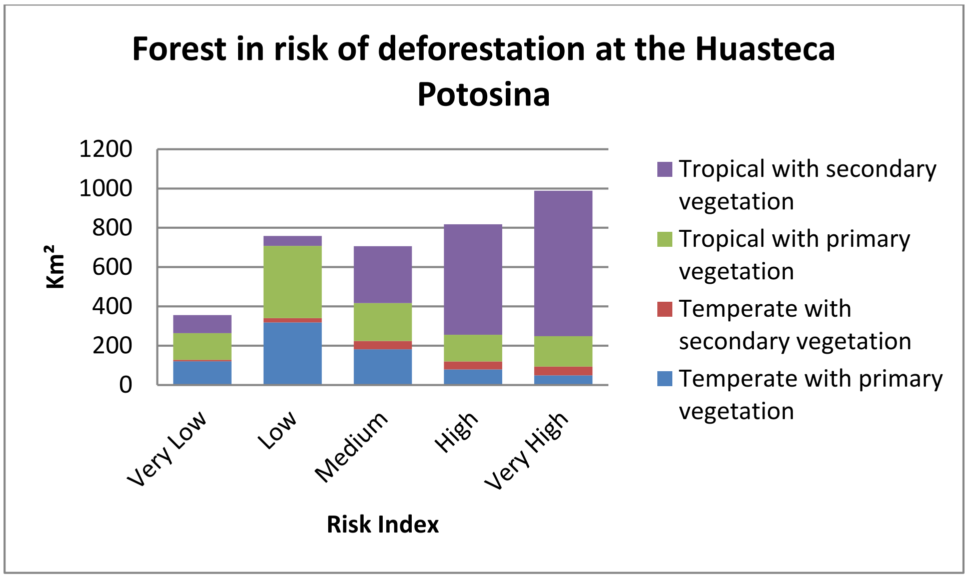
Table 14. Types of vegetation in critical areas for deforestation in the Huasteca study area

To find out the degree of deforestation risk that these areas are facing, the IRDef (risk of deforestation index) 2.0.1 data set, developed by INE, was used. This model calculates the probability of deforestation based on the locals' decision to change nine hectares of forest to another more profitable land use according to the Von Thünen model. The results from intersecting the vegetation data and IRDef raster data shows secondary tropical forests are at the most risk (see table and graphic below). Of those, 329.29 km² were transitional ecosystems like palm grove (natural and induced) and farming lands surrounding forested areas. This indicates that either deforestation already occurred in these areas during the observed period (1993 – 2000), or they were the piedmont frontier between farming lands and forested mountains.

Level of Risk	Type of forest in the Huasteca region (km²)	
	Temperate Forest	Tropical Forest

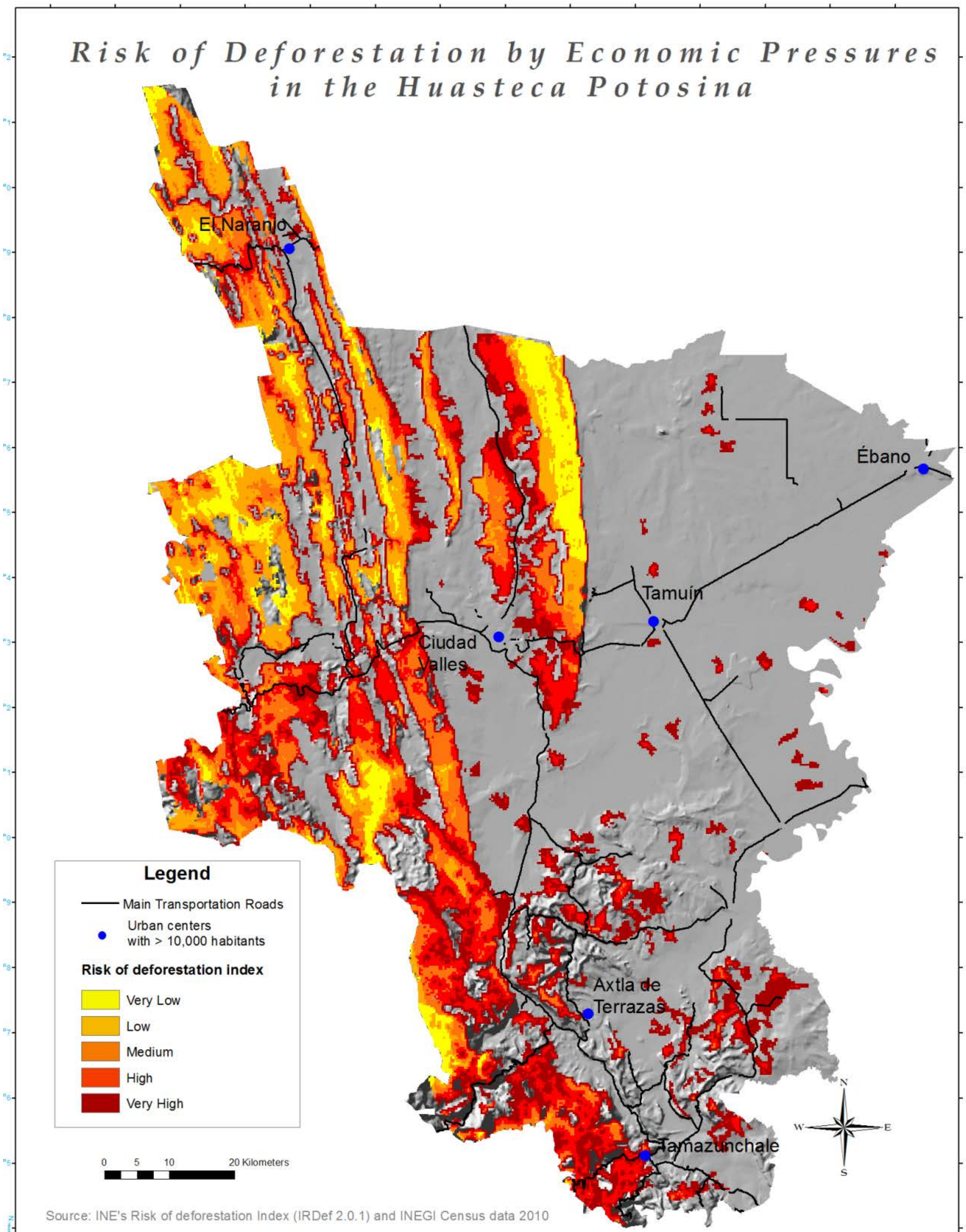
	Primary	Secondary	Primary	Secondary
Very Low	120.35	7.07	136.19	92.16
Low	318.06	22.27	367.33	50.94
Medium	181.73	42.01	193.14	289.30
High	78.65	41.05	136.19	561.97
Very High	48.85	44.35	155.14	740.10
Total	747.64	156.75	987.99	1734.47

Table 15. Risk of deforestation index by forest type



Graphic 9. Forest in risk of deforestation at the Huasteca region

The map below shows the location of areas under different degrees of risk according to features like distance to main roads and major towns that would facilitate access to markets and agricultural conversion. The lower forested areas closer to main roads, towns and agricultural frontiers are at higher risk (in red) while the highest parts of the mountain range present the lowest risk (in yellow). According to this model, from the 4,101 km² of forested lands in the Huasteca Potosina, 87 percent were classified in risk of deforestation, while the rest is found scattered in small areas throughout the region, especially in El Naranjo and Xilitla. A more detail analyses of these areas will be shown at the *nucleos agrarios* level.



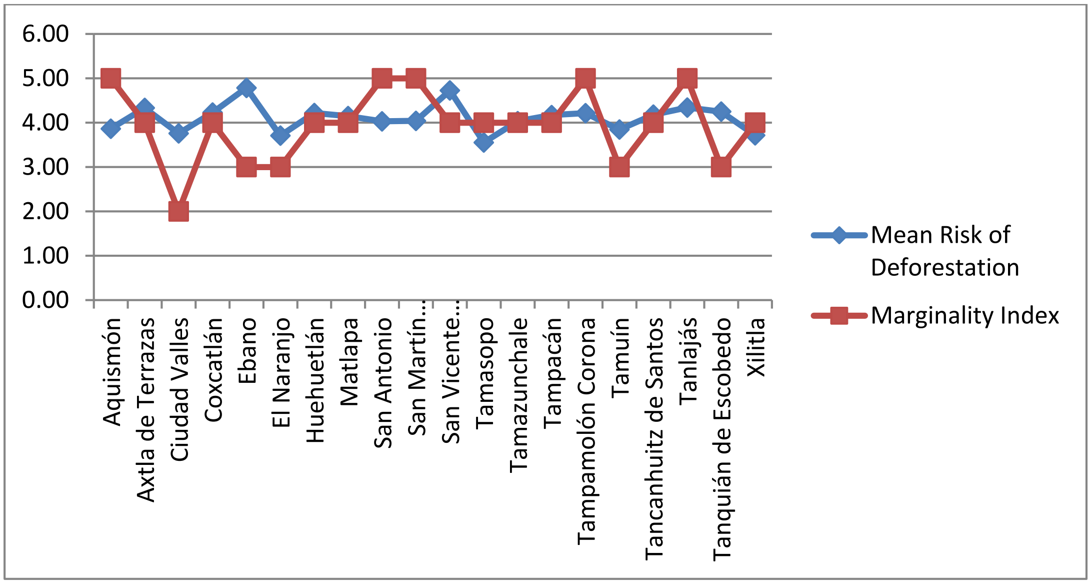
The IRDef's data resolution of 9 hectares per grid allowed making spatial correlations between the marginality index and change of forest cover at the local scale.

The table below indicates the *municipio's* total forested area, mean risk of deforestation, and marginality index categorized from 1(low) to 5 (high).

ID	Municipio	Forested area in Km²	Percentage of forest	Mean Risk of Deforestation	Marginality Index
1	Aquismón	482.16	60.79	3.87	5
2	Axtla de Terrazas	23.17	12.22	4.33	4
3	Ciudad Valles	1146.83	47.40	3.76	2
4	Coxcatlán	23.48	26.20	4.23	4
5	Ebano	12.55	1.77	4.79	3
6	El Naranjo	571.15	67.46	3.71	3
7	Huehuetlán	20.17	29.87	4.22	4
8	Matlapa	34.85	31.33	4.15	4
9	San Antonio	25.96	25.25	4.03	5
10	San Martín Chalchicuautla	99.75	24.03	4.04	5
11	San Vicente Tancuayalab	18.88	3.66	4.73	4
12	Tamasopo	966.72	72.07	3.55	4
13	Tamazunchale	162.26	45.85	4.03	4
14	Tampacán	42.97	23.25	4.17	4
15	Tampamolón Corona	49.23	18.94	4.22	5
16	Tamuín	57.98	3.15	3.85	3
17	Tancanhuitz de Santos	31.51	23.29	4.18	4
18	Tanlajás	38.32	10.35	4.34	5
19	Tanquián de Escobedo	1.05	0.74	4.25	3
20	Xilitla	269.66	66.56	3.72	4

Table 16. Mean risk of deforestation and marginality at the *municipios'* level in the Huasteca region.

When correlating marginality and risk of deforestation at the *municipio* level, no significant correlation (.101 using Pearson's correlation) was found (see graphic below).

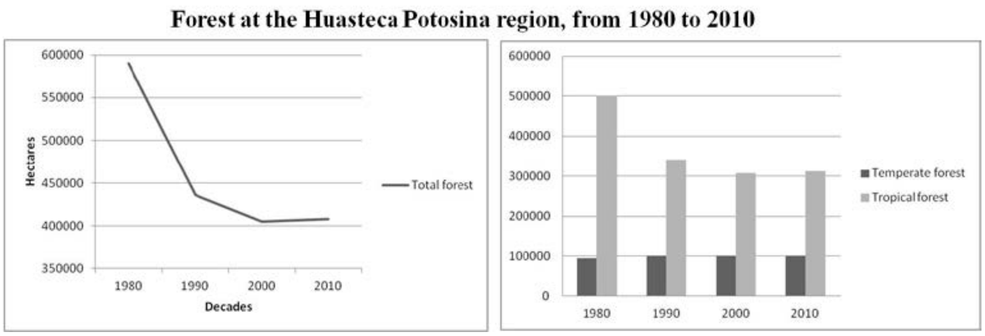


Graphic 10. Risk of deforestation and marginality at the *municipios* of the Huasteca

Forest converted into herbaceous areas from the 1980's to 2010

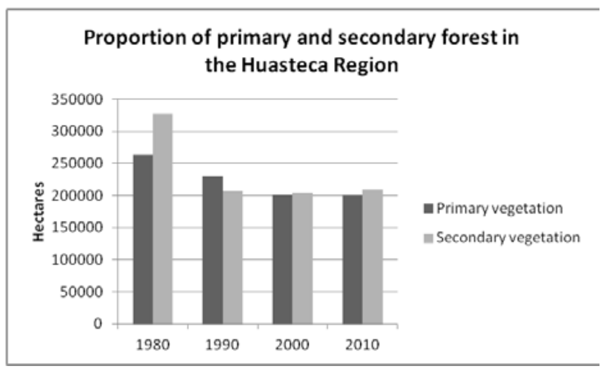
The analysis of change in forest coverage was based on INEGI's land use and vegetation series SI to SIV, which includes the decades of the 1980s to 2010. The different types of forest included in these series were grouped into two categories: temperate (TE) and tropical (TR) forest in order to simplify the analysis.

From 1980 to 2010 the region forest's decreased 31 percent. Tropical forests suffered the most, while temperate forests actually regain coverage over the last decade. These values coincide with the risk of deforestation index data, which place TR under major risk. The most intense deforestation period occurred between the 1980s and 1990s and then slowly decreased and stabilized during the last decade (see graphic below).



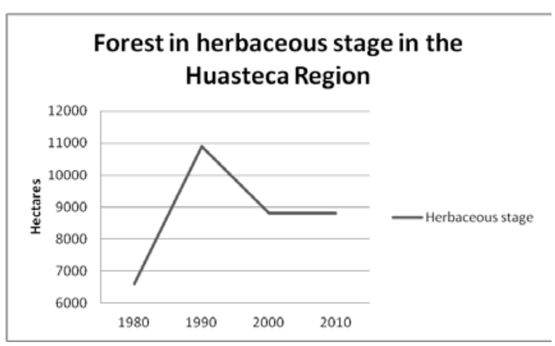
Graphic 11. Changes in forest coverage at the regional level, from 1980 to 2010.
Source: INEGI Land use and vegetation series I, II, III, and IV

Secondary forests were also particularly hard hit, especially in the 1980s, as seen in the graphic below.



Graphic 12. Forest composition at four different periods in the Huasteca Potosina, from 1980 to 2010.
Source: INEGI Land use and vegetation series I, II, III, and IV

For a forest to be secondary means that the original coverage has been disturbed and has undergone partial regrowth, with no guarantees that it will not be cut again and made into permanent herbaceous pasture or agricultural fields.



Graphic 13. Forest in herbaceous stages in the region (1980 to 2010)

Herbaceous areas are no longer forests at all, and analyses show that they are rarely if ever allowed to revert to the original primary forest. Herbaceous areas increased by 33 percent (from 6,400 hectares of perennial tropical forest, 4,200 hectares of sub-perennial and deciduous forest, and 1,105 hectares of temperate forest) in the 1980s, the majority of which occurred in social properties of the *municipios* of Xilitla, Huehuetlan, Coxcatlan, Tanlajas, Ciudad Valles and San Vicente Tancuayalab. By 2000, 25 percent of those herbaceous areas were permanently converted into agricultural lands and the rest remained herbaceous stage in 2010.

Changes in the agrarian structure and deforestation patterns

Land use decisions are affected by social, economic, political, and environmental factors. Part of the political and social context in which forest coverage in the region has changed during the period of analysis involves major transformations in land ownership. The 1980s, the period of the most intense deforestation, corresponds with the last major land granting process – the NCPE (new centers of *ejido* population) – before the neoliberal land reform. The NCPE in conjunction with the government efforts to expand the agricultural frontier into the tropics were intended to modernize and boost production in the countryside.

The bonanza of cattle ranching that started in the 1940s ended in the 1990s for both social and private properties but especially the former. Harnapp (1972) explained the "Mexican miracle" of modern cattle ranching in the Huasteca from the 1940s to the 1970s as a convergence of increasing urban demand for meat associated with a rising of living standards and the government policies to develop the region.[50] The prosperity of cattle market in the Huasteca allowed investment in intensive cattle ranching for some areas that took advantage of government aid programs to improve pastures and ranch facilities. In addition, cattle quality and quantity rose with the introduction of species suited to tropical conditions, like the Zebu breed and exotic grasses (Harnapp 1972). During the 1980s and 1990s, the growth of cattle ranching continued, although at a slower rate due to the 1982 economic crisis and a switch in government focus to expanding the agricultural frontier. As explained in the ethnography chapter, the NCPE ejidos were expropriated lands, most of which were "unused" areas, but in the northeastern

[50] The government implemented a law in 1966 that loosened the restrictions on sales and shipment of beef and in 1968 created the Livestock development program for the Huasteca to speed the ranching industry as part of the first integral regional planning program.

Huasteca (Ebano, Tamuin, Cd. Valles and San Vicente Tancuayalab), these were pasturelands with extensive cattle ranching.

Also contributing to deforestation in the 1980s was the granting of about 176 agrarian *nucleos* as part of the irrigation program of Pujal-Coy, which intended to convert the pasturelands and the remained tropical forest of the lowlands into irrigated agricultural areas (Hernández et al. 2008). Against the will of cattle ranchers of the region, the Pujal-Coy project started its first phase in 1973 buoyed by 197 million USD of World Bank investment and pressures by the landless peasant movement *Tierra y Libertad* (Díaz Cisneros et al. 1991 in Aguilar Robledo 1995:26-31). Especially for the *municipio* of Ebano, where the first phase of the program was implemented, 46,753 hectares of *ejido* lands were granted, including some deforested with bulldozers for the implementation of the irrigation program. In fact, of the 300,000 hectares affected by the Pujal-Coy the irrigation project from 1973 to 2000, 90 percent was deciduous and thorn forest (Hernández et al. 2008). It bears noting that the program never fully transformed the previous land use practices of the region or implemented an irrigation system for the new *ejidos*. The majority of irrigated areas remain in private hands (bis). In Ebano, for example, about half of its 84 NCPE *nucleos* rely on rain-fed agriculture, while the other half continued to graze cattle.[51]

The implementation of the NCPEs were not, however, the main cause of forest depletion during the 1980s; according to the GIS analysis, the loss of 14,463 hectares of TR and 726 hectares of TE within the new NCPEs represent only ten percent of the total deforestation (153,700 ha) of that period. The major decrease during the 1980s was found within private properties, representing 64 percent of the total forest loss while the already established social properties equate for another 36 percentage of the total deforestation. The major changes took place in the previously mentioned *municipios* of the northeast, where the Pujal-Coy project in addition to the land use transformation introduced a dramatic increase in population into areas previously dominated by cattle; Tamuin, for example, doubled its population in 15 years from 18,000 in 1970 to 32,000 inhabitants by 1985 (Aguilar-Robledo 1995). The increased population during the last period of expropriations brought instability to private properties, encouraging the depletion of remnants of forest in the lowlands for the introduction of pasturelands, which increased 43 percent between 1985 and 1990 and another 40 percent increase between 1990 and

[51] For more details about the Pujal-Coy project and the causes of its failure, see (Aguilar-Robledo 1995)

2000 (Aguilar-Robledo 1995, Hernández et al. 2008). For the last decade pasturelands have stopped expanding, however, agriculture has continued to creep into the forests.

The influence of the agrarian land reform of 1992 at the regional scale

After the implementation of the new land reform in 1992, only 32 more *nucleos* were created in the Huasteca Potosina, opening an additional 6,952 hectares to agriculture. During this last decade, the speed of deforestation decreased in comparison with the previous (31,129 hectares deforested in 10 years), however, this time old growth forest was affected the most.

The last two decades have been marked by the implementation of the neoliberal reforms and two major aid government interventions: the agricultural program of "Procampo," meant to promote agricultural productivity, and the PROCEDE program with the goal of certifying and titling all social properties.

Procampo, launched in 1994 and still in full action, emerged as part of the NAFTA negotiations for free trade and labor. This profit-driven program intended to pay for the cultivation of a fixed area of land until the year of 2010 in order to make farmers more competitive in international markets, incentivize the modernization of agricultural practices, and use lands more efficiently (Klepeis 2003). The idea of intensifying production within a fixed area to reduce pressures on forests has proven to be a major failure in impoverished areas of southern Yucatan peninsula according Klepeis *et all.* (2003). There, the model was incompatible with the traditional agricultural systems of swidden agriculture. A detailed study of the Procampo program and its impacts on deforestation has not been made for the Huasteca Potosina, but anecdotes about the negative impacts of the program on forested areas are abundant and will be discussed later.

The PROCEDE land certification and titling program started in 1993 and by 1999 completed the registration of 56 percent of the social properties in the region. As discussed in the neoliberal reforms section, one advantage of land certification was the reduction of deforestation due to property certainty. However, analysis of the different degrees in which agrarian *nucleos* embraced certification and their deforestation patterns reveals a more complex picture. For this analysis, I grouped 613 *nucleos* in the Huasteca Potosina according to their type of certification: 466 certified their properties at the individual parcel level, 80 certified only the perimeter of their *nucleos* and maybe few communal parcels like schools plots, 41 had not entered the certification process at all by 2013, and 25 privatized some or all of their individual lands under the *dominio* *pleno* category. In general, all groups experienced a small decrease in forest coverage (less than seven percent) during the first decade of the certification process, from 1990 to 2000, except for the *dominio pleno* group that lost 24 percent of its forest. Contrary to predictions, *nucleos* without certification and the ones that certified only the perimeter of their *nucleo* preserved their forests better, losing only two percent, while *nucleos* that certified individual parcels had a six percent decrease in forest coverage during the same period.

Over the last decade, the *nucleos* that only certified their perimeter had a forest increase of three percent, nucleos that certified all their parcels saw a one percent increase, and those without certification whatsoever increased their forest coverage by less than one percent. In contrast with the rest, the *nucleos* with *dominio pleno* have not recovered any forest coverage, although the rate of deforestation fell to two percent. Before concluding that greater degrees of privatization lead to greater deforestation, a deeper analysis of the internal and external factors prompting individual land use decisions is necessary.

Deforestation at the *municipios* of study

To understand the importance of forests in local livelihoods, 11 *municipios* in the Huasteca region with 30 percent or more of their territory covered with forest were prioritized in this study, as well as lands adjacent to them (numbers 2, 4, 7, 17 of table 14 above) held in *nucleos agrarios*.

Municipios	TE (hectares)	TR	Total forest in the 1980s	TE (hectares)	TR	Total forest in 2010	Percentage of forest lost
Aquismón	1002	55077	56079	1940	46276	48216	14.02
Axtla de Terrazas	0	4851	4851	0	2317	2317	52.24
Cd. Valles	214	155947	156161	183	114497	114680	26.56
Coxcatlan	0	2895	2895	0	2350	2350	18.83
El Naranjo	35142	25309	60451	35649	21468	57117	5.52
Huehuetlan	0	3321	3321	0	2017	2017	39.27
Matlapa	0	4834	4834	0	3485	3485	27.91
Tamasopo	46382	53351	99733	47860	48813	96673	3.07
Tamazunchale	2	20244	20246	25	16202	16227	19.85
Tancanhuitz	0	5200	5200	0	3151	3151	39.40
Xilitla	7688	25762	33450	12523	14441	26964	19.39

Table 17. Forest lost at the municipal level from 1980 to 2010

According to the percentage of forest lost on the INEGI's vegetation series I (from 1980s) and IV (2010), two *municipios* presented considerably low change in forest cover: Tamasopo and El Naranjo (see table below). El Naranjo's low percentage of forest change (5.52) and medium marginality index suggest that deforestation is higher in high marginality areas;

however, Tamasopo with the lowest percentage of change (3.07) presents a high marginality index, while others like Aquismón, Coxcatlán and Tamazuchale, which also have between 14 to 20 percent of forest lost, have very high and high marginality.

Municipio	Percentage of forest change (1980-2010)	Deforestation index	Marginality index (2005)	Degree of marginality
Aquismón	14.02	3.91	1.47345	High
Axtla de Terrazas	52.24	4.29	0.39458	Medium
Cd. Valles	26.56	3.27	-1.09287	Very low
Coxcatlan	18.83	4.47	0.79284	High
El Naranjo	5.52	3.02	0.21848	Very low
Huehuetlan	39.27	4.70	0.84717	High
Matlapa	27.91	3.97	1.04811	High
Tamasopo	3.07	2.44	0.23585	Medium
Tamazunchale	19.85	4.51	0.43663	Medium
Tancanhuitz	39.40	4.88	0.96855	High
Xilitla	19.39	3.85	0.69622	High

Table 18. Percentage of Forest and Marginality Index at the Municipios of the Study Area

Be that as it may, the percentage of total forest within *municipios* is inversely correlated with the risk of deforestation and percentage of forest loss. As the matrix below shows, the risk of deforestation increases as the percentage of forest decreases. The amount of forest is also inversely correlated with marginality, although the correlations it is not significant.

		Percentage of forest change (1980-2010)	Mean risk of Deforestation	Marginality index (2005)	Percentage of forest
Percentage of forest loss (1980-2010)	Pearson Correlation	1	.798**	.064	-.869**
	Sig. (2-tailed)		.003	.851	.001
	N	11	11	11	11
Mean risk of Deforestation	Pearson Correlation	.798**	1	.389	-.954**
	Sig. (2-tailed)	.003		.238	.000
	N	11	11	11	11
Marginality index (2005)	Pearson Correlation	.064	.389	1	-.162
	Sig. (2-tailed)	.851	.238		.634
	N	11	11	11	11
Percentage of forest	Pearson Correlation	-.869**	-.954**	-.162	1
	Sig. (2-tailed)	.001	.000	.634	

N	11	11	11	11

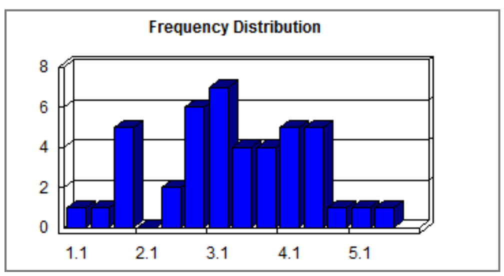
**. Correlation is significant at the 0.01 level (2-tailed).

Table 19. Correlation Matrix of Percentage of Deforestation, Marginality and Risk of Deforestation

Like the deforestation pattern of the Huasteca Potosina Region, the major percentages of deforestation at the *municipios* took place during the 1980s, most of it occurring in the *municipio* of Cd. Valles, while Aquismon, Tamasopo and El Naranjo experienced more forest depletion during the last two decades. Here again, the differences in land tenure systems might also be influencing such differences given that among these selected *municipios,* Cd. Valles is the one with major area under private property (44 percent). To have a better understanding of what have actually happened within social properties and its forest a sample of 43 *nucleos* selected for the analysis.

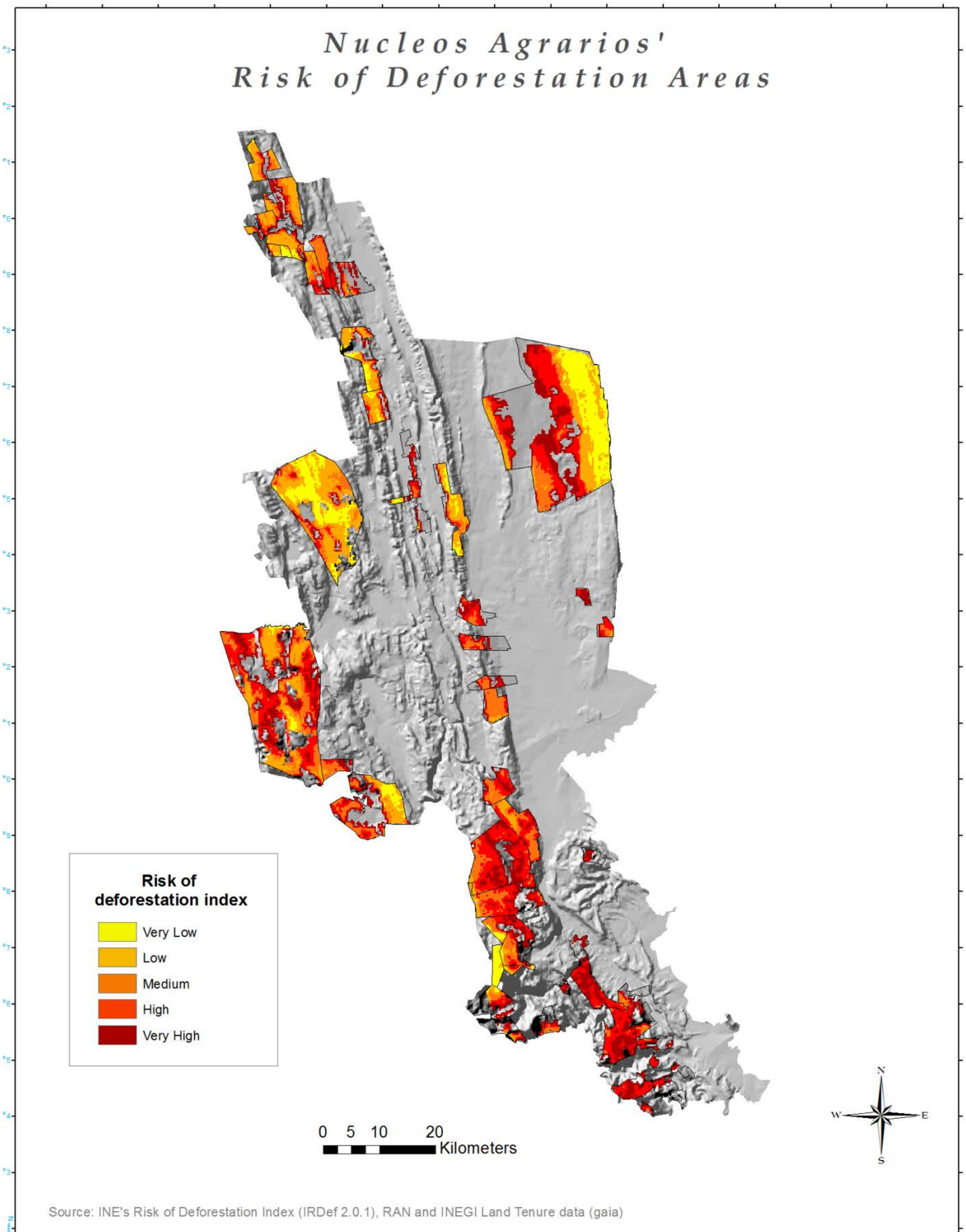
Risk of deforestation at the *nucleos agrarios* scale

From the sample of 43 *nucleos*, 31 were within or at least part of a critical area defined by PROFEPA and altogether presented a mean risk of deforestation of 3.47 (medium risk). The graphic below shows the distribution frequency of the deforestation index value (X axis) among the *nucleos* in the sample.



Graphic 14.Frequency distribution of the risk of deforestation index among the *nucleos* of the sample

The map of the *nucleos'* risk of deforestation below shows clearly that the forested territories in the south presented higher risk.



Map 24. Risk of deforestation in the sample of *nucleos agrarios*

The risk of deforestation index and percentage of forest change were compared with the variables thought to influence deforestation at the *nucleo* level. Marginality was not significantly related to either. Instead, the most influential variables for the risk of deforestation turned out to be 1) the percentage of indigenous population (0.412 with Pearsons' at 0.01), 2) population density (0.345 at 0.05), and 3) the percentage of forest within the *nucleos* (-0.328 at 0.05) (see correlation matrix below). The *nucleos* with the highest percentages of forest decrease, located predominantly in the south, do not always coincide with their risk of deforestation. Moreover, the percentage of forest lost by *nucleos* is correlated (0.471 Pearson's at 0.01) with the proportion of land held in forest; the bigger the percentage in forest, the greater the percentage of forest lost during the period.

Correlations

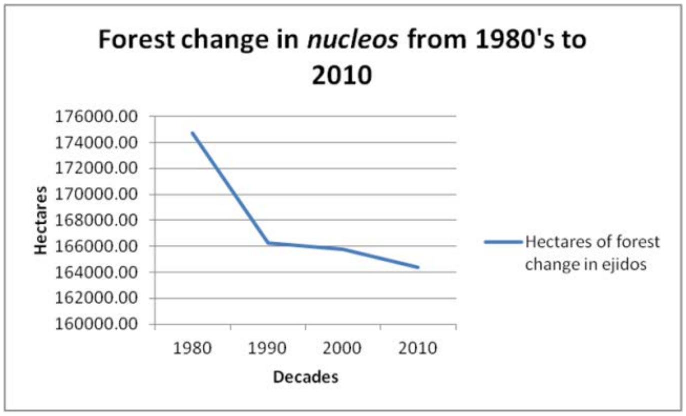
		forestedarea	Indigenous Population	pUsocomun	Margin_INDEX	Total Population	Deforestation Index	TotchangeTE	TotchangeTR	TotalForestchange
forestedarea	Pearson Correlation	1	-.183	.155	.015	-.058	-.328*	.288	.069	.471**
	Sig. (2-tailed)		.239	.320	.922	.710	.032	.061	.658	.001
	N	43	43	43	43	43	43	43	43	43
Indigenous Population	Pearson Correlation	-.183	1	-.250	.206	.487**	.412**	.134	.120	.120
	Sig. (2-tailed)	.239		.106	.186	.001	.006	.391	.445	.442
	N	43	43	43	43	43	43	43	43	43
pUsocomun	Pearson Correlation	.155	-.250	1	-.054	-.368*	-.149	-.195	.198	.289
	Sig. (2-tailed)	.320	.106		.733	.015	.340	.210	.202	.060
	N	43	43	43	43	43	43	43	43	43
Margin_INDEX	Pearson Correlation	.015	.206	-.054	1	.109	.004	.391**	-.108	-.013
	Sig. (2-tailed)	.922	.186	.733		.485	.979	.010	.492	.934
	N	43	43	43	43	43	43	43	43	43
Total Population	Pearson Correlation	-.058	.487**	-.368*	.109	1	.347*	.163	.026	-.042
	Sig. (2-tailed)	.710	.001	.015	.485		.023	.297	.868	.787
	N	43	43	43	43	43	43	43	43	43
Deforestation Index	Pearson Correlation	-.328*	.412**	-.149	.004	.347*	1	-.162	.152	-.149
	Sig. (2-tailed)	.032	.006	.340	.979	.023		.299	.330	.341
	N	43	43	43	43	43	43	43	43	43
TotchangeTE	Pearson Correlation	.288	.134	-.195	.391**	.163	-.162	1	-.204	.212
	Sig. (2-tailed)	.061	.391	.210	.010	.297	.299		.189	.172
	N	43	43	43	43	43	43	43	43	43
TotchangeTR	Pearson Correlation	.069	.120	.198	-.108	.026	.152	-.204	1	.552**
	Sig. (2-tailed)	.658	.445	.202	.492	.868	.330	.189		.000
	N	43	43	43	43	43	43	43	43	43
TotalForestchange	Pearson Correlation	.471**	.120	.289	-.013	-.042	-.149	.212	.552**	1
	Sig. (2-tailed)	.001	.442	.060	.934	.787	.341	.172	.000	
	N	43	43	43	43	43	43	43	43	43

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

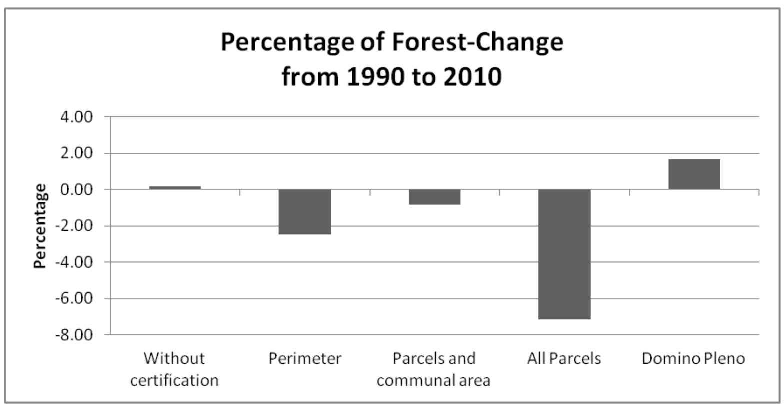
Patterns of land use and deforestation within the sample of *nucleos agrarios*

Deforestation in social properties varies according to their geographical context and land use composition; within the sample of 43 *nucleos* located along the *sierra* and where the majority has more than 50 percent of its territory forested, the periods of deforestation differ from the overall region. After the same major drop in forest coverage during the 1980s, a period of stabilization occurred from 1990 to 2000, but over the last decade two thousand hectares of forest have been lost (see graphic below).



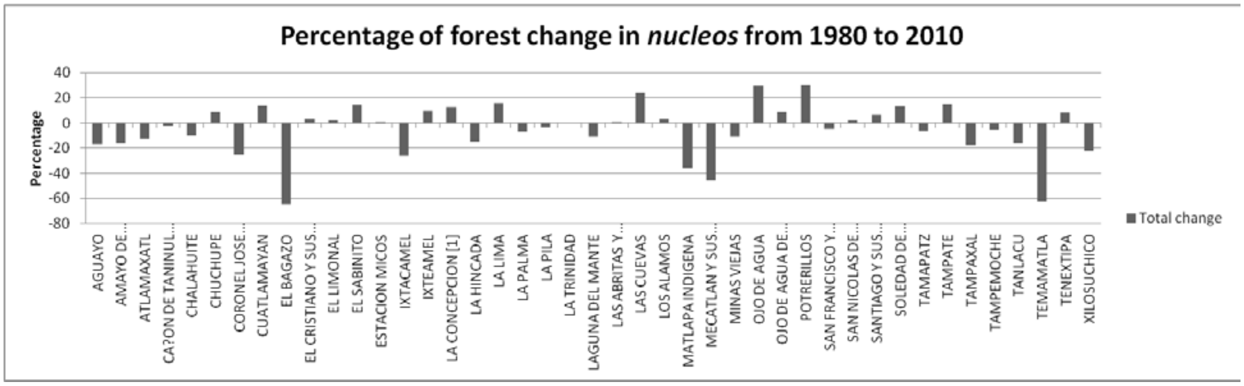
Graphic 15. Forest coverage in the sampled *nucleos* from 1980 to 2010

Looking more closely at where forests were lost over the last two decades (a period of land certification and titling), the biggest losses occurred in *nucleos* that certified all their territory as individual parcels (see table below).



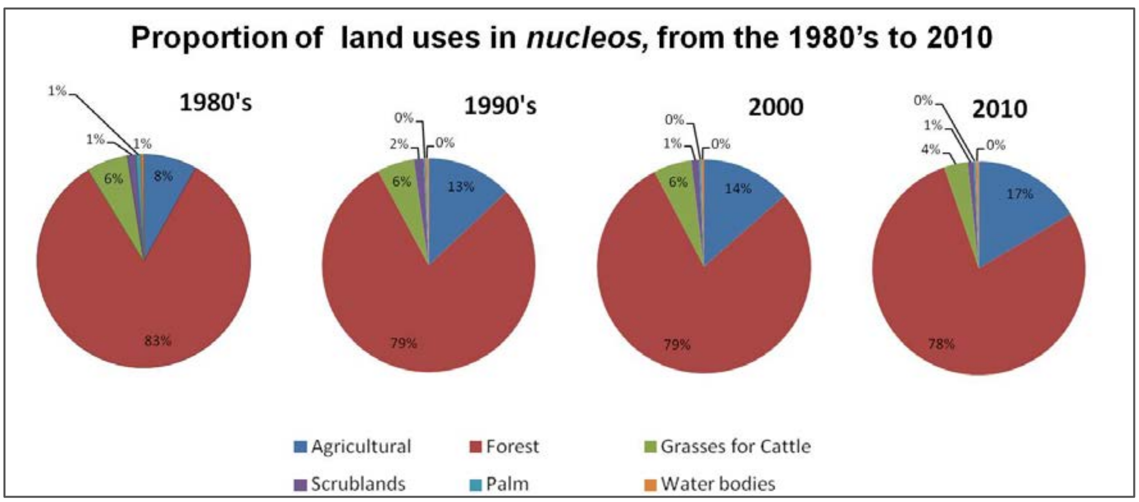
Graphic 16. Percentage of forest change in sampled *nucleos* according to their certification process

The overall forest within the sample decreased 23 percent in three decades, but as the graphic below shows, changes in forest among *nucleos* of the sample had different outcomes; 19 out of the 43 actually increased their forested areas, some as much as 30 percent, while 22 have lost up to 60 percent of forest.



Graphic 17. Percentage of forest change by *nucleos* (from 1980 to 2010)

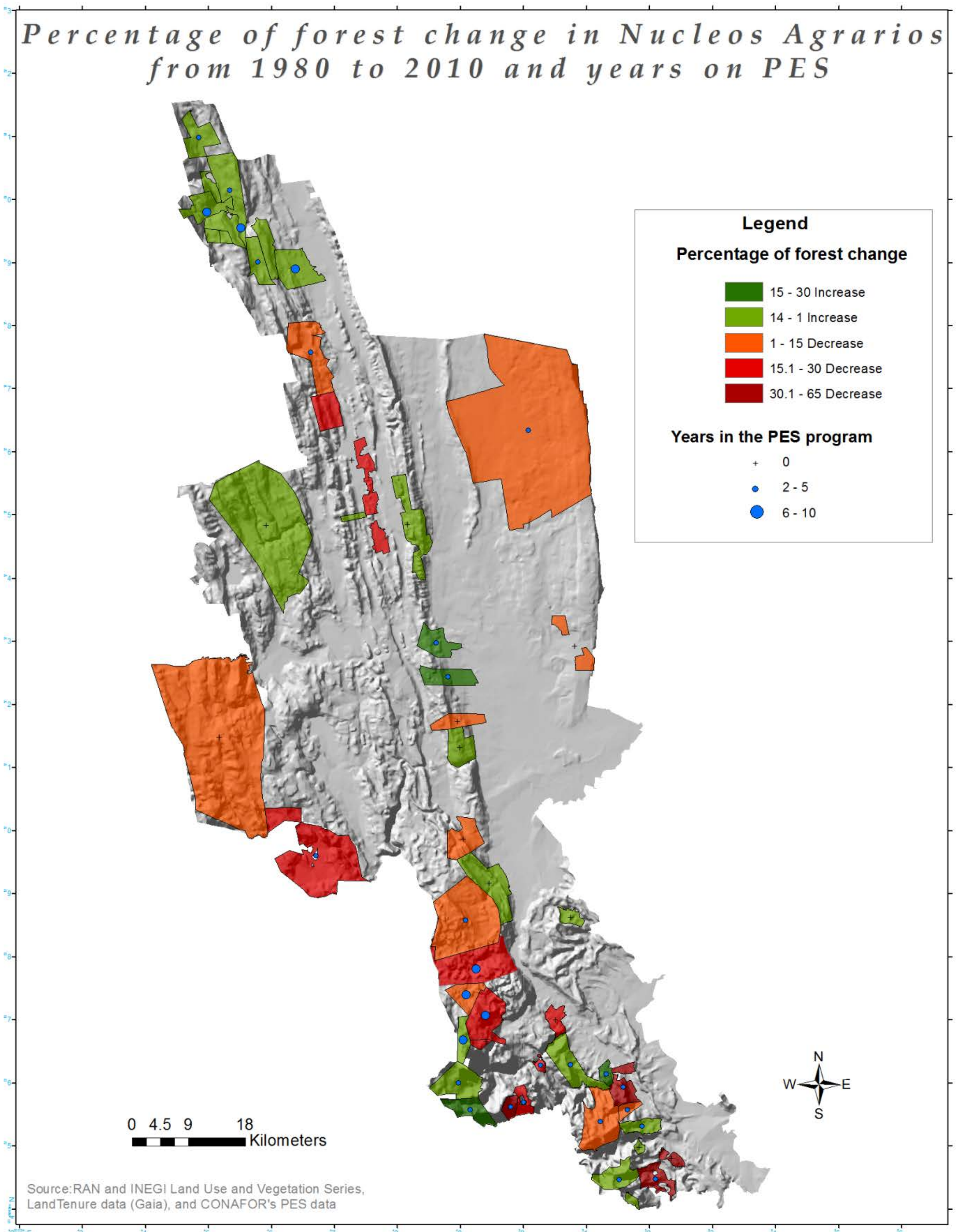
Looking at the land use composition of these social properties throughout the period, it was mainly agricultural land that was replacing forest, occupying from 8 percent of the territory in 1980 but 17 percent by 2010 (see graphic below).



Graphic 18. Proportion of land uses in sampled *nucleos,* from 1980 to 2010

Interestingly, grasses for cattle (induced and cultivated) also have decreased over agricultural lands, reflecting the region's rugged topography, low quality soils for the cultivation of grasses, and many other political and economic reasons mentioned above that undermined the cattle market. The causes for decline in cattle production in the region are beyond the reach of this dissertation but anecdotally several sample *nucleos* reported the activity to be unprofitable when new options like PES appeared.

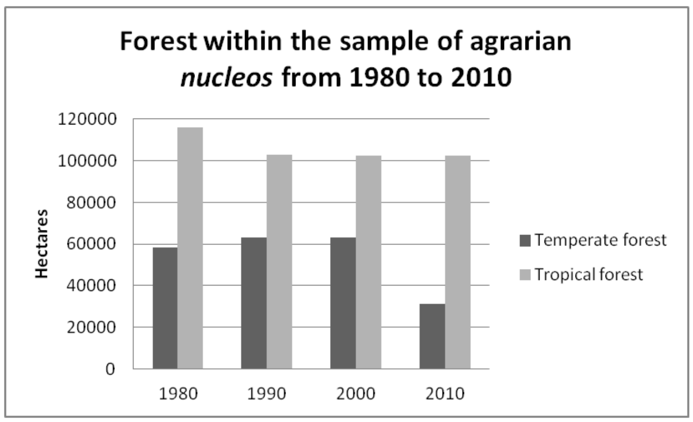
As previously mentioned, the forest conservation programs have become popular in the region over the past two decades, especially the PES program during the last one. The map below shows the percentage of nucleo forest change with the amount of years participating in PES.



Map 25. Percentage of forest change in sampled *nucleos* from 1980 to 2010 and years on PES

Deforestation at the *nucleos'* scale, tropical vs. temperate forest

The types of forest affected most by deforestation within the *nucleos'* level differ from the regional pattern; in nucleos, temperate forests showed a total reduction of 46 percent while tropical forest decreased 12 percent (see graphic below). While at the Huasteca Potosina region scale temperate forest has actually regained areas during the last decades, the biggest lost in temperate forest among the sampled *nucleos* happened during the last decade, while tropical forest has stayed stable for the last two decades. The discrepancy between the forest change at the regional and the sampled *nucleos'* scale could be due to a skewed sample of nucleos or a different dynamic of forest clearing between nucleos, private, and public properties, but further investigation would be needed to identify the discrepancies.



Graphic 19. Forest change by type of forest within the sampled *nucleos* from 198 to 2010

The correlation values between marginality and deforestation at the *nucleos'* scale also differed from the regional results, showing a significant correlation of 0.391 (under Pearson's at 0.01 level) but only when restricting the analysis to temperate, not tropical, forest. The areas of the sample where temperate forest is dominant include the *municipios* of Tamasopo, El Naranjo and Xilitla. For the last two, where the PES program has been operating over a decade, several *nucleos* have actually experienced an increase in their forest coverage, but for Tamasopo, where the presence of PES has been null so far, temperate forest decreased prominently. Some *nucleos* in Xilitla have lost temperate forest, contrasting with the El Naranjo to the north, where, on the contrary, all *nucleos* have increased their temperate forests (as high as 14 percent) and where the marginality rating is medium, thanks to the sugarcane industry. In communities losing the most temperate forest, marginality levels were consistently high with a significant statistical correlation; however, the causes of deforestation may not lie in poverty itself but in recent longer, hotter, and drier dry seasons, resulting in more forest fires, and other factors associated with poverty, like the imposition of highways and illegal privatization of land.

La Palma, for example, has lost the most temperate forest and represents a starkly clear case of how insecurity of land tenure, ethnically discriminatory development schemes, and social disruption can deeply impact the forest and its inhabitants. An indigenous community in Tamasopo and one of the biggest *nucleos agrarios* in the state, La Palma lost 2,071 ha. of forest from 1990 to 2010, and of those 1,542 ha. were primary temperate forest. A factor long exacerbating deforestation there has been the Mexico-70 freeway, the main artery connecting the city of San Luis Potosí with the Huasteca. Compounding this, the construction of a new parallel toll road begun in the mid 2000s and completed in 2013, which has dramatically impacted the area socially and ecologically. The new road inflamed territorial divisions between the indigenous and the mestizo (45 percent) populations in the *nucleo*. The lands, originally bought by the indigenous people after the passage of the communal lands law and officially restituted as such by a presidential decree in 1922, have since 2006 been in the process of conversion to a non-ethnic *ejido* by the mestizos without the indigenous people's consent. Indigenous resistance has stalled the certification process, but regardless, during highway construction several mestizos sold permits and properties to the construction company ICA for land the indigenous people consider theirs.[52] In 2012 a wave of ethnic violence surged when the *mestizos* tried to complete the certification process while the indigenous population was trying to secure the title of indigenous community based on the new state reforms on indigenous rights. Two indigenous activists were killed and death threats continue against other members.[53] Despite the internal conflict, the *nucleo* tried to participate in the PES program in 2010, but since no agreement could be made between the mestizo and indigenous populations, their participation never passed the proposal stage.

For the tropical forest, decreases occurred throughout the region during the 1980s, especially in the southern *municipios* of Xilitla, Matlapa and Tamazunchale, but thereafter

[52] Interview with indigenous inhabitants of the *ejido* by the human rights commission of the State of San Luis Potosíin 2009.
[53] Personal communication with Juan Cisneros, personnel of the National Commission for the Development of Indigenous People (CDI) in San Luis, who was assisting them in legitimate the indigenous community as part of one of the CDI programs.

remained stable. It is worth noting that all the *nucleos* that experienced over 30 percent decrease in tropical forest are now participating in the PES program, specifically in shade grown coffee agroforestry, which includes the promotion of a great variety of arboreal species that provide fruits, traditional medicines, and construction material.

The cultivation of shade grown coffee is so embedded in the cultural traditions especially in the southern region despite the instability of coffee prices, less land availability, and the increasingly unpredictable weather. When the government withdrew support for coffee production in 1989, it had little impact on the amount of land devoted to coffee in the southern region (Martinez-Torres 2006). The world coffee crisis in the 1990s due to overproduction and a dramatic drop in prices, devastated small coffee growers in the region the most. Regardless, Ponette-Gonzales (2007) reported that almost ten years of low coffee prices did not deter the Teenek region of Aquismón from continuing coffee cultivation. What is ultimately motivating conversion from coffee to subsistence production is rising population, such that landowners must consider food security over the risks of the market (Ponette-González 2007).

Between 2011 and 2012, coffee production dropped dramatically within the region, in part because of unusually hot, dry weather and a severe frost in the high-altitude areas. Coffee orchards were temporarily used to grow subsistence crops, but the coffee plantations eventually recovered (see photo below).

Figure 19. Coffee plot turned into a milpa (with corn and squash) while recovering from a frost. Tampaxal, Xilitla 2011.

Unfortunately, as in many other places, more extreme temperatures have become common, hurting peasant production already stressed by overpopulation, shorter fallow periods, and soil degradation.

The state-government implemented the *Fondo Potosino del Café* (Potosí Coffee Fund) to bolster coffee production and help growers during natural disasters, but as with many other programs, the program is inefficient due to a well-established culture of corruption in the region. The money designated for inclement weather losses barely trickles to the affected people, reinforcing the urge to combine coffee production with swidden agriculture as a way to diversify and secure subsistence in impoverished areas. The agroforestry PES program, in which several southern *nucleos* are participating, is another way that coffee growers can increase their profits, but not enough to reduce poverty.

In sum, the correlation between deforestation and poverty was weak at the regional and *nucleo* scales from 1980 to 2010. Both marginality and deforestation decreased, but they did not coincide to a significant degree at the local level and the degrees of marginality did not vary with the amount of deforestation. Rather, land reforms and government programs have been more influential in changing land use of the region. Deforestation was highest in the 1980s especially for tropical forest affected by the last ejido land grants and the northeastern deciduous forest impacted by the Pujal Coy irrigation project. During the 1990s, deforestation slowed, as tropical forest depletion decelerated and temperate forest regain three thousand hectares. Correspondinlgy, the distribution of NCPE ejidos slowed and finally ended in 1997 and the restitution of indigenous community lands ended in 2000. Although forest depletion due to land redistribution practically ended during this period, the implementation of the neoliberal reforms starting with the land certification and titling process, and the liberalization of the market impacted lands use in agrarian *nucleos*, including their communal forested areas. In addition, subsidiary programs like Procampo, launched in the mid of the 1990s with the purpose of improving peasants' agricultural practices and the economy, encouraged the expansion of agriculture into forested areas. At the same time, the first programs involving payments for forestry conservation began, such as that of the grassroots' *Sierra Gorda* organization in several *nucleos* of Xilitla.

For the last decade, forest cover has maintained fairly stable with no major decreases; only 950 hectares of temperate forest were lost while tropical forest actually gained 4,422 hectares. In this period the land certification process ended in 2006 with the completion of 90 percent of the social properties of the region,[54] but land certification and titling did not prove to have a decreasing impact on deforestation. *Nucleos* that certified their lands up to the parcel level have higher percentage of loss than the ones that did not enter the certification process or that only certified the perimeter. On the contrary, *nucleos* that engaged in full privatization in the form of *dominio pleno* experienced higher forest depletion during the first decade of the certification process.

The creation of the CONAFOR forest commission in 2001 promoted numerous reforestation projects at the community level throughout the region. Even though many of these projects failed due to poor planning and bad quality of seedlings,[55] it revived the discourse on the importance of forest protection and restoration, and together with Sierra Gorda set the bases for the implementation of the PES program in 2004. While forest depletion has largely been due to agricultural expansion and government incentives, more so than marginality per se, as seen

[54] After 2006, a similar program, FANAR, has continued certifying the remaining agrarian *nucleos* at a much slower pace, since most of them pending ones have either boundary problems or are against the certification ideology.
[55] From field work and interviews with private and social properties that participated in the CONAFOR's reforestation program between 2009 and 2010

below environmental services programs have more recently played a critical role in forest preservation and regrowth.

VI. The Spatial Correspondence between the Implementation of PES Programs in the Huasteca Region and CONAFOR's Prioritized Areas.

After identifying the patterns of the deforestation in the region, one of the main research objectives was to see correspondence between deforestation and the implemented projects in CONAFOR's PES program. First, I will describe the PES areas, their coverage in the Huasteca region and the sampled nucleos' degree of prioritization according to CONAFOR's grading system.

By 2012 CONAFOR's prioritization scheme included six categories of eligible areas (I to VI) based on the type of forest, the environmental services it provided, and its risk of deforestation. Certain categories of vegetation, like cloud forest under high risk of deforestation, were graded for the higher payments, while dryer and disturbed forest, like thorn forest and secondary forest with low risk of deforestation, received the lowest payments. For San Luis Potosi, the areas eligible for PES cover 8,403 km² of different types of vegetation. Areas in categories I, II, and III are eligible for hydrological services, and areas IV, V and VI are eligible for biodiversity services. The Huasteca only includes areas in categories from II to VI, not I for cloud forest under very high risk of deforestarion. This exclusion of category I by CONAFOR contradicts INEGI's IV (2010) land use vegetation series and INE's risk of deforestation data, which if overlapped cartographically show 90 ha of cloud forest with very high risk in the southern *municipio* of Xilitla. Land owners with forest designated in category I would get around 100 USD per hectare each year for the first five years with a possible extension of up to 10 years.

Category II includes cloud forest under high to low risk of deforestation and is applied to areas found scattered in the *municipalities* of Xilitla, Tamasopo and El Naranjo. There were 3,742 hectares of cloud forest in the region classified by CONAFOR, but only 2,729 ha. were found when GIS intersecting vegetation and the risk of deforestation index. Payments for these areas are around 70 USD/ha. but the areas must fall between 100-200 hectaries for individual properties and 200-3,000 for lands controlled by social entities like ejidos and communities.

Area III includes temperate and sub deciduous forest under very high to very low risk of deforestation. For this category land owners receive considerably less money, around $38 USD/ha., but the area limits are increased to a maximum of 6,000 ha (CONAFOR, 2012). Temperate and sub deciduous forests – particularly the former – are the most representative of the study area, covering 144,859 ha., from which only 89,322 ha were as under risk according to the risk of deforestation index.

Category IV covers perennial and sub-perennial tropical forest with very high to very low risk of deforestation. Within the region, there are 141,364 ha of perennial and sub-perennial tropical forest, with 64 percent being sub-perennial forest and 36 percent perennial, and 70 percent of these are classified with some risk of deforestation. This type of vegetation was taken out of hydrological services to conservation of biodiversity services in 2012, which is more appropriate for the region since most of the areas with perennial forest shelters shade grown coffee plantations with high diversity of birds. The payments in this area are around $55 USD per ha/year for land areas that must fall within 200-3,000 ha for social organizations (CONAFOR, 2012).

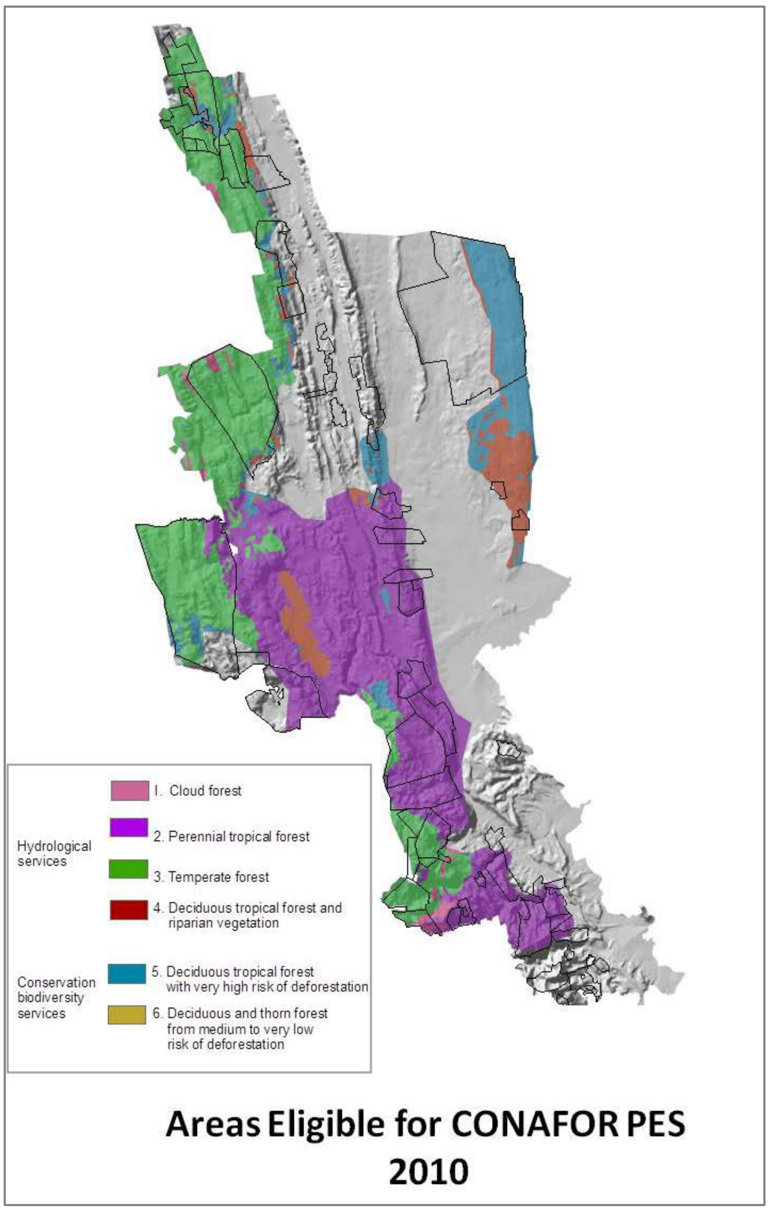
The V and VI categories are also for the conservation of biodiversity, and the limits for area submission for organizations are between 200 to 2,000 hectares. The V category includes deciduous and thorn forest with high and very high risk of deforestation, while category VI includes the same type of vegetation but with medium to very low risk. For the study region, 45,522 hectares of deciduous forest is covered under category V, three percent of which is riparian vegetation. Landowners in these areas receive $38 USD/ha. For VI category, with less risk of deforestation, covers 185,837 ha. of the study area. The program pays around $28 USD per ha/year under this category (ibib.). Oddly, 59 percent of category VI lands were agricultural fields and urban areas, according to INEGI's survey.

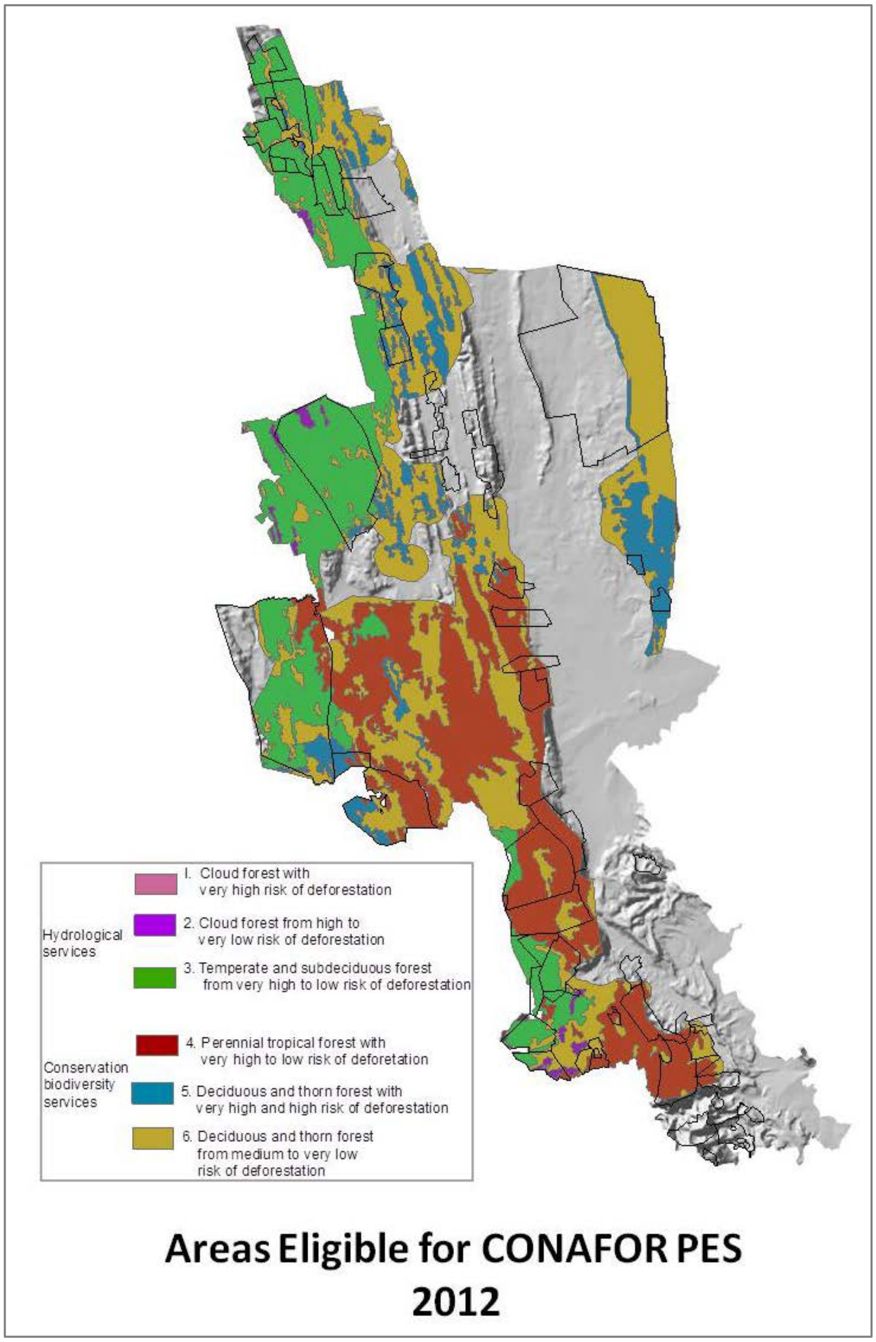
The new delimitations eligible for PES in the study region published in 2012 have some moderate changes from those of 2010, expanding from 352,688 ha. to 389,366 ha. The types of land uses under each category changed as well. One major change was perennial tropical forest (category IV) being transfered from hydrological services to conservation of biodiversity services. The changes according to CONAFOR respond to the demand of applicants, observed results, and updated information of land use and forest change.[56] Many of these are forested shade coffee plantations, and the biggest ecological benefit is providing habitat for a high diversity of birds. The areas with perennial and sub-deciduous forest are one of the most extensive in the study region, and the reclassification of use for conservation of biodiversity has

[56] Operation rules of the ProArbol program for 2012, available at http://www.conafor.gob.mx/portal/index.php/tramites-y-servicios/apoyos-2012

meant a reduction in payments from 56 USD/ha. to 44 USD/ha for areas of very high risk of deforestation and 30 USD/ha for areas of less risk. Thus, even with an overall increase of land in the PES program, the re-classification of areas has diminished the value of payments provided to the region (see maps below). The diminution of category IV payments has hit the southern region the hardest because it has more perennial forest (and coffee orchards) and is also the poorest in the region, providing further reason, besides having to engage in activities that does not suit their land use, to withdraw from the program.

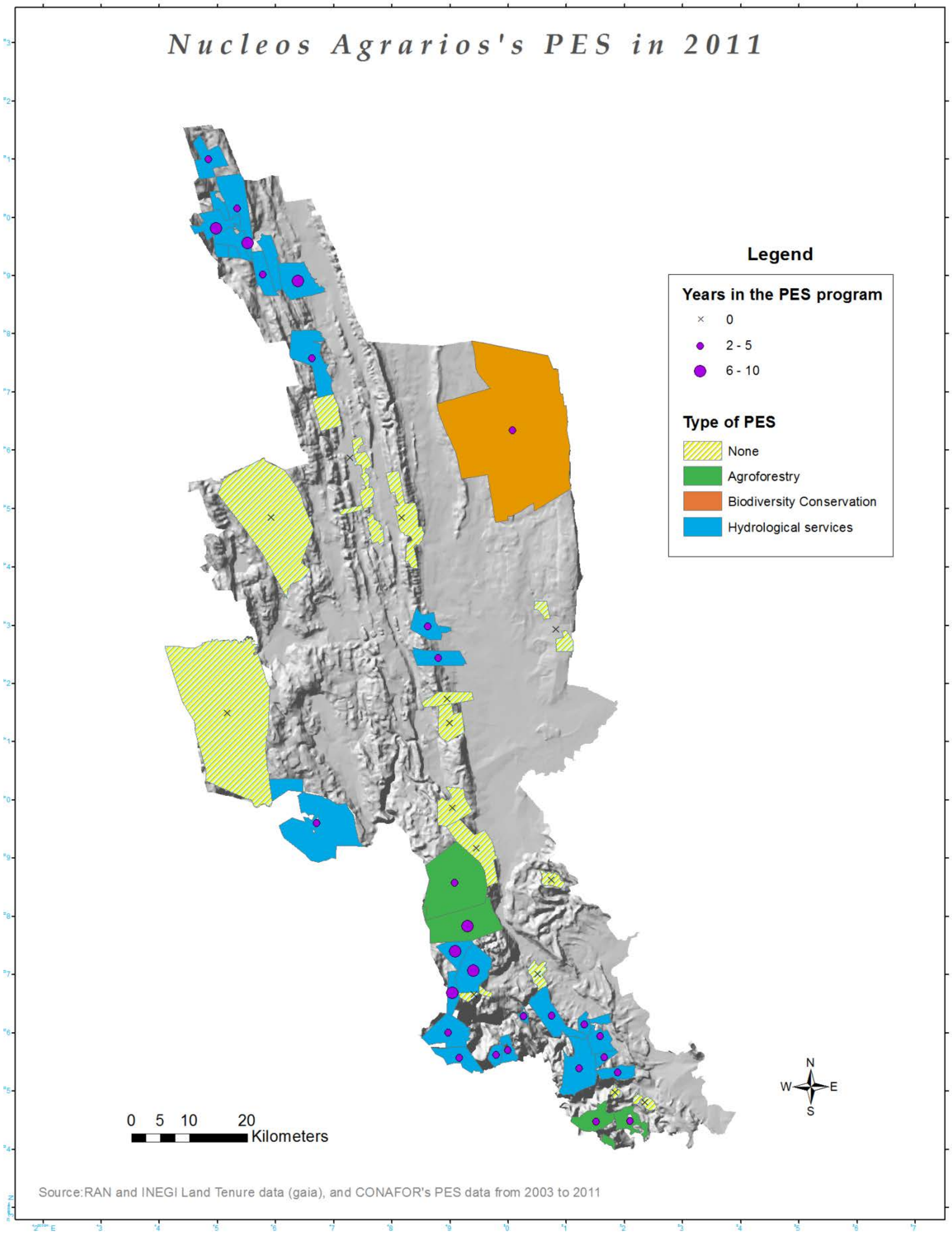
Map 26. Areas eligible for PES in 2010





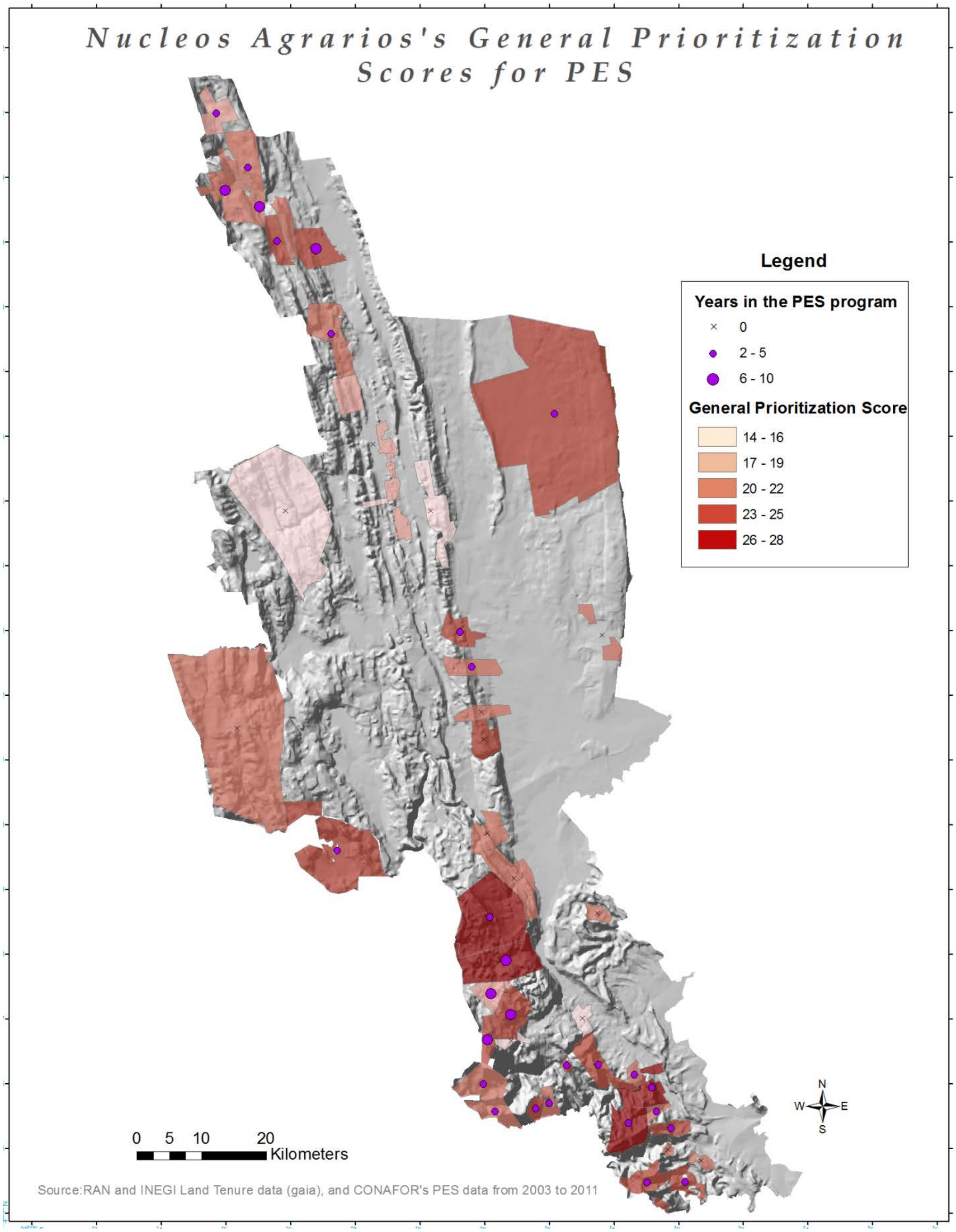
Map 27. Areas eligible for PES in 2012

From the sample of 43 *nucleos* of the study area in the 2010 delimitation, 37 had more than 50 percent of their territory eligible for PES, while six were not eligible at all. In 2012 one more nucleo became eligible. Regarding the actual enrollment in the program, 29 *nucleos* are participating: 23 in hydrological services, five in agroforestry with forests shading coffee, and one in a planning phase of a project for conservation for biodiversity. For the 14 not participating, seven have applied for the program and were rejected at least once. The next map shows the location of the *nucleos*, their number of years in the program since its implementation, and the distribution of categories. Because the program length is five years, the *nucleos* were grouped into three categories: zero, five, and ten years or more. A common practice among the participating *nucleos* is the submission of separate forested areas to the program during different periods to increase their chances of extended funding. This strategy is obvious in the bigger nucleos of the northern zone. There, for example, participating *ejidos* commonly have areas staggered in different periods under hydrological services, while in the southern region, where the land uses are more diverse, the periods coincide but the land designation is more varied.

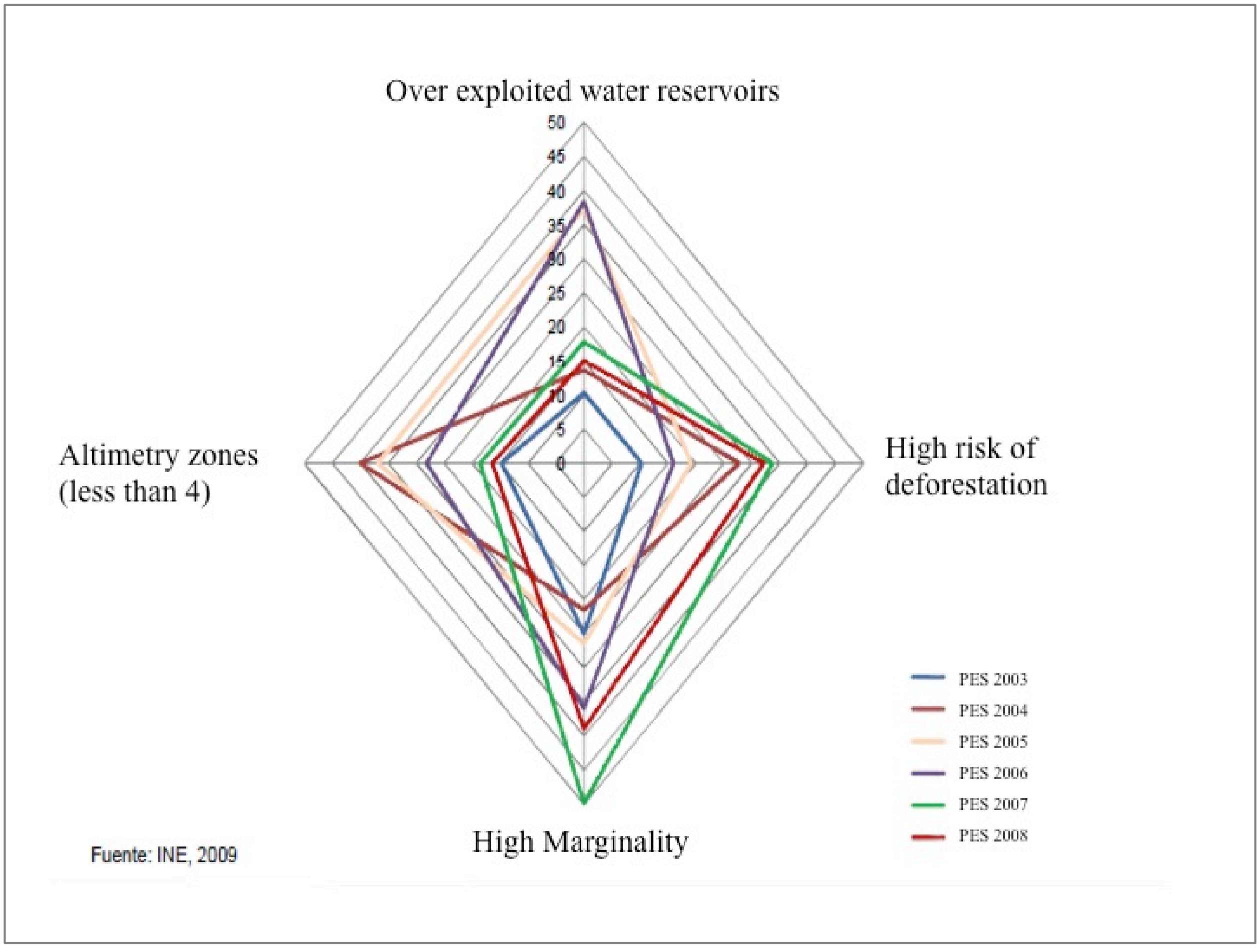

Nucleos Agrarios's PES in 2011
Legend
Years in the PES program
0
2 - 5
6 - 10
Type of PES
None
Agroforestry
Biodiversity Conservation
Hydrological services
0 5 10 20
Kilometers
N
W
E
S
Source:RAN and INEGI Land Tenure data (gaia), and CONAFOR's PES data from 2003 to 2011

The CONAFOR's grading system for the prioritization of proposed areas for PES is explained in detail in the methodology section, so only the main three parts of the prioritization process will be highlighted here. First, the proposed polygon has to be within the eligible areas described before; only applicants to agroforestry – mainly coffee growers – can apply without this requirement. Then, a grading system of eight general variables with a maximum score of 37 point is applied to all the applicants, and depending on the category of the program they want to participate, there are six other variables considered, for a maximum score of 29 points (see the appendix I. PES grading prioritization in nucleos). Curiously, the point totals for participants ranged from 14 to 27 points, but some non-participants ranged even higher, from 18 to 27 points, and the average of rejected applicants was 25 points.

The map below displays the *nucleos*' scores and the years they have been in the program, showing that in general there is a correspondence between lower scores and lesser time in the program. Conversely, the areas with longest time in the program – the northern mountains of El Naranjo and the southeastern mountains of Xilitla – had the highest prioritization scores. Using Pearson's correlation coefficient to analyze the relationship between the environmental and social variables on the one hand, and length in the program on the other, revealed a significant correlation (0.431 at a 0.05 level). The nonparametric Spearman's coefficient also showed a high correlation (0.462 at a 0.05 level, see appendix II). In these terms, the allocation of the PES program is consistent with the CONAFOR's priorities.


Nucleos Agrarios's General Prioritization Scores for PES
Legend
Years in the PES program
0
2 - 5
6 - 10
General Prioritization Score
14 - 16
17 - 19
20 - 22
23 - 25
26 - 28
N
W
E
S
0 5 10 20
Kilometers
Source:RAN and INEGI Land Tenure data (gaia), and CONAFOR's PES data from 2003 to 2011

Since CONAFOR’s prioritization variables for PES have constantly changed, the targeting areas have also changed throughout the years, but as the INE graphic shows below, high marginality, although with different weight, has always been an element of focus (INE 2011). Even for the years after 2008, marginality has maintained a core element along with risk of deforestation for the prioritization of PES areas.



Graphic 20. Prioritization of variables for PES, from 2003 to 2008. Source: INE, 2009

For the sample of *nucleos*, however, an analysis between prioritization scores and marginality index presented no significant correlation in any of the parametric or non-parametric coefficients. Although the marginality index has been used by government agencies to prioritize program implementation at the local and regional level, it does not seem to be related to increasing deforestation or any other environmental variables considered for the prioritization of PES areas. As mentioned in chapter V, all the *municipios* of the region presented marginality, and at the *nucleos* scale most of the sample presented from medium to very high marginality values. This alone should make all nucleos priorities for the PES program.

When compared with the actual implementation of the program we found that among the seven *nucleos* with very high marginality, four of them have PES, and one of them, “Tampaxal”, has been incrementing its PES categories since 2007 and now manages three services. In terms of the economic impact of PES funding, it is not reflected in the *nucleos* decrease of the marginality[57]. The marginalization index alone, however, does not explain all the possible economic benefits that these kinds of programs can bring to a community in the short or long term; therefore, a deeper scrutiny involving interviews with community members regarding the economic impact of the program was implemented. These economic impacts will be discussed at the section, “Perceptions and Impressions on the Social Impacts of the Program among PES Participants.”

On the other hand, the risk of deforestation and prioritization scores were significantly correlated (0.612 at 0.05 level using Spearman’s coefficient), coherent with the PES program’s policy to prevent deforestation in areas of high risk. When evaluating the actual implementation of the program among the PES participants of the sample, 16 *nucleos* presented very low and medium risk of deforestation while 13 presented high and very a high risk. Between the nonparticipants, 8 out of 14 with medium prioritization scores (between 16 to 20 points) presented medium to high deforestation risks, two with higher scores (22 points) presented high and very high risk, and one with 25 points presented medium risk. This last case in particular refers to El Chuchupe, an indigenous *ejido* that has been rejected two times and once accepted with no funding, is surrounded by PES participant communities and 98 percent of its territory is forested, all elements that gives them a high score, however its medium risk of deforestation and boundary conflicts with private owners seems to prevent their participation.

When calculating the scores of the *nucleos* for the two main categories of the program, hydrological and conservation for biodiversity services, the northern region appeared more suitable for hydrological services and the southern for biodiversity services, as the 2012 re-categorization determined.

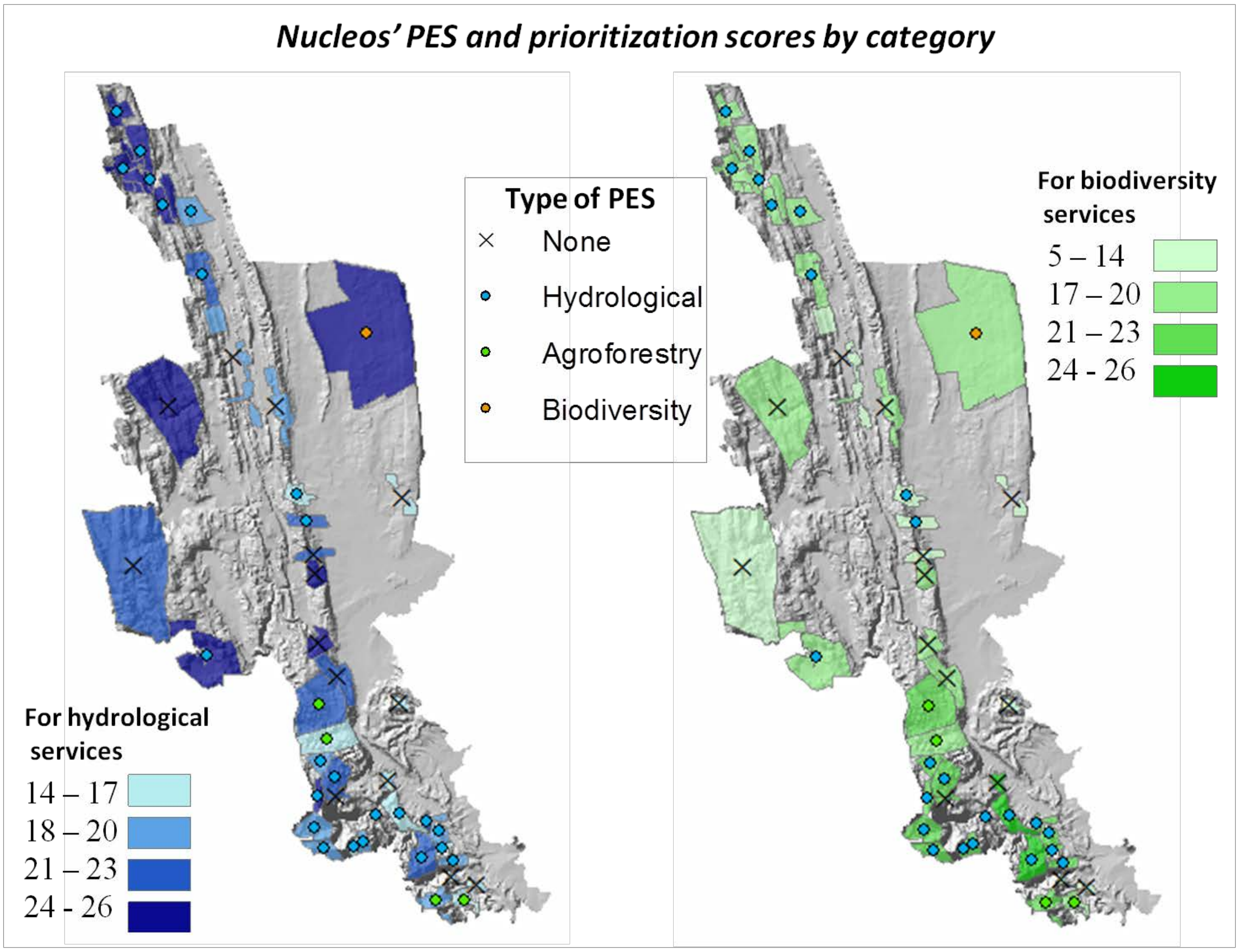
[57] Marginality is calculated every five-year period, but periods cannot be easily compared because each period is calculated according to the variables that have the strongest weight, which might be different among each period.

For the category of hydrological services, the highest score obtained was 26 out of 29 points possible by the *ejido* San Nicolás de los Montes, whose proposal was actually rejected in 2010. It contains a mestizo population, presents high marginality, lies within eligible areas, but its forests covering 95 percent of the communal lands (16,913 ha.) have low risk of deforestation. On the other extreme, a community with second lowest score at only 16 points was participating in the program. From the polygons already participating in hydrological services, five received higher scores for agroforestry services, but as mentioned, participants prefer hydrological services because they are more profitable.

For the conservation of biodiversity services, the highest score found in the sample was 26 points from 29 possible, received by both participant and non-participant nucleos with shade grown coffee. Scores for agroforestry were particularly high in the southern region because of its importance as areas for the conservation of birds and endangered species. The Huasteca Potosina is part of the distribution corridors of mammals in danger of extinction like *Panthera onca* (jaguar) and potentially for *Leopardus pardalis* (ocelot). It is also inhabited by threatened nectar-feeding bat species like *Choeronycteris Mexicana,* located around the *municipios* of Cd. Valles and Xilitla, and *Leptonycteris nivalis*, found in Cd. Valles. Both are key pollinators with an ample distribution around the country, but their temperate forest habitat is shrinking and has put their population under risk (Baker and Cockrum 1966). The region also hosts protected species like the monkey *Poto flavus (*kinkajou or *mico de noche)* still found in remote areas of Xilitla and Tamazunchale, and the small-eared shrew *Cryptotis obscura,* also found in Xilitla.

For the category of biodiversity services, the two highest scores were obtained by participant nucleos in the hydrological services program, which again provides greater payments. One of the consequences of coffee-growing *nucleos* participating in categories other than the more suitable biodiversity one has been the reduction of the variety of tree species used as shade. The lowest scores of participating nucelos were 12 points, a score lower than all seven of the non-participating nucleos, including three that had in fact applied and were rejected. There seems to be no pattern for why non-participating nucleos are rejected. Most had the same or higher scores as the participating *nucleos*, were within eligible areas, and had at least 50 percent of their territory forested. Only one, the *ejido* of Estación Micos, did not meet the priority qualification of having old grown forest (also categorized as in arboreal stage), while the rest had more than the minimum amount of hectares required. Another important factor in awarding PES is the presentation of *nucleos'* legal documentation (*carpeta basica*) for the area to be managed. For the *nucleos* that were certified by PROCEDE all this documentation is easily assembled, but for the *nucleos* not certified it can be much more challenging. As mentioned above, the certification of property was once a requirement for participation, but since many of the areas with higher risk of deforestation were not certified, that requirement was rescinded, at least until the last operational rules in 2012. Within the sample, there are 13 *nucleos* without certification and 10 of them are participating in the program (see Map 27), but in many cases the reason why they are not certified, for example boundary problems, can prevent their participation in the PES. Of the seven nucleos outside the PES program, none were officially excluded due to certification, and the three non-certified were officially rejected not due to lack of certification but insufficient funding.

The following map shows the location of the PES program and the scores for the two categories within the sample of *nucleos agrarios.*



Map 28. PES prioritization scores by category within the agrarian *nucleos* of the sample

When the scores for each category were correlated with the social variables involved in the prioritization process (see appendix II. Correlation matrix of PES in *nucleos*), statistically significant relationships were found but not with the marginality index.

Using Pearson's correlation coefficient, the scores for hydrological services were significantly correlated with the percentages of: forest within the *nucleo*, common use areas, and forest in arboreal stages within the program. The *nucleos* with higher scores for hydrological services also had a higher proportion of forest within the nucleo and the highest percentage of it in arboreal stages. The percentage of land held in forest was inversely correlated with the deforestation index, meaning that the risk of deforestation decreases as the *nucleos* increase their proportion of forest. The risk of deforestation was correlated with the general preference scores, such that *nucleos* with higher risk of deforestation in CONAFOR's prioritization scheme are indeed prioritized for the implementation of PES.

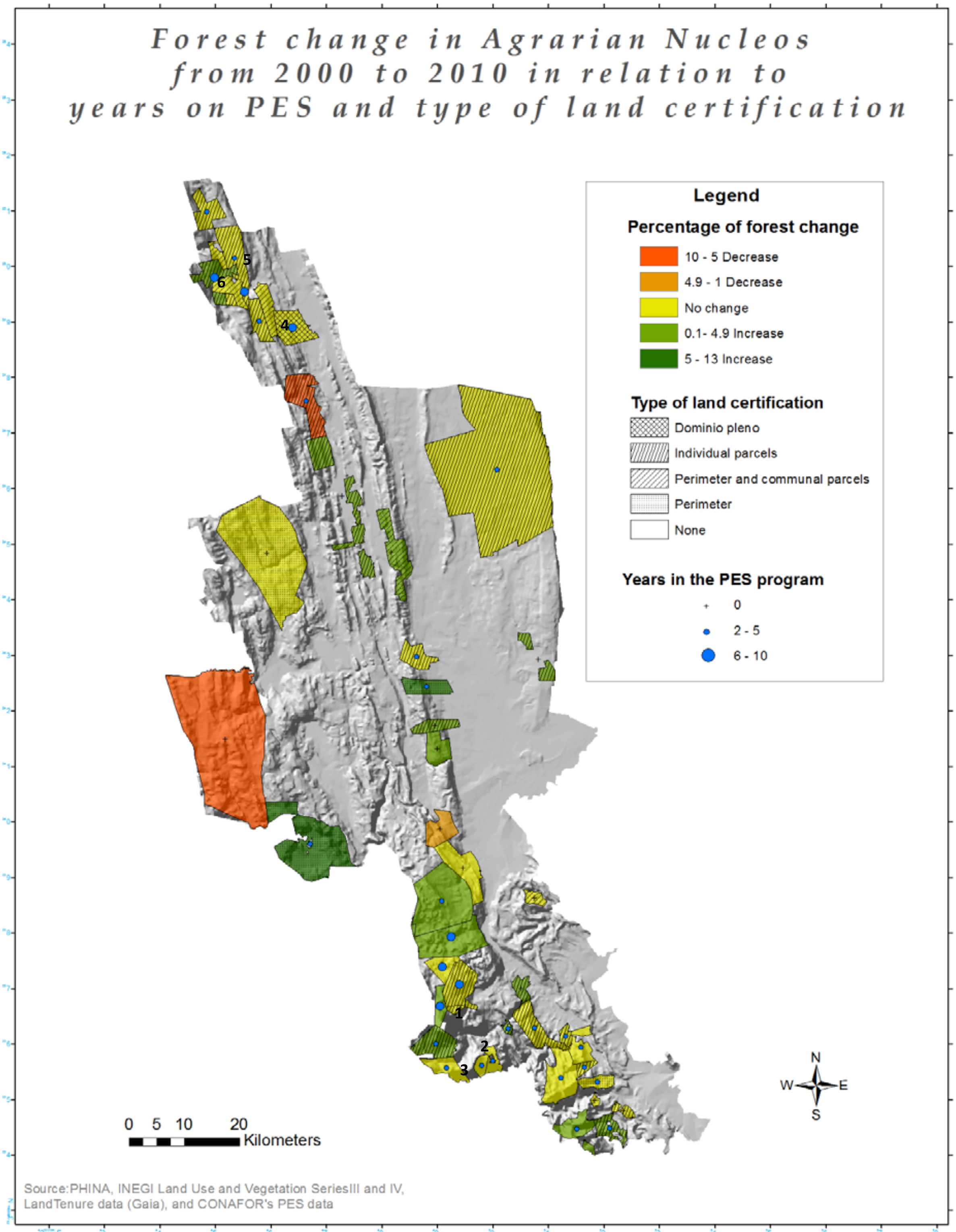
For the biodiversity scores, the Spearman's coefficient showed a significant inverse correlation (-0.553) with the percentage of communal use; the *nucleos* with higher scores tend to have less percentage of land held in communal property. This value is consistent with the *nucleos* that have shade grown coffee, the most common activity practiced by indigenous population where parcels are owned communlly and reported as such for the hydrological PES program, but managed individually. The difference between the "official"ownership and the internal land management makes the administration of the program a little trickier when payments and labor have to be made according to the percentage of land that each member has submitted. The new categorization of perennial tropical forest into the eligible areas for biodiversity conservation might restrict these practices, but the payments must increase or at least match the hydrological payments per hectare for the services to be profitable and for coffee farmers to remain in the program.

VII. The Contributions of the PES Program to Stop Deforestation.

The scope of the PES program since the beginning of its implementation in 2003 until 2011 has been small but nonetheless important, covering less than 20 percent of the 407,800 hectares of forest in the Huasteca Potosina. As seen in the patterns of deforestation section, forest for the whole region has stabilized during the last decade and tropical forest even increased 1.5 percent, but because of the programs' scope, the decrease on deforestation cannot be attributed to it. As discussed in previous sections, there are numerous economic, political and cultural factors that influence the lost of forest, but among the most representative for the region during the analyzed time period have been in the form of the state interventions. As Aguilar-Robledo (1995, 2002) characterizes state interventions that target land-uses, they can be operative or normative, the regional development projects of Pujal-Coy for example, is a perfect illustration of an operative direct intervention. Other not regionally specific operative interventions that nonetheless have different impacts within the region are for example, the agricultural subsidiary programs like Procampo or the Payments for Environmental Services program. Impacts of such programs differ according to specific social, cultural, economic and environmental factors in each micro-region. The impacts of the PES program have been different in the north and southern region of the study area but also within *nucleos* of each area, however, as will be described below, some shared elements of the PES development can predict a positive or negative impact on reducing deforestation.

At the nucleos level

Since most of the forest in the country is owned and managed communally within agrarian *nucleos* or social properties and most of the PES programs have been implemented on these land tenure system, the analyses focused on the variety of conditions in which the program work or do not work at this scale. To approach the impact of the program on reducing deforestation only the six *nucleos* in my sample that have been participating in the program for at least two periods (ten years) were considered. These *nucleos* are: 1. Chalahuite, 2. Coronel Jose Castillo Tlamaya, 3. La Trinidad, 4. La Concepcion, 5. El Limonal, and 6. Los Alamos (see map below). Some of them have had continuous funding since they entered the program in 2003 and some have experienced disrupted payments for a variety of reasons that will be discussed ahead. Influential factors like land tenure, land use, forest management, community organization and perceptions will be addressed for each and their neighboring non-participant *nucleos* through the following anecdotes.



Map 29. Forest change in nucleos of the sample (from 2000 to 2010), in relation to years on PES and type of certification.

El Chalahuite

The *ejido* of Chalahuite has 1,950 hectares and a relatively small population, with 180 in total and 38 *ejidatarios*. It is one of the *nucleos* with the highest marginality index in the sample, and one of the first *nucleos* in the region to enter the PES program in 2003. Its orginal 1,460 hectares in the program has been reduced to only 645 hectares, but it is applying for another 700 hectares. The *ejido* has not been certified because it has boundaries problems with the neighboring *ejido* of Tampaxal, Aquismón, whose inhabitants have invaded the territory. Its land tenure system has gradually changed from originally all common use in 1960 to only the hectares in hydrological services program as communal today. They also have 40 ha. of collective pasturelands and 400 ha. of individually controlled croplands.

The *ejido* entered the program with the assisatnce of the Sierra Gorda NGO, an ecological group with a long-standing presence in the area. The *comisariado* (president of the ejido) explained that initially only 11 *ejidatarios* entered the program because everyone else was afraid that the NGO intended to buy their lands. Only after the municipal president of Xilitla at the time, Mario Mtz. Peralta, convinced them of the program's real intensions did enrollments increase.

Besides the forest-maintenance activities required by the program, like building fire breaks and keeping the water springs clean of debris, payments helped them on the construction of a 32-ton water reservoir for the dry season. After the first five-year period more *ejidatarios* decided to participate, totaling 24 by 2009. The money ($790 USD) is distributed equally between *ejidatarios* (landowners) and *avecindados* (residents with rights to assigned lands) and the rest $1,2000 USD is kept as cash reserves for coming expenses[58]. Problems of internal corruption have been disrupting maintenance activities and payments, and the last administration reported the cash reserves as missing. The current *comisariado* explained that the payments are not always sufficient because the amount of work-days needed to complete the activities, paid at $9.6 USD/day, exceeds the profits of the program. By the time I visited the *ejido* in 2011, they were still waiting for the 2010 payment, and the delay had angered some community members to the point that they started to deforest areas inside the program for slash-burn agriculture. This created divisiveness in the *ejido* because some members preferred to wait for the payments but

[58] Interview with commeette members of the PES program in the *ejido.*

would be punished or even banned from the program just as the others who did not wait. This a common problem for lands communally held when actually they are managed individually.

Despite the problems, the *ejido* experienced no major changes in forest coverage over the decade. As with the regional pattern, its major deforestation occurred during the 1980s when it lost 10 percent of its forest cover. Today, although 90 percent of the *ejido* is forested, only 15 percent of the forest inside the PES polygon is in the arboreal stage, and the forested areas lost in 1980 have not been recovered. One outstanding difference in forest cover is an increase of 33 percent of temperate forest and a decrease of 65 percent of tropical forest. Such changes in forest categorization, however, should be taken with caution, especially when comparing between the first and the rest of INEGI's vegetation series due to the different techniques used for the classification of vegetation.

From the participants' perspective, the major impact of PES has been the reduction of seasonal migration. Fewer people have to leave in search of *jornales* (temporary labor): "Before, people use to go as far as the state of Monterrey in the search of a job, and now with the program many prefer to stay. We all prefer the program to continue, but when payments are so unstable I cannot prohibit other members to work their lands and reestablish pastures to obtain much needed income[59]"

Payments delays are a common problem, the reason for which is almost always the poor performance of technician. For Chalahuite, technicians have delayed submitting annual activities reports to CONAFOR. Especially worrisome is that technicians receive their payment in advance, so they are not punished for poor performance. Members of *ejido* believe that the $3,280 USD earned annually by the technician could be better spent. CONAFOR has tried different payments system throughout the years, initially passing payments to the technicians by way of participants, but poor accounting practices resulted in a shortfall of payments to technicans, so CONAFOR began to pay the technicians directly even though technically they are in the employ of the participants. The *comisariado* suggests that if payments were increased and given on time, the program would work better.

In summary, it is hard to evaluate the effects of the PES program in reducing deforestation in the *ejido* over the course of a decade because Chalahuite experienced the same long-term forest patterns as the rest of the region. Nevertheless, the fact that forest coverage is not decreasing and

[59] Interview with Don Andres, head-chief of the *ejido* Chalahuite in March 09 of 2011.

its members are receiving much needed extra income suggests some positive impact. The payments alone have benefitted *ejido* members in reducing migration, although marginality levels are still very high. For an *ejido* that is still fighting over boundary limits, to have both community cohesion by participation in a common program and decreased migration is critical in their struggle for just certification of their land.

Coronel Jose Castillo Tlamaya

Also within the jurisdiction of Xilitla, the Nahua *ejido* of Coronel Jose Castillo Tlamaya has been participating in the program for more than a decade. It is one of the most beautiful *ejidos* of the region in terms of scenery, is 75 percent forested, and contains the emblematic geographical feature of the Xilitla region, "*El Cerro de la Silleta*" (Saddle Mountain), the highest peak of the Xilitla range that resembles a seat. The *ejido* has a total population of 2,463, with 200 landowners, increasing by 2.2 percent from 2005 to 2010 while maintaining a high marginality index. The principal economic activities is the production of shade-grown coffee, subsistence agriculture, and occasionally guiding tours to Saddle Mountain (Xilitla is better known for Sir Edward James enormous surrealistic jungle sculpture or "castle"). The *ejido* entered the program without PROCEDE certification in 2003 with 2,600 hectares, submitting 85 percent of their territory into the PES, but in 2005 they certified their lands, parceling 1,836 hectares and leaving 1,197 hectares in common use according to PHINA. E*jido* members, however, claim they have 2,600 hectares for common use. When they renewed their contract with CONAFOR in 2008, only the "official" 1,197 hectares of communal use were accepted, but the ejido had not given up the struggle to add 1,400 hectares of parceled lands to the program. The parceled lands are primarily used for shade-grown coffee, although also include between 300 and 400 hectares of corn, and around 70 hectares of pastures.[60] Only *ejidatarios* (land owners) have the right to access and decide on the use of the common area. When asked about the regulations of the communal area, all agreed about their existence but nobody has seen them for more than 25 years.

One of the committee members commented that before they started participating in the PES program, they use to cut a lot of timber without control, but now they have oversight committees for each neighborhood that also perform reforestation. As a result, the forest coverage analysis

[60] Data provided by community members during questionnaire about land uses in the *ejido.*

shows a loss of 25 percent during the 1980s but none thereafter, with risk of deforestation declining to “medium.”

The major problem that they face now is plagues like mistletoe, which occupies a primary maintenance activity supported by the program, and although the PES money can be applied to it, participants can and usually do request additional funding for this procedure. The only plague control that the *ejido* implemented was in 2003 as an activity separate from the PES, but the *ejido* funds typically used to pay for day labor was “lost,” compelling the *ejido* to demand *faena* (obligatory and usually unpaid community work). After that experience, two delegates now manage the money to be distributed to community laborers.

The first years of the PES program, as previously mentioned, did not require participants to do any maintenance activities, only encouraged them to guard the forests from illegal timber cutting. Since 2008, however, reforestation activities and the construction of firebreaks and water reservoirs were included as part of the required activities for PES. This *ejido* assures that for the last four years they have planted 5,000 pines and made more than 50 kilometers of firebreaks. In regards to the management of reforestation, they usually occur immediately before the municipal president or somebody else in the government needs to report ecological activities, so the optimum seasons and locations for replanting are often not considered. I had the opportunity to be present at one of these events when the representative of CONAFOR in San Luis, needed to report the amount of area reforested for the period and Poncho, a former oceanographer now working as PES technician for several *ejidos* of the Huasteca, offered to distribute the needed seedlings among the participating *nucleos*, and after only a brief meeting with some *ejido* members, they decided to plant the pine seedlings in a private shade grown coffee plot that had recently frozen (see picture below).

Figure 20. Reforestation with Pine seedlings in a shade grown coffee plot in Coronel Jose Castillo Tlamaya

As in Tamaxal, the owner had planted corn in the plot while his coffee recovered. When I asked Poncho about the percentage of surviving plants in this kind of reforestation on private parcels, he said it was actually better than in communal areas. It is a win-win for everyone because they fulfill the requirements of the program while the private owners get planted trees free of charge. After noticing my skepticism, he later took me to a private corn plot where another reforestation had taken place the year before. To my surprise, pine saplings a meter and half high were spread around the hectare plot (see photo below). Though such private plantings of pine are seen all over the region, the future of such reforestations is uncertain because pine is suitable neither for shade grown coffee or corn plots, both of which are central activities in local life. Poncho's hope is that people will abandon those long-established activities for the sake of hopefully more profitable forestry.

Figure 21. A year old pine, reforestation in a cornfield.

Another common activity in hydrological services is clearing lanes for firebreaks, which is fortuitous for *ejidos* because their members have traditionally made such lanes at territorial boundaries for free anyway, but now are done with PES remuneration. Only the *ejidatarios* which sum 200 or more members can participate in the program and receive individual payments of $164 USD for forest maintenance. At the onset of PES they received $312 USD, but since the amount hectares in the program were reduced, the payments were cut nearly in half. As in other large *ejidos*, the members of Coronel Jose Castillo consider the payments to be inadquate for the activities required, but they appreciate how the payments have served as an impetus for community organization for the protection of the forest.

Overall, this *ejido* has had a better experience than their neighbors in El Chalahuite. The payments themselves have not reduced the high marginality rating for the community, and reforestation has had little impact because of poor planning, but they praised the experience of community organization and the protection of the forest. They also spoke positively about Poncho, the technician, and his forestry PES collaborator, Miguel, together they receive $4,544 USD annually for the technical assistance, an amount that the *ejido* feels fair considering the impact that bad assistance had on their neighboring *ejido*.

La Trinidad

La Trinidad is another *ejido* from the Xilitla region that has been participating in the PES program since 2003. It has 1,885 hectares of forest and a small settlement located in a valley at the top of the mountain range, with a total population of only 103 (see photo below).

Figure 22. Village of La Trinidad, by Sierra Gorda A.C

Its marginality index is high despite the implementation of a tourism project in 2005, and its population experienced a 24 percent increase in the 7 years thereafter. They started with only 90 hectares in the PES program but by 2011 had 256 in and were in the process of including another 700 more to the forest management program (controlled timber). The *ejido* is now mostly devoted to rural ecotourism by renting the use of bungalows and a rustic meeting hall (see photo below), providing tours to the surrounding cloud forest, and selling rural cuisine with local, organic garden produce and fresh made *tortillas*, to which they hope to add a trout farm. Unlike the rest of the communities and *ejidos* where houses are made from either bamboo and mud or concrete blocks, all the houses here are made from wooden logs and have solar panels installed in their roofs.

Figure 23. Rustic meeting hall in the *ejido* La Trinidad, by Alejandro Ortiz Moya

La Trinidad is remarkable for its dramatic reversal in land use. Since the formation of the *ejido*, one outsider arranged to rent their land for his 60 head of free ranging livestock for the bargain price of seven dollars per year, when the going rate was 30 cents per head in natural grass and 40 cents in cultivated grass. Most of the people also practiced subsistence agriculture and earned income by illegally cutting cheap timber in Xilitla (14 km below). Since the livestock business was profitable for only a very few, the PES program combined with the Sierra Gorda tourism project provided an opportunity for all *ejido* members to better manage the land. They terminated a grass-planting project that benefitted mostly outsider for 35 years[61] and were required to fence their own animals, such that one by one the members decided to sell their own animals. Although they have all the documentation required, unlike the vast majority of ejidos in the region, they have refused to certify their territory because most of it is held in common use and certification could cause privatization and eventual sale. As the *comisariado* proudly explained to me, and as I later experienced in one of my visits as a "tourist," they are very well organized. Recovering their lands, forest and soils were among the major benefits that the program brought to the entire community, in addition to new jobs with the ecotourism project and the experience of community organization.

[61] Interview with the head-chief in turn in March 2011

Their geographic location on the ridge of the mountain range, natural resources like streams and forests, and organization via the forestry and tourism programs have empowered them to demand basic services from the municipal government in exchange for access to their water. Gaining government support for infrastructure improvements is a constant battle communities and *ejidos* face. In Xilitla, the landscape is littered with evidence of conflict, negligence, incompetence, and corruption, except when one nears La Trinidad, where mixed patches of crumbling pavement and rutted dirt gives way to a wide asphalt road. This was only constructed with municipal and state government funding after the *ejido* took extreme measures and closed the water supply for 14 communities down the mountain, including parts of the Xilitla town center. Members of the *ejido* are proud of this achievement, however, the road is only improved within La Trinidad, not the 10 km between it and town, thus discouraging tourists without four-wheel-drive vehicles. Nonetheless, that battle has showed them the power of natural resources and the negotiating skills that they need to make the most of environmental services.

They receive around $6,960 USD annually from the PES program for 256 hectares, which is supplemented by the proceeds from ecotourism and other temporary projects. The income is shared "almost evenly" by all families on Catholic holidays special days: on all saints day every family receives $80 USD, and on Christmas *avencindados* receive $160, *ejidatarios* receive $200, and the rest is kept to pay for work in reforestation, clearings, firebreak lines, etc. As mentioned, the population is relatively small but has been growing steadily, and the *comisariado* – who himself had 10 kids and a pregnant wife living in one room house – pointed out that "the community never ends, families keep growing in great need and the resources they receive are never sufficient."

The community lost six percent of its forest in the 1980s, but all regrow by 2000, and since, they have maintained a very low risk of deforestation. The GIS analysis concurred with the community representation of forest maintenance and the total land use conversion into forest conservation practices. As the *comisariado* explained, the conservation program has improved not only the forest but their living conditions, although sustainability is jeopardized by a growing population.

The non participant nucleos at the southern region

All the nucleos in the southern region know about the PES program and many want to participate, but for internal problems or problems with property boundaries, many have failed to even complete the application process.

The overwhelmingly mestizo *nucleo* of Miramar, for example, a neighbor of La Trinidad with 1,020 inhabitants in 1,144 hectares, tried to submit 256 of their common use area into the PES program in 2008, but internal disrupts and land invasions prevented them from continuing the application process. The *ejido* had become involved in forest conservation with the Sierra Gorda association, and from 2003-08 fifteen members received payments for setting their individual parcels in the common use area for reforestation. They were still waiting for some promised equipment for pruning from the Sierra Gorda association. During a community assembly they explained that the invasions in their common use area started in 1994 with the Procampo program, when landless peasant colonized provisional parcels there to receive the government support. The problem was exacerbated in 2004 when those disputed lands were certified in PROCEDE despite the trespassers not having proper documentation. Miramar legally challenged the certification of those areas based on the agrarian attorney rules[62] about the common use, which states that it cannot be divided, but no agreement has been reached. During my visit in 2012, there were 80 hectares invaded by 38 peasants from whom 15 were *ejidatarios* and the rest *avecindados*. The usurpation has given them five to eight hectares per person whereas the rest of the *ejidatarios* and *posesionarios* (217 land owners in total) with legal titles had one and a half hectares apiece.[63]

The *ejidatarios* all felt that PROCEDE divided the community and created a situation in which people are selling their parcels and very few attend the assemblies anymore. Although taxes are paid as a community, in reality most certified their properties and even house plots as agricultural parcels but are not paying their corresponding individual taxes. To make matters worse, “the amount of people invading the common use area keeps increasing because nobody receives a punishment,” said the *comisariado,* and “in the mean time we are losing our forest and the good source of income that La Trinidad has.” Another member added, “our land is not

[62] Their case is managed by the agrarian tribunal of Tampico, where they requested a government expert to investigate, but the case cannot proceed until both sides (the demanders and invaders) accept its help. A private lawyer charges $6,000 USD and the *ejido* cannot afford it.

[63] Data provided by community members during an interview in a general assembly.

expanding but people are, and there is nowhere else to grow but to the common use area." Despite land conflicts, the usurpations of the communal use area, and the high risk of deforestation index, the *ejido* has increased their forest coverage from 1980 to 2010 from 631 to 747 hectares. However, population pressure and the consequent division of the agricultural land, the internal land conflicts, and the fact that they are not under any forest conservation program has put its forest and common use area at risk. Paradoxically, the agrarian reform intended to end land division has put pressure over common use areas, as they become the safety valve for desperate peasants. Unlike regions like Oaxaca, Michoacan, and Guerrero, where migration constitutes such a safety valve, peasants of the southern Huasteca Potosina migrate seasonaly to major cities like Monterrey, San Luis Potosi, and Guadalajara. For underpopulated *nucleos* like El Chalahuite, the PES program has reduced migration, but for overpopulated *nucleos* like Miramar, population pressure combined with poor community organization has increased their risk of deforestation and disqualified them from environmental services.

Aguayo is another forested *ejido* within the jurisdiction of Xilitla, with 307 hectares certified by PROCEDE in 2003, 83 percent of which is forested and 78 percent is in arboreal stage. According to the INEGI vegetation inventories, Aguayo has lost 17 percent of their forest in the last 30 years, but in contrast with Miramar, its largely mestizo population is considerably smaller with only 33 *ejidatarios* and 156 people. The *ejido* has 139 hectares of parceled lands and 161 hectares of common use forest, for an average of workable land per *ejidatario* and *posesionario* of four hectares, above the regional average. The marginality of the ejido reduced from 2005 to 2010, and, unlike the majority of the houses in other communities, those in Aguayo are made of concrete with paved floors. Nonetheless, it is still has high marginality rating. Although the *ejido* is surrounded by areas under the PES program, they are not participating in it because they do not had the minimum 200 hectares required to enter in the hydrological services category. According to the risk of deforestation index, the *ejido* has a high risk of deforestation, which is threatened further still by a growing population. Still, they have prevented major deforestation since the 1980s and expanded the forest by eight percent in the 1990s.

Another southern community of the sample not participating in the program is the Nahua community of Cuatlamayan in the municipio of Tacanhuitz, which has 788 hectares certified for common use. Here only the boundaries of the territory were certified in addition to few community parcels like the schools and the clinics, but most of their land is parceled and controlled by individual *comuneros* (330). The total population in the 2010 census was 2,463, an increase of 1.4 percent per year since 2005, a little above the national rate of one percent for the same period. The marginality index declined from 0.52 in 2005 to 0.06 by 2010 due to several infrastructure projects, although they still lie within the range of high marginality (-0.81 to 0.7).

The last vegetation inventory of 2010 indicates 308 hectares of tropical forest in the community, almost none of which in the arboreal stage, making them unlikely candidates for the hydrological PES program. They do, however, qualify for the agroforestry category. They transformed their landscape dramatically since the 1980s, as is visible in INEGI's vegetation series. According to the participatory research mapping of the *Mexico Indigena* project in the Huasteca, the cultivation of corn during the 1970s and 80s was replaced by citrus orchards, especially oranges. Oranges were profitable for several years but falling prices have caused the abandonment of several orange plantations,[64] which explains why former crop lands have reverted forest for a total increase of 12 percent since the 1980s. Their economy is now based on migratory wage labor and a little earned from the orange and chamaedorea palm plantations, which is completmented with subsistence crops like corn, sugar cane and coffee. Despite this forest increase and normal population growth within the *ejido*, the risk of deforestation index remains very high.

Cuatlamayan has received CONAFOR and SEMARNAT support for the reforestation of 10 hectares and the development of a carpentry shop involving a small group of *comuneros.* This enterprise has become renowned in the region for the quality of their products, but a solid forest conservation program involving the majority of the community remains lacking. Deforestation has been reduced in part because of the abandonment of orchards and CONAFOR and SEMARNAT requested vigilance against illegal timber cutting, but also because all the old growth forests with precious woods had already been cut. Elders lament the replacement of vast amount of valuable cedar and rosewood sold outside the community and the remaining less profitable woods like *chijol* (*Psidia grandifolia*), *chaka* (*Bursera simaruba*), and *garabatillo* (*Mimmosa aculeaticarpa*).

When I visited the community in 2011, people knew little about the PES program, and in fact no *nucleos* were participating in PES in the entire municipio of Tancanhuitz, where no forest

[64] An interview in Cuatlamayan's assembly conducted by Gerardo Lopez Roque, anthropology student of the Autonomous University of San Luis Potosí(UASLP) participating in the project of *Mexico Indigena*.

remains under communal use and what is left of it lies outside CONAFOR eligible areas for the program. Their lack of mature forest and forest in common use makes the implementation of such programs harder because enough individual owners would have to organize to meet the minimum requirement of 200 hectares. Even so, since they are outside the areas eligible for PES, their chances would be very low anyway. In addition, the long internal conflict between two of the major barrios of the community, Tuzantla and Cuatlamayan, has already prevented them from taking advantage of other government programs.

Forest health and management in the southern mountain range

Overall, the forested *ejidos* participating longer in the program have reduced their deforestation rates over the last two decades, but so have non-participants of PES. The region's forests, particularly the temperate ones, however, are under the new threat of a rapidly spreading pine beetle (*Dendroctonus frontalis*, see photo below), which only the PES *nucleos*, with only 10% of the region's forests, are trying to control in an organized fashion.

Figure 24. Temperate forest infested with pine beetles in the Xilitla region. Source: Alfonso Robledo

The *nucleos* under the PES program have the obligation to notify CONAFOR or SEMARNAT about any pest or plagues affecting their forest and mitigate them. They can request extra funds for clearing and fumigating, but regardless of whether they receive extra funding, they are obligated to take remedial measures. So far, in the cases I have witnessed, all who have notified authorities about the plague have received funds for needed material (electric saws and pesticides) and worker remuneration, thanks to their technicians' assistance. To attack the pine beetle, the forest technician has to identify and mark all the affected trees in an area, then the community members cut them as close to the ground as possible, after which the bark is stripped and pesticide is applied to the trunk and the branches (see sequence below).

Figure 25. A clearing of pine beetle infestation in the *ejido* Ollita de Pino, Xilitla.

For the labor in clearing and fumigating the infested forests, CONAFOR offers around 80 USD per hectare, where 80 percent is for the work and 20 percent for the technical assistance. Ollita del Pino, the example seen above, solicited the clearing of 88 hectares infested with the beetle and received around $5,632 USD for the community and 1,408 for the technician in addition to their regular PES payments. As with the regular payments, 80 percent of the money is granted up front and the rest after the work is completed and the report delivered to CONAFOR. All of the *nucleos* in the PES program managed by technicians with training in forestry were implementing plague controls against the pine beetle, but several others managed by unqualified technicians were not. The lack of coordination in controlling plagues leads to one of the major threats to forest conservation in the region: corruption, especially at the municipal level.

The effects of corrupt forest conservation practices in the southern area

Especially in this region, corruption and political proselytism from municipal governments have severely threatened the sustainability of the PES program, causing a chain of adverse effects in participant *nucleos*. The implementation and administration of the PES program and its money have become a matter of contention between different actors, starting at municipal government levels. The main link between mayors offices and the PES program are the municipal ecology offices, which every *municipio* is supposed to have for attending to environmental problems within their jurisdictions and promoting and supporting federal and state programs. The extent of ecology offices' effectiveness depends in large part on their administrators, in the south administrators monopolized the post for several years, charging communities extra fees for its services and diverting PES payments to support political parties.

As an example, in January of 2011, a piece in the regional newspaper of Xilitla complimented the mayor who took credit for distributing PES funding to the participant communities (Reséndiz 2011). Precisely to avoid such misrepresentation, CONAFOR is supposed to deliver the PES directly to the communities' and *ejidos'* bank accounts, but somehow municipal governments managed to procure control of the money. The *modus operandi* is to simply request the PES money from participanting *nucleos* so the mayor could "officially" record the distribution of the funds. This was a secret to no one – neither the *nucleos*, technicians, or even the PES delegate in San Luis Potosi, but certain municipal administration threatened any *nucleo* with cutting off municipal services if they did not cooperate. To make matters worse, in some areas PES were not returned entirely to the *nucleos* because the ecology department kept a "fee" and in some cases even nucleo representatives (*comisariados* and committee members) received a cut. In direct contravention of CONAFOR's guidelines stipulating that PES be given in remuneration for work, the mayor distributes the money in envelopes personally to all members present in assemblies, regardless of whether they had worked in program activities or not. Obviously, this created internal divisions and discouraged all from subsequent work in program activities consequently reducing the chances of receiving upcoming payments or a second five-year PES period. Thus, such municipal administrations has managed to damage not only the communities participating with ecology offices, but also the ones refusisg to be complicit in the corruption and have thus had their services cut.

Not satisfied with the "fees" charged to *nucleos*, certain ecology admistrators also charged a fee to the PES technicians' working in the region, sometimes requesting 50 percent of their earnings for its backing, as three of the most respected technicians of the region explained. One ecology office usually subcontracts technicians willing to surrender half or even more of their earnings, which they were willing to do because they came from far away regions and felt no obligation to the communities under their supervision. The actual technical work was taken on by the administrator, but with no training or professional degree he guided the nucleos to a series of failures.

For example, he submitted areas into the wrong categories, especially shade grown coffee areas and even arable lands for hydrological services and then requesting funding for their reforestation that was never intended to take place. In the shade grown coffee-oriented *ejido* of Xilosuchico, the ecology office assisted in the submission of 297 individual parcels as a "common use area" for the hydrological PES program. The *ejido* had no common use areas but was registered in the program as such and they were required to reforest the area. The ecology office pushed reforestation with cedar, but the people rejected it because it is not compatible with coffee. The technician then suggested reforesting the arable lands, but they were not registered in the program and the *ejido* refused to surrender lands on which they depended for subsistence. At that point most wanted to simply abandon the program, but the *comisariado* suggested reforesting a small area of cattle pasture, but free range cattle are likely to destroy all the seedlings. This was only one mismanaged, corrupt case among many.

On the northern region, three *ejidos* in the sample have been participating in the program since 2003: La Concepcion, El Limonal and Los Alamos. Only La Concepción and Los Álamos have managed to maintain areas under the program for an uninterrupted period of time.

La Concepcion

La Concepción is a *mestizo ejido* with 4,327 hectares certified by PROCEDE in 1997, although they insist on a total of 5,428 hectares. Almost all, 4,051 hectares, are certified as common use, while only 261 hectares were registered as parceled plots and several uncertified private parcels are located below the common use area. As previously mentioned, the northern region is known for its sugarcane and cattle ranching, and the *nucleos* are no different; sugarcane is the principal activity supplemented by cattle grazing. Sugarcane is mostly produced in certified individual parcels, remains of an old *hacienda* that had its own a sugar factory and currency[65]. The uncertified parcels on the slopes are mostly for pasture, but some grow a total of 20 hectares of corn. Before they certified their lands in 1997, the population was separated into three polygons granted at different periods; the first 1,550 hectares were granted to 22 *ejidatarios* in 1963, and two more extensions of 3,249 hectares were assigned to 45 of their sons in 1982, although only 2,766 were actually granted. Now the total population of 293 members is concentrated in one settlement to ease the provision of services. Although the number of houses with utility services is greater than in the southern region, its marginality index is still medium-high. Regarding the disparity between the agrarian registry and community claims, it is common for the amount of hectares granted by the government to be more than the amount actually measured on the ground (*ejecutadas* in agrarian slang). This has caused several problems between the government departments involved in the measurements and the agrarian *nucleos*. In this case, La Concepcion members think they have more than 5,000 hectares because the granting government document *Resolucion presidencial* said so, but PROCEDE's measurements resulted in almost a thousand hectares less, arguing this was the amount they always really had. This could be true, but many private owners have tried to corruptly expand their properties in collusion with the agrarian prosecution at the expense of *ejidos* and communities. La Concepcion accepted the certification regardless of the reduction of hectares because no limits were changed on the ground, but every time they are asked the size of the *ejido* they insist on more than 5,000 hectares.

[65] Don Lupe, a member of the committee at that time, mentioned that he found one of the coins in the forest with the inscription of "Roy Cunninham-La Concepcion" and his grandfather confirmed that was the currency that it was used to pay the workers, when the sugar factory was owned by a an American.

La Concepción started in the PES program in 2005 with 3,600 hectares of temperate forest under hydrological services (see photo below), then in 2010 they renovated their contract. People were not sure how many hectares they had submitted in the second period, but according to the CONAFOR's archives, it was 3,301 hectares, a little less than what they have now. During one group interview, a woman mentioned that it was the same amount they submitted in 2005, but that they were receiving less money because CONAFOR decreased the payments per hectare. In 2005 the government was paying 300 pesos (about $24 USD) per hectare and by 2010 the payments were $430 pesos (around $35 USD) per hectare according to the operational rules, so they should have been receiving more money but instead some was being embezzled[66].

Figure 26. The sierra under PES in La Concepcion

This *ejido* has been very active in the forums that CONAFOR organizes in Cd. Valles every two months because they get to know what other *nucleos* are doing in regions like Xilitla or even in other states. Recently, the committee won a "scholarship" to visit the state of Michoacán for a PES convention, months later for which, by the way, they were still waiting for

[66] I did not mention anything about the fact that they should be receiving more because of the increased hectares in the program and the increase in payments per hectare, I feared a confrontation with whoever was involve in it so I jumped into my questions about the technical assistance they have received.

second half of their reimbursement. There they took a trip to the ejido of San Juan Nuevo, one of the most successful sustainable forest management programs in the country, which include controlled forestry, the extraction of resins, and the production of turpentine. The delegation from la Concepcion was very pleased to see that this model of PES program included extraction of resources instead of simple forest preservation, although plague control and and intentional management were required. According to one of the delegates, "nothing got wasted there, and besides the stumps, there was no sign of the forest exploitation. The branches of trees with less than two meters were used for the production of turpentine and the manufacture of brooms. The trees over two meters were kept for the production of boards, and the tops of the trees were shredded for compost and the production of particle boards."[67] The delegation said that they would like to have an area of controlled exploitation, such as harvesting fallen branches, but just for their own use in carpentry, especially for the production of furniture. Controlled timber extraction interests several PES participants, but currently they need to obtain a permit from SEMARNAT, which discouragingly requires time and money. The *ejido*, however, was seriously thinking on acquiring a special permit to harvest fallen trees because they are a fire hazard in the dry season.

One member highlighted that they are continually learning new techniques in the program. For example, they used to make firebreaks even before entering the program but now include other strategies like the construction of barriers with rocks and sticks to prevent washouts during the rainy season (see photo below).

Figure 27. Fence to prevent washouts during rainy season in La Concha.

[67] The impressions of the secretary of the committee in La Concepcion about San Juan Nuevo.

Other arduous activities are firebreak lines, especially around sugar cane crops, which are burned before harvest, the construction of shelter (see picture) and an observational station in conjuction with the neighboring *ejido* of Las Abritas on the mountain ridge, as suggested by their technician. This later activity involved carrying the zinc roofing 10 km. up rugged mountain slopes to La Hierbabuena, a place where they share a border with Las Abritas, another PES participant. Besides having a great view of the sierra, the area also has a little spring, the water for which is used to fill a water trough for grazing animals in the dry season.

Figure 28. Roof installed in the sierra by La Concepcion with PES money.

Don Tano, the *comisariado*, mentioned another advantage of PES was the constitution of a fire-fighting crew in coordination with their neighboring *ejidos* of El Limonal and Los Alamos, although still lacking is better coordination within the community.

Here, only landowners or *ejidatarios* are allowed in the PES program, and they designate about 50 percent of the annual payment to the required activities, such as the construction of ditches, fences, and the posting of signs demarcating the area under the program.[68] Another 20 percent goes for the construction of infrastructure like the mentioned shelter, a one km extension of their paved road, and the first phases in the construction of a health clinic. The remaining payments are distributed among the *ejidatarios* participating in the required activities. Although the personal payments are considered inadequate, the *ejido* has invested the community payments to general improvements, such that everyone benefits indirectly whether they receive personal payments or not.

[68] As it is the case in the *nucleos* participating in the hydrological PES program, the polygons do not have a physical delimitation of the area under the program, firebreak lines within neighboring *ejidos* and announcements placed on the busiest roads are the principal sources of advertisement.

When I started visiting the *ejido* they were working with Alfonso Robledo[69], the afore mentioned technician who works throughout the region, including in Xilitla, Rio Verde in conjunction with Miguel Cruz from Xalpan, and *ejidos* in Cd. Valles, Tamasopo, and Sta. Catarina. The community praised his capabilities as a technician but felt that he could not commit enough time to them. The concern was raised when CONAFOR's San Luis branch withheld a payment from them, and they thought it was because of the technician's decreased visits (two per year), assistance, and submission of reports. After two years of delays (for 2011 and 2012), the *ejido* was considering replacing the technician, which they eventually succeeded in doing. As with the *ejido* of El Chalahuite in the south, they lamented that they could no longer control the technician's payments directly, but as stated, the operational rules changed because many communities were keeping the technicians money regardless of performance. Now the *nucleos* are even unaware of how much the technicians are being paid. According to the operational rules the technician should receive $60,000 pesos (around $4,878 USD) for more than 1,000 hectares under PES.

Concerning the impact of the program on preventing deforestation, the *ejido* has actually increased its forest coverage by 12 percent from 1980s to 2010. Here again, the forest increase cannot be attributed to the program alone since it has also increased for the overall *municipio*. The people, however, mentioned that they now know many more values of the forest and how to take advantage of them, so they will likely continue to conserve it as long as the profits are maintained.

The payments are destined to be replaced by the market of environmental services, for which the *nucleo* is little prepared. The CONAFOR crew had just begun to explain during regional PES meetings held in Cd. Valles, the market in services is basically the same as PES program except with the inclusion of private enterprises and organizations purchasing environmental services from ejidos rather than ejidos receiving payments from the government. In the northern region some businesses, the Federal Electric Commission (CFE) that has a hydroelectric dam in the region, and a sugar mill are already directly benefitting from the hydrological services. One of the neighboring *ejidos*, El Sabinito, has signed an agreement with the sugar mill in which laborers' contributions of one to two tons of sugar cane to a community

[69] Alfonso incurred into the PES with a private environmental consultancy office in Rio Verde and after a few years decided to work by his own and since then its career has been quite a success.

fund is matched by the mill, the state government, and the federal government. Don Tano, the *comisariado*, acknowledged that besides the afore mentioned enterprises, Coca Cola, Pepsi, and breweries are also desirous of their water. The marketing of environmental services is supposed to develop with a joining fund after they get to know the companies and arrange agreements. La Concepcion is heading in that direction but is already facing the pervasive problem of corruption.

El Limonal

El Limonal is another *ejido* in the northern mountain range. It entered 50 percent of its 4,301 hectares into the PES program from 2005 to 2009, after which their were disqualified. They certified the property in 1997, but it created boundary problems within and outside the *ejido* that prevail today. Boundary problems have also affected the management of the PES program; according to the *ejido* Los Alamos, El Limonal has been invading their land and clearing their forest, subverting their credibility with CONAFOR verification staff. Private landowners and the *ejido* La Concepcion also accuse El Limonal of destroying boundary markers and appropriating 1,545 hectares of their land, which is devoted mostly to sugar cane and some corn. El Limonal has two communal parcels of seven hectares where they grow sugar cane, one to benefit the *ejido* union and the other one for a school. In the highland in other area they grow crops but PROCEDE refused to measure and certify it because it was inaccessible. The remaining 2,725 hectares in the common use area is maintained as forest for the most part, although around 400 hectares are used for cattle herding by individuals. With the sugarcane and an average of 17 hectares per *ejidatario*, El Limonal has one of the lowest marginality indices in the region.

Like La Concepcion, the right to access the common use area is given to *ejidatarios, avecindados* and *posesionarios,* but only the former participated in the PES program. Among the activities they did was reforestation of a pasture in the sierra with pine and cedar, but as usual, none of the plants survived the dry season.

As mentioned, the dry season is especially dangerous in the north because of the burning of sugarcane before harvest. A tour to the area once in the program revealed evidence of a massive forest fire in a particularly dry year. Since the 1980s, though, the *ejido's* forest cover increased by six percent, but due to recent fires spreading from the state of Tamaulipas south to El Naranjo over the last two years, forest in the arboreal stage will show a reduction in the next vegetation survey. The *Sabal Mexicana* palm, a secondary species that appears on disturbed areas, has spread due to these fires (see photo 11 and 12).

Figure 29. ***Sabal Mexicana*** **palm sprouts after a forest fire in the** ***ejido*** **El Limonal**

Although the palm is considered an invasive plant, almost all of it is traditionally used; the indigenous people eat the heart of palm (*palmito*) obtained from the stems of young plants especially in soups, while the mature stems are so resistant to decomposition that they are used as fence and electricity posts. The leaves are used for thatching, all sorts of crafts, and also for cattle feed when tender and no other forage is available. Finally, the flowers are also de-tasseled, washed, boiled to release their bitterness, and eaten, usually with tortillas or eggs. Because of its several uses, locals do not consider it a plague unless it spreads to croplands where it grows fast and the roots can only be removed with bulldozers.

Figure 30. Palm hearts at the market of Cd. Valles.

Figure 31. Sprouts of *Sabal Mexicana* in a burned sugar cane field in El Naranjo

El Limonal is having a hard time obtaining a second PES period apparently because of its refusal to pay a fee demanded by a CONAFOR staff member in San Luis Potosi. As I was told, the previous delegate of the PES program in San Luis knew about this extra fee and told one of the *ejido* members that it was bogus, so when that member became the *comisariado*, they refused to pay it. Unfortunately, that technician also rose in the CONAFOR system and managed to exclude them somehow from the program. The same story was corroborated by the delegate of the ecology department of El Naranjo, who is also an *ejidatario* of El Limonal; he explained that the ex-technician worked with them for several years and brought profitable programs, so he felt the community owed him more than the technician's stipulated payment. They gave him extra money but over time he became more and more brazen, asking the delegate to collect 50 thousand pesos from each of the *ejidos* he helped before. This was when El Limonal stopped paying him fees.

The ejido's forest coverage has not decreased in the last 30 years, and the deforestation index shows a medium risk of deforestation; however, the loss of 66,463 USD in annual PES has hurt them financially, and they continued to look for ways to re-enter the PES program. During my stay in the region, they acquired a new technician for this purpose but they still failed to gain PES approval for 2012. In 2013 the PES program passed to its second phase, "Support to promote local mechanisms of payments for environmental services through conjoining funds," so the *ejido* needs to find a private business partner. Nonetheless, they are moving in the right direction by winning a CONAFOR grant of 6,400 USD to attend seminars about PES success stories.

Los Alamos

The ejido of Los Alamos has managed to participate in the PES program by submitting separate polygons in two consecutive periods. According to its members, the ejido has 2,950 hectares, 2,650 of which are common use, but according to the agrarian registry only 1,718 are such. There are 90 *ejidatarios* in a population of about 350 people, and as opposed to other *nucleos,* here the *posesionarios* have rights and access to the common use area as if they were *ejidatarios.* This was also one of the few ejidos that had internal regulations developed when one of its polygons was granted in 1984, before the PROCEDE program. They certified their lands in 1998, including individual parcels that sum 872 hectares. Besides the registered parcels, another 160 hectares of unregistered parcels remain in the common use area where *posesionarios* grow corn and graze cattle during their fallow. Not having those properties registered does not seem to create any problems with the government, one *posesionario* told me, as his parcel was in the common use area and he was able to obtain aid from the federal support for farmers program, PROCAMPO. Those parcels were granted to the *posesionarios* 28 years ago and there is still a debate over whether they should grant more parcels in the common use area or not. The *comisariado* at the time said they would not, such that all the *ejidatarios* have a right to put their livestock there, but they have to pay the *ejido* for each head. So far they estimate 400 head in the common use area, which they herd from one area to another, depending on which area is under the program.

They started participating in PES in 2006 with 909 hectares and obtained the second phase for another 375-hectares zone in 2010. They submitted the 909 hectares again in 2011, which was approved but without funding, meaning CONAFOR simply ran out of resources. As mentioned, this gives them extra points but does not assure funding in the next selection of *nucleos*. During my visit in 2012 they submitted 1,500 hectares and were waiting for the approval.

When asked what would happen to the 400 head of cattle if all the common use area gets accepted into the PES, they said they were already planning to circulate them, although this might cause more harm to the forest than free grazing. Unlike their southern counterparts, their forests had no overwhelming plagues of mistletoe or weevils. Los Alamos does have some areas with mistletoe that they want to eliminate using the PES funds and technical help, however. During the early months of 2012, the community did manage to procure a forest specialist in plagues to visit and agree on a mistletoes control plan.

Despite the regularization of their property, the cutting of firebreaks for their PES project exposed boundary problems with the neighboring *ejido* of La Concepcion. As previously mentioned, *nucleos* are obligated to clear their boundary limits, and such clearings can count as part of the firebreaks required by the PES program. When two neighboring *nucleos* are participating in the PES, each needs to clear a swath 3 meters wide (see photo below) precisely on the property line.

Figure 32. A road to the mountain range of Los Alamos, also maintained as a firebreak

The other boundary problem, described previously, is with El Limonal, which extracts wood from El Alamo PES lands, affecting the evaluation of their project. Therefore, they are planning to hire a surveyor to make another demarcation.

The forest coverage analysis reveals that the *ejido* has increased six percent of its forest coverage, although the level of detail reached in the study is not precise enough to reveal changes in forest density. We know at least that no land use conversion have taken place there.

Regarding how the program is managed within the *nucleo,* both *ejidatarios* and *posesionarios* participate in the PES program, in contrast to the majority of *nucleos* where only *ejidatarios* participate. They comment that with their previous technician (who demanded additional fees) they did not directly receive remuneration for labor such as constructing firebreaks, as did the rest of the participant *ejidos*, but now they do at the workshops organized by CONAFOR in Cd. Valles. CONAFOR, however, has suggested that the money only be applied to required activities, like the acquisition of tools and equipment for forest maintenance. So far they have taken this heart, spending all the money to pave a road that connects them to La Concepcion, construct a bridge, and pay for labor. Having no payments go directly to participants' pockets is fine for the people of Los Alamos, as most produce enough sugarcane to cover household needs and the PES then can go towards infrastructural improvements for the community. It also helps that they already had a tradition of investing the profits of their collective sugarcane in collective endeavors as well.

Another impact of the PES program is the decrease in timber extraction. They recounted that illegal logging used to be rampant but is now regulated and only with the permission of *ejido* for personal use within the community. They are very interested in contracts for hydrological services, such as with the sugar cane factory and the Federal Electric Commission, that benefit from their captured water. "If every *ejidatario* invests a penny, the municipality matches that or half the amount, and if a private company is found to match the total, then government support would no longer be needed and we would be self sufficient in the conservation business."[70]

In relation to the technical assistance, the *ejido* felt comfortable with their technician, although they could not agree on how much he was earning since they were no longer paying him directly. The discussion during an assembly about how much the technician was paid went from 20 percent to 8 eight percent, but they knew the previous corrupt technican charged 20 percent. They actually had an argument with their neighboring *nucleo* of El Limonal, which refused to pay 20 percent, because Los Alamos insists that the technicians, with three visits per year, deserve 20 percent of their PES payment.

Corruption in the north and its effects

The illegal fees that *ejidos* in the region have been paying have varying effects. As described before, some *nucleos* have simply submitted to added fees in order to stay in the PES and other CONAFOR programs, and the only one to refuse has been disqualified. On the other

[70] Don Agustin, *comisariado* at the time in Los Alamos, February 2012.

hand, surrendering to the extra fee is not without its problems, either. According to Abel, the delegate of the ecology department of El Naranjo, the payments withheld from La Concepcion were related to the fees. The administrator of PES in San Luis withheld their payments to tear down the long-lasting corruption of the chief of CONAFOR operational department, who used to work as their technician. The people of La Concepcion told me that the PES delegate wanted to personally check their last activities before releasing the payments, so it was not clear whether they knew the real reason for the withholding payments or not, but several months later they got paid and acquired a new technician from Cd. Valles. To my dismay, I later discovered that the delegate told their ex-technician, Alfonso, that I convinced the people of La Concepcion to replace him. It seemed that the delegate associated the technician with the extra fees and did not want to make it obvious, but whatever the case, competition between the technicians and the CONAFOR staff was evident. Sadly, as in the southern area, the *nucleos* were caught in the middle and always ended up losing the most, such as El Limonal that lost the program or the rest that pay illegal fees.

VIII. The PES participants' perspectives on the social impacts of the program.

As seen in the previous chapter's anecdotes, the social milieu within each community influences the effectiveness of the PES program, and the program itself can can have a positive or negative impact on community well being. The organizational capacity, culture, local traditions regarding equity of participation, and the economic standing before and after the program influence the nucleos pesepctives of the program. Semi-structured group interviews during assemblies, CONAFOR meetings, and participant observation on excursions to evaluate PES areas were the methods used to collect such perceptions.

From the sample of 29 *nucleos* and one agrarian colony participating in the program, 18 strongly considered that the program had benefitted them overall, but the different levels of participation and the perceptions of its effectiveness are correlated. The main issues discussed are whether communities decide to distribute the money among all members or apply it to community infrastructure improvements.

Community infrastructure improvements

The use of money for infrastructural improvements was for the most part perceived as an effective measure of program success among participants since they were direct and tangible results that benefitted all. Thus, participants that used some of the PES money for community improvements tended to have a positive perception of the program even if they were not paid individually for work. Unfortunately, this allocation was practiced mostly in the north while in the southern region only La Trinidad used the money this way, despite the fact that investments in such activities were strongly encouraged by technicians. This may be because the southern region is poorer and therefore families have immediate needs to address with the money.

In the northern region the types of infrastructure improvements varied. The most common was the construction of *galeras* (open community halls) for community assemblies and events as well as meeting rooms and the purchase of furniture (see top images in Figure 15). For several *ejidos* this was a great improvement since several of them had no proper meeting halls before. Also improvements included the construction of paved roads, sidewalks, a research station, a health clinic and the purchase of a plot to expand a cemetery. Often, these community improvements were not made with PES money alone and involved matching funds from the different levels of government. For example, the construction of a road in Los Alamos involved matching PES funding from the sugar cane board and the municipal government.

Figure 33. Infrastructure improvements using PES funding in the northern region.

In both regions *ejidatarios* and *comuneros,* or landowners, were the main beneficiaries of the PES payments; however, there were marked differences between the northern and southern regions regarding the inclusion of others into PES labor and payments. In the northern region, *nucleos* tended to set aside part of the money for daily wages to members who wanted to work on the required activities, regardless their status in the nucleos. In the southern region, the money tended to be divided almost exclusively among landowners.

Helping explain the differences between the northern and southern regions regarding the differential uses of the PES are population density, the amount of arable land, land use, and tenure system stand out. There is an average of 80 landowners per *nucleo* in the north and around 700 in the south. When fewer owners and thus laborers in the north, they can incorporate *posesionarios* and *avecindados* into the paid labor (*jornales*), while in the south the labor force surpasses the need, and in several cases they even have a waiting list for the landowners to work. The *nucleos* of the south also have a lower percentage of arable lands for individual use, and with the exception of the ones with temperate forest, none manage their property areas in common use. The northern *nucleos*, on the other hand, have more arable lands and held forested areas in common. Having sugarcane, the northern *nucleos* have more stable income that those in the south, where communities tend to rely on coffee production that is risky due to both weather and the fluctuating market. Consequently, competition for PES money in the north is less. While the PES money is not absolutely critical in the south, especially when it is shared among all landowners, the poverty there is such that few are willing to divert this source of family income to community projects.

From the southern, often indigenous, perspective, the distribution of payments to individuals actually follows their traditional *cargo* system. The *cargo* system[71] once present in most indigenous *nucleos* consisted of individuals fulfilling communal duties. In some indigenous *nucleos* it was common to see young males working on the PES activities for only meals because, in the words of one Teenek leader, “It is good for them to go and learn how to work and know their *ejido*. Most don’t know its boundaries. We all did the same when we were young, and it’s their duty as members of the *ejido.*” However, in some communities like the Nahua San Pedro Huizquilico, the elders recognized that the youth needed money, so they reserved payments for them to do arduous activities like the making firebreaks, clearing wells, and reforestation, and if there was money left over, it was shared among the *ejidatarios*.

In the northern *ejidos*, as the leader of Ojo de Agua explained, the situation was completely different, as young members avoided working in PES activities because they could earn more by working as seasonal sugarcane cutters, so the legal landowners ended up doing most of the required activities whether they needed the money or not.

In terms of gender, participants have been almost exclusively male, although women have slowly become more active in decision-making as they replace their diseased or seasonally migrating husbands. Of 20 *nucleos* in the PES program, three had women’s committees specifically for the program, and in three others – Ollita del Pino, El Cristiano and La Victoria –

[71] Also known as civil-religious hierarchies within communities, involves “voluntary” service without remuneration (although there are usually high pressures to participate in it) in order to complete the system of hierarchically based offices and earn prestige or access to land in the community (see Dewalt (1975) for a detailed description and analysis of cargo systems in Mesoamerica).

women were either part of PES committee or related administration committees like those for firebreaks. Otherwise, no women were involved in projects related to forest in common use areas, and only the agroforestry program did women work in individual shade grown coffee plots. Thus, it was hard to obtain their opinion about PES since few attended the meetings. Fortunately, on two occasions they were invited to accompany me for safety while walking in the sierra with the men. I initially insisted that it was not necessary, but desisted when it became clear that they were excited to walk the sierra for the first time. They mentioned the positive impact of the program in bringing job opportunities for men and the protection of diminishing water resources. Conversely, women in the agroforestry PES program saw it as making little difference to their marginalized situation, as they had already been practicing ES improvements prior to the program except for making compost receptors.

Finally, the agroforestry program in the more marginal south has only exacerbated inequalities because it includes only formal landowners, not the landless people or those without title. In fact, the greatest concentration of benefits goes to those with the most land.

Organizational capacity

Building community organizational capacity is a key program objective for long-term sustainability. Several *nucleo*s were already well organized before the implementation of the program, while for others the program helped develop their organization skills. One example of the first case is the Nahua *ejido* of El Cristiano y sus anexos, which had a population near nine thousand habitants and 706 *ejidatarios* or landowners. This coffee growing *ejido* entered all its parceled territory (3,124 hectares) to hydrological services program in 2007. Recently, a young group of community members (between 16 to 24 years old) manages the PES program, together with other development programs, and are supervised by the *ejido's* committee and Fidel, an agronomist who has worked with them for several years, originally as a promoter of the indigenous reforms to the constitution lead by the CDI. The reforms – Article IX of the San Luis Potosístate constitution – were developed in three communities of the Huasteca region: El Cristiano, Tampaxal and Coxcatlan starting in 2000. The process inspired of the community organization, indigenous pride, and self-governance still seen today in their management of the PES. The PES program was originally managed by an outside NGO called the Foro Huasteco, which channels government development aid to communities, but after two years the *ejido* decided to take over. Since 2010 the youth have been in charge of promoting and obtaining resources for *ejido* development programs. Below, there is a photo of new members recruitment, led by CDI activist, Juan Cisneros.

Figure 34. Committee members of PES in El Cristiano y sus anexos

The crew had a small office in the head town of the *ejido*, equipped with a conference room, computers, a projector and other office furniture necessary for meetings. All but two or three members out of ten staff members rotate in and out of the office, and each of twelve barrios has a representative in charge of reporting on the current programs. As Fidel, the agronomist that coordinates the group explained to me, it was the *ejido's* idea to have its young people working as technicians and promoters of programs to become self-sufficient. Right now the group still needs a lot of guidance from Fidel, but they are learning quickly with full community support.

The major problem that this *ejido* faces is with outside agencies. CONAFOR, for example, has requirements for certified technicians that El Cristiano has been unable to fulfill. At the beginning of the program technicians were not needed because no maintenance activities were required. None of the youth has more than a high school education, although they aspire to gain a professional degree. Even Fidel, with his agronomy degree from the best program in the country (the University of Chapingo) has not been able to pass the certification process. He argues that it is corrupt so that certification is given only to politically connected people, but, of course, other certified technicians expressed no such suspicions. The PES delegate in San Luis has nonetheless allowed El Cristiano to continue without a certified technician as long as the youth team fulfill the technician's work, like turning in reports and attending to CONAFOR meetings.

The overall organization of the *ejido* is also impressive, as I learned when I was invited to their general assembly to present my research. In exchange for the maps I made for their territorial planning project, they organized a series of meetings and tours in each of their 12 barrios, some of their shade grown coffee parcels, and some of their projects like the butterfly sanctuary in the barrio of Tecaya. Such projects are intended to develop the *ejido*'s eco-touristic potential and have been implemented with the help of a CDI program called PETAZI (Alternative Tourism Program for Indigenous Zones). In each barrio a PES committee keeps a list of members and the work they have done in such activities as the soil prevention and enrichment agreed upon in their better practices program (PMP in Spanish). The development of a PMP is a requirement of CONAFOR for the PES to help them plan their annual goals for five years. This process in El Cristiano was very difficult because it required the agreement of all the community and most did not want to do collective work, so in the end they decided to work on individual parcels and report the work by barrios. That was also when they came up with the idea of having their own technician, after reflecting on the bad experience they had with Foro Huasteco, which seemed to involve the Foro pushing for support of a political party.[72] The PES program in El Cristiano is not working perfectly, as some members pointed out, as not all the barrios are responding as they should, but their progress until now makes them optimistic.

Another example of building organizational capacity was the northern *ejidos* collaborative efforts to decrease fires during the dry season. *Zafra*, the burning of sugarcane plots before harvesting, is an activity dating back to Spanish colonial times, but now it is controversial because of the unintended spread of fires to the forest. As part of the PES program, the participant *nucleos* have to organize and equip a fire brigade of around ten members in charge of mobilizing people in case of fire outbreaks in the sierra. At the beginning their technician urged them to coordinate with other *ejidos* for fire control, and PES can be reduced or canceled if property under the program gets burned. After the great loss of forest to fire in 2012, they decided that more efforts were needed to prevent fires instead of only combating them, so a

[72] During an interview with the president of the NGO, a women interrupted us asking why she did not get her funding support of the Procampo program and he replied shamelessly that he withhold it because she voted for the political party they did not agreed to vote for as a community.

multi-*ejido* meeting was set that included two of the main technicians in the region, the municipal secretary, and representatives of the sugar mill. All the *ejido* representatives were very active in the discussion and proposed several approaches, from training sugar growers and cutters in fire prevention, to environmental education of the youth to increase awareness of fires, and to have more community participation during fires outbreaks. One of the main subjects of discussion was the *zafra* and how it can be done more safely. Everyone already knew that to burn the cane, one needs a permit from SEMARNAT and the sugarcane committee has to verify proper firebreaks (*guarda-rayas* in spanish, see photo below) are in place, but these have traditionally been ignored.

Figure 35. Firebreak between sugarcane and the forest in the agrarian community of El Salto

The debate centered on who should enforce those permits, with the sugar mill company arguing that it was the responsibility of the workers committee and the *ejidatarios* claiming it should be a higher authority with enforcement power. SEMARNAT permits are also problematic because they require two costly fire hazard studies. Some spoke of completely banning the zafra, which the sugar mill supported, explaining that they already have the machinery to harvest unburned sugarcane and do so for 25 percent of production already; however, to expand machine harvesting to the other three quarters of production would enormously increase costs and cause the loss of hundreds of cutting jobs. Other suggestions involved obligatory courses on fire prevention along with the enforcement of sanctions for anyone who refused not follow instructed procedures. One challenge to this is that sugarcane plots commonly change hands, such that newcomers are ignorant of firebreaks, the danger of burning with winds, and the time of the day when the spread of fires is least likely. A representative of the *ejido* Minas Viejas suggested the alignment of the cane stubble in rows instead of burning (see photo below), but that requires a lot of work. Still, after a recent 14-hectares forest fire caused by the combustion of stubble, some have started doing it. This practice also returns nutrients to the soil and keeps it moist.

Figure 36. Alignment of stubble in a sugar cane plot in the ejido of La Concepcion

Ultimately, they did not reach an agreement on methods, verification, or sanctions, but the municipality, the sugar mill and the representatives of the *ejidos* agreed to purchase a water tanker. Though a water tanker alone will not solve the problem, the unity behind fire prevention was a major step forward.

IX. The Program's Influence on Forest Community Management: Land Tenure, Rights, Access, Use and Decision-Making.

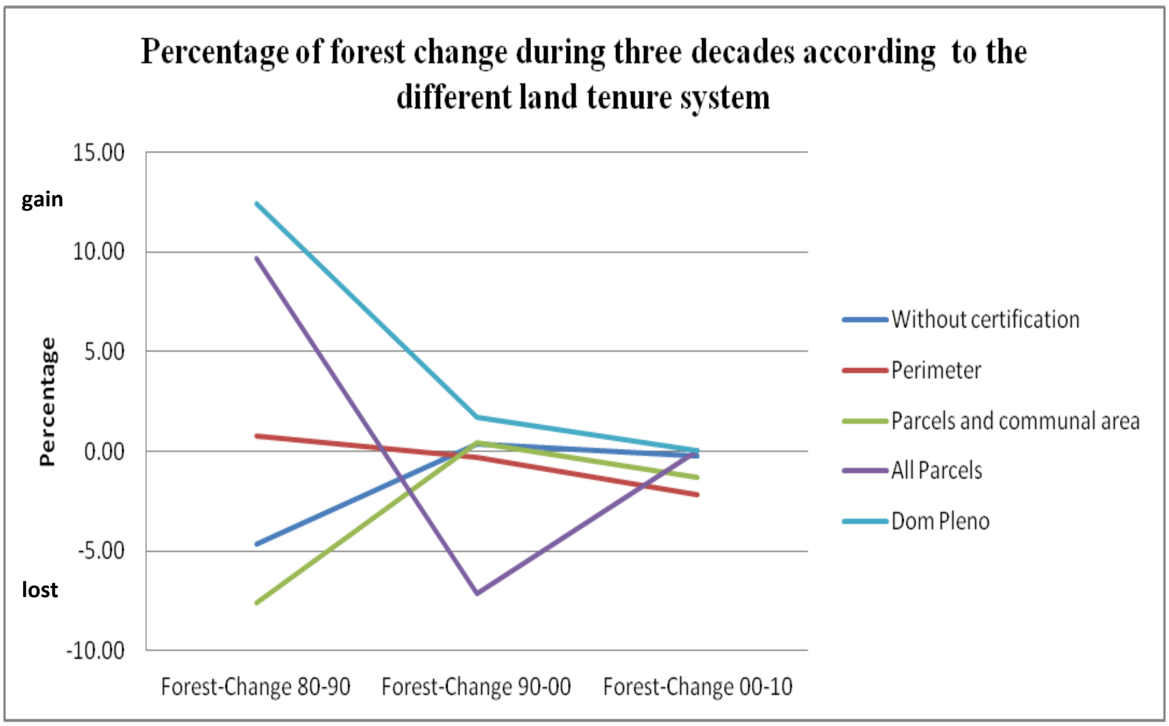
The 1992 land reforms that created different land tenure arrangements among communities and ejidos also influenced forest access and management. Such new arrangements have a direct effect on how programs like the PES are developed and executed. Having a certified forest was once a CONAFOR requirement for entering into the PES program, but due to the amount of uncertified forest throughout the country, CONAFOR decided to expand coverage to the most critical areas subject to deforestation, which were often uncertified. Nevertheless, the PES program does require *nucleos* to have their property documentation, or *carpeta basica*, in order, which has compelled some to do just that.

The analysis of the forest change according to the five categories of land tenure – uncertified, the perimeter and communal use areas certified, individual parcels and communal use areas certified, all parcels certified, and *dominio pleno* – reveals an interesting pattern: in *nucleos* that only certified the perimeter forest has remained most stable while at the ones that certified at the parcel level forest coverage had more fluctuation.

Land tenure system	Forest in 1980s	Forest in 1990s	Forest in 2000s	Forest in 2010s
Without certification	26,004.43	24,797.54	24,892.03	24,836.16
Perimeter	57,343.16	57,774.39	57,588.54	56,348.37
Parcels and communal area	60,408.55	55,798.16	56,056.03	55,325.32
All Parcels	5,549.05	6,084.53	5,648.62	5,648.62
Dominio Pleno*	1,378.08	1,549.05	1,575.22	1,575.22

Table 20. Land tenure systems and forest change in the sample of agrarian *nucleos*.
Source: INEGI's vegetation series I to IV and PHINA's agrarian data.

*Under *dominio pleno*, *nucleos* dissolve into private parcels but forests remain public. As previously seen, only one *nucleo* in the sample, El Sabinito, reverted to dominio pleno for a small percentage of its individual parcels of sugarcane, and it is interesting to see that this positively impacted forest management.



Graphic 21. Percentage of forest change in the sample of nucleos from 1980 to 2010 acording to their land tenure system

The information collected from the sample of certified and uncertified *nucleos* revealed three different types of relationships between land tenure systems and the management of forests in the PES program: *nucleos* that certified forests as communal lands and managed them communally in the PES program; *nucleos* that certified forests as communal but managed them as individual parcels; and *nucleos* that certified parcels individually but managed them communally. The same categories hold for the uncertified *nucleos* that were participating in the program.

As pointed out in the examples of participant *nucleos*, some problems can come with the implementation of the hydrological PES program for individual parcels, not only for required activities but also for the distribution of payments because they are allocated according to the amount of hectares each person has. One example of how complex this situation can get was the Nahua *ejido* of San Pedro Huizquilico, a community in the process of certification that started participating in the Hydrological PES program in 2010, submitting its individual parcels as common use forest. They were familiarized with forest conservation programs from their previous work with Sierra Gorda, but back then they participated with individual parcels since they do not have a common use area. The last 45 hectares of common use area were divided 30 years ago among individual owners. San Pedro, as well as other uncertified *nucleos*, have shunned land certification mainly to avoid the payment of taxes. Don Remigio, the *comisariado*, also explained that people consider the certification to be necessary, but the level of poverty pushes them to reconsider it. Some consider certifying their parcels only without obtaining title for their houses (*solar*), for which taxes have to be paid individually. Some of the poorest even considered moving their house to their parcels to avoid taxes. Don Remigio was confident that the certification process will eventually be completed and he will get a title for his property because he has the means to do it, but also understands why people are resisting.

Most in San Pedro have shade grown coffee and said they entered into the hydrological PES program at the recommendation of a technician from Queretaro who presented a persuasive video during an assembly. One conflict that they faced while I was there was the requirement of reforesting 20 hectares because all their property was individually parceled for coffee. Someone would have to give up their coffee for communal forest. Similarly, in other *ejidos* where forest is held communally, the PES program has contributed to the prohibition of individual cattle ranching in the commons.

X. The multi-scalar approach

Deforestation and marginality patterns were examined at two geographical scales, the Huasteca Potosina region as a whole and the local scale with the sample of 43 *nucleos*. The evidence from both scales complemented each level most of the time, but some inconsistencies between them highlighted the need of the multi-scalar approach. Patterns of deforestation, as previously discussed, proved to differ in some degree within the Huasteca Potosina region, at the municipal level within the 11 forested *municipios* of the Sierra, and among the sample of *nucleos agrarios* throughout the 30-year period. Although for all scales of analysis the 1980s was the period of major deforestation, each scale gave more detailed information as to the factors influencing it. According to the GIS analysis of deforestation and land tenure at the regional scale, it was found that most of the deforestation during this decade took place within already established private properties (64 percent) mostly in the lowland northeastern *municipios* (Ebano, Tamuin, Cd. Valles and San Vicente Tancuayalab). The findings coincide with Aguilar-Robledo (1995) and Hernández et al.'s (2008) findings about the government agricultural project of Pujal-Coy, which in addition to the land use transformation introduced a dramatic increase in population that destabilized private properties, resulting in the depletion of their remnant-forests. Social properties accounted for 36 percent of the deforestation from which granted lands in the form of NCPE's represent only ten percent of the total deforestation (153,700 ha) of that period.

Attention to deforestation in the sample of 43 *nucleos agrarios* yielded more details. Temperate forests showed a total reduction of 46 percent, most of which occurred in the last decade in the central and souther areas, as the regional scale analysis showed temperate forest actually regaining areas in the north during the last decade. Tropical forests, located mainly in the south, decreased 12 percent, mostly in the 1980s, but have remained stable since. Fieldwork and archival analysis at the community level, like the *ejido* of La Palma, allow for explanations of such varying patterns.

Examination of deforestation patterns at the regional and local scales over time also proved insightful when analyzing the impacts of the PES program. A halting of deforestation would seem to point to the effectiveness of the program, but in fact *nucleos* outside the program experienced the same trend.

The different scales of analyzing marginality also proved useful. While the region as a whole is categorized as marginal, only fieldwork and spatial analysis at the community level revealed that marginality and temperate forest depletion have a significant correlation. The construction of a marginality index at the *nucleo* scale, using population census data versus the mean marginality index per locality, allowed a clearer differentiation of marginality within the sample.

XI. Conclusion

Five hypotheses were posited at the outset of this research, which will be evaluated here. Other major findings will be discussed, as well as the limitations of this research and directions for future study. The first hypothesis was that the poorest communities are less likely to deforest but the most likely to be priority areas for the PES program. The hypothesis was formulated from the fact that most of the standing forest in the country are located in the hilliest and poorest regions (Alix-Garcia, De Janvry, and Sadoulet 2008) with least risk of deforestation. The two propositions of the hypothesis were tested at the municipal and community scales, with different outcomes throughout the region.

As the results showed, the region has different degrees of marginality as well as patterns of deforestation, and these variables were not significantly correlated at the *municipal* scale. Aquismón, for example, where 60 percent of its territory is covered by forest, had the highest marginality index value (5) and a high risk of deforestation (3.87 from a maximum of 5), but its total percentage of deforestation from the 1980s to 2010 is among the lowest of the region (14.02 percent). The low percentage of deforestation in Aquismón is even more impressive considering that its main vegetation is tropical forest, which tends to be the preferred target of land use conversion. The lowest percentages of deforestation in the region, with less than 5 percent change, came from the *municipios* of Tamasopo with a high marginality index (4) and El Naranjo with a medium marginality index (3). These examples might suggest that marginality is related to low deforestation, however, the pattern was not constant; the *municipios* of Axtla de Terrazas, Tancanhuitz and Huehuetlán lost about 40 percent of their forests in the same period and also have a high marginality index (4). Hence, at the municipal scale no clear connection can be seen between poverty and deforestation, and other factors like the type of forest proved to be more important.

A higher resolution scale at the community level using the sample *nucleos*, however, showed a correlation between poverty, deforestation, and the type of forest. The percentage of agricultural lands grew from eight to 17 percent from the 1980s to 2010, but the resulting deforestation was concentrated in poorer nucleos with temperate forests in the northern zone (positively correlated at 0.391 for the 0.01 level), not for poor nucleos with tropical forest concentrated in the southern zone.

Although temperate forest has actually regained cover at the regional scale over the last three decades, in my sample of 43 communities the pattern has reversed over the last decade, especially in the middle and southern zones. The *ejidos* of La Palma in Tamasopo and El Bagazo in Xilitla are very poor and have major deforestation, but other factors like the introduction of highways and the illegal privatization of land are more influential than poverty, especially in La Palma. Meanwhile, the northern *nucleos* of El Naranjo have seen an increase in temperate forest (as high as 14 percent) during the last three decades thanks to more arable land and the sugarcane industry, such that poverty and forest conservation are inversely correlated there.

The clearing of tropical forest in poor nucleos of the southern zone was due to the expansion of cattle pastures and agricultural plots in the 1980s and the 1990s, especially in the *municipios* of Tanlajas, Ciudad Valles and San Vicente Tancuayalab in the low coastal plains toward the gulf coast and in the slopes of Xilitla, Huehuetlán, Coxcatlán. The forest clearing was not related to poverty or marginality, since 64 percent of the conversion occurred on private properties. Rather, the conversion was encouraged by government agricultural incentives, irrigation programs from the 1970s to 1980s, and the land expropriation program accompanying them. These, in turn, led to a dramatic population increase as people flooded in to take advantage of the development programs. These major events shook the stability of private landowners, who felt pressure to double the amount of pasturage from 1985 to 2000. In fact, the data shows a correlation between increased tropical deforestation during the last two decades and nucleos that certified at the individual parcel level.

In summary, the poorest, most marginalized communities were not more likely to deforest as predicted in the hypothesis. Other factors like government agricultural programs, lack of arable land, major infrastructure projects, and social instability during land granting periods were more determinant of deforestation.

The second part of the hypothesis concerned the PES program's preference for poorest areas. This proved to be partly true, but other variables were more influential to PES prioritization. As explained above, one of the main national PES objectives over the last decade has been to reach the poorest communities in order to reduce deforestation while improving their economic condition, but the constant modification of the prioritization scheme has expanded coverage to other areas, too. At the beginning of the program, large areas of temperate forest serving as water reservoirs were prioritized, as in El Naranjo and Xilitla, even though El Naranjo is considered one of the least marginalized *municipios* in the Sierra. More recently the emphasis has shifted toward poverty reduction, yet El Naranjo and Xilitla continue to hold most of the PES projects. In contrast, Aquismón, the most marginalized *municipio* in the Huasteca, has largely been left behind despite significant patches of tropical forest. The fact that numerous agrarian *nucleos* in Aquismón faced property-rights issues at the start of the PES program complicated their inclusion. Although the certification requirement has since been waived, Aquismón contentious land issues are still perceived to influence the PES in largely excluding them.

Hypothesis 2. Agrarian *nucleos* with well-defined property rights are more likely to conserve their forest and participate in conservation programs than ones without.

Well-defined property rights have been part of the neoliberal land reform strategy to alleviate poverty and the deterioration of natural resources under the assumption that insecurities in land tenure and poverty are one of the first threats to forest and biodiversity conservation. Presumably, securing property rights will encourage landowners to regulate land uses and stop migration into forested areas while providing them the legal tools crucial for environmental governance (Spears et al. 1994). Others have argued, however, that land privatization does not guarantee the mitigation of poverty, and could lead to community disruption and forest overexploitation (Heynen N 2005). The assumption under Hardin's "tragedy of the commons" is people will selfishly overexploit communal resources such as forests, as opposed to their own private properties. However, I found that most *nucleos*, regardless of their certification status, have internal rules and traditions for regulating access and use of the forest. In addition, government conservation programs did not seem to privilege either communal or private properties.

As mentioned, land certification was once required for PES but is now considered as only one of several positive scoring elements in the prioritization scheme. The ongoing preference is because land certification enables CONAFOR to ensure the exact amount of hectares that communities legally own and the assumption that *nucleos* with property rights will have less internal and external territorial conflicts. Indeed, in the sample of 43 agrarian *nucleos*, 14 (32 percent) were not certified, mainly because of the difficulty in reaching an agreement with the *Procuraduria Agraria* (agrarian attorney) about boundaries and the amount of hectares owned.

The results show that since the 1990s (the decade where the land certification process started to be implemented) the *nucleos* that had parceled all their territory lost the most percentage of forest, seven percent. *Nucleos* that only certified their perimeter lost two percent of their forests, while the ones without land certification presented an overall increase of 0.56 percent. Thus, the certification of property rights has not necessarily entailed better forest conservation practices and vice versa, and the lack of certification has not implied a major increase in deforestation. In fact, looking more specifically at the uncertified nucleos over the first decade of the 21st century, only two lost forest, while eight maintained a stable coverage and five increased coverage (by less than five percent).

The hypothesis that nucleos with certified lands would have increased PES participation and forest conservation was nullified for the region, and especially for high priority areas for hydrological services like that of the temperate forest of Xilitla, with its high percentage of uncertified *nucleos* participating in the PES program. Even the less prioritized shade-grown coffee areas of Tamazunchale and Aquismón, had several uncertified *nucleos* participating in the PES program. Ten out of the 28 participating *nucleos* did not had their lands certified, and of the seven *nucleos* rejected for PES program, only two were not certified, whereas three had certified their perimeters and the other two had certified individual parcels and common use areas.

Securing land tenure, however, remains one of the key elements for successful PES schemes. While it is true that economists, policy makers and stakeholders in the national and international arenas, and grassroots actors continue to debate its positive impacts and threats, conservation strategies like that of the PES have always supported the regulation of property rights, and more recently the subject has received unprecedented attention with the second phase of the market for environmental services and the international REDD+ (Reducing Emissions from Deforestation and Forest Degradation in Developing countries) climate change initiative. Fortunately for Mexico, between 70 to 80 percent of its forest has been legally demarcated or granted as social properties for the peasantry in processes beginning with the Revolution and ending with the introduction of neoliberal land reforms in the 1990s.

The neoliberal reforms never intended to divide and privatize forests, only the individualization of property rights as a way to liberate the market economy in rural areas, but the creation of permanent and undividable parcels took a toll on social properties, especially in heavy populated *nucleos* where landless peasants saw their last chance to obtain a piece of land.

Hernández (2012) found cases in Teenek *nucleos* of the total division of communal forest into individual properties (Hernández-Cendejas 2012). In several of my sample *nucleos,* even after the land certification of individual parcels and forested communal areas, landless members had been lent parcels in the forests. In these cases, overpopulation and desperate need of arable lands seem to have trumped certification.

In the regions of the country where vast tracks of social properties remain uncertified, such as in Oaxaca, Chiapas, lands are usually held in common, but that does not mean that property rights are not well defined internally. PES requires a common and clear management scheme of the land itself, so internally well defined property rights had a major impact in the implementation of the program at the *nucleo* scale even without certification. Internal property rights could or could not be in tune with the certification process recognized by the State, as the sampled *nucleos* showed, internal property rights are not always registered and therefore recognized by state institutions. The discrepancies between the internal and the officially registered land rights should not suggest an immediate conflict for the *nucleos,* but when interacting with government institutions like CONAFOR, the design and implementation of programs can create conflicts if a good internal diagnostic of the participant *nucleo* is not made. Especially for PES projects, it is imperative to have well defined property rights understood by both the *nucleo* members and the external organizations and technicians working with them, such as the municipal ecology departments, the state branches of CONAFOR, and technicians working directly with communities. Reciprocally, nucleos with well defined property rights – certified or not – proved to perform better in PES projects.

In the near future, the international emphasis on reducing greenhouse emissions from deforestation and forest degradation and counting carbon stocks in conjunction with national institutions on programs like REDD+ have reinvigorated an urgency to complete the lands certification process in Mexico. If Mexico is to fully engage the carbon market, it needs to have its lands registered. It may be that PES policy regarding certification will be reversed again such that uncertified *nucleos* will have to certify to participate in the new phase of development for carbon market.

Hypothesis 3. The addition of an economic value to the environmental services of the forest has created positive adaptations in the way communities and ejidos manage their resources.

In developing countries, several cases can be found in which the commercialization of environmental services of the forest has resulted in more rational land uses, forest conservation, and the diversification of local economies (C. Muñoz-Piña 2003, Velázquez, Durán-Medina, and Jean-Francois 2003). In the Huasteca, I found that the commercialization of forest services via the PES has indeed diversified local economies in some cases and multiplied adaptations according to *nucleos'* land tenure systems and uses. For example, in the northern area, where the majority of the *ejidos* have forest in communal use and individual parcels for agriculture, the payments were used to invest in community infrastructure and protect the forest against fires, including the strengthening of collaboration between *nucleos* and enterprises like the regional sugarcane mill. Here, the payments have become such an important part of the communities' income that brigades and patrolling crews, to combat fires and illegal logging, have been created, enhancing community organization and unity. The extra income and matching state and municipal funding complement their local inputs for infrastructure projects. This support has provided the *nucleos* the chance to plan and improve the services they need while creating a positive association between the PES program and the community building process, even for members that do not receive direct payments from the program.

In the southern, more indigenous area where shade-grown coffee dominates the landscape and individual parcels prevail as the dominant land tenure system, PES's management and economic impacts are significantly different. Prior to the PES program, the region used to receive government subsidies from INMECAFE (The National Coffee Institute of Mexico) for their coffee crops, but with the collapse of the program in 1989, the PES for agroforestry has more or less partially replaced that lost source of aid. The PES funding subsidizes individual shadegrown coffee farmers independently from the category of the program in which they are participating. The management of the program here is complicated by the land being divided into collective and obligatory activities – from religious affairs to social and economic development – traditionally being organized by *barrios*, especially in bigger *nucleos,* like El Cristiano in Xilitla or Santiago and Mecatlán in Tamazunchale with over five thousand inhabitants. Each *barrio* resembles the *ejido's* organizational structure, and decisions about land management start here in many occasions, followed by approval of the general *nucleo* committee. In El Cristiano, for example, where a special committee is in charge of managing government programs, delegates must visit each barrio to discuss and approve in an assembly all PES activities. This is in contrast to smaller participant *nucleos,* where the planning activities for government programs are usually proposed by the external technicians and approvals are made only with the general committee. Ultimately, though, the management of participant lands is done individually. In El Cristiano for example, where CONAFOR pays the *nucleo* for the overall amount of forest, the *ejido* internally distributes payments to each parcel owner participating in the program.

Regarding the introduction of new or improved techniques for cultivating shade-grown coffee, little new has been adopted. The installation of compost is one exception and not universally adopted. The addition of non-native species for shade has been noteworthy in several areas, although this was less voluntary than resulting from government pressure to reforest and the availability of seedlings in contracted greenhouses. The introduction of unsuitable species for shade-grown coffee has indirect negative effects on the PES program, particularly the introduction of pines that prevent anything from grow beneath them. The coffee growers knew this but planted them anyway to avoid sanctions and loss of future government support. As one of the coffee owners explained, if the pine seedlings succeed, they will have to plant their coffee in another area, but such areas are scarce.

In both the northern and southern areas, the commercialization of forested lands is not new, whether they be temperate or tropical. The novelty of the PES has more to do with the commercialization of forest and ecosystem preservation, which has prompted communities to think about their natural resources (and their economic marginality) as a new source of income. It has also brought communities together for a shared vision and management of these forests and allocation of the funds to community investment projects in the north and subsistence in the south.

Hypothesis 4. The effects of the PES program on decreasing deforestation vary geographically, depending on the topographical characteristics of the agrarian *nucleos* and their degree and time of dependency on agricultural and cattle ranching activities.

This hypothesis relates to the previous one in the sense that the impacts of the program have differed between the northern and southern regions. As previously explained, the economic conditions and possibilities of land use diversification play important roles in the effects of PES programs, and these elements are linked to the topographical characteristics of the *nucleos*. The availability of arable lands in the northern *nucleos* has helped them maintain their forests. One of the major threats to the forests here is the introduction of free ranging cattle areas and the demand for more farm land as the population of *avecindados* and *posesionarios* keep growing. Temporary PES-related income from activities such as forest maintenance, fire prevention, and community infrastructure projects have at least slowed deforestation. While it is true that in the lowland valleys well established dependencies on sugarcane and cattle ranching have thwarted PES projects there, the income from employment in sugarcane has taken the pressure off the forests from landless peasants who might otherwise cut it down for subsistence farming.

For regions with deciduous tropical forest like the Teenek of Sierra La Pila near Cd. Valles, communities have needed no persuasion to adopt PES because arable lands in the forested sierra are so scarce. Deforestation during the 1980s and 1990s was due to the exploitation of precious tropical woods, leaving the sierra largely in secondary forest, but now the program is expected to achieve full restoration. In the majority of the *nucleos* located along this sierra, small provisional *milpas* can always be seen in forest clearings, but since landowners possess at least one half a hectare of arable land outside the forest, it reduces the deforestation pressures on the sierra.

For the communities relying on traditional slash and burn agriculture in the mountains, the benefits of setting aside forests were not so easily perceived, especially with growing families. In addition, federal and state subsidies for agricultural development counteract the forest conservation efforts. As previously discussed, the Procampo program, economic support intended only for established agricultural plots, actually encouraged the clearing of forests for new *milpas*, even in areas that were under the PES program. These competing government programs created conflicting interests inside *nucleos*, especially where the topography allows for only shifting agriculture. Such factors bore hypothesis four to be true: the impacts of the PES program were closely related to the topography and the possibility of land use diversification, although the degree and time of dependency on agricultural activities did not always prove to be determinant factors.

As shown in the sample of cases, the *ejido* of La Trinidad was an extraordinary example of how a long tradition of timber and cattle ranching can be completely converted to forest conservation through PES when it benefits the majority. Here, the combination of PES subsidies, the struggling timber business, and the inequitable sharing of cattle grazing all encouraged land use conversion. The PES program has benefited all members equally over the ten years of its implementation, but as the small original population has grown, the profits per family have diminished and now threatens forest conservation.

The growing population density, as mentioned throughout the dissertation, has impacted the Huasteca environment and its social organization over the time. The patterns of population growth within *nucleos* directly affect land use and resources management; less densely populated *nucleos* have more land to put aside for conservation than the more heavily populated, especially when there is arable land available. Despite this fact, some heavily populated *nucleos* have managed to conserve their ecosystems and participate in PES projects, especially in agroforestry projects which highlight the importance of supporting well established economic activities like shade-grown coffee production.

For the highly indigenous and heavy populated southern region, shade-grown coffee production is not only a well established economic activity, it is also an activity deeply imbedded in their culture as subsistence corn and beans agriculture, or *milpas*. The indices of deforestation in highly populated areas are always higher than reality pans out the southern region, mainly because of the permance of shadegrown coffee orchards and the shifting nature of subsistence agriculture; therefore, the protection of these agro-systems complements PES goals. However, as previously mentioned, the financial support that PES designates for these agroecosystems is not nearly sufficient to lower the poverty levels of the inhabitants.

The middle region actually suffered the worst deforestation and incidentally was not in the PES program. This area, specifically the *ejido* La Palma, suffered all of the factors inversely correlated with PES success: lack of unity and organization due to Mestizo land invasions, privatization and selling of disputed lands, and external interference in the form of a massive highway construction project.

Hypothesis 5. The maintenance of traditional community organization in an essential factor in the sustainability of forest conservation programs.

With the introduction of the neoliberal land reforms and accelerated privatization, traditional community organization in social properties was considered to be under threat. *Nucleos* with forests under communal ownership tend to have strong community organizational structures with internal rules for forest management, including involvement with NGOs in forest management programs (Alcorn 1984a, Velázquez, Durán-Medina, and Jean-Francois 2003, Klooster 2002, Alix-Garcia et al. 2009), so the potential threat that land reforms could bring to traditional community organization are also extended to forest management and conservation. From what I found in the sample of participant *nucleos,* community organization was crucial for the local performance of the PES program.

Big and strongly indigenous *nucleos* like Tampaxal or El Cristiano, which had strong and complex organizational structures, participate in several environmental conservation programs. The Teenek *ejido* of Tampaxal, for example, managed two PES projects from CONAFOR (one in agroforestry and one in hydrological services) in addition to participating in carbon market with the private NGO Pronatura, all managed through their traditional *cargo* system and the aforementioned *barrio* division of activities. The Nahua *ejido* of El Cristiano adapted its traditional community organization scheme by delegating development program management to a group of young student members. According to the general committee, the inclusion of young members in the management of government programs and land use matters as a replacement of external technicians has eased internal distrust from the planning process and the activities' verification. Training their younger members in such matters on the job also served to strengthen traditions and reinforce their autonomy. It is no coincidence that Tampaxal and El Cristiano were key informants in the consultation process for desiging indigenous constitutional reforms of the State of San Luis Potosi. Well organized *nucleos* with no major internal problems had better opportunities to reach community agreements to participate in conservation programs.

Among the non-indigenous *nucleos* successfully managing the PES program, the *ejido* of Las Abritas stands out for its ability to use the funding to improve the community's infrastructure and acquire technological equipment like GPS devices and cameras to track their activities. Here, the construction of their first community meeting hall and an awning for community gatherings and celebrations highlights how important commune and traditional organization is for them. Las Abritas has little arable land compared to the majority of *nucleos* in the northern region, and most of its territory is covered by forest submitted to PES. The program significantly increased their income and encouraged the improvement of their community organization. The success of the *ejido* in managing the program made them a model for the region, as CONAFOR selected it as an exemplary PES project and awarded some members grants to travel abroad to other successful community projects and share their experiences. For them, the PES program encouraged their community re-orientation, and CONAFOR training seminars and workshops have helped them sustain the project for their first five year period.

On the contrary, *nucleos* with major internal conflicts were less likely to participate in such programs, and when they did, the project often was not sustained. The *ejidos* of Miramar and Soledad de Zaragoza in Xilitla are illustrative examples. Although Miramar wanted to participate in PES like its neighboring ejidos, internal invasions in its common forest prevented them from reaching an agreement to apply for the program. Miramar's internal problems worsened during the certification process, when several landless members of the community obtained certificates of property in areas inside the communal area that had been lent to them. This conflict hurt individuals who reforested plots in the communal area and were receiving funding from the Sierra Gorda initiative, as eventually the NGO withdrew Miramar's payments for forest conservation because of the clearing. Besides the impacts on the forest, the internal conflicts in Miramar were also reflected in the lack of paved roads, in contrasted to their neighbors. They themselves admit that the lack of organization and land invasions have motivated very few to attend general assemblies anymore, which are held less often.

Soledad de Zaragoza had not only complex community divisions but also deleterious interventions by the *municipal* government. Pre-existing community divisions were exacerbated when the PES payments were delayed and a splinter group decided to enter the Procampo program with the help of the municipality's ecology department, despite the *ejido* committee's insistence to not participate in contradictory programs. As PES delegate of the PES program declared, CONAFOR's delay in PES payments was caused by its own mismanagement. The *ejido* had fulfilled all the program requirement on time, but CONAFOR's long delay of payments nonetheless and the resulting distrust was too much to keep an already fractious group together. The *ejido* committee made several petitions to CONAFOR to visit the *nucleo* and clarify the situation, but it never occurred and the *ejido* had to slow the pace of programmed activities. Added to the increasing internal distrust and interruption of activities, was an opportunistic delegate in the ecology department of the Xilitla municipal government's fanning of the flames by promoting the nucleo's involvement in Procampo. This example shows that even if a *nucleo* is unified and organized enough to enter the PES program, mismanagement by a few government officials can easily dismantle hard-won achievements.

As reviewed in the case studies, *nucleos* managed the PES program in myriad ways but the advance of such programs to the marketing of environmental services stage requires most of all a strong community organization. It is exactly at the *nucleos* level and their local organization where a major effort needs to be and is put. Government agencies like CDI have invested greatly in the development and strengthening of *nucleo* autonomy, especially indigenous ones through the incorporation of indigenous reforms, programs to strengthen indigenous identities and capacities, and community planning and development projects. Other agencies like CONAFOR have fostered community organization as well by holding workshops to construct participatory land management plans.

In summary, from the five objectives that were established at the beginning of this dissertation, the correlation between deforestation and extreme poverty proved to be weak. Only at the community scale did reduction in temperate forest coverage significantly correlate with marginality. Thus, the PES program focus on marginalized areas as major risks of deforestation is not efficient. Other factors like agricultural government programs, major infrastructure projects and agricultural conversion of forest mainly within private properties have had more impact on forest depletion.

As for the coincidence of the PES program in marginal areas based on the CONAFOR prioritization scheme, I found it to be partially true. Although the program has claimed to prioritize high marginality areas, very few *nucleos* of Aquismón, the most marginalized *municipio* in the region, were participating. The allocation of PES projects according to their category of suitability did not occur for several agroforestry areas that were participating in hydrological services. One of the main causes of this had to do with land tenure system; where communities that certified only the perimeter of their *nucleo* tended to manage the program as a communal area, although within, it was all divided into individual parcels. Entering the program as a communal area makes is easy for entry into the program, but the individualized parcels inhibited program management and the fulfillment of required improvements. The new prioritization scheme of 2014 is expected to reduce this issue.

Concerning PES's contribution toward stopping deforestation in the Huasteca, deforestation indeed slowed and even reversed at the regional level, but a more fine grained analysis at the community level shows that this was regardless of participation in the program. Both the *nucleos* that have been participating for a decade in the program, as well as their non-participating neighbors show no change in forest coverage from 2000 to 2010. The influence of previous forest management programs, like previous CONAFOR programs and the Sierra Gorda initiative in the southern area, have also contributed to the reduction. Other possible contributing factors considered were property regimes, population density, and marginality, which had significantly different impacts in the northern and southern areas. In regards to property regime, the north had more areas registered in communal use and managed as such for the PES program, as opposed to the south where many registered communal areas were internally managed as individual parcels, even for the PES program. Regardless, both have worked in terms of forest conservation. The hypothesis that *nucleos* with certified lands would have increased participation was nullified, as 36 percent of the participating *nucleos* in my sample were not certified. The uncertified nucleos did not show higher percentages of deforestation either when compared to the different modalities of certification. Population density on the other hand did impact the internal management of the program and its overall effect on reducing marginalization. In the less populated north, PES payments have a more tangible impact on communities, as the improvement of roads, construction of community halls and other elements strengthen community cohesion. In the more impoverished and populated south, although payments are a very much-needed source of family income, it is far from enough to eliminate their marginality.

In terms of the PES influence on land tenure, rights, access, and decisions over forest use, no change in land tenure and rights over the forest on participant communities could be identified, but access to and use of land did change in several cases. The PES influenced La Trinidad, for example, to revert cattle pastures back to forests, and in other cases communities prevented landless members from grazing or cultivating *milpas* in participating areas. This has diverted campesinos to deforest other areas, but as milpa cultivation is shifted from one area to another, forest recovery does so too, especially in the more lightly populated northern area, allowing at least partial forest revegetation. Although *nucleos* reported small numbers of such *milpas* in common use areas with little related conflict, more study of their effect on the land and the program is needed.

One of the main forces acting against the success of the program is the corruption found at different levels and sometimes convoluted within communities, government officials, technicians and CONAFOR staff. When present, it led to poor management of the program and divisionism that primarily affected the participant communities. This is of course not a surprise as San Luis

Potosí led the list of the most corrupted states within the public sector of the country in 2013 (Forbes Mexico 2014). Well organized communities however have been able to fight back and come up with ways to reduce it by minimizing external administrators and training their own PES staff like the *ejido* El Cristiano or like other *nucleos* in the south that refused to obligated to the rules of *municipal* administrators despite threats of cutting them out of *municipal* financial support. CONAFOR regional PES workshops have been one way to minimize corruption as communities have the opportunity to share experiences with other communities and talk to staff members, however the most affected communities were usually not notified of such meetings, actually, the missmanagemnt of information was one of the main corruption channels.

Despite the heavy toll of corruption at all levels of the PES management, the program has had positive impacts in the region, communities now not only think about the conservation of natural resources as a new source of income but about their important contribution to their next generations. I belive that more effects of the program are yet to come as the new phase of markets of environmental services develop and the discourse of forest conservation as well as the popularity of the program continue to spread within the region.

Scope, significance and limitations of the research

The cultural and political ecology approach of this dissertation to analyze to the PES program in the Huasteca Potosina helped identify how environmental and social variables influence forest conservation practices at different geographic scales. This regional study enriches the developing field of study on PES and their effects throughout the world. As seen here, great differences and impacts on such forest conservation models are present even in small regions like the Huasteca Potosina. The broader documentation and analysis of the workings and impacts of this models the more we learn about what works and what does not in general and what need to be adapted at local levels.

The variety of environmental and social conditions present in the Huasteca Potosina are in some ways unique to the region, but they also overlap with those in other regions of the country. Similarities include forest heterogeneity in coexistence with agricultural activities, land tenure systems, and different levels of government intervention. The influential factors in local forest management like ethnicity, cultural traditions, land tenure, land uses, varying types of vegetation, and variable topography in my samples echo those in many parts of the country. For example, the two of the three main types of land tenure for forest in the country – communally owned and individually parceled – as well as four of the major agricultural matrixes – pasture, sugarcane plantations, slash and burn subsistence agriculture, and shade-grown coffee production – were present in the sample. Thus, this study is likely highly relevant for other parts of Mexico and perhaps beyond.

In relation to land tenure, those *nucleos* in the sample that parceled all their territory and left no communal lands showed a major decrease of forest (eight percent in the last two decades), contradicting the hypothesis that forests on individual properties are better protected. In comparison, *nucleos* with mixed land rights, including individual parcels, forest in communal use, and some properties in *dominio pleno* showed a two percent forest regained over the same period of time. Land certification did not decrease deforestation in social properties, but if anything the individualization of land rights increased the risk for deforestation. These findings differ from those deforestation factors for the temperate forest in northern *ejidos* of Durango, where specific characteristics of the *nucleos* like location, soil productivity and marginality had significantly more weight in comparison to *ejidos'* attributes like the structure of property rights, total area, and numbers of members (Perez-Verdin et al. 2009). Interestingly, population density for the Huasteca Potosina region turned out to be corrrelated with marginality and risk of deforestation, but not total deforestation.

The risk of deforestation was correlated (0.412 using Pearson's at 0.01) with the percentage of indigenous population at the *nucleo* level largely because of their high population density, as it also showed significant correlation with this index (0.354 using Pearson's at 0.05). But high population density and high percentage of indigenous population also correlates to certain land tenure and land use systems in the southern region, which is dominated by individually owned parcels devoted mostly to shade-grown coffee. This agroforestry system, integral to contemporary indigenous traditions, is economicaly unstable because of unpredictable weather conditions and the volatility of international coffee prices.

Location and soil productivity are also significantly related to the total percentage of forest change, as they are in the northern *ejidos* of Durango. In the Huasteca, location determined not only the type of forest but the availability of arable lands, the soil productivity, and the type of *nucleo* land tenure systems.

Patterns of temperate and tropical forest coverage and change varied between the regional and *nucleo* scales, indicating that further analysis might be needed to determine why temperate forests coverage seem to be expanding at the regional but not the *nucleo* level. The research focused only on the impacts of the forest management on the *nucleo* level but a finer analysis of private properties might reveal why temperate forests are expanding at the regional level. The national vegetation inventory series, landsat imagery, otho-photos, and this field work all cover changes in forest at the nucleo scale but lack fine-grained imagery at the level of individual peasant parcels. The average area of such slash and burn plots is around one half to one hectare, too small for INEGI's national vegetation series at a scale of 1:250,000. Land use dynamics at the parcel scale are very important for understanding the impacts of conservation programs like PES on individuals' land use decision-making. For example, such an analysis would have allowed me to go beyond documenting general forest transformations from, say, primary to secondary forest and vice versa, to ascertain more subtle changes stages of reforestation on plots in and outside of the program. Thus, higher resolution imagery like spot imagery would be helpful. Participatory mapping techniques could also be particularly useful to document land use changes in conjunction with conservation programs. These methods are complementary and optimally both would be used for the clearest revelation of stated practices in participatory mapping and actual practices detected by higher resolution imagery.

One final recommendation for future research would be analysis of private properties (non-nucleos) participating in PES. The government's primary focus on social properties for PES has resulted in private owners of forest lobbying for participation, and slowly gaining inclusion in the Huasteca, especially in the northern region. The technicians actually prefer private owners over *nucleos* because the latter are harder to organize. A preliminary 2008 survey for the CONAFOR reforestation program showed that private owners had higher rates of seedling survival than social properties. Here, the technicians' choosing and supporting private participants was decisive. For private owners, the money received for reforestation enabled them to pay labor to water and care for the seedlings, whereas in social properties funds were exhausted just in the transportation of seedlings, payments to the community members who worked on the reforestation, and the corruption of community leaders and technicians.

vii. Bibliography

Agrawal, Arun, and Kent Redford. 2009. "Conservation and Displacement: An Overview.(Introduction)." *Conservation and Society* 7 (1):1.

Aguilar-Robledo, Miguel. 1995. *Autopsia de un Fracaso: El Caso del Proyecto Pujal-Coy de la Huasteca Potosina*. San Luis Potosí: Editorial Ponciano Arriaga.

Aguilar-Robledo, Miguel. 1999. "Land Use, Land Tenure, and Environmental Change in the Jurisdiction of Santiago de los Valles de Oxitipa, Eastern New Spain, Sixteenth to Eighteenth Century." PhD., Geography, Universtity of Texas.

Aguilar-Robledo, Miguel. 2001. "Ganadería, tenencia de la tierra e impacto ambiental en la Huasteca Potosina: los años de la Colonia." In *Historia Ambiental de la Ganadería en México*, edited by Lucina Hernández, 9-24. Xalapa, Veracruz: Institut de Recherche por le Développement IRD & Instituto Nacional de Ecología A.C.

Aguilar-Robledo, Miguel. 2002. "Las condiciones ambientales de la Huasteca: cambio y continuidad en una región biogeográfica fronteriza." Magna Exposición sobre la Huasteca, Museo Nacional de Culturas Populares, Consejo Nacional para la Cultura y las Artes.

Aguilar-Robledo, Miguel. 2003. "Formation of the Miraflores Hacienda: Lands, Indians, and Livestock in Eastern New Spain at the end of the Sixteenth Century." *Journal of Latin American Geography* 2 (1):87-110.

Alatorre, Adriana. 2011. Investigan Nexos de Incendios Forestales con Narcotráfico. *Reforma*. Accessed 03-04-2013.

Alcorn, Janis B. 1984a. "Development Policy, Forests, and Peasant Farms: Reflections on Huastec-Managed Forests' Contributions to Commercial Production and Resource Conservation." *Economic Botany* 38 (4):389-406.

Alcorn, Janis B. 1984b. "Plant resources and their management: human responses to plants." In *Huastec Mayan Ethnobotany*, 372-380. Austin, Texas: University of Texas Press.

Alix-Garcia, J., A. De Janvry, and E. Sadoulet. 2008. "The role of deforestation risk and calibrated compensation in designing payments for environmental services." *Environment and Development Economics* 13 (3):375-394.

Alix-Garcia, Jennifer, Alain De Janvri, Elisabeth Sadoulet, and Juan Manuel Torres. 2009. "Lessons Learned from Mexico's Payment for Environmental Services Program." In *Payment for Environmental Services in Agricultural Landscapes: Economic Policies and Poverty Reduction in Developing Countires*, edited by Lipper Leslie, Sakuyama Takumi, Stringer Randy and David Zilberman, 163-188. Berkeley, CA: FAO and Springer Science.

Andrews, Anthony P. 1983. *Maya salt production and trade*. Tucson, Ariz.: University of Arizona Press

Angelsen, A., and D Kaimowitz. 1999. "Rethinking the causes of deforestation: lessons from economic models." *World Bank Research Observer* 14 (1).

Ariel de Vidas, Anath. 2003. *El Trueno ya no Vive Aqui. Representacion de la Marginalidad y Construccion de la Indentidad Teenek. (Huasteca Veracruzana, Mexico).* Coleccion Huasteca. Ed. Mexico D.F. : CIESAS: COLSAN: CEMCA: IRD.

Arriagada, R. 2008. "Private provision of public goods: Applying matching methods to evaluate payments for ecosystem services in Costa Rica." Ph.D. 3345325, North Carolina State University.

Ávila Mendez, Agustín. 2008 (coord). *Diagnostico Regional La Huasteca.* Ed. CIESAS: CONACYT.

Ávila Mendez, Agustín. 2009. "La reforma indígena potosina. Un reto al centralismo." In *Una década de reformas indígenas? Multiculturalismo y derechos de los pueblos indios de México,* edited by Diódoro Carrasco-Altamirano and Moisés Jaime Bailón-Corres. Mexico: Camara de diputados del congreso de la union, CNDH, IIHUABJO.

Ávila, José L. 1995. Desigualdad Regional Y Marginalización Municipal en México. *Demos*: 23-24.

Baker, J. Robert, and E. Lendell Cockrum. 1966. "Geographical and ecological range of the long-nosed bats *Leptonycteris*." *Journal of Mammology* 41 (2):329-331.

Barrows, Harlan H. 1923. "Geography as Human Ecology." *Annals of the Association of American Geographers* 13 (1):1-14.

Bassols-Batalla, Angel. 1977a. *Las Huastecas en el Desarrollo Regional de México.* Edited by Angel Bassols-Batalla, Santiago Rentería Romero, Arturo Ortiz-Wadgymar, Carlos Bustamante-Lemus and Patricia Sosa. 1st. ed. Mexico D.F.: Editorial Trillas.

Bassols-Batalla, Angel. 1977b. "Situación y Límites de la Región Económica." In *Las Huastecas en el desarrollo regional de Mexico*, edited by Angel Bassols-Batalla, Santiago Rentería Romero, Arturo Ortiz-Wadgymar, Carlos Bustamante-Lemus and Patricia Sosa, 24-31. Mexico: Editorial Trillas.

Blaikie, Piers 1985. *The Political Economy of Soil Erosion* Edited by Longman Development Studies. Dwyer, D.J. ed. London: Longman.

Boyer, C. R. 2007. "Miguel Ángel de Quevedo y la política forestal en México 1929-1940." *Historia Mexicana* 57 (1):91-138.

Boyer, Christopher. R. 2005. "Contested Terrain: Forestry Regime and Community Responses in North Eastern Michoacan, 1940-2000." In *Community Forests of Mexico: Managing for Sustainable Landscapes*, edited by Deborah Barry, David Barton Bray and Leticia Merino-Perez, 27-48. Austin Tx.: University of Texas Press.

Bray, David Barton, Leticia Merino-Pérez, Patricia Negreros-Castillo, Gerardo Segura-Warnholtz, Juan Manuel Torres-Rojo, and Henricus F. M. Vester. 2003. "Mexico's Community-Managed Forests as a Global Model for Sustainable Landscapes" *Conservation Biology* 17 (3): 672-677.

Bryant, Raymond L. 1992. "Political ecology : An emerging research agenda in Third-World studies." *Political Geography* 11 (1):12-36.

Bryant, Raymond L. 1996. *The political ecology of forestry in Burma, 1824–1994*. London: C. Hurst.

Bryant, Raymond L. and Sinead Bailey. 1997. *Third World Political Ecology.* NY: Routledge.

Brookfield 1964. "Questions on the Human Frontiers of Geography." *Economic Geography* (40) 283-303.

Bryant, Raymond L., and Sinéad Bailey. 1997. *Third World Political Ecolgy*. New York: Routledge.

Bumpus, A. G., and D. M. Liverman 2011. "Carbon Colonialism? Offsets, Greenhouse Gas Reductions, and Sustainable Development." In *Global Political Ecology*, N.Y: Routledge. 203-25

Butzer, Karl W. 1991. "Spanish Colonization of the New World: Cultural Continuity and Change in Mexico (Die spanische Kolonisierung der Neuen Welt. Kulturelle Kontinuität und kultureller Wandel in Mexiko)." *Erdkunde* 45 (3):205-219.

Butzer, Karl W. 1992. "The Americas before and after 1492: An Introduction to Current Geographical Research." *Annals of the Association of American Geographers* 82 (3):345-368.

Bunker, Sthephen. G. 1985. *Underdeveloping the Amazon: Extraction of Unequal Exchange and the Failure of the Modern State.* University of Illinois Press, Urbana II.

C. Muñoz-Piña, Alarcón Gabriela, and José C. Fernández. 2003. Pixel Patterns of Deforestation in Mexico: 1993-2000. In *INE-Working Paper Series*, edited by INE-SEMARNAT. Mexico: Instituto Nacional de Ecología.

Castells, Manuel, and Roberto Laserna. 1989. "The New Dependency: Technological Change and Socioeconomic Restructuring in Latin America." *Sociological Forum* 4 (4):535-560.

Castree, N. 2008. "Neoliberalising nature: the logics of deregulation and reregulation." *Environment and Planning A* 40 (1):131-152.

Castro, E. 2001. "Costarrican Experience in the Charge for Hydro Environmental Services of the Biodiversity to Finance Conservation and recuperation of Hillside Ecosystems." International Workshop on Market Creation for Biodiversity Products and Services, Paris, 25-26 January.

CBD. 1993. Convention on biological diversity. Concluded at Rio de Janeiro on June 1992. In *Multilateral*: CBD.

Chase, Jacquelyn. 2002. "The Spaces of Neoliberalism in Latin America." In *The Spaces of Neoliberalism. Land Place and Family in Latin America*, edited by Jacquelyn Chase, 1-21. New Caledonia: Kumarian Press. Original edition, 2002.

Chipman, Donald E. 1966. "The Traffic of Indian Slaves in the Province of Pánuco, New Spain, 1523-1533." *The Americas* 23 (2):142-155.

Chipman, Donald E. 1967. *Nuño de Guzmán and the province of Pánuco in New Spain, 1518-1533*, *Spain in the West*. Glendale, California: A. H. Clark Co.

Cisneros, Juan. 2011a. "Indigenous Communities Social Organization and Governance " San Luis Potosi.

Cisneros, Juan. 2011b. "Reforma del artículo 9 de la Constitucion del Estado de San Luis Potosí." San Luis Potosí.

CONAFOR (Comisión Nacional Forestal). 2009. Matriz de Indicadores de Reglas de Operación Proárbol 2009 In *CONAFOR*, edited by Indicadores 2009: CONAFOR.

CONAFOR. 2012. Reglas de Operación del Programa ProArbol 2012. *Diario Oficial*, 21 de Diciembre 2011. Secretaria de Medio Ambiente y Recursos Naturales (SEMARNAT).

CONAGUA (Comisión Nacional del Agua). 2012. Atlas del Agua en México 2012. Mexico D.F.: SEMARNAT.

CONAPO (Consejo Nacional de Población). 2012. Indice de Marginación por Localidad 2010. Mexico, D.F.: UNFPA and Consejo de Población y Vivienda.

CONEVAL (Consejo Nacional de Evaluación de la Política de Desarrollo Social). 2012. Inventario CONEVAL de Programas y Acciones Federales de Desarrollo Social.

Corbera, Esteve, and Manuel Estrada. 2010. "Snapshots of REDD experiences in six countries: Mexico." In *REDD, forest goverment and rural livelyhoods. The emerging agenda* edited by Oliver Springate-Baginski and Eva Wollenberg, 95-108. Bogor, Barat: CIFOR.

Corbera, Esteve, Carmen González Soberanis, and Katrina Brown. 2009. "Institutional dimensions of Payments for Ecosystem Services: An analysis of Mexico's carbon forestry programme." *Ecological Economics* 68 (3):743-761. doi: http://dx.doi.org/10.1016/j.ecolecon.2008.06.008.

D.Cattaneo, Matias, Sebastian Galiani, Paul J. Gertler, Sebastian Martinez, and Rocio Titiunik. 2009. "Housing, Health, and Happiness." *American Economic Journal: Economic Policy* 1 (1):30.

De Jong, Bernandus H.J., Richard Tipper, and G. Montoya-Gómez. 2000. "An economic analysis of the potential of carbon sequestration by forest: evidence from southern Mexico." *Ecological Economics* 33 (2):313-327.

Denevan, William M. 1966. *The Aboriginal Cultural Geography of the Llanos the Mojos of Bolivia.* Ibero-americana: 48. Berkeley, University of California Press.

Denevan, William M. 1971. "Campa Sussistence in the Gran Pajonal, Eastern Peru." *Geographical Review* 61:496-518.

Denevan, William M. 1983. "Adaptation, Variation and Cultural Geography." *The Professional Geographer* 35 (4): 399-406.

Dewalt, Billie L. 1975."Inequalities of Wealth, Adoption of Technology, and Production in a Mexican Ejido, *American Ethnologist* 2 (1): 149-168

Dorner, Peter. 1992. "Thirty Years of Reform: Accomplishments and Limitations." In *Latin American Land Reforms in Teory and Practice*, edited by Peter Dorner, 32-57. Madison: The University of Wisconsin Press.

Ducey, Michael. 2004. *A Nation of Villages. Riot and Rebellion on the Mexican Huasteca, 1750-1850*. Tucson: The university of Arizona Press.

Ducey, Michael T. 2001. "Indian Communities and Ayuntamientos in the Mexican Huasteca: Sujeto Revolts, Pronunciamientos and Caste War." *The Americas* 57 (4):525-550.

Dueñas, Lily. 2013. "Narcotráfico y Crimen Organizado Devastan Bosques." *La Crónica de Chihuahua*, 03-25-2013.

Duncan, J.S. 1980. "The Superorganic in American Cultural Geography." *Annals of the association of American Geographers*. (70) 181-98

Durán, E., D. B. Bray, A. Velázquez, and A. Larrazábal. 2011. "Multi-Scale Forest Governance, Deforestation, and Violence in Two Regions of Guerrero, Mexico." *World Development* 39 (4):611-619. doi: http://dx.doi.org/10.1016/j.worlddev.2010.08.018.

Echavarria, Marta. 1999. Agua: Valoración del Servicio Ambiental que Prestan las Áreas Protegidas. In *Manual de Capacitación América Verde*. Quito: The Nature Conservancy.

Echavarria, Marta. 2002. "Financing Watershed Conservation: The FONAG Water Fund in Quito, Ecuador." In *Selling Forest Environmental Services. Market-based Mechanism for Conservation and Development* edited by Stefano Pagiola, Joshua Bishop and Natasha Landell-Mills, 91-101. London: Earthscan.

Enciso, Angélica. 2013. "Consume el fuego 3,987 hectáreas de bosque en San Luis Potosí." *La Jornada*, 03/25/2013. http://www.jornada.unam.mx/2013/03/25/sociedad/038n1soc.

Escobar, Arturo. 1995. *Encountering Development: The Making and Unmaking of the Third World*. New Yersey: Princeton University Press.

Escobar, Arturo. 1998. "Whose Knowledge, Whose nature? Biodiversity, Conservation, and the Political Ecology of Social Movements." *Journal of Political Ecology* 5 (1):53-82.

Ezzine-de-Blas, Driss, Jan Börner, Ana-Luiza Violato-Espada, Natalia Nascimento, and Marie-Gabrielle Piketty. 2011. "Forest loss and management in land reform settlements: Implications for REDD governance in the Brazilian Amazon." *Environmental Science & Policy* 14 (2):188-200. doi: http://dx.doi.org/10.1016/j.envsci.2010.11.009.

Fernandes, Edesio. 2002. "The Influence of De Soto's The Mystery of Capital." *Land Lines* 14 (1).

Ferraro, Paul J. 2001. "Global Habitat Protection: Limitations of Development Interventions and a Role for Conservation Performance Payments." *Conservation Biology* 15 (4):990-1000.
Ferraro, Paul J., and R. David Simpson. 2002. "The Cost-Effectiveness of Conservation Payments." *Land Economics* 78 (3):339-353.
Finley-Brook, Mary. 2007. "Green Neoliberal Space: The Mesoamerican Biological Corridor." *Journal of Latin American Geography* 6 (1):101-124.
Forbes Mexico. 2014. "Los 10 Estados con más corrupción en México." *Forbes* 22/06/2014 http://www.forbes.com.mx/los-10-estados-con-mas-corrupcion-en-mexico/
Gillespie, A. R., D. M. Bocanegra-Ferguson, and J. J. Jimenez-Osornio. 2004. "The propagation of Ramón (Brosimum alicastrum Sw.; Moraceae) in Mayan homegardens of the Yucatan peninsula of Mexico." *New Forests* 27 (1):25-38. doi: 10.1023/a:1025081224852.
Goldman, Michael. 2005. *Imperial Nature. The World Bank and struggles for social justice in the age of globalization.* Edited by James C. Scott., *Agrarian Studies Series*. New Haven and London: Yale University Press.
González-Guillén, Manuel de Jesús 2008. Evaluación Externa de los Apoyos de los Servicios Ambientales, Ejercicio Fiscal 2007 Colegio de Posgraduados.
Gorman, Leo B. 2003. "Indigenous People, Development of Megaprojects, and Internet Resistance " In *Trouble in Paradise*, edited by Timmons & Demetria-Thanos Roberts, Nikki, 165-191. New York Routledge.
Grieg-Gran, Maryanne, Ina Porras, and Sven Wunder. 2005. "How can market mechanisms for forest environmental services help the poor? Preliminary lessons from Latin America." *World Development* 33 (9):1511-1527.
Grossman, Larry. 1977. "Man-Environment Relationship in Anthropology and Geography." *Annals of the Association of American Geographers* 67 (1) 126-144.
Guha, Ramanchandra. 1989. *Saboteus in the Forest: Colonialism and Peasant Resistance in the Indian Hilamaya,* F.D. Colburn (ed).
Harnapp, Vern. 1972. "The Mexican Huasteca: A Region in Formation." Ph.D. Dissertation, Geography, The University of Kansas.
Hecht, Susana and Alexander Cockburn. 1989. *The Fate of the Forest.* London:Verso.
Herlihy, Peter H. 1999. "Participatory Research Zoning of the Río Platano Biosphere in the Honduran Mosquitia " In *Natural Resources Management. Between Poverty Alleviation and Nature Conservation: Experiences from development projects in Asia, Latin America and Africa*, edited by Gesellschaf für Agrarprojekte, 225-243. Hamburg, Germany: Wissenschaftsverlag Vauk Kiel KG.
Herlihy, Peter H. 2001. "Indigenous and Ladino People of the Río Platano Biosphere Reserve, Honduras." In *Endangered Peoples of Latin America: Struggles to Survive and Thrive* edited by Susan C. Stonich. Wesport, Conn.: Greenwood Press.
Herlihy, Peter H. 2003. "Participatory Research Mapping of Indigenous Lands in Darién, Panama." *Human Organization* 62 (4):315-331.
Herlihy, Peter H., and Gregory Knapp. 2003. "Maps of, by, and for the Peoples of Latin America." *Human Organization* 62 (4):303.
Herlihy, Peter H., and Andrew P. Leake. 1990. "The Tawaka Sumu: A Delicate Balance in Mosquitia." *Cultural Survival Quarterly* 14 (4):13-16.
Hernández-Cendejas, Gerardo A. 2012. "Las transformaciones agrarias y el impacto del PROCEDE en los Tének de la Huasteca Potosina. Un análisis multiescalar." Doctorate, Geography, Universidad Autónoma de México UNAM.

Hernández, Humberto Reyes, Miguel Aguilar Robledo, Juan Rogelio Aguirre Rivera, and Javier Fortanelli Martinez. 2008. "Spatial Configuration of Land-Use/Land-Cover in the Pujal-Coy Project Area, Huasteca Potosina Region, Mexico." *Ambio* 37 (5):381-389.
Herrera-Casasús, Maria L. 1989. *Presencia y esclavitud del negro en la Huasteca.* Edited by 1 ed. Mexico: M.A. Porrúa.
Heynen N; P. Robbins. 2005. "The Neoliberalization of Nature: Governance, Privatization, Enclosure and Valuation." *Capitalism, Nature, Socialism* 16 (1):1-4.
Heynen N., McCarthy J., Prudham S., P. Robbins. 2007. "False Promises " In *Neoliberal Environments*, edited by McCarthy J. Heynen N., Prudham S., Robbins P., 1-21. New York: Routledge.
Hudson, Paul F. 2004. "Geomorphic context of the prehistoric Huastec floodplain environments: lower Pánuco basin, Mexico." *Journal of Archaeological Science* 31 (6):653-668.
Igoe, J. and D. Brockington. 2007. "Neoliberal Conservation: A Brief Introduction." *Conservation and Society* 5 (4):432-449.
INE-SEMARNAT. 2002. Estimacion de Costos de Oportunidad del Uso de Suelo Forestal en Ejidos a Nivel Nacional edited by Dirección General de Investigación en Política y Economía Ambiental. Mexico: INE-SEMARNAT.
INE (Instituto Nacional de Ecología). 2011. Indice de Presión Económica a la Deforestación. Nota Metodológica. Dirección General de Política y Economía Ambiental Instituto Nacional de Ecología.
INEGI (Instituto Nacional de Estadistica y Geografia) 2007. "Censo Ejidal 2007. Tabulados municipales" Webpage: http://www.inegi.org.mx/est/contenidos/proyectos/Agro/ca2007/Resultados_Ejidal/default.aspx
INECC. (Instituto Nacional de Ecología y Cambio Climático) 2013. "Uso del Indice de Presión Económica (Riesgo) de la Deforestación" Webpage http://www.inecc.gob.mx/irdef-db
Jackiewicz, Edward L. 2006. "Community-Centered Globalization: Modernization under Control in Rural Costa Rica." *Latin American Perspectives* 33 (6):136-146.
Jewitt, S.1995 Europe's 'others'? Forestry policy and practices in colonial and postcolonial India. Environ. Plann. D: *Society and Space* 13: 67-90.
Johannssen, C. 1963. "Savannas of Interior Honduras." *Iberoamericana* 46: Los Angeles CA: University of California Press.
Johnson, Nancy L. 2001. ""Tierra y libertad:" Will Tenure Reform Improve Productivity in Mexico's "Ejido" Agriculture?" *Economic Development and Cultural Change* 49 (2):291-309.
Kaimowitz, D. 2001. "Cuatro medio verdales: la relacion bosques y agua en Centroamericana." *Revista Forestal Centroamericana* (33).
Kay, Cristóbal. 1995. "Rural Development and Agrarian Issues in Contemporary Latin America." In *Structural Adjustment and the Agricultural Sector in Latin America and the Caribbean*, edited by John Weeks, 11-44. New York: St. Martin's Press, INC.
Kay, Cristóbal. 2002. "Agrarian and Territorial Rights." In *The Spaces of Neoliberalism. Land Place and Family in Latin America*, edited by Jacquelyn Chase, 25-52. New Caledonia: Kumarian Press.
Kelly, John H., Peter H. Herlihy, Derek A. Smith, Aida. Ramos-Viera, Andrew M. Hilburn, and Gerardo A. Hernández-Cendejas. 2010. "Indigenous Territoriality at the End of the Social Property Era in Mexico." *Journal of Latin American Geography* 9 (3):161-181.

Kenneth Iain, MacDonald. 2005. "Global hunting grounds: power, scale and ecology in the negotiation of conservation." *Cultural Geographies* 12 (3):259.

Kepleis, Peter, and Collin Vance. 2003. "Neoliberal Policy and Deforestation in Southeastern Mexico: An Assessment of the PROCAMPO Program." *Economic Geography* 79 (3):221-240.

Kiss, Agi, Gonzalo Castro, and Kenneth Newcombe. 2002. "The Role of Multilateral Institutions." *Philosophical Transactions: Mathematical, Physical and Engineering Sciences* 360 (1797):1641-1652.

Klepeis, Peter. 2003. "Neoliberal Policy and Deforestation in Southeastern Mexico: An Assessment of the PROCAMPO Program." *Economic Geography* 79 (3):223.

Klooster, D. 2002. "Toward Adaptive Community Forest Management: Integrating Local Forest Knowledge with Scientific Forestry." *Economic Geography* 78 (1):43-70

Klooster, Dan. 2003. "Campesinos and Mexican Forest Policy during the Twentieth Century." *Latin American Research Review* 38 (2):94-126.

Lambin, Eric F., B. L. Turner, Helmut J. Geist, Samuel B. Agbola, Arild Angelsen, John W. Bruce, Oliver T. Coomes, Rodolfo Dirzo, Günther Fischer, Carl Folke, P. S. George, Katherine Homewood, Jacques Imbernon, Rik Leemans, Xiubin Li, Emilio F. Moran, Michael Mortimore, P. S. Ramakrishnan, John F. Richards, Helle Skånes, Will Steffen, Glenn D. Stone, Uno Svedin, Tom A. Veldkamp, Coleen Vogel, and Jianchu Xu. 2001. "The causes of land-use and land-cover change: moving beyond the myths." *Global Environmental Change* 11 (4):261-269.

Landell-Mills, Natasha. 2002. "Developing Markets for Forest Environmental Services: An Opportunity for Promoting Equity While Securing Efficiency?" *Philosophical Transactions: Mathematical, Physical and Engineering Sciences* 360 (1797):1817-1825.

Landell-Mills, Natasha, and Jason Ford. 1999. *Privatizing Sustainable Forestry. A global review of trends and challenge, Instruments for sustainable private sector forestry series*. London: International Institute for Environment and Development.

Landell-Mills, Natasha, and Porras Ina T. 2002b. *Silver Bullet or Fools' Gold? A Global Review of Markets for Forest Environmental Services and their Impact on the Poor, Instruments for Sustainable Private Sector Forestry Series*. London: International Institute for Environment and Development (IIED).

Larson, A.M., D. Barry, G.R. Dahal, and Colfer C. J. P. 2010. *Forests for People: Community Rights and Forest Tenure Reform*: Earthscan.

Larson, Anne M., Maria Brockhaus, William D. Sunderlin, Amy Duchelle, Andrea Babon, Therese Dokken, Thu Thuy Pham, I. A. P. Resosudarmo, Galia Selaya, Abdon Awono, and Thu-Ba Huynh. 2013. "Land tenure and REDD+: The good, the bad and the ugly." *Global Environmental Change* 23 (3):678-689. doi: http://dx.doi.org/10.1016/j.gloenvcha.2013.02.014.

Ley reglamentaria del artículo 9° de la Constitución Política del Estado. Sobre Derechos y Cultura Indígenas de San Luis Potosí. Gobierno del Estado de San Luis Potosí. San Luis Potosí: Diario Oficial 28 de Diciembre 2010.

Lipper, Leslie, Nancy McCarthy, and Zilberman David. 2009. "Putting Payments for Environmental Services in the Context of Economic Development." In *Payment for Environmental Services in Agricultural Landscapes: Economic Policies and Poverty Reduction in Developing Countires*, edited by Lipper Leslie, Sakuyama Takumi, Stringer Randy and David Zilberman, 9-33. Berkeley, CA: FAO and Springer Science

Loa-Loza, E., M.D. Sánches-Hermosillo, J.G. Torres-Jimenez, O.C. Rosas-Rosa, and Sierra-Rivera M.S. 2009. *Areas prioritarias para el manejo y conservación en el estado de San Luis Potosí.* : Secretaria de desarrollo agropecuario y recursos hidraulicos.
Lundell, Cyrus Longworth. 1937. *The vegetation of Peten*. Washington, D.C: Carnegie Institution of Washington.
Lyster, Rosemary. 2011. "REDD+, transparency, participation and resource rights: the role of law." *Environmental Science & Policy* 14 (2):118-126. doi: http://dx.doi.org/10.1016/j.envsci.2010.11.008.
MacNeish, Richard S. 1947. "A Preliminary Report on Coastal Tamaulipas, Mexico." *American Antiquity* 13 (1):1-15.
Magaña, Gildardo. 1985. "Antecedentes Históricos del Ejido." In *Emiliano Zapata y el Agrarismo en México. Tomo 1*. Mexico: Instituto Nacional de Estudios Históricos de la Revolución Mexicana - (INEHRM).
Mansfield, Becky. 2004. "Rules of Privatization: Contradictions in Neoliberal Regulation of North Pacific Fisheries." *Annals of the Association of American Geographers* 94 (3):565-584.
Mansourian, Stephanie, Daniel Vallauri, Nigel Dudley, and Kirsten Schuyt. 2005. "Payment for Environmental Services and Restoration." In *Forest Restoration in Landscapes*, 166-170. Springer New York.
Martinez-Torres, Maria Elena. 2006. *Organic coffee sustainable development by Mayan farmers*. Edited by Ohio University research in international studies., *Latin America series*. Athens, Ohio University Center for International Studies.
Mathews, Andrew S. 2009. "Unlikely Alliance. Encounters between State Science, Natural Spirits, and Indigenous Industrial Forestry in Mexico, 1926-2008." *Current Anthropology* 50 (1):27.
May, H. Peter, Fernando Veiga-Neto, Valdir Denardin, and Wilson Loureiro. 2002. "Using Fiscal Instruments to Encourage Conservation: Municipal Responses to the "Ecological" Value-added Tax in Paraná and Minas Gerais, Brazil." In *Selling Forest Environmental Services. Market-based Mechanism for Conservation and Development* edited by Stefano Pagiola, Joshua Bishop and Natasha Landell-Mills, 173-199. London: Earthscan.
McAfee, Kathleen, and Elizabeth N. Shapiro. 2010. "Payments for Ecosystem Services in Mexico: Nature, Neoliberalism, Social Movements, and the State." *Annals of the Association of American Geographers* 100 (3):579 - 599.
Meade, Joaquin. 1942. *La Huasteca, Epoca Antigua*. Edited by Publicaciones Historicas. Mexico, D.F.: Editorial Colossio.
Meade, Joaquín. 1955. "Notes on the Franciscans in the Huasteca Region of Mexico." *The Americas* 11 (3):429-447.
Medina, M. 2007. Objetivos Estrategicos Proarbol. edited by Comisión Nacional Forestal.
Merino, Leticia, and Ana Eugenia Martínez. 2009. "Rights, Pressures and Conservation in Forest Regions of Mexico.The Results of a Survey on the Conditions of Community Forests." Workshop of Political Theory and Policy Analysis Indiana University, 2009.
Miksicek, Charles H., Kathryn J. Elsesser, Ingrid A. Wuebber, Karen Olsen Bruhns, and Norman Hammond. 1981. "Rethinking Ramon: A Comment on Reina and Hill's Lowland Maya Subsistence." *American Antiquity* 46 (4):916-919. doi: 10.2307/280117.

Muñoz-Piña, Carlos, Alejandro Guevara, Juan Manuel Torres, and Josefina Braña. 2008. "Paying for the hydrological services of Mexico's forests: Analysis, negotiations and results." *Ecological Economics* 65 (4):725-736.
Neumann, Rod. 1992. *Social Origins of Natural resource Conflict in Arusha National Park, Tanzania.* Dissertation. University of California, Berkeley.
Neumann, Rod. 1999. *Imposing Wilderness*. Edited by Berkeley: University of California Press.
Nietschmann, Bernard. 1973. *Between Land and Water: The Subsistence Ecology of the Miskito Indians, esatern NIcaragua.* New York: Seminar Press.
Noguera, Eduardo. 1946. "Cultura Huaxteca." In *Mexico Prehispanico*, 249-254. Mexico: Editorial Hurtado.
Ochoa, Lorenzo. 1979. *Historia Prehispanica de la Huaxteca*. Edited by Instituto de Investigaciones Antropológicas. 1st. ed. Vol. 26, *Antropológica*. México, D.F.: UNAM.
Offen, Karl. 2004. "Historical Political Ecology: An Introduction." *Historical Geography* 32 (2004):19-42.
Ohmstede, Antonio Escobar. 1996. "Del Gobierno Indigena al Ayuntamiento Constitucional en las Huastecas Hidalguense y Veracruzana, 1780-1853." *Mexican Studies/Estudios Mexicanos* 12 (1):1-26.
O'Keefe, P., K. Westgate and B. Wisner. 1976. "Taking the Naturaleness Out of Natural Disasters. *Nature* 260: 566-7.
Pagiola, Stefano. 2002. "Paying for Water Services in Central America: Learning from Costa Rica." In *Selling Forest Environmental Services. Market-based Mechanism for Conservation and Development.* Edited by Stefano Pagiola, Joshua Bishop and Natasha Landell-Mills. London: Earthscan. 38-61.
Pagiola, Stefano, Paola Agostini, José Gobbi, Cees de Haan, Muhammad Ibrahim, Enrique Murgueitio, Elías Ramírez, Mauricio Rosales, and Juan Pablo Ruíz. 2005. "Paying for Biodiversity Conservation Services: Experience in Colombia, Costa Rica, and Nicaragua." *Mountain Research and Development* 25 (3):206-211.
Pagiola, Stefano, Natasha Landell-Mills, and Joshua Bishop. 2002a. "Market-based Mechanisms for Forest Conservation and Development." In *Selling Environmental Services*, edited by Stefano Pagiola, Natasha Landell-Mills and Joshua Bishop, 1:35. London. Sterling, VA: Earthscan.
Parsons, James J. 1955. "The Miskito Pine Savannas of Nicaragua and Honduras. *Annals of the Association of American Geographers,* 45:36-63.
Paulson, Susan, Lisa L. Gezon, and Michael Watts. 2005. "Politics, Ecologies, Genealogies." in *Political Ecology Across Spaces, Sclaes and Social Groups.* Edited by Susan Palson and Lisa L. Gezon. Rutgers University Press. 17- 37.
Peet, Richard, Paul Robins, and Michael J.Watts. (eds.) 2011. *Global Political Ecology*. Routledge.
Peluso, Nancy. 1993. "Coercing Conservations: The Politics of State Resource Control." *Global Environmental Change* 3 (3):199-218.
Peluso, Nancy, and Michael Watts, eds. 2001. *Violent Environments* , Ithaca, N.Y. Cornell University Press.
Perez-Verdin, Gustavo, Yeon-Su Kim, Denver Hospodarsky, and Aregai Tecle. 2009. "Factors driving deforestation in common-pool resources in northern Mexico." *Journal of Environmental Management* 90 (1):331-340.

Pérez-Zevallos, Juan Manuel. 2005. "The Ethnohistory of the Huasteca." In *Native People of the Gulf Cost of Mexico*, edited by Alan R. Sandstrom and Hugo E. García-Valencia, 66-99. Tucson: The University of Arizona Press.

Perfecto, I., J. Vandermeer, and A. Wright. 2009. "The Broad Social Context for Understanding Biodiversity, Conservation and Agriculture." In *Nature's Matrix. Linking Agriculture, Conservation and Food Sovereignty*, 80-136. London: Earthscan.

Perramond, Eric P. 2010. *Political Ecologies of Cattle ranching in Northern Mexico. Private Revolutions*. 1st. ed. Arizona: The University of Arizona Press.

Perreault, T., and P. Martin. 2005. "Geographies of neoliberalism in Latin America." *Environment and Planning A* 37 (2):191-201.

Pfaff, Alexander, Juan Robalino, Robert Walker, Steven Aldrich, Marcellus Caldas, Eustaquio Reis, Stephen Perz, Claudio Bohrer, Eugenio Arima, William Laurance, and Kathryn Kirby. 2007. "Road, Investments, Spatial Spillovers, and Deforestation in the Brazilian Amazon." *Journal of Regional Science* 47 (1):109-123.

Ponette-González, Alexandra Gisele. 2007. "2001: A Household Analysis of Huastec Maya Agriculture and Land Use at the Height of the Coffee Crisis." *Human Ecology* 35 (3):289-301.

Porter-Bolland, Luciana, Edward A. Ellis, Manuel R. Guariguata, Isabel Ruiz-Mallén, Simoneta Negrete-Yankelevich, and Victoria Reyes-García. 2012. "Community managed forests and forest protected areas: An assessment of their conservation effectiveness across the tropics." *Forest Ecology and Management* 268 (0):6-17. doi: http://dx.doi.org/10.1016/j.foreco.2011.05.034.

Price, Marie and Martin Lewis. 1993. The Reinvention of Cultural Geography. *Annals of the Association of American Geographers* 28 (1) 1-17.

Raustiala, Kal. 1997. "Domestic Institutions and International Regulatory Cooperation: Comparative Responses to the Convention on Biological Diversity." *World Politics* 49 (4):482-509.

Reséndiz, Tonatiúh. 2011. "Programas ecologistas apoyan en Ahuacatlan." *El Mañana de Valles*, 01-17-2011.

Resosudarmo, Ida Aju Pradnja, Stibniati Atmadja, Andini Desita Ekaputri, Dian Y. Intarini, Yayan Indriatmoko, and Pangestuti Astri. 2013 "Does Tenure Security Lead to REDD+ Project Effectiveness? Reflections from Five Emerging Sites in Indonesia." *World Development* (0). doi: http://dx.doi.org/10.1016/j.worlddev.2013.01.015.

Reyes-García, Victoria, Isabel Ruiz-Mallén, Luciana Porter-Bolland, Eduardo Garcia-Frapolli, Edward A. Ellis, Maria E. Mendez, Diana Pritchard, and Maria C. Sanchez-Gonzales. 2012. "Local Understanding of Conservation in Southern Mexico and Their Implications fo Community-Based Conservation as an Alternative Paradigm." *Conservation Biology* 27 (4):856-865.

Roberts, Timmons, and Nikki Demetria-Thanos. 2003a. "Green Revolutions, Deforestation, and New Ideas." In *Trouble in Paradise,* edited by Timmons & Demetria-Thanos Roberts, Nikki, 64-94. New York Routledge.

Roberts, Timmons, and Nikki Demetria-Thanos. 2003b. "The Scene, Its Problem and Roots." In *Trouble in Paradise* edited by Timmons & Demetria-Thanos Roberts, Nikki, 1-34. New York Routledge.

Robinson, Brian E., Margaret B. Holland, and Lisa Naughton-Treves. 2013. "Does secure land tenure save forests? A meta-analysis of the relationship between land tenure and tropical

deforestation." *Global Environmental Change* (0). doi: http://dx.doi.org/10.1016/j.gloenvcha.2013.05.012.
Rothe, Ann-Kristin, and Paul Munro-Faure. 2013. "Tenure and REDD+ Developing enabling tenure conditions for REDD+." *UN-REDD Policy Brief* (6):18.
Ruvalcaba-Mercado, Jesus. 2005. "The Huastec Maya." In *Native peoples of the Gulf coast of Mexico*, edited by Alan R. Sandstrom and Hugo E. García-Valencia, 255-282. Tucson: The University of Arizona Press.
Rzedowski, Jerzy. 1963. "El extremo boreal del bosque tropical siempre verde en norteamerica continental." *Vegetatio* 11 (4):173-198.
Sahagún-Sánchez, Francisco Javier, Humberto Reyes-Hernández, José Luis Flores Flores, and Leonardo Chapa Vargas. 2011. "Modelización de escenarios de cambio potencial en la vegetación y el uso de suelo en la Sierra Madre Oriental de San Luis Potosí, México." *Journal of Latin American Geography* 10 (2).
Sahagún Sánchez, Francisco Javier, Jaime Castro Navarro, and Humberto Reyes Hernández. 2013. "Distribución geográfica de la avifauna en la Sierra Madre Oriental de San Luís Potosí, México: Un analisis regional de su estado de conservación." *Revista de Biología Tropical* 61 (2):897+.
Saka, Mark Saad. 2013a. "The capitalization of the country side." In *For God and Revolution*, 83-102. Alburquerque: University of New Mexico.
Saka, Mark Saad. 2013b. "The cultural geography of the huasteca potosina." In *For God and revolution*. Alburquerque: University of Nuevo Mexico Press.
Saka, Mark Saad. 2013c. "Peasant Nationalism and Agrarian War, 1848 -1856." In *For God and revolution*, 33-50. Alburquerque: University of New Mexico Press.
Sánchez-Azofeifa, G. Arturo, Alexander Pfaff, Juan Andres Robalino, and P. Boomhower Judson. 2007. "Costa Rica's Payment for Environmental Services Program: Intention, Implementation, and Impact." *Conservation Biology* 21 (5):1165-1173.
Santiago, Myrna. 2006. *The Ecology of Oil. Environment, Labor, and The Mexican Revolution, 1900-1938*. Edited by Donald Worster and J.R. McNeill, *Studies in Environmental History*. New York: Cambridge University Press.
Santiago, Myrna. 2011. "The Huasteca Rain Forest. An Environmental History." *Latin American Research Review* 46 (Special Issue 2011):32-54.
Schryer, Frans J. 1986. "Peasants and the Law: A History of Land Tenure and Conflict in the Huasteca." *Journal of Latin American Studies* 18 (2):283-311.
SENDAS, AC (Senderos y Encuentros para un Desarrollo Autonomo). 2010. Análisis de los Programas de Pago o Compensación por Servicios Ambientales en la Cuenca del Pixquiac. Debilidades y Fortalezas en el Contexto Local. edited by Tajín Fuentes Pangtay.
Serrano, Enrique , Arnulfo Embriz, and Patricia Fernández-Ham. 2002. *Indicadores socioeconómicos de los pueblos indígenas de México.* México: INI-PNUD-CONAPO.
Spears, J., P. Oram, Neil Byron, S. Scherr, and A. M. Izac. 1994. *A Review of Tropical Forestry and Agroforestry. Problem Areas and Policy Research Needs and the Planned Response of the CGIAR System.* Center for International Forest Research (5): 45.
Springate-Baginski, Oliver, and Eva Wollenberg. 2010. "Introduction." In *REDD, forest governance and rural livelihoods*, edited by Oliver Springate-Baginski and Eva Wollenberg, 1-18. Bogor, Indonesia: CIFOR.

Steward, Jualin H. 1955. "The Concept and Method of Cultural Ecology." In *Theory of Culture Change. The methodology of multilinear evolution*, edited by Julian H. Steward, 30-42. Illinois: The University of Illinois Press Urbana.
Stocks, Anthony. 2003. "Mapping Dreams in Nicaragua's Bosawa Reserve " *Human Organization* 62 (4):344-356.
Stresser-Péan, Guy. 2008. *Viaje a la Huasteca con Guy Stresser-Péan*: Fondo de Cultura Económica, Centro de Estudios Mexicanos y Centroamericanos.
Stringer, Randy. 1989a. Farmland Transfers and the Role of Land Banks in Latin America. edited by LTC. Madison: Land Tenure Center.
Sunderlin, William D. , Jeffrey Hatcher, and Megan Liddle. 2008. From Exclusion to Ownership? Challenges and Opportunities in Advancing Forest Tenure Reform. In *Rights and Resource Initiative*. Washington DC: Rights and Resources Iniciative.
Tamayo, Jorge L. 2004. *Geografía Moderna de México*. 11a ed. México: Trillas.
Taylor Berardo, Karin. 1998. "The Influence of Globalization on Land Tenure and Resource Management in Neoliberal Latin America " In *Regional worlds, Cultural environments and development debates. Latin America*, edited by Center for Latin American Studies, 7-36. Chicago, Illinois: University of Chicago.
The Nature Conservancy. 2010. "Learn More About The Nature Conservancy. Protecting Nature, Preserving Life." Accessed 7/12/2010. http://www.nature.org/aboutus/?src=home.
Thoms C., Betters D. 1998. "The potencial for ecosystem management in Mexico's forest ejidos." *Forest Ecology and Management* 103.
Tiedje, Kristina. 2005. "People, Place and Politics in the Huasteca, Mexico." *Anthropology Today* 21 (4):13-17.
Tutino, John. 1998. "The Revolution in Mexican Independence: Insurgency and the Renegotiation of Property, Production, and Patriarchy in the Bajío, 1800-1855." *The Hispanic American Historical Review* 78 (3):367-418.
UN-REDD. 2009. "UN-REDD Porgram in Latin America and The Caribbean." 2009. http://www.un-redd.org/LACRegionalActivities/tabid/131892/Default.aspx.
Urquiza-Haas, Tania , Melanie Kolb, Patricia Koleff, Andrés Lira-Noriega, and Jesús Alarcón. 2009. "Methodological Approach to Identify Mexico's Terrestrial Priority Sites for Conservation." *GAP Analysis Bulletin* (16):11.
Valle-Esquivel, Julieta. 2003. *Nahuas de la Huasteca*. Edited by CDI:PNUD, *Pueblos Indígenas del México Contemporáneo*. México: CDI, PNUD.
Vandermeer, Jhon, and Ivette Perfecto. 2005. *Breakfast of Biodiversity. The Political Ecology of Rain Forest Destruction*. 2nd. ed. Oakland, California.: Food First Books.
Vayda Andrew. and R. Rappaport 1967. "Ecology, Cultural and Noncultural." in *Introduction to Cultural Anthropology*, edited by J. Clifton: 477-97.
Vayda Andrew and Bradley Walters, 1999. "Againts Political Ecology." *Human Ecology* 27 (1):167-79.
Velazquez, Alejandro, Elvira Duran-Medina and Jean Francois Mass. 2003. Land Use/Cover Changein Community Based Forest Management Regions and Protected Areas in Mexico. In *Ecology and Land Use Change in Community Forest.* (10): 215-238.
Wagner, Philip L., and Marvin W. Mikesell. 1962. "General Introduction: The Themes of Cultural Geography." In *Readings in Cultural Geography*, edited by Philip L. Wagner and Marvin W. Mikesell, 1-25. Chicago, Illinois: The University of Chicago Press.

Watts, Michael. 1983. "The Poverty of Theory." In *Interpretations of Calamity*, edited by K. Hewitt. London: Allen and Unwin.
Watts, Michael and Richard Peet. 1993. "Environment and Development, Part 2." *Economic Geography* 64 (4).
Watts, Michael and Richard Peet. 2004. *Liberation Ecologies: Environment, Development and Social Movements.* London: Routledge.
West, Robert C. 1948. *Cultural Geography of the Modern Tarascan Area*. Washington D.C. US Government Printing Office.
Wu, JunJie. 2000. "Slippage Effects of the Conservation Reserve Program." *American Journal of Agricultural Economics* 82 (4):979-992.
Wunder, Sven. 2005. Payments for environmental services: some nuts and bolts. *CIFOR Ocassional Papper* (42): 24p.
Yates, P.L. 1981. *Mexico's Agricultural Dilema*. Tucson, AZ.: University of Arizona Press.
Yetman, David, and Alberto Burquez. 1998. "Twenty-Seven: A Case Study in Ejido Privatization in Mexico." *Journal of Anthropological Research* 54 (1):73-95.
Zimmerer, Karl S. and Thomas Bassett, eds. 2003. *Political Ecology: An Integrative Approach to Geography and Environment-Dvelopment Studies. New York: Guilford*
Zimmerer, Karl S., Ryan E. Galt, and Margaret V. Buck. 2004. "Globalization and Multi-Spatial Trends in the Coverage of Protected-Area Conservation (1980-2000)." *Ambio* 33 (8):520-529.

Appendix I. PES grading prioritization in nucleo

Nucleo Agrario	total area (ha)	forest (ha)	forested area	Inside a natural protected area	inside the same waters hade where other PES participants are	has a surveillance and environmental protection committee	whitin an area of local mechanisms of payments for PES	has a land use plan aproved by CONAFOR	inside risk of deforestation areas	in risk of natural desaster areas defined by CENAPRED	has a proposal polygon for PES	previously aproved witout funding	preference score	priority Zone
SAN FRANCISCO Y SUS BARRIOS	4437.929944	4089.666417	92	1	5	3	1	1	6	6	4	0	27	2
EL BAGAZO	707.217484	162.602843	23	1	5	3	1	1	6	4	4	0	25	2
CUATLAMAYAN	787.468475	308.553574	39	1	5	1	1	1	6	6	1	0	22	0
IXTEAMEL	1260.486863	579.17904	46	1	5	3	1	1	6	4	4	0	25	2
MATLAPA INDIGENA (2007)	1943.585476	484.972976	25	1	5	3	1	1	6	6	4	0	27	2
EL SABINITO (2006)	3366.843677	1575.216048	47	1	5	3	1	1	6	4	4	0	25	3
OJO DE AGUA	1017.513094	967.217214	95	1	5	3	1	1	6	2	4	0	23	2
SANTIAGO Y SUS BARRIOS	16913.07246	2098.009493	12	1	5	3	1	1	4	6	4	0	25	0
EL CRISTIANO Y SUS ANEXOS (2007)	3124.602991	3016.247013	97	1	5	3	1	1	4	4	4	0	23	2
LA LIMA	2207.588889	1165.531654	53	1	5	3	1	1	4	6	1	0	22	2
TEMAMATLA	614.796654	112.97714	18	1	5	1	1	1	4	6	1	0	20	0
TAMAPATZ	10078.09929	9043.587037	90	2	5	3	1	1	4	6	4	0	26	2 y 3
CAÑON DE TANINUL O EL ABRA	1334.627687	1334.627687	98	1	5	1		1	4	6	1	0	19	4
LA PILA	1577.531172	766.431745	49	1	5	1	1	1	4	6	1	0	20	2
TAMPEMOCHE	2598.837312	2454.778388	94	1	5	1	1	1	4	6	1	0	20	2
LA PALMA	34672.57626	26423.57431	76	1	5	1	1	1	4	6	1	0	20	3
TENEXTIPA	254.241714	254.241714	100	1	5	1	1	1	4	6	1	0	20	0
ATLAMAXATL	585.668617	369.207237	63	1	5	3	1	1	4	4	1	0	20	4
CORONEL JOSE CASTILLO (2003)	3498.787756	2629.793162	75	1	5	3	1	1	4	4	4	0	23	3 y 2
TAMPAXAL (2010)	6165.978404	5048.91574	82	2	5	3	1	1	4	6	4	0	26	2
LAS CUEVAS	651.389781	344.441555	52	1	5	3	1	1	4	6	1	0	22	2
XILOSUCHICO	297.125681	230.003945	77	1	5	3	1	1	4	4	4	0	23	2
AMAYO DE ZARAGOZA	848.645013	515.265503	61	1	5	3	1	1	2	4	4	0	21	4
TAMPATE	3937.963768	3924.602924	99	1	5	1	1	1	2	6	1	0	18	2
LA HINCADA	5098.151462	3118.643296	61	1	5	1	1	1	2	6	1	0	18	0
TANLACU	11378.43141	8182.624066	72	1	5	3	1	1	2	6	4	0	23	2
AGUAYO	579.751741	480.269446	83	1	5	1	1	1	2	4	1	0	16	4
LA CONCEPCION [1] (2005)	4324.063553	4067.80346	94	1	5	3	1	1	2	4	4	0	21	3,4,5
LAS ABRITAS (2008)	1870.503526	1650.45243	88	1	5	3	1	1	2	4	4	0	21	3
CHALAHUITE (2003)	1666.581623	1493.322786	90	1	5	3	1	1	2	4	1	0	18	3
CHUCHUPE	2168.008975	2125.559454	98	1	5	3	1	1	2	4	4	4	25	2
MECATLAN Y SUS BARRIOS (2009)	1658.703106	417.685732	25	1	5	3	1	1	2	6	4	0	23	0
EL LIMONAL (2005)	4298.753802	3472.239109	81	1	5	3	1	1	2	4	4	0	21	3
LAGUNA DEL MANTE	46219.57975	34570.5645	75	2	5	3	1	1	2	6	1	0	21	4 y 5
OJO DE AGUA DE TIERRA NUEVA	2403.293528	2076.99469	86	1	5	3	1	1	2	2	4	0	19	3
LOS ALAMOS (2006)	2640.16324	1998.256623	76	1	5	3	1	1	2	4	4	0	21	3
ESTACION MICOS	4305.642984	3938.780922	91	1	5	1	1	1	0	4	1	0	14	5 y 4

Table 21. Rating prioritization of PES on sampled nucleos using CONAFOR general variables

NUCLEO AGRARIO	Prioritization Variables for Hydrological Services									Prioritization Variables for Biodiversity Services							Hectares in PES	Years in PES	Type of PES
	forest on arboreal stage inside the PES polygon	percentage of forest on arboreal stage in the PES polygon	Grade for percentage of forest in arboreal stage	Overexploited aquifer	watershed with availability of superficial water	Soils degradation	zone for restauration or attention	Biomass density	H_Score	Conservation areas for birds AICAS	In priority hydrological (RHP) or terrestrial region (THP)	in areas of NOM-059-SEMARNAT-2001	GAP Conservation Analyses	Whitin a Biological Corridor	Undershaded coffee registered with ASERCA	B_Score			
SAN FRANCISCO Y SUS BARRIOS	2350.125089	80	5	3	5	3	3	3	22	4	4	4	7	1	3	23	2929.96944	5	PSA-H
EL BAGAZO	151.471547	27	0	3	5	3	3	3	17	4	4	7	0	1	3	19	553.840163	3	PSA-H
CUATLAMAYAN	0	0	0	3	5	3	3	3	17	1	1	1	0	1	1	5	NA	0	
IXTEAMEL	194.148043	68	3	3	5	3	3	3	20	4	4	7	0	1	3	19	287.17094	4	PSA-H
MATLAPA INDIGENA (2007)	55.732302	50	1	3	5	3	3	3	18	4	4	1	7	1	3	20	110.387699	5	PSA-H
EL SABINITO (2006)	277.361305	43	0	3	5	3	3	5	19	1	1	7	1	1	1	12	640.644134	6	PSA-H
OJO DE AGUA	203.944525	20	0	3	5	2	3	3	16	1	1	4	0	1	1	8	1017.51309	5	PSA-H
SANTIAGO Y SUS BARRIOS	461.582752	100	5	3	3	2	3	3	19	4	4	4	0	1	3	16	AGF	5	PSA-AGF
EL CRISTIANO Y SUS ANEXOS (2007)	472.33469	16	0	3	5	3	3	3	17	4	4	7	7	1	3	26	3033.73911	5	PSA-H
LA LIMA	885.899053	87	5	3	5	2	3	3	21	1	1	4	0	1	1	8	1016.97448	3	PSA-H
TEMAMATLA	34.960526	0	0	3	5	3	3	3	17	1	4	1	0	1	3	10	NA	0	
TAMAPATZ	5946.904807	100	5	3	5	3	3	3	22	4	4	7	0	1	3	19	AGF	5	PSA-AGF
CAÑON DE TANINUL O EL ABRA	811.482641	61	3	3	5	3	1	1	16	1	4	1	0	1	1	8	NA	0	
LA PILA	331.122447	100	5	3	5	3	3	3	22	1	1	4	1	1	1	9	NA	0	
TAMPEMOCHE	1429.313393	100	5	3	5	3	3	5	24	4	4	1	1	1	3	14	NA	0	
LA PALMA	18827.10073	100	5	3	5	3	3	3	22	1	1	4	0	1	1	8	NA	0	
TENEXTIPA	34.803345	0	0	3	5	2	3	1	14	4	4	1	0	1	3	13	NA	0	
ATLAMAXATL	369.207237	63	3	3	3	3	3	1	16	4	4	1	7	1	3	20		5	PSA-H
CORONEL JOSE CASTILLO (2003)	2167.392824	50	1	3	7	3	3	5	22	4	4	7	1	1	3	20	4301.34642	10	PSA-H
TAMPAXAL (2010)	781.327253	37	0	3	5	3	3	3	17	4	4	1	1	1	3	14	2100.62047	7	PSA-AGF
LAS CUEVAS	190.850242	92	5	3	5	3	3	3	22	4	4	1	7	1	3	20	208.208921	3	PSA-H
XILOSUCHICO	189.108541	79	5	3	5	3	3	3	22	4	4	7	7	1	3	26	239.474331	3	PSA-H
AMAYO DE ZARAGOZA		61	3	3	5	3	3	3	20	4	4	7	0	1	3	19		5	PSA-H
TAMPATE	626.768481	100	5	3	5	3	3	3	22	4	4	1	0	1	3	13	NA	0	
LA HINCADA	2658.464254	100	5	3	5	2	3	1	19	1	1	4	1	1	1	9	NA	0	
TANLACU	2650.754343	84	5	3	5	3	3	5	24	4	4	1	1	1	1	12	3147.74647	3	PSA-H
AGUAYO	452.405657	78.03	5	3	5	3	3	3	22	4	4	7	1	1	1	18	NA	0	
LA CONCEPCION [1] (2005)	3133.230829	98	5	3	5	3	3	5	24	1	1	7	1	1	1	12	3232.54281	8	PSA-H
LAS ABRITAS (2008)	1282.897017	86	5	3	5	3	3	5	24	1	1	7	1	1	1	12	1496.62468	5	PSA-H
CHALAHUITE (2003)	245.363203	15	0	3	7	3	3	3	19	4	4	7	1	1	1	18	1637.90246	10	PSA-H
CHUCHUPE	714.794987	100	5	3	5	3	3	5	24	1	1	7	1	1	1	12	NA	0	
MECATLAN Y SUS BARRIOS (2009)	0	0	0	3	5	3	3	3	17	4	4		0	1	3	12		5	PSA-AGF
EL LIMONAL (2005)	2152.053433	89	5	3	5	3	3	5	24	1	1	7	1	1	1	12	2411.87831	5	PSA-H
LAGUNA DEL MANTE	29747.47042	100	5	3	5	3	3	5	24	4	4	4	1	1	1	15	2050.23959	3	PSA-CBD
OJO DE AGUA DE TIERRA NUEVA	910.671253	98	5	3	5	3	3	5	24	1	1	7	1	1	1	12	926.568701	2	PSA-H
LOS ALAMOS (2006)	979.478288	100	5	3	5	3	3	5	24	1	1	7	1	1	1	12	979.486365	7	PSA-H
ESTACION MICOS	0	0	0	3	5	2	3	5	18	1	1	7	1	1	1	12	NA	0	
SOLEDAD DE ZARAGOZA (2003)	546.53493	21	0	3	7	3	3	3	19	4	4	7	1	1	1	18	2539.4039	5	PSA-H
MINAS VIEJAS	210.709128	98	5	3	5	2	3	5	23	1	1	7	0	1	1	11	216.036979	5	PSA-H
SAN NICOLAS DE LOS MONTES	16913.07246	100	5	3	7	3	3	5	26	4	1	4	4	1	1	15	NA	0	
IXTACAMEL	0	0	0	3	5	3	3	1	15	4	4	7	7	1	3	26	NA	0	
POTRERILLOS (2003)	431.02765	35	0	3	7	3	3	3	19	4	4	7	0	1	3	19	1219.08152	5	PSA-H
LA TRINIDAD (2003)	283.428506	100	5	3	7	3	3	3	24	4	4	7	1	1	1	18	283.428506	10	PSA-H

Table 22. Rating prioritization of nucleos by category of PES

Appendix II. Nucleo's Correlation Matrices of PES variables

Parametric correlation coefficient: Pearson

Correlations

		Zscore: forest (ha)	Zscore: forested area	Zscore: Preference score	Zscore: forest on arboreal stage inside the PES polygon	Zscore (H_Score)	Zscore (B_Score)	Zscore: land owners	Zscore: Total Population	Zscore (pUsocomun)	Zscore (Year_in_A)	Zscore (Margin_INDEX)	Zscore: Deforestation Index
Zscore: forest (ha)	Pearson Correlation	1	.209	-.064	.981**	.381*	-.127	-.064	.047	-.153	-.151	.196	-.050
	Sig. (2-tailed)		.179	.686	.000	.012	.417	.683	.764	.345	.333	.208	.751
	N	43	43	43	42	43	43	43	43	40	43	43	43
Zscore: forested area	Pearson Correlation	.209	1	-.226	.159	.363*	-.011	.095	.197	-.515**	.056	.111	.272
	Sig. (2-tailed)	.179		.145	.314	.017	.944	.545	.206	.001	.723	.479	.078
	N	43	43	43	42	43	43	43	43	40	43	43	43
Zscore: Preference score	Pearson Correlation	-.064	-.226	1	-.083	.039	.160	-.076	-.013	-.076	.431**	.168	-.312*
	Sig. (2-tailed)	.686	.145		.601	.801	.307	.629	.936	.640	.004	.280	.041
	N	43	43	43	42	43	43	43	43	40	43	43	43
Zscore: forest on arboreal stage inside the PES polygon	Pearson Correlation	.981**	.159	-.083	1	.376*	-.096	-.112	-.014	-.140	-.147	.118	-.086
	Sig. (2-tailed)	.000	.314	.601		.014	.545	.482	.929	.397	.355	.457	.589
	N	42	42	42	42	42	42	42	42	39	42	42	42
Zscore(H_Score)	Pearson Correlation	.381*	.363*	.039	.376*	1	-.078	.176	.268	-.327*	.121	-.002	.079
	Sig. (2-tailed)	.012	.017	.801	.014		.620	.260	.083	.040	.438	.987	.613
	N	43	43	43	42	43	43	43	43	40	43	43	43
Zscore(B_Score)	Pearson Correlation	-.127	-.011	.160	-.096	-.078	1	-.206	-.223	-.206	.320*	.000	-.139
	Sig. (2-tailed)	.417	.944	.307	.545	.620		.185	.150	.203	.036	.999	.373
	N	43	43	43	42	43	43	43	43	40	43	43	43
Zscore: land owners	Pearson Correlation	-.064	.095	-.076	-.112	.176	-.206	1	.617**	-.023	-.135	.021	.126
	Sig. (2-tailed)	.683	.545	.629	.482	.260	.185		.000	.887	.388	.895	.422
	N	43	43	43	42	43	43	43	43	40	43	43	43
Zscore: Total Population	Pearson Correlation	.047	.197	-.013	-.014	.268	-.223	.617**	1	-.346*	-.163	.109	.347*
	Sig. (2-tailed)	.764	.206	.936	.929	.083	.150	.000		.029	.298	.485	.023
	N	43	43	43	42	43	43	43	43	40	43	43	43
Zscore(pUsocomun)	Pearson Correlation	-.153	-.515**	-.076	-.140	-.327*	-.206	-.023	-.346*	1	-.038	.011	-.111
	Sig. (2-tailed)	.345	.001	.640	.397	.040	.203	.887	.029		.816	.946	.494
	N	40	40	40	39	40	40	40	40	40	40	40	40
Zscore(Year_in_A)	Pearson Correlation	-.151	.056	.431**	-.147	.121	.320*	-.135	-.163	-.038	1	.026	-.121
	Sig. (2-tailed)	.333	.723	.004	.355	.438	.036	.388	.298	.816		.867	.440
	N	43	43	43	42	43	43	43	43	40	43	43	43
Zscore(Margin_INDEX)	Pearson Correlation	.196	.111	.168	.118	-.002	.000	.021	.109	.011	.026	1	.004
	Sig. (2-tailed)	.208	.479	.280	.457	.987	.999	.895	.485	.946	.867		.979
	N	43	43	43	42	43	43	43	43	40	43	43	43
Zscore: Deforestation Index	Pearson Correlation	-.050	.272	-.312*	-.086	.079	-.139	.126	.347*	-.111	-.121	.004	1
	Sig. (2-tailed)	.751	.078	.041	.589	.613	.373	.422	.023	.494	.440	.979	
	N	43	43	43	42	43	43	43	43	40	43	43	43

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Nonparametric correlation coefficient: Spearman

Correlations

			Zscore: forest (ha)	Zscore: forested area	Zscore: Preference score	Zscore: forest on arboreal stage inside the PES polygon	Zscore (H_Score)	Zscore (B_Score)	Zscore: land owners	Zscore: Total Population	Zscore (pUsocomun)	Zscore (Year_in_A)	Zscore (Margin_INDEX)	Zscore: Deforestation Index
Spearman's rho	Zscore: forest (ha)	Correlation Coefficient	1.000	.425**	.031	.783**	.514**	-.137	-.183	.333*	-.281	.106	.064	.109
		Sig. (2-tailed)	.	.004	.845	.000	.000	.380	.240	.029	.079	.499	.683	.489
		N	43	43	43	42	43	43	43	43	40	43	43	43
	Zscore: forested area	Correlation Coefficient	.425**	1.000	-.184	.350*	.287	-.032	-.091	.271	-.498**	-.016	.061	.336*
		Sig. (2-tailed)	.004	.	.239	.023	.062	.836	.560	.079	.001	.921	.697	.027
		N	43	43	43	42	43	43	43	43	40	43	43	43
	Zscore: Preference score	Correlation Coefficient	.031	-.184	1.000	.012	.031	.247	-.110	.046	-.036	.462**	.263	-.303*
		Sig. (2-tailed)	.845	.239	.	.938	.844	.110	.484	.768	.824	.002	.089	.049
		N	43	43	43	42	43	43	43	43	40	43	43	43
	Zscore: forest on arboreal stage inside the PES polygon	Correlation Coefficient	.783**	.350*	.012	1.000	.637**	-.116	-.182	.167	-.289	.089	.044	.086
		Sig. (2-tailed)	.000	.023	.938	.	.000	.465	.249	.291	.075	.574	.780	.589
		N	42	42	42	42	42	42	42	42	39	42	42	42
	Zscore(H_Score)	Correlation Coefficient	.514**	.287	.031	.637**	1.000	-.071	-.021	.359*	-.374*	.087	-.074	.095
		Sig. (2-tailed)	.000	.062	.844	.000	.	.652	.893	.018	.017	.578	.637	.547
		N	43	43	43	42	43	43	43	43	40	43	43	43
	Zscore(B_Score)	Correlation Coefficient	-.137	-.032	.247	-.116	-.071	1.000	-.224	-.287	-.223	.311*	.183	-.149
		Sig. (2-tailed)	.380	.836	.110	.465	.652	.	.148	.062	.167	.042	.241	.340
		N	43	43	43	42	43	43	43	43	40	43	43	43
	Zscore: land owners	Correlation Coefficient	-.183	-.091	-.110	-.182	-.021	-.224	1.000	.216	.272	-.043	-.235	-.006
		Sig. (2-tailed)	.240	.560	.484	.249	.893	.148	.	.163	.090	.787	.129	.970
		N	43	43	43	42	43	43	43	43	40	43	43	43
	Zscore: Total Population	Correlation Coefficient	.333*	.271	.046	.167	.359*	-.287	.216	1.000	-.380*	-.096	.208	.339*
		Sig. (2-tailed)	.029	.079	.768	.291	.018	.062	.163	.	.016	.541	.181	.026
		N	43	43	43	42	43	43	43	43	40	43	43	43
	Zscore(pUsocomun)	Correlation Coefficient	-.281	-.498**	-.036	-.289	-.374*	-.223	.272	-.380*	1.000	-.092	-.037	-.111
		Sig. (2-tailed)	.079	.001	.824	.075	.017	.167	.090	.016	.	.571	.822	.494
		N	40	40	40	39	40	40	40	40	40	40	40	40
	Zscore(Year_in_A)	Correlation Coefficient	.106	-.016	.462**	.089	.087	.311*	-.043	-.096	-.092	1.000	.006	-.158
		Sig. (2-tailed)	.499	.921	.002	.574	.578	.042	.787	.541	.571	.	.971	.312
		N	43	43	43	42	43	43	43	43	40	43	43	43
	Zscore(Margin_INDEX)	Correlation Coefficient	.064	.061	.263	.044	-.074	.183	-.235	.208	-.037	.006	1.000	-.054
		Sig. (2-tailed)	.683	.697	.089	.780	.637	.241	.129	.181	.822	.971	.	.731
		N	43	43	43	42	43	43	43	43	40	43	43	43
	Zscore: Deforestation Index	Correlation Coefficient	.109	.336*	-.303*	.086	.095	-.149	-.006	.339*	-.111	-.158	-.054	1.000
		Sig. (2-tailed)	.489	.027	.049	.589	.547	.340	.970	.026	.494	.312	.731	.
		N	43	43	43	42	43	43	43	43	40	43	43	43

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix III. Plants commonly found in shaded grown coffee plots of the Huastec Potosina

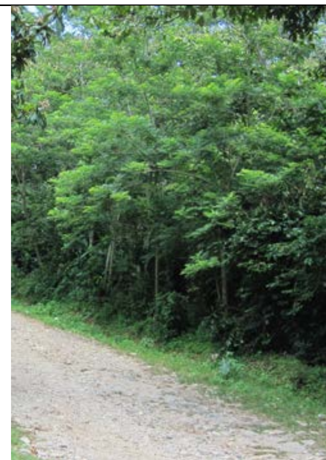
Scientific name	Indigenous name	Spanish name	Uses	Images
Inga vera Willd.	Thsunbchik (Teenek) Chalahuite (Nahua)	Chalahuite	Shade, introduced for coffee plantations during the 1980's. The fruit is eaten as snacks.	 
Melia azedarach L.	Piochis (Teenek)	Paraíso	Shade, Asian origin, introduced for the fabrication of particle boards, very appreciated in coffee plantations for its rapid growth and more resistance to frost than Chalahuite	 

Amphipterygium adstringens	Cuauchalalatl (Nahua)	Cuachalalat e or plátano maduro	Medicinal, its bark is used to cure digestive problems.	 
Acrocarpus fraxinifolius	Tiocuáhuitl Achichijtik (Nahua)	Cedro Rosado	Shade, introduced. Good source of shade due to its rapid growth	
Cedrela odorata	Ik te' (Teenek) Tiocuáhuitl Chichijtik (Nahua)	Cedro Rojo Cedro Blanco (amarillo)	Wood & Medicine. Good for furniture, musical instruments and post.. Medicinal, leaves, seeds and bark are use for cold, edemas and infections. Second source of wood for construction	

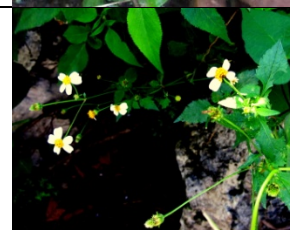
				 
Pitecellobium arboreum	It'il (Teenek) Etlcuáhuitl (Nahua)	Frijolillo	Wood products & shade	 

Tabebuia rosea	Ikul o K'uul (Teenek) Cachahua (Nahua)	Palo de rosa	Shade, wood & medicinal uses.	 
Maclura tinctoria	Tsitsiy (Teenek)	Palo de mora	Wood products, for carving tools and kitchen utensils	 
Eriobotrya japonica		Níspero or Nespora	Introduced. Fruits are edible and are sold on markets.	 

Cupania glabra Sw.	Ts' aw te' (Teenek) Tepesin (Nahua)	Rabo de cojolite	Wood, for construction and utilities tools	
Dendropanax arboreus	Multe' (Teenek)	Vidrioso	Medicinal uses.	
Calycophyllum candidissimum		Canelo	Wood, introduced. Good for reforestation and the elaboration of tools.	
Vainilla planifolia	Tlilxóchitl (Nahua)	Vainilla	Cash crop, common in Nahua communities.	
Eupatorium cuadrangulare	Holol (Teenek)	San Isidro	Living barriers, medicial uses.	

				
Gliricidia sepium (Jacq.) Steud.	Kweteem te' (Teenek) Cocuite (Nahua)	Primavera	Living fencepost.	
Sideroxylon capiri	Tsabac (Teenek)	Zabaque	Edible fruits, good wood for housepost.	
Bahuinia sp.	Tzetzemolom (Teenek)	Pata de vaca	Medicinal uses.	
Manihot esculenta	T'inchee' (Teenek)	Yuca	Edible roots, widely selled on markets. It also has medicinal uses.	
Chamaedora cf. elegans	Pahuwiya (Teenek)	Palmilla	Cash crop, decoration for religious celebrations, medicinal uses.	

				 
Xantosoma violaceoum	Luum (Teenek)	Camote regalger	Edible leaves, & roots have medicianal uses.	
Piper umbellatum	Tiiya' (Teenek)	Padre Blanco	Medicinal uses, edible stem.	
Ipomoea batatas	Ith (Teenek)	Camote real	Edible tubers & leaves, cash crop.	 

Syngonium podophyllum	Kuaht (Teenek)		Medicinal uses, also widely sold on marquets as hornamental plant.	
Bidens leucanta	Ke'lem (Teenek)	Aceitilla	Medicinal uses for nervious system's affectations	
Pilea microphylia	Ha' il tsan (Teenek)	Hierba de la Peña	Medicinal uses.	
Solanum americanum	Wal ts'ok (Teenek)	Hierba mora	Medicinal uses.	
Pilea pubescens	Pux lat'em (Teenek)	Hierba del agua	Medicinal uses.	

Appendix IV. Community Questionnaire about the PES

CUESTIONARIO COMUNITARIO
Sobre el programa Pagos por Servicios Ambientales (PSA)
de la Comisión Nacional Forestal CONAFOR
Proyecto de Investigación: Politicas de Conservación y la Reformas de la Tierra México
Un acercamiento a los Pagos por Servicios Ambientales en la Huasteca Potosina
Universidad de Kansas

Fecha: ______________

Municipio ________________________ Ejido □ Comunidad Agraria □

Informante: hombre: __ mujer: __

Cargo:_______________ Ejidatario/Comunero__ Avecindado__

Otro_______________________

Área total del ejido o comunidad agraria en hectáreas ____________ Población total_________

Área total dentro de la categoría del programa Proarbol _____________

Aspectos generales del ejido o comunidad agraria

1. Este ejido o comunidad agraria cuenta con:
   - Resolución presidencial Si__ No__
   - Acta de posesión y deslinde Si__ No__
   - Reglamento interno Si__ No__
   - Certificación por PROCEDE Si__ No__
   - Dominio pleno Si__ No__

2. En este ejido o comunidad agraria, se tienen problemas de:
   - Linderos al interior del ejido Si__ No__
   - Linderos con sus colindantes Si__ No__
   - Invasión de terrenos Si__ No__
   - Algún otro problema que considere importante Si__ No__

(especifique:_______________)

Favor de detallar los problemas mencionados arriba:___________________________

____

____

Uso del suelo en áreas parceladas de la comunidad o ejido

3. ¿Cuántas hectáreas están parceladas? ___________
¿Cuántas son para uso individual?______________
¿Cuántas son para uso colectivo?______________

4. Dentro de las áreas parceladas cuáles de los principales usos que se tienen son para:
Agricultura parcelada ________
Ganadería parcelada ________
Bosque parcelado con café, frutales, etc. ________
Cultivo de caña: ________
Otras áreas parceladas ________

Área de Uso Común

5. Cuando se estableció el ejido o comunidad agraria, aproximadamente ¿cuántas hectáreas fueron otorgadas como área de uso común? ___________

6. ¿Cuántas hectáreas hay en el área de uso común hoy en día? ___________

7. Dentro del área de uso común, aproximadamente cuántas hectáreas hay de:

	no hay	0.1-10	10-50	50-100	100-200	200-500	mas de 500
Milcahuales							
Cultivos							
Bosque con pasto para ganado							
Bosque cultivado con café							
Bosque cultivado con frutales							
Bosque natural sin cultivo							
Potreros cultivados para ganado							
Potreros naturales							
Otro (especifique):							
Otro (especifique):							

8. ¿Quiénes tienen derecho para usar las tierras en el área de uso común (por ejemplo, ejidatarios solamente, cualquier persona de la comunidad, etc.)? Ejidatarios__ Comuneros__ Posesionarios__ Avecindados__ Otros (especifique:____)

9. ¿Qué usos de la tierra **no son permitidos** por reglamento interno en el área de uso común?
____

10. El área de uso común, ¿Se alquila o renta para alguna actividad?

Si □ (pastoreo, extracción de leña, plantas, caza, milpa, otro________) No□

11. ¿Se permite que personas ajenas a la comunidad puedan practicar alguna actividad en el área de uso común?
Si□ qué actividades? ______________________________________ No□

12. ¿Se ha parcelado el área de uso común? Si□ No□
a. ¿Cuantas hectáreas de las áreas de uso común están parceladas en total? _______
b. ¿En qué año se parceló por primera vez? ________
c. ¿Por qué se parceló esta área inicialmente?_________________________________
d. ¿Actualmente están parcelando el área de uso común? Si□ No□
e. ¿Por qué se está parcelando esta área hoy en día?_____________________________

13. ¿Dentro de el área de uso común, ¿existe áreas protegidas (por ejemplo, para la conservación de plantas o animales, reserva de bosque, sitios sagrados o espirituales, sitios histórico, sitios arqueológico, protección de cuenca o fuente de agua)? Si__ No__
Más o menos cuántos

Tipo de Área	Nombre	hectáreas (si aplica)	Uso

14. ¿Se ha recibido capacitación en la comunidad en los últimos años relacionado con el manejo de bosque / conservación de la flora y fauna:
Los programas/objetivos de CONAFOR Si__ No__
SEMARNAT Si__ No__
PROFEPA Si__ No__
Otros___________________________ Si__ No__

15. ¿En general cómo califica las siguientes condiciones en su comunidad?

	Muy buenas	Buenas	Regular	Malas	Muy malas
Salud de los bosques					
Diversidad de plantas y animales					
Limpieza del agua					
Abasto de agua					
Control de la tala ilegal					
Control de tráfico de especies exóticas					

Programa PSA.

16. ¿Desde cuándo participan en el programa de Proarbol?________________________________
____

17. ¿Cómo se enteraron del programa?____
____

18. ¿En qué categoría del programa Proarbol participan actualmente?_______________________

19. ¿Por qué decidieron participar en esta categoría del programa?__________________________
____

20. ¿Cuáles eran los propósitos y beneficios que les ofrecía esta categoría del programa?_______
____

21. ¿Cómo participan? Toda la comunidad___ Sólo ejidatarios/comuneros____(cuántos__)
Cómo colectivo___(cuantos__) De forma individual___ (cuantos___)

22. ¿A cuánto asciende el monto recibido por el programa individual y/o colectivamente?
____

23. ¿Cómo fueron utilizados los recursos recibidos?______________________________________
____
____

24. ¿Cuantas hectáreas se inscribieron inicialmente bajo el programa?_______________________

25. ¿Cuántas hectáreas se mantienen actualmente bajo el programa?________________________

26. ¿Existen mojoneras u otras marcaciones físicas para delimitar y anunciar el área dentro del programa?____

27. ¿Cuál es el seguimiento que ustedes le dan al área dentro del programa?__________________
____

28. ¿Considera usted que el monto otorgado para estas actividades es suficiente para los objetivos propuestos? Si__ porqué____
no__ por qué____

29. ¿Cuales son las obligaciones que tiene la comunidad o participantes dentro del programa?____

30. ¿Se ha desmontado bosque o selva dentro del área en el programa para uso agrícola o ganadero?
Si__ No__

31. ¿Han habido cambios en el uso de la tierra fuera de esta área a causa del programa? _______
____
____

32. ¿En general cree usted que se han cumplido los propósitos de la categoría de Proarbol en que participan?
Si__Porque?____
____
No__Porque?____
____

33. Cómo participante de Proarbol ¿cuáles son las sugerencias que daría para mejorar el funcionamiento del programa?____
____
____

34. Si se da la posibilidad, volverían a participar en el programa de Proarbol?________________
____

Asesoría técnica del programa PSA

35. ¿Cómo obtuvieron asesoría técnica?____
____

36. El técnico o alguien más de la CONAFOR les habló de las distintas categorías de apoyo que ofreceProarbol?____
____

37. ¿A cuánto asciende el monto para la asesoría técnica?_______________________________

38. ¿Considera ésta una retribución justa para el técnico? Si__ Por qué____________________
No__ Por qué_____________________________________

39. El técnico indicó cómo debía ser utilizado el recurso?
Si__Indique cómo____
No__ Indique cómo se utilizó____

40. Se ha entregado algún producto por parte del técnico a la comunidad o beneficiario como resultado de su trabajo?
Si___qué productos____
No__ por qué____

41. ¿Se han recibido los planos o mapas de la comunidad como resultado del trabajo técnico de Proarbol? Si__ No__

42. ¿Cuántas visitas realizó el técnico para éste trabajo?____

43. ¿En general, cómo considera el trabajo del técnico? Muy bueno_ Bueno_ Regular_ Malo_ Muy malo_

44. En general cómo es su relación con el técnico? Muy buena__ Buena__ Regular__ Mala__ Muy mala__

45. Como participante ¿qué recomendaciones daría para mejorar el trabajo técnico?____
____

46. Si se da la posibilidad de un nuevo apoyo para otro trabajo ¿buscaría la asesoría del mismo técnico o le gustaría trabajar con uno distinto?____
____