INDIGENOUS KNOWLEDGE AND WILDFIRES IN THE SIERRA DE SANTA MARTA, MEXICO

by

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ABSTRACT

This thesis examines the role of environmental, economic, political and social change in the increasing incidence of wildfires in a tropical rainforest region of southern Mexico. Through consideration of the indigenous knowledge (IK) of local farmers in the area, I show how changes to both the biophysical and cultural environments have greatly affected traditional patterns of thought and behavior, ultimately resulting in an increase in the number of escaping agricultural fires in recent years. Deforestation has led to a more flammable environment in which traditional techniques of controlling agricultural burning have become increasingly inadequate. Wider economic, political and social forces have ultimately led to a weakening of the traditional conservation ethic and farmer motivation to protect the land from wildfires. At the heart of the problem of wildfires, I will argue, is the overall breakdown and transformation of a traditional way of life.

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INTRODUCTION

Statement of Thesis

This thesis examines the role of environmental, economic, political and social change in the increasing incidence of wildfires in a tropical rainforest region of southern Mexico. Through consideration of the indigenous knowledge (IK) of local farmers in the area, I show how changes to both the biophysical and cultural environments have greatly affected traditional patterns of thought and behavior, ultimately resulting in an increase in the number of escaping agricultural fires in recent years. At the heart of the problem of fires and the ecological destruction to which they contribute, I will argue, is the overall breakdown and transformation of a traditional way of life.

As this thesis will demonstrate, the penetration of a market economy, government land policies and foreign beliefs and values have had a profound impact on both the natural environment and the traditional culture of the Zoque-Popoluca. Deforestation has led to a more flammable environment in which traditional techniques of controlling agricultural burning have become increasingly inadequate. Changes to family and community structure, and an undermining of traditional attitudes towards the environment have resulted in an erosion of the sense of obligation and responsibility that traditionally defined people's relationship to the land and to each other. There seems now to be a weakened motivation among the Zoque-Popoluca to take care of the land as their ancestors have done for generations, and a resulting tendency for fires to occur with greater frequency.

This research touches on several broader issues raised in the literature on the use of indigenous knowledge for sustainable development, in particular the limitations of

indigenous knowledge and the conditions under which these systems become maladaptive. The goal of the research is to not only make a contribution regarding these broader issues associated with IK and sustainable development, but to provide useful insight into the problem of fires in the Sierra de Santa Marta that could be put to practical use in the prevention of this environmentally destructive phenomenon.

Development Theory and Indigenous Knowledge

The concepts of *indigenous knowledge* and *sustainable development* have appeared rather recently in the discourse on world development, and have arisen as a result of the debate concerning the effectiveness of past international efforts to 'develop' the poorer countries of the world. There is general agreement that these efforts, based on a collection of approaches subsumed under the rubric of so-called modernization theory, have largely failed to attain the goal of economic development and have, in fact, contributed to processes of underdevelopment and environmental degradation (IDRC, 1992: 39-41).

The failure of modernization theory, critics assert, can be traced to several factors. First, the situation in the South was much more complex than modernization theorists and planners had conceptualized. Through his dependency theory of the 1960's, Frank argued that countries in the South were part of a larger, all-encompassing world system, in which northern countries had arranged the world so that they could exploit wealth from poorer nations and keep them in a state of 'dependency', reliant on the North and unable to achieve self-sufficiency (Harrison, 1988: 81-84). Basically, Frank argued that the South could never duplicate the history of northern economic growth, because the growth of the North occurred

only through the exploitation and deliberate underdevelopment of the South (ibid: 84). His focus on external causes of underdevelopment directly challenged the assumption of modernization theorists that underdevelopment was a result of the internal deficiencies of southern societies. According to Frank, the mere inclusion of the South into the capitalist world system means that the potential for development in these countries is blocked (ibid: 97).

Second, theorists and development planners ignored the power structures of countries in the South. The notion of 'trickle-down' did not work because it failed to recognize that governments and elites, the recipients of direct assistance from the North, are often more concerned with their own interests than in helping the rural poor (Axinn, 1991: 120). Aid from the North often served to strengthen those groups that were in power, to the detriment of the rest of the population (Griffin, 1991: 668).

Finally, theorists and development planners were ignorant of the destructive effects that inappropriate northern technologies had on local environments. From the era of colonialism to the present, Northerners have been guilty of introducing practices that have had adverse ecological effects on southern environments (IDRC, 1992: 41). The reason for this, according to Timberlake, is what he calls "the temperate bias": the tendency among Northerners to treat tropical and sub-tropical southern environments as if they were similar to the temperate nations of the North (Timberlake, 1986: 62). This results in technologies adapted to northern temperate climates being introduced into areas that may have vastly different climatic and biophysical properties. Implicit in this approach is the further assumption that indigenous technologies are backward and inefficient, and therefore must

be replaced (Peters and Neuenschwander, 1988: 83).

The failure of the modernization model to bring about improved conditions in the South led to a 'soul-searching' period in the 1980's, during which development theorists and planners cast about for alternative strategies to development (Pottier, 1993: 13). The search was guided by the rejection of the modernization approach and awareness of its many shortcomings. The new model of 'sustainable development' that has emerged seems to reflect a better understanding of the processes involved in bettering the lives of people in the South, and of the importance of a human-centered approach (ibid: 14). Defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987: 43), it is based on several tenets that are the direct antithesis of modernization theory (Axinn, 1991: 120):

- Development must be driven from within, not by outsiders
- The rural poor must actively participate in their own development
- Ecologically-sound technologies and practices must be employed to avoid destruction of the natural environment.

Critical to this approach is the use of indigenous knowledge about the social and biophysical environment, not only as a means of promoting self-reliance, but as a valuable contributor to the search for sustainable strategies of development. The idea is to utilize the vast stores of knowledge that indigenous people have acquired over the centuries about living in their particular environment, knowledge which has allowed them to adapt to constantly changing conditions without compromising the carrying capacity of the lands which they inhabit (Warren, 1991: 1).

A Brief Overview of Indigenous Knowledge

Indigenous knowledge (IK) is, broadly speaking, the knowledge used by local people to make a living in a particular environment (ibid.). Terms used to designate this concept include, among others, traditional environmental or ecological knowledge, rural knowledge, local knowledge and farmer's knowledge. Indigenous knowledge can be defined as "A body of knowledge built up by a group of people through generations of living in close contact with nature" (Johnson, 1992: 4). Generally speaking, such knowledge evolves in the local environment, so that it is specifically adapted to the requirements of local people and conditions (Dewalt, 1994: 125). It is also creative and experimental, constantly incorporating outside influences and inside innovations to meet new conditions (Grenier, 1998: 1). It is not, as originally believed by the scientific and development community, 'old-fashioned', 'backwards', 'static' or 'unchanging'.

Indigenous people are defined as the original inhabitants of a particular geographic location, who have a distinctive culture and belief system from the international system of knowledge (e.g., the Tribal, Native, First, or Aboriginal people of an area) (Knudtson and Suzuki, 1992: 7-8). Generally, such groups can be distinguished through self-definition: indigenous people tend to know who they are (ibid.). While they live within a broader context (district, province, country) that is based on international politics and a scientific knowledge system, they tend to retain many of their traditional beliefs, customs and knowledge (ibid.).

Some feel that such a definition is too restrictive, however, in that it excludes peoples who may have lived in an area for a long period of time, but are not the original inhabitants.

This has led to widespread use of the term 'local knowledge', a broader concept which refers to the knowledge possessed by *any* group living in a particular area for a long period of time in an intimate association with nature. Under this approach, the origin of the people in question is unimportant; the focus is to learn how 'local' people—aboriginal or non-aboriginal—in a particular area view and interact with their environment, in order that their knowledge can be mobilized for the design of appropriate interventions. In this study, I use the terms interchangeably, although it should be understood that the Zoque-Popoluca are, in fact, to be considered as the 'original' inhabitants of this part of Mexico, in the strictest sense of the term.

While IK research originally emphasized indigenous *technical* knowledge of the environment, it is now accepted that the concept of IK goes beyond this narrow interpretation (Thompson and Schoones, 1994: 60). IK is now considered to be *cultural* knowledge in its broadest sense, including all aspects of a local way of life (ibid.). IK is embedded in a dynamic system in which social, economic, political, spiritual and environmental factors are tied together and influence one another. While research may focus on a particular category or type of IK, it is important to realize that any IK under investigation must be viewed in terms of the overall cultural context. For example, religion and spiritual beliefs are an integral part of IK and cannot necessarily be separated from technical forms of knowledge (IIRR, 1996: 11). Spiritual beliefs about nature may influence how resources are managed and how willing people are to adopt new resource management strategies (ibid.).

Many indigenous knowledge systems are based upon several key features which many feel make them important models for developing more efficient, sustainable ways of managing resources. For example, indigenous belief systems are often based on a 'conservation ethic', where the land is considered sacred, humans are seen as being dependent on nature for survival, and all species are interconnected with one another (Johnson, 1992: 7-8; Grenier, 1998: 55). Indigenous systems also usually show a degree of flexibility, with the ability to adapt to new conditions and incorporate outside knowledge (Johnson, 1992: 4). As well, there are usually strong feelings of social responsibility in indigenous communities, with strong family and community ties leading to feelings of obligation and responsibility to preserve the land for future generations (Dei, 1994: 29).

As with scientific knowledge, however, IK has its limitations, and these must be recognized. IK is sometimes accepted uncritically because of naive notions that whatever indigenous people do is naturally in harmony with the environment. There is historical and contemporary evidence that indigenous peoples have also committed environmental 'sins' through over-grazing, over-hunting, or over-cultivation of the land (Knudtson and Suzuki, 1992: 17). Most of those involved in the field of development agree that a synthesis of IK and international science is necessary in order that benefit be gained from the best qualities of each (Johnson, 1992: 10).

In the context of this thesis, there are two limitations that are of particular relevance. First, indigenous knowledge can be eroded or degraded by wider economic and social forces (Grenier, 1998: 4). Pressure on indigenous peoples to integrate with larger societies is often great, and as they become more integrated, the social structures which generate indigenous

knowledge and practices can break down. The growth of national and international markets, the imposition of educational and religious systems and the impact of various development processes are leading more and more to the homogenization of the world's cultures (ibid.). Younger generations are acquiring different values and lifestyles as a result of exposure to global and national influences, and traditional communication networks are breaking down, meaning that Elders are dying without passing their knowledge on to children. Consequently, indigenous beliefs, values, customs, know-how and practices may be altered and the resulting knowledge base incomplete.

Second, sometimes IK that was once well-adapted and effective for securing a livelihood in a particular environment becomes inappropriate under conditions of environmental degradation (Thrupp, 1989: 15). Although IK systems have a certain amount of flexibility in adapting to ecological change, when change is particularly rapid or drastic, the knowledge associated with them may be rendered inappropriate and possibly even damaging in the altered conditions (Grenier, 1998: 55). Newer, highly innovative strategies of subsistence must be created, and it is here that both IK and science can contribute.

Research Methods

The research was carried out over three months in 1995 in two towns of the Sierra de Santa Marta in southern Veracruz, in collaboration with the Zoque-Popoluca, an aboriginal group of slash and burn farmers who have lived in the area for generations. Every year, this area is ravaged by wildfires, which occasionally turn into larger fires which damage many hectares of forest and farmland. Indigenous farmers, who burn their small

milpa plots every year to prepare them for planting, blame the problem of wildfires on deforestation which has reduced the rainforest in many places to flammable areas of 'pure grass', and on farmers who 'don't care anymore' and disregard traditional conservation rules and methods of fire control. Researchers working in the Sierra agree that agricultural burning is the main source of wildfires in the region, although they say that the largest fires are usually caused by the careless burning of pasture in the areas where ranching is prevalent. It was these explanations of the problem which formed the basis of my investigation. I decided to focus on *milpa* burning (sp. *la quema*), since it is the most common form of agricultural burning in this particular area of the Sierra de Santa Marta. I wanted to take a closer look at the techniques and motivations associated with fire control, analyzing them in the context of all of the environmental and socioeconomic changes that have occurred in the Sierra recently, in order to see if there was any validity to farmers' explanations about wildfires.

The research utilized a comparative methodology contrasting data from the Zoque-Popoluca towns of San Pedro Soteapan and Ocotal Chico. I decided on this approach because very early in my fieldwork I learned from both local farmers and researchers in the area that there were many more escaped *milpa* fires near San Pedro Soteapan, the largest town of the municipality, than in the more isolated village of Ocotal Chico. I felt that comparing data from these communities would enable me to uncover the factors responsible for this phenomena much more effectively than if I worked in only one village. While the research focused on only these two towns, I hoped that results could give a general insight into why wildfires are occurring throughout the Sierra de Santa Marta.

The main methods of data collection were individual and small group interviews, both informal and formal, with the latter conducted using a questionnaire and tape-recorder. A total of 34 farmers were formally interviewed during the research, 18 from San Pedro Soteapan, 12 from Ocotal Chico and 4 from other villages in the area, with a core of 10 collaborators being re-interviewed on several occasions. A number of informal interviews were also conducted in both villages, many being done as I visited farmers working in their *milpas*, a strategy that proved to be particularly effective. By actually being present at a site, I could ask more specific questions about the most recent burn by referring to the *milpa* itself. This strategy also seemed to facilitate farmer descriptions and recall, since they had something 'tangible' as a reference.

The interviews were designed to elicit Zoque-Popoluca knowledge and understanding of how fires occur, where they occur, why they occur, what damage they cause to the environment, and what can be done to combat the problem. Farmers were also asked to describe safety techniques employed in agricultural burning, as well as why, when and by whom they are employed. Concerning the latter, the question of exactly *who* follows/doesn't follow safe burning techniques is one which evokes extremely vague answers, no doubt due to the controversial nature of the topic. For example, I did not encounter any individuals who admitted to *not* following safe burning practices and to causing escaped fires. Most fires, I learned, were caused by 'other people' whose identities were unknown or who lived far away. All the people I spoke to told me that they themselves, as well as their immediate neighbors, were extremely careful when they burned and that they practiced the traditional techniques of burning. I found that a much more fruitful line of

questioning involved asking farmers to describe in general the burning techniques of the farmers of the other village, as opposed to asking about individuals. For example, a typical question for farmers from both San Pedro Soteapan and Ocotal Chico was: Are there any escaped *milpa* fires in San Pedro Soteapan when they burn? Why? This line of questioning, somewhat surprisingly, evoked a strong consensus among all farmers about which of the two areas experienced the most fires, and for what reasons.

Another effective interview technique was to begin an interview by going over key concepts using the Zoque-Popoluca language. I learned early on that using certain Spanish words created confusion and misunderstanding for some of my collaborators. For example, several did not understand the Spanish terms for 'forest fires' or 'uncontrolled fires', interpreting them as simply meaning 'agricultural burning.' Using Popoluca words such as *jucti poypa* (escaped *milpa* fire) greatly facilitated the interview process, particularly with the older farmers whose knowledge of Spanish is sometimes limited.

Perhaps the greatest obstacle to my research was in its timing: the 'burning' phase of Zoque-Popoluca agriculture was mostly carried out in the months of April and May, leaving me little opportunity for first-hand observation of burning techniques during my combined three months of fieldwork in June/July and October/November. However, I was fortunate enough to witness one late burn in early June, done by a farmer in Ocotal Chico, and was present at a number of secondary burns, where farmers burn *la basura* (literally, 'garbage', but meaning either vegetation that was not burned in the original burn, or the burning of old maize stalks in an established plot). I also found that observing *milpas* that had already been burned was quite informative as well: in most cases, little physical change

had occurred since the burn. There was also substantial evidence of past uncontrolled fires in the area, and I was also able to observe several fires in progress.

Order of Presentation

The thesis is comprised of six chapters. In the first chapter, I present some background information on the area of study, describing the natural environment of the Sierra de Santa Marta, the general characteristics of the two indigenous communities in which the research took place, and the relationship between the subsistence agriculture practiced by the Zoque-Popoluca and the use of fire. The second chapter describes traditional beliefs and customs which made wildfires a rare occurrence in the past. I discuss traditional attitudes towards environmental conservation, the rules and techniques employed to control agricultural burning, and the natural fire resistance of the properly-managed forest. Traditionally, the Zoque-Popoluca possessed a strong 'conservation ethic' through which they were committed to protecting the rainforest ecology upon which they depended for subsistence. In the third chapter, I describe the increasing incidence of wildfires in the Sierra de Santa Marta and the damage they have caused recently. Despite a cultural tradition which emphasized conservation and the use of techniques to properly control fire, it seems that some farmers are allowing their *milpa* burns to escape and damage the surrounding forest and agricultural land. The next two chapters explain how recent environmental and cultural change have led to the increasing problem of wildfires. In the fourth chapter, I describe how deforestation in the Sierra has compromised the natural fire resistance of the tropical rainforest ecology, rendering traditional techniques of fire control less effective than

in the past. I go on, in the fifth chapter, to discuss how traditional culture has been altered by outside economic, political and social forces, leading ultimately to a weakening of the conservation ethic and motivations to protect the land from wildfires. In the concluding chapter, I summarize my argument about why *milpa* fires are escaping the control of farmers in this region of the Sierra, and discuss some ways in which the problem can be addressed.

Chapter 1

THE LAND AND PEOPLE

In this chapter, I describe the natural environment of the Sierra de Santa Marta, the general characteristics of the two indigenous communities in which the research took place, and the relationship between subsistence agriculture and fire. Although agricultural burning was effectively controlled in the past, it is now causing an increasing incidence of wildfires which are contributing to the overall environmental degradation of the region.

1.1 The Natural Environment

The Sierra de Santa Marta is one of two volcanic systems which make up the Sierra de Los Tuxtlas, located in the southern portion of the state of Veracruz on the Gulf coast of Mexico. The municipalities of Soteapan, Mecayapan and Pajapan make up the north-eastern and southern slopes of the volcano, while parts of the municipalities of Hueyapan de Ocampo and Catemaco comprise its western slope. It encompasses an area of 1200 sq. km which rises rapidly from sea level on the Gulf coast to over 1700 m on the highest peak (Buckles and Erenstein, 1996: 1).

Because of the varying elevations and topography of the Sierra, there occurs a wide range of climatic conditions over its relatively small area. Rainfall can be as high as 4 000 mm annually on the northern parts of the range, and as little as 1 200 mm on its south-eastern slopes, as moisture from the Gulf of Mexico is released as it passes over the higher elevations (Chevalier and Buckles, 1995: 182). Temperature also varies due to altitude,

from annual means of 18 C for the highest peaks to 25 C for the lowlands. There are three basic seasons annually, each with its characteristic weather patterns. The rainy season lasts from June until September, and is characterized by heavy rains and intense thunderstorms, with a short dry period known as *la canicula* occurring towards the end of August (ibid: 189). From October until early March, strong winds from the north, or *nortes* of up to 100 km/hr bring intermittent showers and generally cooler weather (ibid.). The dry season lasts from March to May, during which time hot, dry winds from the south known as *suradas* blow in, bringing clear weather (ibid.).

Fourteen vegetation types have been identified in the area, comprised of approximately 3,000 plant species identified so far and providing a home for 1,149 animal species, a number of which are unique to the area (Ramirez in Chevalier and Buckles, 1995: 182). Over 450 bird species, representing 40% of the total in Veracruz, are found in the Sierra de Santa Marta and neighboring areas (Buckles and Erenstein, 1996: 1). Researchers have recorded 248 wild plant species that are used by the indigenous population as medicinals, 73 others are collected for food and 54 species are used as building materials for houses, furniture and tools (Paré et al in Chevalier and Buckles, 1995: 182).

The complex web of ecological relationships associated with the rain forest provides the basis for local subsistence agriculture. The unique balance between climate, soil, water and vegetation forms the backbone to the Zoque-Popoluca's traditional form of corn cultivation. Researchers have divided the Sierra de Santa Marta into the following three

general agro-ecological zones (Buckles and Erenstein, 1996: 2,4):

- Nucleus zone: the mountain peaks and craters between 1200 to 1700 m which are covered by various types of tropical rain forest and subtropical montane forest. Average annual rainfall is over 4,000 mm per year. This region is generally uninhabited, due mainly to the fact that steep slopes in excess of 50% make it difficult to use for agricultural purposes.

- Buffer zone: high hills between 800 and 1200 m, where the natural cover consists of several kinds of subtropical rain forest as well as oak and pine forest. Rainfall in this area is between 2,000 and 3,000 mm per year, and slopes between 30 and 60%. Agricultural land use is dominated by corn and coffee, although there are significant areas devoted to cattle pasture on the northern slopes that are utilized by a few *mestizo* communities.

- Influence zone: low hills and sloping land from sea level to 800 m, where the original cover of tropical rain forest has almost been completely removed and replaced by pastures, crops and secondary vegetation. Rainfall is variable in this zone. Ranching and cropping are the main land-uses, with pastures dominating the northern and south-eastern slopes and cropping the southern and western slopes.

1.2 Two Zoque-Popoluca Communities

The Sierra de Santa Marta was once inhabited by the Olmecs, Mesoamerica's mother culture which flourished in the region between 1200 and 400 B.C. (Garcia de Leon, 1976: 280). The majority of the present population of more than 50,000 is made up of two indigenous groups, the Zoque-Popoluca and Nahua, who have lived in the area since pre-Hispanic times (Buckles and Erenstein, 1996: 2). Although *mestizo* communities of more recent origin are also located in the Sierra, they are mostly confined to the northern slopes where ranching dominates. The population is organized into some 91 communities, most of which have access to communal lands of varying sizes (ibid.).

My research was concentrated in the towns of San Pedro Soteapan and Ocotal Chico, both located in the municipality of Soteapan, on the southern slopes of the Sierra de Santa Marta (see Figure 1, below). Each town has access to a tract of land known as an *ejido*, which is controlled by an association of producers or *ejidatarios* who have rights to use the collectively owned land. The *ejido* of San Pedro Soteapan, which lies in the influence zone between 120 and 560 m above sea level and is bisected by the Soteapan and Huazuntlan rivers, has an area of 3,784 Ha (PSSM, 1996: 2-7). The communal land of Ocotal Chico, which borders San Pedro Soteapan to the north-east, is located in the influence and buffer zones between 490 and 1,110 m above sea level and covers an area of 1,496 Ha (ibid.).

There are important differences between the two towns included in this study. The town of San Pedro Soteapan, or *Aktevek* as it is called in Popoluca, is an ancient, prehispanic town that serves as the administrative and economic center for the municipality of Soteapan (Blanco, 1994a: 10). The population of 4,051 is predominantly Zoque-

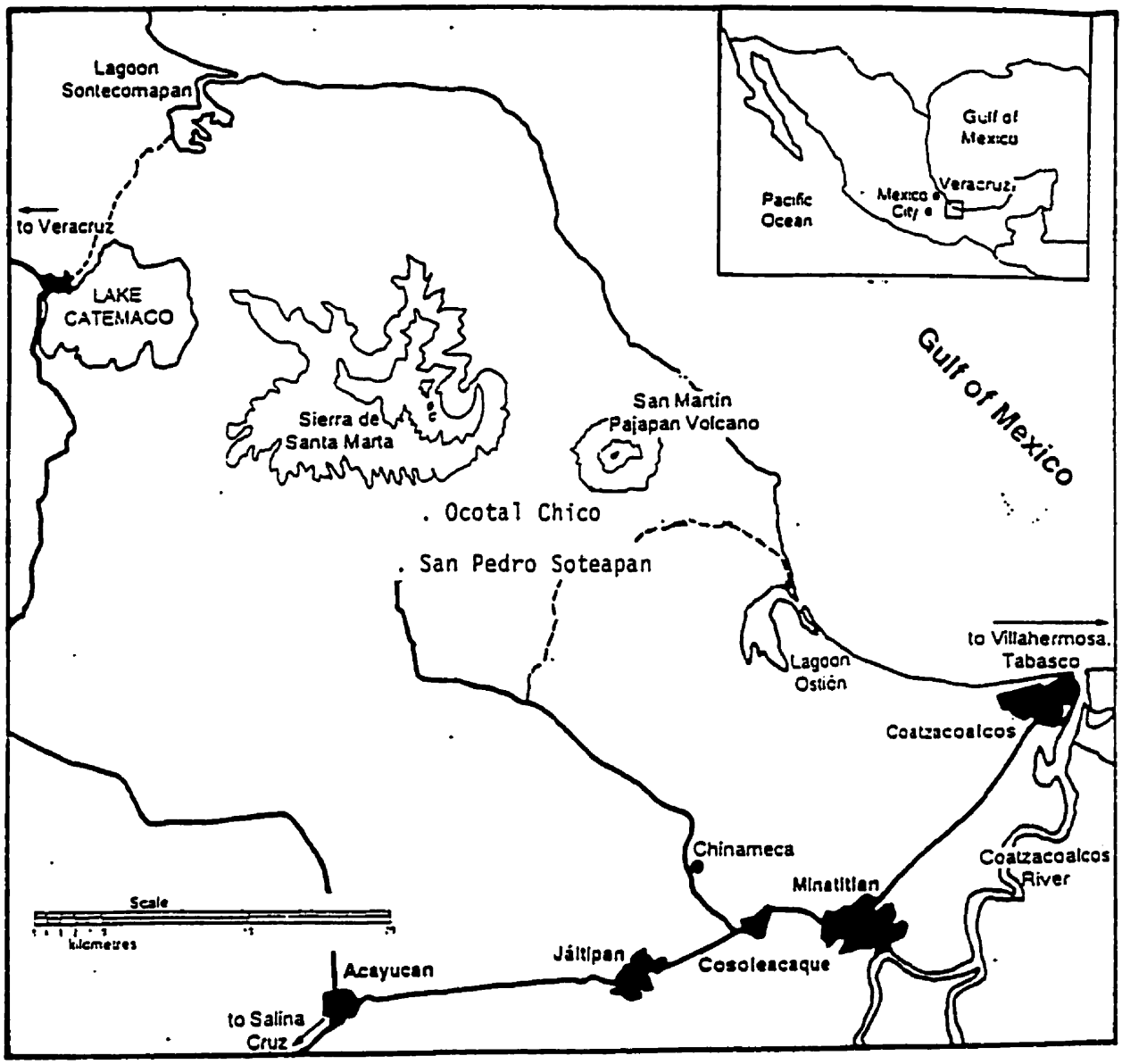


Figure 1: Location of San Pedro Soteapan and Ocotal Chico in the Sierra de Santa Marta, Veracruz, Mexico

Popoluca, although a small number of Zapotecos and *mestizos*, mostly merchants and service people of various sorts, live here as well (PSSM, 1996: 2-7; Blanco, 1994a: 10). Besides containing the municipal government headquarters, the town has a church, five schools, a clinic, a telephone, numerous small stores and merchants, veterinarians, and offices of various producers associations. A main road and regular bus service connects the town with the larger population centers such as Minatitlan to the south, and smaller roads and foot paths, often difficult to traverse during the rainy season, link San Pedro Soteapan to the other towns and villages of the Sierra. While commercial enterprises such as cattle-ranching and plantation cropping of papaya and mango are practiced on a small scale in San Pedro Soteapan, the indigenous population's participation in the regional economy is mainly through low-paying wage labor and the petty trade of agricultural products and handicrafts.

Ocotal Chico, or *Suchichincon* in Popoluca, is a smaller, more isolated town of 715 located about five kilometers north of San Pedro Soteapan in an area dominated by sloping ridges and pine and subtropical forest (PSSM, 1996: 2-7). A hamlet of only five families at the beginning of this century, its population began to grow in the 1920's when people from San Pedro Soteapan and the neighboring town of Ocotal Grande began pouring into the area as they fled government persecution for their part in an uprising just prior to the Mexican Revolution (Blanco, 1994a: 11). Although possessing two schools, telephone and a few small stores, the people of Ocotal Chico have traditionally traveled to San Pedro Soteapan to attend secondary school, purchase supplies, and to reach other destinations. The towns are connected by both a dirt road that spans the Huazuntlan River and a narrow, difficult foot path. The higher elevation and resulting cooler, wetter climate of the area is

favorable to the growing of coffee, and most families rely principally on coffee as the main cash crop and grow corn for household consumption (Blanco, 1994b: 23).

1.3 Subsistence Agriculture and Fire

While the local economy in the municipality of Soteapan includes the commercial activities mentioned above, the majority of people still rely on slash and burn corn cultivation as their primary means of subsistence. Corn is grown as a subsistence crop by the vast majority of the population, with an estimated 95% of households in the buffer zone and 80% in the influence zone growing corn for family consumption (Buckles and Erenstein, 1996: 6).

Corn is cultivated through a traditional slash and burn system which relies heavily on the rainforest and the environmental services it provides. Practiced in the area for more than 4,000 years, this type of cultivation involves clearing a small plot of forest and burning the cut vegetation, planting it with corn and other crops for a few years, and then abandoning it to allow for natural regrowth (Stuart, 1978: 20). A new plot or *milpa* is then established in another forested or regrown area, where the cycle begins again. Burning is considered to be an absolutely essential part of this cycle. Farmers say that without it, the corn will not grow. Because they are well aware of the dangers that fire can pose to the surrounding fields and forests, farmers have developed informal rules and techniques for how it should be controlled. However, as we shall see, various environmental, economic and social factors are threatening both the effectiveness of these practices and the degree to which fire control rules are followed by individual farmers.

Deforestation throughout the Sierra over the last few decades has greatly diminished the ecological sustainability of this traditional form of cultivation (Chevalier and Buckles, 1995: 206). In San Pedro Soteapan, the landscape has come to be dominated by *milpas*, fields of grass (sp. *zacate*), cow pastures and very immature stands of secondary growth, and is rapidly succumbing to various processes of environmental degradation such as soil erosion, loss of biodiversity, and degradation of fallow land. Fires, both small and large-scale, are also contributing to these processes, and have become a growing menace in recent years. Similar circumstances exist in Ocotal Chico as well, although deforestation is not quite as severe and fires not as common, although here as well their occurrence is increasing. In both cases, however, the land is rapidly approaching the limit to sustain its human population.

1.4 Summary

The Sierra de Santa Marta is a biologically rich and diverse region of Mexico with a wide range of climatic, topographical and ecological features. Its population is made up mainly of indigenous peoples who rely on the rainforest and the environmental services it provides for their livelihood. The study focuses on two Zoque-Popoluca communities located in the municipality of Soteapan. The town of San Pedro Soteapan has a much larger population and is older, more accessible and more economically-developed than the town of Ocotal Chico. Although the local economy includes some commercial activities, most local people still rely on slash and burn corn cultivation for subsistence. An indispensable part of this form of cultivation is the use of fire to clear plots prior to planting, and local

farmers have developed effective ways of controlling burning so that it does not harm the surrounding land. However, in recent years wildfires have become an increasing problem for both communities, particularly in San Pedro Soteapan. In each case, fires are contributing to deforestation, compromising the integrity of the local ecology and its ability to support the indigenous population.

Chapter 2

TRADITIONAL FIRE CONTROL

In this chapter, I discuss traditional attitudes towards environmental conservation, the informal rules and techniques employed to control agricultural burning, and the natural fire resistance of the properly managed rainforest. In the past, Zoque-Popoluca farmers had a deep spiritual respect for the natural environment, an attitude that was reflected in both the knowledge associated with the safe use of fire and the overall commitment to preserving a rainforest ecology that was naturally resistant to fire. As a result, wildfires were not a common occurrence in the region in the past.

2.1 Traditional Worldview

Traditionally, the natural resource management strategies of the Zoque-Popoluca were based upon a worldview which included a strong conservation ethic. There was a deep respect for the natural world that comes from a realization of the interconnectedness of all species, both plant and animal, and the necessity of maintaining these relationships in a balanced manner (Chevalier and Buckles, 1995: 276). All of the activities associated with making a living from the rainforest, including agricultural burning, were all practiced within the boundaries of spiritual beliefs which stressed the sacredness of the land and its resources and the obligation to preserve them. The Zoque-Popoluca way of life represented a sustainable form of living that did not sacrifice long term ecological viability for short term needs.

For the Zoque-Popoluca, the land is alive and abounds with natural spirits and gods who have the power to inflict punishment on those who are greedy or disrespectful. Occupying an important position among these spirits and gods is *Homshuk*, the 'God of Corn', who also appears in Nahua mythology as *Sintiopiltsin* the 'Son of the Corn God' or as *Tamakastsin*, 'the little priest' (Chevalier and Buckles, 1995: 269). This deity plays a central role in both Popoluca and Nahua beliefs of the linkages between nature and culture, and amongst human beings. These beliefs are embodied in myths and rituals which place humans within a web of relationships involving plant gods, animal spirits and all other forces of nature. They are characterized, not by the hierarchical dominance of humans over nature as in European religions, but by a vertical relationship in which humans are subordinated to and dependent upon the natural entities who hold dominion over nature. As Chevalier and Buckles put it:

> Creatures of nature may be mastered by humans who must eat plants and animals in order to live, yet humans must ultimately defer to natural gods and spirit animal-owners who control the resource base and livelihood of native people. (1995: 275)

These natural spirits or 'Masters of the Universe' can either assist humans in their struggle to make a living from the land, or punish them for inappropriate behavior such as over-cultivating land without giving it a chance to rest, killing more animals than are needed while hunting or fishing, collecting plants without tributes to spirit-owners or displaying wealth without sharing it (ibid: 276). When clearing land, hunting or fishing, for example, a person must first ask permission from the *Chaneco*, the 'Owner of the Animals and

Trees', a spirit who is the eternal guardian of the forest and all of the creatures that reside within it (Félix-Báez, 1973: 103; Stuart, 1978: 189). The *Chaneco* requires that proper respect be shown to the forest because, as one man put it, "the animals of the forest are very delicate" (Félix-Báez, 1973: 103). When hunting, a ritual must be strictly adhered to so as not to raise the ire of the *Chaneco* and to ensure that he 'gives animals' to the hunters (Félix-Báez, 1973: 103). For seven days before the hunt, the men are prohibited from engaging in sexual relations, and on the night before the hunt the men meet at midnight and burn copal, remaining awake and without anything to eat (ibid.). Upon entering the forest in the early morning, they recite a hunting prayer to the *Chaneco*, which one man explained to anthropologist James Stuart in this way:

> When I go into the forest, I ask of god, of my god, that he free me of all evil, of all danger, of all bad spirits. Then I ask, I say, to the earth that it should pardon me, that I am going to enter here, that I am going to look for a little animal, a little deer, a pheasant, for example a chicken of the forest, and this, then I say: Little old man *Chaneco*, little old woman, give me because I want. Pardon me because I am hungry, I am hungry. I am also going to give a little gift, because I am hungry. Don't go and frighten me here in this forest. (Stuart, 1978: 189-190)

If an animal is killed, the meat is distributed equally among the hunters, and the bones of the animal, after drying in the sun, are thrown into the river "so that the *Chaneco* can reclaim them" (Félix-Báez, 1973: 105). If this ritual is not followed, a person risks being bitten by snakes sent by the *Chaneco* (Stuart, 1978: 189). Similar rules must be observed when fishing, as one man related to anthropologist Félix-Báez:

> The *Chaneco* is the owner of the fish. Because of this, the man who is going to fish asks him to find what he needs. So that the *Chaneco* is not annoyed and takes away your fish, you have to burn copal before starting to fish at night or day; if you don't burn it, you can't fish. (1972:107)

When planting corn at the beginning of the rainy season, a similar ritual, known as *La Siembra de Siete Dias* (the Seven Days of Planting) is also observed, in reverence to *Homshuk*, the 'Corn God' (ibid: 98). As with the hunt, seven days of sexual abstinence are required, followed by a sleepless night of fasting in the *milpa* during which a sacred candle is lit and copal burned until midnight, when both the candle and a lime are buried in a small hole in the shape of a cross. In the morning, the *milpa* is cleared of any remaining weeds and the next day the man returns alone to begin planting, putting seven ears of corn in seven holes. When this is completed, the general planting can begin, and the man can break his fast. If the ritual is not followed, *Homshuk* can render punishment in the form of withholding the rains or sending pests such as rats to invade the *milpa* (ibid.).

While humans are in many ways at the mercy of these natural spirits for their sustenance, their powers are, nevertheless, not oppressive or despotic (Chevalier and Buckles, 1995: 276). In fact, there exists a mutual dependency that binds human beings and natural spirits together. *Homshuk*, who resides in the smallest ears of corn and who has power over the natural forces necessary for its growth, is also dependent upon the labor of humans to reproduce himself (ibid.). He offers himself in death during the harvest so that humans might live, and is born again with the help of human hands when the next planting cycle arrives. Communication between natural gods and humans is carried out through an

intermediary embodied in the person of the *Xoca*, a shaman who has the power to pray to the gods and ask that the forces of nature are made favorable for human activities (Blanco, 1994a: 19). Community leaders usually ask that each man of the village contribute towards a small fund which is used to pay the *Xoca* for services such as ensuring that the rains begin on time (ibid.).

2.2 Traditional Techniques of Fire Control

The Zoque-Popoluca conservation ethic is further embodied in the detailed knowledge passed from generation to generation on how to safely burn a plot of land without causing unnecessary damage to the surrounding forests, fields and fallows. All of my collaborators could recount in detail the techniques associated with proper fire control, underscoring, in my mind, the importance that is placed upon such knowledge.

As stated earlier, burning of fallow is considered to be an essential part of the agricultural cycle. It is described simply as a "custom of the people" and farmers give several practical reasons for burning, including (1) to clean or remove the cut vegetation and weeds from the *milpa*; (2) to get rid of pests such as rats that eat the corn; and (3) to fertilize the soil with ash. However, burning also has a deep symbolic significance as well. Recovery of soil fertility is thought of as 'healing' the land, in which a balance was symbolically struck between the two opposite themes of 'cold' and 'hot' (Chevalier and Buckles, 1995: 211). Fallow vegetation, for instance, is seen as providing a large amount of plant litter that "gives life to corn" by shading out weeds, decomposing and keeping the soil cold and wet (ibid.). Plant species considered to be 'cold' were instrumental in this process, producing

a large amount of leaf litter, softening the soil and acting to "easily release the juices of the earth" (ibid.). But in order to grow, the corn plant must have a balanced combination of the hot and the cold, since it "does not want sun or heat only, nor does it want water or cold only" (ibid.). Burning of fallow vegetation was thus also seen as an integral part of the *milpa* cycle, heating and drying the land so that crops would not be 'burned' by excessive wetness and reducing the slash to ash which fertilizes the soil (ibid.).

A burn is considered successful if the fire does not escape to adjacent areas, if all of the cut vegetation or 'garbage' (sp. *basura*) is consumed by the fire leaving the *milpa* 'clean', if all of the pests and weeds are killed, and if there's ash to be washed into the soil with the first rains. Concerning the latter, farmers describe two types of ash produced by the burn: 'white' (sp. *blanco*) which comes from tree trunks, and black (sp. *negro*) which comes from leaves and smaller debris. According to some, the white signifies too intense a fire and will not produce anything, while the black is the preferred type essential for a good harvest. Others disagree, saying that both types are equally necessary for the corn to grow. A good burn is described as 'very pretty' (sp. *muy bonita*).

Preparations to burn are different in different types of terrain. For a *milpa* cut out of mature forest (sp. *monte*) or fallow (sp. *acauale*), preparation begins in March or April with the cutting of undergrowth and the felling of trees. Wood may be removed at this time for use as firewood or as building material, but there seems to be no conscious effort on the part of farmers to remove material from the *milpa* to lessen the burn's intensity and therefore ensure a more easily controlled fire. In the less mature fallowed plots (sp. *acauales jovenes*) and established *milpas*, virtually no material is removed prior to burning, since there is little,

if any, of sufficient size for use elsewhere. The cut vegetation, especially the larger trees, is then chopped up further so that drying is facilitated, and then allowed to dry for approximately 15 days, with drying times for immature fallows and established *milpas* being less. If the material is left for a longer period, farmers say that it begins to rot and will thus not burn very well. There is no manipulation of drying time in order to control fire intensity—it appears that the main preoccupation is to have the material as dry as possible so that all of it is consumed during the burn.

All of the men I spoke to identified the building of a firebreak (sp. *guardarraya*) as the most important technique to ensure that a *milpa* fire does not escape. In mature forest or fallow, the firebreak is constructed during initial clearing of the *milpa*, and involves the careful removal of all vegetation along the perimeter of the plot to a width of several meters, so that fire is inhibited from spreading to adjacent areas. More dangerous areas, such as the downwind side of the *milpa*, may require a wider firebreak, so that the firebreak is not necessarily uniform in width throughout its length. Roots are also chopped by machete to a depth of several centimeters, since farmers recognize that fire can pass underground along roots. The firebreak should be 'cleaned' again just prior to the burn, in order to remove any new growth or material that was missed in the initial clearing phase.

Many farmers I spoke to stressed that a firebreak should be made regardless of terrain type, although there are differences in construction that are related to where the burning takes place. In immature fallows and established *milpa*, the task is much less arduous, and is often done by one or two men on the day of the burn. The firebreak itself is only about 1 to 2 m in width, as opposed to the 3 to 5 m required in mature forest or fallow;

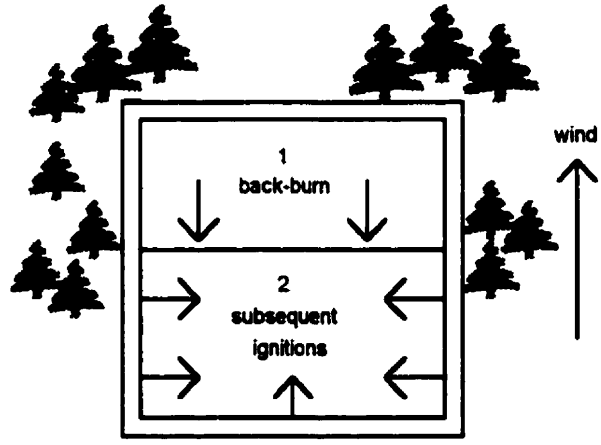
since fire intensity and therefore danger is less. Sometimes in established *milpa*, when the only material to burn is the old corn stalks and a few weeds, a 'formal burn' (sp. *la quema*)is not done. Rather, the debris is collected into rows or piles, and is then burned, a technique known as 'the burning of the garbage' (sp. *la quema de la basura*), which, incidentally, is also the term used to describe the later burning of any debris left over from the original burn. This secondary type of burning is considered to be distinct from a formal burn, and much less dangerous, since the fire never gets very large due to the small amount of chopped vegetation.

Burning is done in April and May, before the onset of the rainy season in June. The day of the burn should be sunny and dry, with a slight breeze that is just strong enough to fan the fire along, but not so strong that it can carry the fire across the firebreak. All of my collaborators stressed that burning had to be done on a sunny day. If there are clouds, even if it's not raining, the material won't burn. Burning should also be done at around noon, since humidity is less at this time of day and the cut vegetation is thus at its driest. The decision to burn is strictly an individual decision on the part of the farmer, based on his own needs and schedule. There is no critical period in which burning must take place, other than that it must be done before the rains begin. In fact, the one burn I did witness was carried out in early June, and nobody seemed to think that this would have a negative impact on this particular farmer's harvest.

In mature forest or fallow, the actual burn is done in stages to ensure that the fire does not escape. According to farmers, the greatest danger lies in burning a *milpa* in this type of terrain, because the cut debris is 'very thick' and the fire is therefore 'very strong'

and difficult to control. It is also recognized that fires can spread through the sparks emitted from smouldering stumps and logs, and underground through the thick roots of trees. Under these conditions, a number of fire control techniques are used, the most important being the construction of a substantial firebreak 3 to 5 m wide and several centimeters deep. Back-burning is also employed, with the fire being ignited first along the downwind side of the *milpa*, with the farmer walking along the firebreak igniting piles of debris with a torch made out of old corn stalks or other material. The fire is then allowed to burn back against the wind, for a number of meters. Because it is moving against the wind, the fire moves very slowly and is therefore easy to control. Once it reaches to about the half-way point, other points are ignited around the lower perimeter of the *milpa*, and these are allowed to burn inward and upward, until they are stopped by the barrier of burned material created by the first burn (see Figure 2 below).

Figure 2: Steps to Back-Burning a *Milpa*



An important aspect of effective fire control is for a farmer to be able to gather enough people together to help with the construction of a proper firebreak and to provide assistance both during and after the burn. It takes between 5 and 10 people to safely burn in mature forest or fallow, depending on the size of the plot. These people are either family members or neighbors who are asked to help through the traditional labor reciprocity network known as *mano vuelta* or 'return hand', under the assumption that they too will receive help when needed in the future. Before the burn, they assist in the often arduous task of clearing and piling brush from the *milpa* and firebreak. During the actual burn, they patrol the perimeter of the *milpa*, making sure the fire does not spread and extinguishing any sparks that have been carried over the firebreak, either with water contained in water pumps carried on the back (sp. *bombas*) or sprinkled from other containers. When the burn is complete, they cut down burned trees and knock apart smoldering logs and debris, sprinkling water to extinguish them. The farmer and his helpers also check and recheck the burned area for a period of at least 8 days, since they recognize the possible dangers posed by logs and roots which can smolder for days and even weeks after a burn, producing sparks which have the potential for starting fires kilometers away.

Burning in immature fallow and established *milpa* is considered much less dangerous than burning in more mature forest or fallow and therefore much less care is taken. The cut debris, often little more than old corn stalks and weeds, is 'very thin' and the farmers believe that there is little danger of a fire escaping. This type of burning, known in Popoluca as *tanovac tan cama* (the burning of corn stalks) or *tanovac puchi* (the burning of garbage) is often done by one person alone and the firebreak, if constructed at all, is no more

than a meter or so in width. As well, it is not considered necessary to back-burn in these areas, and the burned *milpa* is watched for only a day or two after the burn. I observed one example where a fire was simply lit at the bottom of the *milpa* and allowed to run upslope with the wind, until it encountered a natural barrier of boulders at the top. *Tanovac puchi* is also the term used to describe the later burning of any unburned debris left over from the first or 'formal' burn. Both are considered to be a secondary type of burning that is distinct from the formal burns necessary in more mature forest and fallows. One old man sums up this type of burning in this way:

> The burning of corn stalks [in established *milpa*] is not very dangerous because it's not like in mature forest...you need help to burn the *milpas* that are in mature forest so that the fire doesn't spread...at times the fire can be spread by a gust of wind or an eddy, which takes it to another area and starts a fire.

The Zoque-Popoluca philosophy of environmental conservation and the related diligence practiced when performing *milpa* burns meant that wildfires were infrequent in the hills of the Sierra in the past. Farmers say that their fathers and grandfathers were much more careful when they burned their fields. When asked about wildfires when he was a child, one old man told me that "...almost never, there was little of it [of fires]. We were very careful." Researchers agree that wildfires were a rare occurrence in the Sierra in the past (Perales, 1992: 43: Stuart, 1978: 124).

2.3 Conservation of the Rainforest Ecology

Another major factor contributing to the infrequency of wildfires in the past was the overall preservation of a rainforest ecology which was naturally resistant to wildfires. Through their conservation ethic and sustainable farming practices, the Zoque-Popoluca never exploited or damaged the forest beyond its capacity to regenerate (Buckles, 1989: 223). Farmers 'rested' a plot when the land became 'tired', allowing it time to recover its agricultural potential under secondary vegetation (Buckles and Erenstein, 1996: 6). Such systems of slash and burn agriculture, as is now recognized by scientists, are well-adapted to the tropical rainforest environment, and tend to have a relatively minimal impact, when population density remains low, on the overall workings of the natural ecology (ibid: 8). Although the clearing, burning and planting associated with the cultivation cycle alters soil chemistry and plant communities within the *milpa*, the changes do not result in permanent degradation. The rainforest, because of the system's ability to preserve key ecological mechanisms, is able to regenerate itself in much the same way it would an area destroyed through natural causes, although species composition may not be identical to that of the mature forest (Buckles, 1989: 223).

The result was a relatively intact rainforest ecology that was simply not conducive to wildfires. The mature forests and fallows which surrounded the *milpas* in the past were difficult to ignite because of the wet and humid conditions they created. In such environments, even in the dry season, the moisture content of potential fuels such as leaf litter and downed woody debris is often maintained above a point where sustained burning is possible in such environments (Kauffman and Uhl, 1990:121). The forest canopy creates

a microclimate which provides protection against the drying effects of sun and wind, and relative humidity under the canopy remains quite high. For example, Kauffman and Uhl observed that relative humidity in a tall, closed-canopy forest of Amazonia remained at 100% for 20 hours or more during the dry season and rarely fell below 70%, a significant figure in relation to fires in that, as their research in the Amazon suggests, sustained combustion rarely occurs unless relative humidity is below 65% (ibid.). Such an environment also encourages high rates of decomposition, so that large accumulations of potentially combustible forest litter is mitigated (Mueller-Dombois, 1990:1). Anthropologist James Stuart, who did fieldwork in neighboring Pajapan with Nahua farmers in 1975, agrees that the chances of wildfires occurring in the environment of the Sierra were relatively slim:

> Even in the height of the dry season, the forest vegetation is quite fire resistant and is unlikely to be ignited, even by the high flames and falling sparks that accompany burning *milpas.* (1978:124)

Scientific research, in fact, has shown that wildfires have historically been a rare event in the tropical forest ecosystems of Latin America. For example, in one study done in the Amazon Basin, Sanford found evidence from radiocarbon dating of charcoal in the soil that over the past 6,000 years fires appear to have returned at infrequent intervals of between 389 and 1,540 years, intervals which correspond roughly to drier climatic phases (Sanford, 1985: 55) . Others have recorded similarly long fire return intervals in other tropical forests (Goldammer in Kauffman and Uhl, 1990). In both the Amazon Basin and Central America, further evidence of the rarity of past fires can be found in the general lack of fire adaptations possessed by plant communities, suggesting that native vegetation did not

evolve with fire (Koonce, 1990: 135 ; Kauffman, 1990:118). According to Kauffman, the inability of primary rain forest vegetation to survive even a fire of low intensity further suggests that fire was a rare phenomenon (Kauffman, 1990:118).

2.3 Summary

The Zoque-Popoluca developed a sustainable form of corn cultivation which, although utilizing the resources of the rainforest, did not tax it beyond its capacity to recover. There was a conscious effort to protect and preserve the environment—a 'conservation ethic' that was reflected in the intricate technical knowledge associated with agricultural burning and the prescribed ways in which fire was to be controlled. Farmers appreciated the danger that fire represented to the local ecology, relating the possibility of a fire escaping to the type of plot being burned. Precautions reflected this, so that fire control techniques differed according to terrain type, with areas cleared from dense tree and brush growth receiving relatively more attention than areas covered only with last season's dried corn stalks. These safety measures, along with the naturally fire-resistant nature of the properly-maintained rainforest environment, meant that wildfires were a rare occurrence in the Sierra in the past.

Chapter 3

THE PROBLEM OF WILDFIRES

Despite the traditional conservation ethic and associated customs outlined in the last chapter, wildfires caused by indigenous farmers have become a growing problem over the last few decades. In this chapter, I describe the increasing incidence of wildfires in the Sierra de Santa Marta and the damage they have caused recently. According to both indigenous people and researchers, the problem in San Pedro Soteapan and Ocotal Chico is the result of poorly-controlled *milpa* burning by farmers. These fires have contributed to deforestation and the degradation of soil and water resources, compromising the ability of indigenous people to support themselves from the land.

3.1 The Increasing Problem of Wildfires in the Sierra

In spite of traditional beliefs about conservation and fire control, wildfires caused mostly by agricultural burning have become an increasing problem in the Sierra over the last few decades. In the 80s and early 90s, it is estimated that fires destroyed as much as 14% of the total forested area (PSSM, 1992: 17). Agricultural burning, in fact, has been implicated in the majority of wildfires experienced throughout Mexico recently. One study done in 1993 by the government agency SARH claimed that uncontrolled agricultural burning accounted for 64% of all forest fires in Mexico, while another in the nearby state of Chiapas claimed that 55% of forest fires were attributable to agricultural burning (Flores, 1994:55).

In the Sierra as a whole, researchers consider the main ignition sources of wildfires to be the careless seasonal burning of pastures and, to a lesser extent, the burning of *milpa* plots (Gutiérrez Martínez, 1991: 3; Stuart, 1978: 124). However, in the municipality of Soteapan, where relatively little ranching is done, it is the burning of *milpa*s which farmers say is causing the most problems. Escaped *milpa* fires, called *jucti poypa* in Popoluca, are said by farmers to occur when people are not careful enough when they burn. They either do not make a firebreak or don't make one that's adequately wide and deep, and they generally do not follow the practices associated with safe burning. All of the Zoque-Popoluca farmers that I spoke to agree that there are more wildfires from *milpa* burning now than in the past. As one old man put it, "More, more, many times, yes, the fire goes."

The destruction caused by wildfires around San Pedro Soteapan and Ocotal Chico every dry season is fairly evident to even a casual observer. Damage to pine trees and undergrowth is particularly apparent in the pine forest (sp. *ocotale*) between San Pedro Soteapan and Ocotal Chico, and damage to trees, fallows, fields of grass and even *milpas* was a fairly common sight (and complaint) around San Pedro Soteapan. One old farmer told me how a fire escaped from a neighboring *milpa* this past burning season and destroyed his fallowed plot, saying that "all was burned." Another farmer with several plots along the Huazuntlan River described how a large fire, pushed by the prevailing winds, had recently swept down and passed into the dry vegetation along the banks of the river, causing considerable damage to the fallowed plot. One man from San Pedro Soteapan related how he hadn't had to perform *la quema* or formal burn on his plot for three years, because of wildfires sweeping through the area. Several farmers, in fact, related similar stories of

wildfires passing through their recently-cut *milpas* and destroying the chopped vegetation which they had left to dry before burning—an annoying occurrence for farmers, since they like to burn their *own* plots, both to control the fire and because of the enjoyment factor. Another farmer, when asked about the fire damage in the pine forest at the top of his sloping *milpa*, told me how his neighbor had cut his vegetation and was letting it dry when somebody walking along the path had set a fire in the pines and the fire had burned downslope, destroying everything in its path up to the river[1]. For those who grow green manure cover crops, wildfires which burn through their plots are particularly frustrating, since the green manure is grown so that they *don't* have to burn[2].

The general perception among Zoque-Popoluca farmers is that escaped fires occur mainly in the vicinity of San Pedro Soteapan and other large towns to the east and south where the people do not follow safe burning practices. They consider that the people of the smaller, more isolated villages to the north such as Ocotal Chico, Ocotal Grande, and San Fernando are much more careful when burning. One old farmer from Ocotal Chico told me, for example, about how a man from Mecayapan, a large town to the southeast, allowed his fires to escape three times to destroy *milpas* and coffee plots (sp. *fincas*). Many agreed that San Pedro Soteapan sustains more damage every year from fires than does Ocotal Chico, with one man estimating that there were 20 to 30 escaped *milpa* fires in San Pedro Soteapan

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1 In this case, it might have been that this farmer was trying to cover up his own careless burning practices.

2 There is a possibility that men were deliberately setting fire to plots with green manure, as suggested by a few farmers. See Chapter 4 for a more detailed discussion of green manure crops and the problems associated with their introduction.

this past burning season (1995) alone. As one man from Ocotal Chico stated:

> There are very few fires started in Ocotal Chico. When clearing a *milpa* here, we make a big firebreak, so that we don't start a fire. Fires come from the other side, from below, and by burning the land, come here.

According to researchers, the agricultural land located in the buffer and influence zones of the Sierra de Santa Marta is burned by escaped *milpa* and pasture burns every year, although it is difficult to say just how much land is affected (Gutiérrez Martínez, 1995: 80). I observed myself on several occasions wildfires in progress near San Pedro Soteapan which had obviously originated from adjacent *milpas*, running for short distances until they ran out of fuel or met with some natural obstacle. Such fires, I noticed, pass into the surrounding fallows, burning undergrowth and bushes and killing trees whose burned trunks are often left standing. On the upper slopes of the volcano, which are covered by primary forest, escaped fires appear to be a less frequent occurrence. The largest forest fires usually begin in the more populated areas to the south and east of the Santa Marta volcano, where the amount of land devoted to cattle ranching is more extensive. For example, in 1985, two large fires destroyed approximately 5,000 Ha of forest and pasture on the east slopes of the Santa Marta volcano, and 3,000 Ha on the San Martin Pajapan Volcano (PSSM, 1996: 5-26). In 1991, a series of fires again swept through the Sierra to the south and east of the volcanoes, with the largest fire destroying an estimated 3,000 Ha pasture, fallow land and forest (Paré, 1991: 2). During a reconnaissance flight which took him over an area north of San Pedro Soteapan to survey the recent fire damage, Gutiérrez Martínez estimated that fire had destroyed approximately 10% (20 Ha) of the forest in the *ejidos* of Pillapillo and Santanon

(north of Pajapan), 15% (30 Ha) on the summit of the San Martin Pajapan Volcano, and 10% (80 Ha) on the Santa Marta Volcano (Gutiérrez Martínez, 1991: 4). Concerning the latter, Gutiérrez Martínez notes that very little forest regeneration had occurred in this area since the previous fire of 1985 (ibid.). Apparently, much of the damage from the fire of 1991 occurred in these previously burned areas.

3.2 The Environmental and Human Costs of Wildfires

Farmers are well aware of the ecological and economic costs of wildfires. They say that fires "destroy all the trees and many plants die", creating areas of "pure grass", and how "soil fertility is finished." Farmers don't like having the cut vegetation of their recently cleared plots ignited by fire, saying that vegetation must be properly dried to give good ash, and provide adequate fertilization. An old man from San Pedro Soteapan told me how the loss of trees and the accompanying erosion of soil from the hillsides into the streams and rivers had caused the disappearance of crayfish and other fish. I heard a number of stories where *milpas* and fallowed plots, valued as storehouses of medicinal plants, wild food and firewood were destroyed by fires, and how farmers in Ocotal Chico were concerned every year about fires destroying their coffee *fincas* and the economic loss that this entails. The mango plantations in San Pedro Soteapan are also susceptible to fire and sustain damage every year.

Research in tropical areas has shown that fires usually begin in the flammable grasses and secondary growth that exist outside stands of primary growth forest. Penetration into these stands depends on several factors. Janzen, for example, found that if grass fuel was

moist and wind was low, fires would burn up to the edge of the forest and go out, damaging only the trees at the forest boundary (in Koonce, 1990:151). This, however, can cause enough of a disruption in the microclimate of the forest edge to expose it to colonization by grasses and herbs, making it more flammable and fire-prone for the next year (ibid.). Sparks landing in primary forest and igniting dead branchwood or snags in the upper story may have a similar effect by opening up small holes in the forest canopy (Koonce, 1990:151). If grasses are tall, if wind is strong, or if the year has been unusually dry, fire is more likely to penetrate further into the forest (ibid.). Because of increasing humidity and decreasing wind, fires die down at night, and are fanned again the following day with the return of warmer, drier, windier conditions (ibid.). Dead trees or downed logs, once ignited, can burn for days, sending sparks a considerable distance if the wind is strong.

The type of forest present and the degree to which it is disturbed will dictate the amount of damage it will sustain when exposed to fire. The first time a fire occurs in intact forest vegetation, it is usually a surface fire that burns the leaf litter and smaller plants that make up the understory. In a high, closed-canopy forest site in the Amazon, for example, Uhl observed that fire was restricted to the surface layer, killing stems of less than 5 cm in diameter but having little effect on the larger stems and trees (1985: 267). Young secondary growth forests, however, were much more prone to extensive fire damage due to the more open, windier, drier conditions and the existence of finer, more combustible fuels (ibid.). In a later study, Uhl found that mean consumption of surface fuel biomass from experimental fires was 47% in secondary growth forest, with one fire in secondary growth consuming 89% of the fuels (Kauffman and Uhl, 1990: 125).

Wildfires can have a profound effect on recovery patterns of disturbed tropical forest ecosystems, with severity, extent and frequency of fires determining the degree of change. When an area of the tropical forest is damaged, regeneration or 'succession' begins with regrowth occurring through the sprouting of stumps and underground roots, via wind and animal-borne seeds from the surrounding forest, and from the germination of seeds already in the soil. Forest fires, particularly severe ones, can impede these mechanisms of succession. In general, larger disturbances mean longer periods of regeneration, and very large disturbances can reach a point where regeneration is no longer possible (Mueller-Dombois, 1990:4).

Many species of tropical trees have the ability to survive fires through sprouting, as is demonstrated in one study from the Amazon where Kauffman reports that 64% of rainforest trees survived in this manner after a fire of low severity (1990:129). Particularly severe fires or repeated fires, however, can greatly decrease the number of individuals that sprout (ibid.). Sampaio reports that repeated burning dramatically decreased the number of plants that sprouted in an experimental site in Brazil, with only 10% sprouting after a third burn (1993:452). Kauffman argues that sprouting may be completely eliminated through post-burn disturbances such as repeated agricultural burning (1990:129).

According to Kauffman, there are a number of limitations to animal dispersal of seeds onto a burned site. For example, if the fire was particularly severe and animal habitat was completely destroyed, dispersal through this mechanism can be eliminated since animals would not venture into these areas (1990:130). Particularly extensive fires may destroy adjacent seed sources, and even when seeds do find their way to burned sites, germination

can be impeded by repeated fires, predation by insects and rodents, or inhospitable microclimates of hotter, drier conditions caused by removal of the protective forest canopy (ibid.).

Because soil acts as an effective insulator to the heat generated by forest fires, seeds stored in the soil may survive and germinate after fires. Tropical forest soils contain a large number of seeds, many of them woody species that can maintain viability for years (ibid.). Severe fires, however, can greatly reduce the number of viable seeds by increasing temperatures in the top layers of the soil. For example, Uhl reports that fire reduced the seed bank in a primary forest soil by 80% (Kauffman and Uhl, 1990:129).

What is the overall result of these effects? According to Uhl, some species will be eliminated even though succession in some form will occur following all but the most severe fires (ibid: 131). Those that survive will be those species that are adapted to the altered environments, such as successional species that are light-tolerant, produce an abundance of seeds that can be dispersed over long distances and can maintain their viability for long periods (ibid.). While grasses possess such adaptations and could be expected to proliferate under such conditions, only about 25% of primary forest tree species employ wind dispersal as a seed-spreading mechanism, meaning that many species will disappear under conditions of repeated forest fires (Koonce, 1990:153). The result is a landscape dominated by fire-prone grasses, shrubs and fast-growing, short-lived successional tree species that increase the likelihood of future fires.

The deforestation caused by forest fires in the tropics also contributes to a number of ecological changes which significantly affect hydrology, soil and climate. With less and

less water being trapped, stored and released in the disappearing forests, and less rain falling through reduction of evapotranspiration and an increase in the albedo effect, droughts become more frequent. Springs, streams and rivers are also diminished, hastened by increases in siltation brought on by the rapid erosion of unprotected soils (Cook, 1990: 205). According to Cook, clearing by burning results in an even higher rate of erosion than clearing by cutting, since it loosens the surface soil (ibid: 206). This accelerated erosion, coupled with the destruction of organic matter in the soil through repeated burning, can lead to significant soil nutrient losses, further creating an environment hostile to all but the most resilient species (Mueller-Dombois, 1990: 8).

Other effects include the loss of biological diversity, both plant and animal, either through the direct destruction associated with fires, the loss of habitat, or the breakdown of essential relationships with other species (Hecht and Cockburn, 1989: 46). Fire also contributes to global environmental problems as well. On a world-wide scale, the burning of forests contributes to the 'greenhouse effect', or global heating of the atmosphere, by releasing significant amounts of carbon dioxide into the atmosphere which acts to 'trap' incoming solar radiation (Cook, 1990: 202). This phenomenon is expected to drastically change global climatic patterns over the next few decades. Fires also release small amounts of nitrous oxide to the atmosphere, a gas which has been implicated in the destruction of the ozone layer, a protective layer of gas which shields the earth from the harmful effects of ultraviolet radiation (ibid: 204).

The deforestation to which fires make a significant contribution has had, in turn, a profound effect on the ability of indigenous farmers and their families to support themselves

from the land. Traditionally, families were able to grow a wide variety of fruits and vegetables that, along with the gathering of natural forest products, hunting and fishing, helped to provide an adequately balanced diet. However, with the recent impoverishment of the local ecology, the diversity of both the *milpa* and the forest has disappeared, and yields are declining (ibid.). For example, average corn yields in the Sierra of 3 tons/ha reported in the seventies had decreased to 1.4 tons/ha by the mid eighties, and in many areas have continued to decline to below 1 ton/ha (Sanchez and Wind, 1997: 17). The diversity of food products has also decreased considerably. Where traditionally farmers grew beans, squash, yuca, tomatoes, chayote, bananas, oranges, pineapple, camote, sugar cane, mango and jimica, they are now almost exclusively cultivating only corn and some beans (ibid.). With the loss of the forest and contamination of local rivers and streams, the availability of many edible plants, land animals and fish has also been reduced drastically.

This decline in both the productivity and diversity of *milpa* crops and wild foods has had a direct impact on the nutritional status of peasant families (Paré et al, 1994: 21). Malnutrition has become a significant problem in the Sierra, and it is not uncommon to find mothers and their nursing infants in a malnourished state (ibid.). According to Sanchez and Wind, compounding factors such as poor sanitary conditions which result in a high incidence of parasitic infections, and the very young age of mothers (12 or 13 years old) contribute to the overall effect (ibid.). In the Popoluca community of Mamaloya, for example, Sanchez found that 60% of children under the age of five were suffering from malnutrition (ibid.). A similar study carried out by Sanchez in San Pedro Soteapan and Ocotal Chico in 1994 also showed the existence of a severe nutritional problem in these towns as well (ibid.).

3.3 Summary

Wildfires caused by careless *milpa* burning have been occurring with greater and greater frequency in the Sierra over the past few decades. Despite a cultural tradition which emphasized conservation and the use of techniques to properly control fire, it seems that some farmers are nevertheless allowing their *milpa* burns to escape and damage the surrounding forest and agricultural land. According to indigenous people, wildfires tend to occur more in the vicinity of the larger population centers such as San Pedro Soteapan, where they say farmers tend to be less careful when burning than in the smaller communities such as Ocotal Chico. Fires have contributed to a number of local ecological problems, including deforestation, the diminishment of water resources, and the loss of soil fertility and biodiversity. These problems, in turn, have gravely affected local subsistence and the ability of indigenous people to adequately support themselves from the land. Crop yields and the diversity of food products have declined drastically, leading to significant levels of malnutrition among indigenous people, particularly children.

Chapter 4

DEFORESTATION AND ITS EFFECT ON FIRE CONTROL

So why are there more wildfires now than in the past? In this chapter, I show how recent deforestation in the Sierra, caused mainly by cattle-ranching and over-farming, has compromised the natural fire resistant nature of the tropical rainforest environment, rendering traditional techniques of fire control less effective than in the past. While farmers are attempting to address the situation by adapting agricultural techniques to suit the new conditions, such efforts have not, as yet, yielded any substantial results.

4.1 Deforestation in the Sierra

In the last few decades, human activities have greatly altered tropical forest ecosystems in Latin America and elsewhere in the world. Large areas of primary forest have been cleared in the name of 'economic development', with the result being a checkerboard landscape of remaining stands of primary forest, pastures, logged clear cuts, agricultural land and secondary growth forest that barely resembles the original environment. Myers estimates that of the 14.5 million sq. km of tropical forest that existed in the world, only about half remains today (1993: 9; Mueller-Dombois, 1990: 2). In Mexico, where forests cover about one-quarter of the country, the government estimates that 17 million hectares, or 30% of all forest cover was eliminated between 1970 and 1990 (Sanchez and Wind, 1997: 8). This rate of deforestation has continued into this decade, with estimates of current rates ranging from 700,000 to 1 million hectares (or 1.4 to 2%) per year (ibid.).

In the Sierra, deforestation has played, as will become apparent, a major role in the rising incidence of escaped fires in the region. Forests that once covered 150,000 Ha of the region have been reduced to less than 20,000 Ha over the last few decades (Ramirez, 1991: 1). As Table 1 below indicates, of 81,170 Ha of forest that existed in the Sierra in 1967, 61,170 Ha or 75.4% had been destroyed by 1990. At the present rate, according to Paré, the primary growth forest of the Sierra will be lost completely in 40 years (Paré et al, 1994: 20)

Table 1: Rate of Deforestation in the Sierra de Santa Marta, Veracruz, Mexico, 1967-90

Year	Forested Area (Ha)	Deforestation (Ha)	Percent of Forest Remaining	Rate of Deforestation (Ha/year)
1967	81170		-----	
1967-76	55190	25980	68	2887
1976-86	21170	34020	26.1	3402
1986-1990	20000	1170	24.6	292

source: Pare et al, 1994: Table 1, p. 20

Cattle-ranching has been the major cause of deforestation in the Sierra (PSSM, 1996: 3-39). It is estimated that, in the 1930's, 70% of the region was still covered with mature rain forest (Ramirez in Chevalier and Buckles, 1995: 193). Chevalier and Buckles recount how, at this time, recently introduced cattle were restricted to the natural savannahs on the plain to the east of San Pedro Soteapan, below the village of Pajapan between Metzapa river and San Juan Valador (ibid.). However, they explain that by the 1950s, the cattle industry

began to expand beyond these natural boundaries into areas left fallow by Nahua farmers. Indian ranchers, supported by outside *mestizo* ranchers and land authorities, simply fenced in areas left to fallow or paid farmers small sums for their fallow plots. Land was repeatedly cleared and burned to encourage colonization of pastures by local grasses. As the cattle industry expanded, more fallowed agricultural land was appropriated and turned into pasture, forcing farmers to clear forest for *milpas* further up the hillsides, in lands less suitable for farming. This land in turn was taken and converted to pasture once it was left to fallow, creating a cycle of land clearing, *milpa* cultivation and conversion to pasture that gradually pushed the forest frontier up the slopes of the volcanoes (ibid.).

In the 1960s and 70s, this cycle of clearing forest for pasture by farmers was increased by deliberate clearing for pasture by ranchers (ibid: 194). Cattle men began claiming large tracts of remaining forest for their expanding herds, with the result that huge areas of primary forest, mainly on the upper slopes of the volcanoes, were cut down (ibid.). Ramirez estimates that 15,600 Ha of forest were reduced to 550 Ha in the neighboring municipality of Pajapan between 1967 and 1976 (Ramirez, 1991: 9). In the municipality of Soteapan as a whole, the cattle industry expanded from a total of 3,721 head of cattle in 1970 to 18,880 head in 1988 (Blanco and Cruz, 1992: 61). Although the growth of ranching had begun to slow by the late 1980s, it still consumed an average of 425 Ha of forest per year between 1986 and 1990 (Paré et al, 1994: 20).

Cattle ranching, combined with population growth, has in turn put pressure on the traditional system of shifting cultivation, leading to further deforestation through over-farming (PSSM, 1996: 3-40). Between 1900 and 1995 the population of the Sierra grew

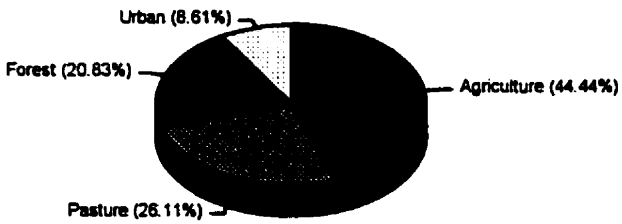
from 8,200 to 57,804 (PSSM, 1996: 4-7), significantly increasing the need for farm land. In the municipality of Soteapan, the population grew from 16 583 in 1990 to 20 736 in 1995, an annual average growth rate of 4.57% which was almost double the national rate of 2.5% for the same period (ibid.). This population increase, along with the appropriation of forest for ranching has resulted in a shortage of agricultural land. Farmers have not only been forced to clear forest in the more remote, agriculturally marginal areas of the Sierra, they have also been forced to cultivate the established agricultural land in these zones more intensively (Buckles and Erenstein, 1996: 9).

The key to slash and burn systems of land management is allowing an appropriate amount of time for abandoned plots to regain agricultural potential through the growth of secondary vegetation (ibid: 7). However, with less and less land available to a growing population, farmers can no longer properly rotate their fields to allow land to regenerate. Fallow times that traditionally lasted 7 or 8 years have been cut in half, and farmers are planting in areas that have not yet recovered from previous periods of cropping (ibid: 9). According to a study done in 1993, only 41% of farmers in the Sierra were allowing fallow times of three years or greater, with fallow times having been reduced by as much as 50% in most areas (Buckles in Paré et al, 1994: 25). Farmers of the influence zone fallow land for an average of only two years now, and those in the buffer zone for only four years, a situation which has led to impoverishment of fallows and deforestation (Buckles and Erenstein, 1996: 9). The problem has been exacerbated by a government subsidy program known as PROCAMPO, which grants money to farmers based on the amount of land they have under *milpa* cultivation. Although implemented with good intentions, the program has,

in fact, inadvertently encouraged farmers to clear and burn more land than is necessary for their immediate subsistence, as they try to maximize the money they receive (PSSM, 1996: 4-88).

In the *ejido* of San Pedro Soteapan, virtually all of the primary forest cover has been lost over the last several decades. Although 20% of *ejido* land was classified as forested in 1991, this forest cover was comprised mainly of immature stands of secondary forest and brush (Blanco, 1994a: 15, Table 4). Land-use is dominated by agriculture and, to a lesser extent, small-scale ranching. For example, as Figure 3 indicates, in 1991, 44% of *ejido* land was under cultivation, while approximately 1000 Ha or 26% was used as pasture. An area once forested is now dominated by *milpas*, fields of grass, cow pastures and very immature fallows of secondary growth.

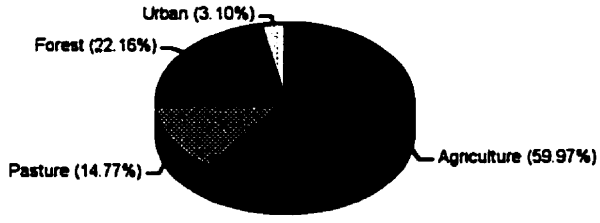
Figure 3: Land-use in San Pedro Soteapan, Veracruz, Mexico 1991



source: Blanco, 1994a: Table 4, p.15

Ocotal Chico has also lost a good portion of its primary forest cover, although deforestation is not quite as severe as in San Pedro Soteapan. In 1991, 22% of *ejido* land was classified as forest, with the stands generally of greater maturity and quality than those of San Pedro Soteapan (Blanco, 1994a: 15, Table 4). Land-use here is also dominated by agriculture, with coffee cultivation taking up more land than corn, and pasture accounting for even less land than in San Pedro Soteapan. For example, in 1991, 536 Ha or 36% of *ejido* land was devoted to coffee, while 276 Ha or 20% was devoted to corn and 200 Ha or 13% of land devoted to pasture (Blanco, 1994b: 23, Table 8).

Figure 4: Land-Use in Ocotal Chico, Veracruz, Mexico 1991



source: Blanco, 1994a: Table 4, p.15

As one farmer's testimony illustrates, indigenous people of the Sierra are acutely aware of the changes that have occurred to the forest in the last few decades:

> When I was younger, the forests were much closer. And the fallows were more mature...But since 1976, it has been changing, because they've been clearing the forest. (PSSM, 1994)

4.2 Relationship Between Deforestation and Wildfires

According to researchers and farmers, ranching and over-farming in the lowland zone of the Sierra have created an environment that is very susceptible to wildfires (Paré, 1991: 3). A number of local men told me how the area around San Pedro Soteapan has become 'pure grass' (sp. *puro zacate*), and how such a landscape is much more susceptible to escaping fires than the relatively less-damaged forests and fallows of Ocotal Chico. Removal of the forest canopy has created microclimates of hotter, drier, windier conditions which quickly dry out potential fuels in stands of uncut forest and fallow fields. Fires are greatly influenced by climatic factors, particularly temperature and rain (Koonce, 1990: 141). According to one study done in the Amazon, areas where 50% or more of the forest canopy was removed experienced increases of as much as 10°C in average daily temperature, while mean midday relative humidity decreased by as much as 35% (Kauffman and Uhl, 1990: 124).

These activities have also created potential fuels by inhibiting the regeneration of mature forest. In the case of ranching, under the repeated cycle of burning to remove invading weeds and over-grazing, the soils have become compacted and nutrient levels reduced through leaching and erosion (Loker, 1993: 18). Coupled with the hotter, drier conditions, it becomes impossible for the seeds of many species of trees to germinate, making it difficult for forest plants to recolonize former pasture areas. The situation is exacerbated by the destruction of potential sources of seeds, since many which are stored in the soil are destroyed through repeated burning, and trees that might have been a source of airborne seeds have been cut down. These processes have, in fact, permanently removed

many tree species from the local environment (Chevalier and Buckles, 1995:194). Similar effects have been recorded in other areas of Latin America where ranching is practiced. For example, in the Peruvian Amazon, Loker found that secondary growth was greatly inhibited in former pastures, both with respect to number of species and overall biomass, as compared to fields abandoned after annual cropping (1993:20). Another study in the Amazon found that, after 8 years of abandonment, a heavily-used pasture had developed only 10% of the biomass produced by a lightly-used pasture in the same area (Uhl, Buschbacher, and Serrao 1988). Over the long term, this process of degradation results in what Loker calls a 'green desert', a landscape of stunted secondary growth permanently dominated by herbaceous plants such as grasses and a few widely scattered pioneer tree species (Loker, 1993:22). Such an environment, needless to say, becomes an extreme fire hazard when coupled with the hot, dry, windy conditions that become prevalent.

The degradation of land through over-farming, a factor of relatively greater importance than ranching in the area surrounding the towns of San Pedro Soteapan and Ocotal Chico, leads to similar ecological effects. While the tradition of burning slashed secondary vegetation is an ecologically sound strategy for management of mature fallows, it loses its adaptive features when fallow times are too short to allow significant regrowth (Buckles and Erenstein, 1996: 12). When the grassy, impoverished fallows which now dominate the lowland zone are cut and burned, they provide very little ash to fertilize crops, meaning that crops must draw on the limited store of nutrients in the soil (ibid.). This results in loss of soil fertility as the successive cropping cycles mine certain nutrients from the soil that are not replaced through the plant-to-plant process of nutrient transfer

characteristic of the traditional milpa (ibid.). Leaching and erosion are in turn accelerated as soils become exposed to rainfall, and long-term recovery is inhibited. Regeneration of fallows is consequently stunted and incomplete, and is dominated by grass species rather than the tree species, shrubs and herbaceous plants that recolonized the traditional milpa (ibid.). Once again, the landscape which is produced through these processes is very susceptible to wildfires.

Finally, deforestation has also been linked to large-scale processes such as decreasing rainfall and drought, in that it reduces the contribution of plant evapotranspiration to atmospheric moisture (Cook, 1990: 205). This, along with an increase in the 'albedo effect', in which the increase in reflected sunlight from denuded land affects the formation of rain clouds, can contribute further to the drying process (ibid.). Both researchers and local farmers agree that drought has played a significant role in the incidence of wildfires. For example, the huge fire which swept through the Sierra in 1985 was blamed in part on the drought conditions at the time (Paré, 1991: 2). The deforestation caused by fires in turn contributes to the ecological changes caused by ranching and over-cultivation, creating a positive feedback loop which further enhances the possibility of more fires and land degradation.

4.3 The Decreasing Effectiveness of Traditional Fire Control

These profound changes to the local ecology have had a direct impact on the effectiveness of traditional fire control methods as described earlier. Indigenous knowledge systems, as explained earlier, are dynamic and creative systems, constantly generating new

knowledge and practices or incorporating outside knowledge to meet new environmental circumstances. However, this ability to adapt has its limitations, particularly when environmental change is rapid or drastic. Under such conditions, knowledge which developed under a certain set of ecological conditions may be rendered irrelevant or inappropriate in the drastically altered environment.

In the case of Zoque-Popoluca farmers, while there may have been less danger of *milpa* burns spreading in the past due to the fire resistant nature of the rainforest ecology, the change to a drier, windier, 'checkerboard' landscape dominated by highly combustible immature fallows, *milpas* and fields of grass, has made burning a much more dangerous undertaking. With more people farming, *milpas* are crowded together, with no natural firebreaks such as stands of forest or mature fallows separating them, with the result that fires can spread without any natural barriers to hinder them. As one man from San Pedro Soteapan puts it, "when a fire escapes, it just keeps going." Traditional techniques of fire control were not designed to operate under such conditions, and they are no longer always adequate to stop fires from spreading in this altered environment. For example, the tradition of burning established *milpa* and immature fallows with few safety precautions can be seen as a dangerous holdover from a time when such burning did not pose a threat to the surrounding intact rain forest. Some men recognize this, arguing that nowadays one must *always* make a firebreak and burn with enough helpers, regardless of terrain type. For the most part, though, more effective techniques to deal with the changing situation have been slow to develop, and people have not yet adjusted their behavior to the new conditions which now prevail. As a woman from San Pedro Soteapan notes:

> The situation is bad because...since we are in a tropical area, and the rains are constant they still say 'let's go and drop a match, we're going to burn because after it rains, and the trees turn green again, more trees will be born.' (PSSM, 1994)

The environmental degradation associated with deforestation has had a psychological effect as well, which further contributes to the possibility of fires occurring. Forests and fallows, once valued as important sources of wild food, medicines, firewood and as 'storehouses' of future corn crops have been degraded to the point where they contain little more than a few bushes, grasses and weeds. The result is a decreased motivation to preserve them, since the perception among farmers is that there is nothing of value left to save.

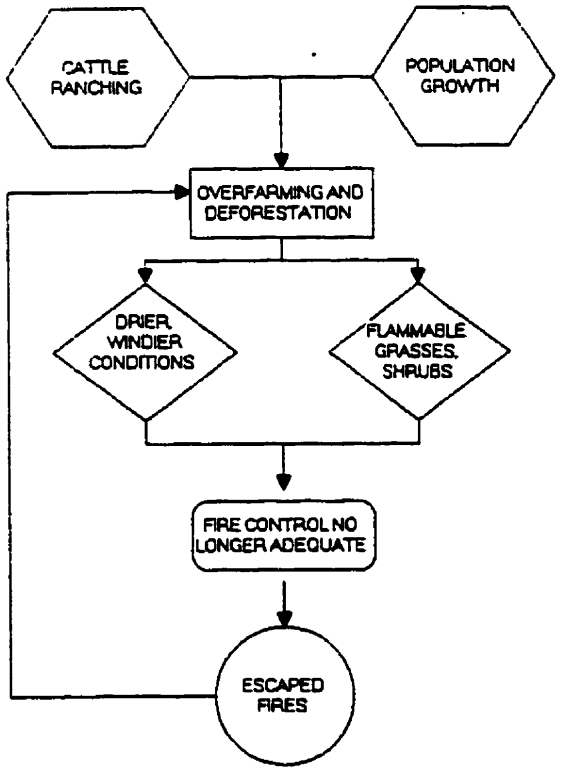


Figure 5: Deforestation and its Effect on Fire Control, Municipality of Soteapan, Veracruz, Mexic

Key: causes are indicated by hexagons; problem by rectangle; outcomes by diamonds; and effects by oval and circle

There has, however, been some innovative response to the problem from some farmers in the last few years. For example, a few men have begun constructing firebreaks not only to contain their own fires, but to keep escaped fires from entering their plots. One farmer told me how he and his neighbors had begun constructing a large fire break encompassing all of their *milpas*, in order to protect them from approaching fires. Others say that even these measures are no longer enough: the combination of dry grass and windier conditions from the more open terrain, particularly around San Pedro Soteapan, mean that the odds are high that sparks will escape and ignite the surrounding vegetation. One old farmer told me how a wildfire passed through his *milpa* even though he had made a firebreak for protection, saying that "the wildfire did not respect the firebreak." The lack of technical innovation in fire control is not particularly surprising, however, given that there are few alternatives to choose from, other than an intensification of existing techniques. Exacerbating the situation is the fact that, like their Nahua neighbors as described by Stuart, Zoque-Popoluca fire-fighting techniques are very rudimentary, and have probably never been a particularly important part of their tradition (Stuart, 1978:126).

Some farmers have also been experimenting with a 'green manure' system which does away with agricultural burning altogether. In San Pedro Soteapan, farmers have discovered through their own observations of fallow regeneration that the leafy legume known as velvetbean or locally as *picapica* smother weeds and improve soil fertility (Buckles and Erenstein, 1996: 18). A number have begun to deliberately cultivate this plant in fallows to improve land and soil quality, a practice which has become known as "making a fallow field" (ibid.). When a fallow consisting of velvetbean is ready to be planted with

corn, the velvetbean is simply slashed and the corn is planted into the mat of decomposing leaves and vines, doing away with the necessity of burning (ibid.). This system, in fact, seems so promising as a means of improving land quality and halting the destruction associated with wildfires that researchers in the area have begun an extension program to promote its use along with *Mucuna pruriens*, a similar green manure crop. However, the program has met with several stumbling blocks. For example, researchers and extension workers have found the practice of burning to be deep-rooted and difficult to change, so that some farmers who grow the green manure crop are still burning it prior to planting (ibid: 22). As well, even when farmers do preserve the slashed residues of the crop, it is often the case that a neighbor will, either deliberately or accidentally, burn the residues for them. I spoke to several farmers in both San Pedro Soteapan and Ocotal Chico, in fact, who claimed that their green manure crops had been burned by a neighbor's fire which had gone out of control into their own plots.

4.4 Summary

Deforestation and its accompanying effects have drastically altered the natural environment of the Sierra, destroying it's natural resistance to fire and creating a landscape in which wildfires are becoming increasingly common. Traditional techniques of fire control, adequate under past ecological conditions, have become increasingly unsuited to the changing environment and have been slow to adapt to the exigencies forced by this recent degradation. The increasing incidence of wildfires can be blamed, at least in part, on the continuing use of knowledge that is no longer adaptive under the new conditions of

environmental degradation. This problem has been felt more keenly in San Pedro Soteapan than in Ocotal Chico since its *ejido* land has suffered a relatively higher degree of deforestation, making it more difficult to control *milpa* burning using a traditional approach.

Chapter 5

CULTURAL CHANGE AND ITS EFFECT ON FIRE CONTROL

In the previous chapter, I explained how deforestation has rendered the technical knowledge of safe burning held by farmers inappropriate and even maladaptive in the altered environment of the Sierra. In this chapter, I will discuss how key features of traditional Zoque-Popoluca culture have been transformed by wider economic, political and social forces, ultimately weakening the traditional conservation ethic and motivations to protect the land from wildfires. Although difficult to quantify, the effect of these forces has nevertheless been significant, and a way of life once characterized by reliance on the land and a willingness to protect it for the benefit of all has been greatly undermined, increasing the chances of *milpa* fires escaping.

5.1 Effects of the Market Economy

Moving from a subsistence economy to one based on cash greatly alters how indigenous people relate to each other and to the land (Bodley, 1990: 114). Relations of production and social institutions become modified, and traditional attitudes, beliefs, values and customs change and become more and more difficult to maintain. Participation in wage labor and other cash-earning activities of the regional market economy has had two effects on indigenous culture in the Sierra that are significant in the context of wildfires. First, traditional labor reciprocity is breaking down. People are becoming less reliant on other community members for their survival, and less inclined to offer their labor to relatives or

neighbors for free, making it more difficult for farmers to find enough help to properly control fire. Second, traditional ties to nature are being eroded. Some people are becoming less dependent on the land to make their living, weakening their motivations to protect it from wildfires.

The Cash Economy in the Sierra

While forced labor had been introduced by Spanish colonialists into Mexico as early as the seventeenth century, it was not until the mid twentieth century that the cash economy began to have a truly fundamental impact on the way local people made their living. With the expansion of the cattle industry over ever larger areas of land beginning in the 1950s, more and more farmers have turned to wage labor to supplement subsistence agriculture (Blanco and Cruz 1992: 57). The growth of cities such as Minatitlan and Coatzacoalcos to the south of the Sierra as important industrial centers, and the construction of a major roadway linking Minatitlan with San Pedro Soteapan in 1964, have afforded increasing opportunities for local people to find work. Over the last few decades, a significant number of people have traveled to these urban centres to work in the construction, oil and ranching industries, while still others have become involved in the cash economy through craft work or petty trade (ibid.). In 1995 for example, the main sources of cash income in the Sierra were, in order of importance, the selling of agricultural products and handicrafts, wage labour and the selling of livestock and associated products (PSSM, 1996: 4-22).

In San Pedro Soteapan, the significant growth in population over the last several decades and resulting land scarcity has forced many families to look for alternative means

of supporting themselves. While traditional *milpa* farming continues to form the basis of local subsistence, a good portion of families now receive income from other agricultural and non-agricultural activities. Greater accessibility to the more populous industrial centers to the south as well as to other farming communities has meant that there are more opportunities for residents of this town to work as wage laborers than those in Ocotal Chico. For example, as Table 2 below indicates, in 1994 46% of farmers in San Pedro Soteapan worked at some time during the year outside of their own *milpa*s. In an earlier study done in 1992, Jimenez-Lopez found that 33.6% of people in San Pedro Soteapan were employed off-farm in positions such as laborer and servant (Jiminez-Lopez, 1993: Table 9). While a few have also turned to cattle-ranching and plantation cropping of papaya, such activities are practiced on a small-scale in San Pedro Soteapan.

Table 2: Farmers Who Work Outside of the *Milpa*, San Pedro Soteapan, 1994

Type of Work	Percent of Farmers
no work	54%
laborer	35%
fishing	6%
promoter	3%
teacher	1%
store merchant	1%

source: Pare et al, 1994: appendix 11

In Ocotal Chico, the modern era has been characterized by the growth of coffee production as the principle economic activity in the area. Here as well the increasing population, which grew by 325% between 1930 and 1960 and by 59% between 1960 and 1990, and lack of land created a shortage of good-quality land for *milpa* agriculture (Blanco, 1994b: 22). However, farmers in Ocotal Chico have been able to turn to coffee production as an alternative survival strategy, a decision that was reinforced by government support programs for coffee growers in the 70s and 80s. Although virtually all families continue to rely to some extent on the *milpa* for subsistence, corn production has dropped dramatically and self-sufficiency in this staple crop has been lost (ibid: 23). Farmers now rely to a large degree on the cash they earn from coffee production to buy food to supplement what they grow in the *milpa*.

The Decline of Traditional Reciprocity and 'Mano Vuelta'

This partial involvement in the regional cash economy has had a significant impact on collective labor practices, ultimately affecting the availability of men and women to perform proper fire control practices. Traditional subsistence labor, which is organized along ties of kinship, has been relegated to a subordinate position under the new market economy, and has been modified to fit its requirements (Chevalier and Buckles, 1995: 241). In the past, the work associated with subsistence agriculture was communal, with individual participation being rewarded through a share in the overall benefits. All household members contributed in some way to the workload, and each contribution was shared by the entire group (ibid.). This labor co-operation extended between households as well. Through the

traditional reciprocity network of *mano vuelta* or 'return hand', farmers could solicit the unpaid labor help of relatives, friends or neighbors with the simple understanding that such labor would be returned in kind in the future (Félix-Báez, 1973: 112).

The cash economy, however, has changed these relationships, making people less reliant on other community members for their survival. A person's labor is no longer something that is offered for free for the benefit of the family and community, but something that is increasingly sold for cash for individual gain (Chevalier and Buckles, 1995: 241). Earnings are now *personal* wealth controlled by the *individual* who can dispose of it in any way chosen. For example, in the Sierra it is mostly men who participate in wage labor, and in many cases their earnings are not used to meet the basic needs of the family (ibid.). Men see money as a means of reducing their dependency on their wives' subsistence labor and their daily obligations towards family life and the household economy (ibid.). Oftentimes, cash earned by men is so limited that it is spent on meeting their own basic needs, to the detriment of properly providing for the members of their household (ibid.).

The result, according to Chevalier and Buckles, has been a "fragmentation of family solidarities" (ibid.). Traditional obligations and responsibilities that family members had towards each other and to the wider community are collapsing under the selfish new attitudes that have developed. The traditional kin group, once based on an extended model which identified distant relatives with the same terms used for members of the nuclear family, has increasingly been reduced to its narrowest definition of a nuclear family consisting of parents and their immediate children (ibid.). Individuals are becoming indifferent towards the communal aspects of subsistence, relying less and less on ties of

kinship to meet their needs, and less inclined to offer their labor for free.

This loss of solidarity has implications for the occurrence of wildfires. As explained earlier, farmers rely on the custom of *mano vuelta* for the labor-intensive tasks associated with proper fire control. However, as a number of farmers told me, it can be difficult now to find enough helpers to build a proper firebreak and perform all of the other tasks associated with controlling a burn. With the greater emphasis on paid labor and individuality, it is becoming more and more difficult to find a body of people willing to help simply as a 'favor' to be returned in the future. This effect is particularly apparent in San Pedro Soteapan, where participation in wage labor and the market economy of the region is relatively higher than in the smaller, more isolated village of Ocotal Chico. In fact, farmers from both towns say that there is more 'organization' and a greater sense of 'community' in Ocotal Chico than in San Pedro Soteapan. As a man from Ocotal Chico relates, "here there's a lot of support. We help each other a lot". Farmers agree that this solidarity is lacking in San Pedro Soteapan. As one man puts it:

> Almost all of the people [in San Pedro Soteapan] say now that it [being careful when burning] is not important. There's no order in San Pedro Soteapan, they lack organization.

Wage labor has a further effect on the possibility of obtaining *mano vuelta* as well, in that it draws men away from their own communities, reducing their availability as potential helpers and creating a labor shortage (Buckles and Barreto, 1995: 275). This problem is particularly acute during the summer, when wage work associated with the main corn crop of the year, the *temporal*, is readily available in nearby communities. Once again,

this factor would have more of an impact in San Pedro Soteapan than in Ocotal Chico because of the greater accessibility of other towns where work can be found.

Decreasing Dependency on the Land

Involvement in the cash economy is also decreasing, for some families, the reliance on subsistence agriculture, disrupting traditional ties to the land and undermining the traditional conservation ethic. Although many households still produce corn for their own use, more and more families in both villages are now buying corn that has already been processed into dough or finished *tortillas* from the *tortilleria* in San Pedro Soteapan, where corn flour imported from outside the area is used (Blanco and Cruz, 1992: 58). Other staples, such as beans and vegetables, which are no longer cultivated in many *milpas*, are being bought as well. The result has been a weakening connection to the natural environment and a decreasing motivation to preserve it. The participation of people in off-farm economic activities, while having the potential for conservation of the natural environment by decreasing the demands placed upon it, may in fact lead to greater levels of degradation as the link between land and livelihoods is weakened. As I was told on numerous occasions by farmers, a growing number of people don't care now if their *milpa* fires escape and damage the surrounding fallowed land and are not interested in investing effort into more careful fire control methods. Such an effect would be stronger in San Pedro Soteapan, where there is more involvement in off-farm activities and thus a relatively greater number of people who would not rely exclusively on subsistence agriculture for survival. In Ocotal Chico, while there may be less reliance on the *milpa* because of the cash that

coffee cultivation brings in, there is still, nevertheless, strong incentive to protect the environment for the sake of the coffee. The people of Ocotal Chico are described as being much more responsible when burning, and this is often attributed to the fact that they must protect the valuable coffee crop, a motivating factor which is lacking in San Pedro Soteapan since very little coffee is grown.

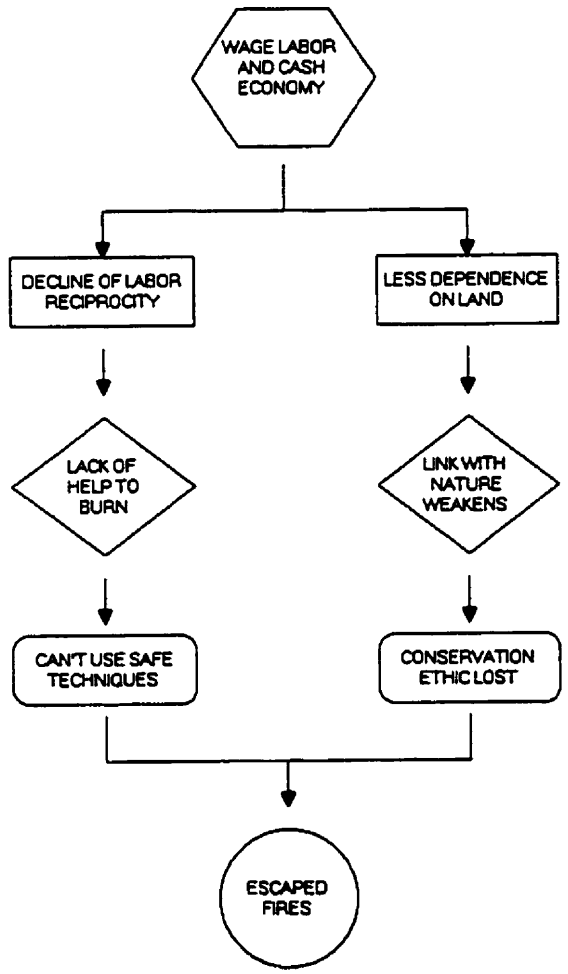


Figure 6: The Market Economy and its Effect on Fire Control. Municipality of Soteapan, Veracruz, Mexico

Key: cause indicated by hexagon; problems by rectangles; outcomes by diamonds; and effects by ovals and circle

If a coffee *finca* is damaged by an escaped *milpa* fire in Ocotal Chico, the man responsible must compensate the owner for his losses, an arrangement which acts as an effective deterrent to careless burning, according to my collaborators. As one old farmer from Ocotal Chico told me:

> I always, all the time make a firebreak, so that I'm not going to burn someone's [coffee] *finca*, because now it's difficult to pay because it costs so much. Because of this, I'm afraid to not make a firebreak. I have to make it, because there's no way I'll be able to pay [for damages]...those who are careless have to pay, but almost everyone makes a firebreak, and there's almost no troubles from burning *fincas*.

5.2 Effects of Agrarian Reform Laws

Government land policies have also contributed to the weakening of traditional attitudes towards conservation and community responsibility as well. The Agrarian Reform legislation of the twentieth century has disrupted the traditional system of land tenure and inheritance, alienating many farmers from lands which their ancestors have cultivated for generations. The certainty that a man would be able to farm his land for life and then pass it on to his descendants has been lost, and with it a crucial incentive for conservation.

Traditionally, the Zoque-Popoluca believed that all community members should have the right to make a living from the land and that all had a responsibility to preserve it for future generations. Land and resource tenure were based on a system of common property under which every family in a village held rights of access and usage (PSSM, 1996: 3-5). Land was not owned privately by individuals, but held collectively by the community, with each farmer guaranteed agricultural land based solely on community membership (Félix-

Báez, 1972: 114). Resources were thus governed through a system of collective stewardship in which there was concern at the village-level for collective sustenance and ecological conservation. While there was no private ownership of land, a farmer did gain perpetual use rights over a particular piece of land by clearing it from forest and planting it with crops, and was allowed to pass these rights on at his death, usually to a son or other relative (Stuart, 1978: 35). With the knowledge that land would be passed on to his descendants, a farmer was highly motivated to take proper care of it.

After the Mexican Revolution of 1910-21, the newly-formed Institutional Revolutionary Party (PRI), passed a crucial piece of legislation concerning agricultural lands which had come to be concentrated in the hands of a few during the earlier regime (Chevalier and Buckles, 1995: 30). Under the new Agrarian Reform laws, communities could petition for a collective land grant called an *ejido*, which would be divided up into individual parcels among *ejidatarios* from the community who would have exclusive legal rights to work a specific parcel of land (ibid: 32). According to the law, each *ejidatario* was entitled to a parcel of between 10 and 20 Ha, depending on land quality and whether or not it was irrigated (ibid: 33). However, in practice the plots distributed were often much smaller than required under the law, because the time lapse between a petition for a land grant and its resolution by the government often spanned decades, during which time farming populations increased (ibid.). For example, in San Pedro Soteapan, 32 years elapsed between the time of the initial request for 3600 Ha of *ejido* land to be distributed among 174 *ejidatarios* (for an average of 20 Ha each) in 1931 and the official resolution in 1963, during which time the population had tripled (Félix-Báez, 1973:84). Ocotal Chico experienced

similar problems, with 55 men requesting 1354 Ha in 1937, gaining official approval in 1962 after the population had quadrupled over the 25 year interval (Blanco, 1994b: 15).

The result, in both *ejidos*, was that there was simply not enough land to go around, and two new categories of farmer, which did not exist under traditional forms of land tenure developed: those with official legal rights to land (sp. *ejidatarios*) and those without (sp. *avecindados*) (PSSM: 3-17). Unlike the old system of communal property management which recognized the usufruct rights of all villagers, the new one represents a more formalized system of rights based on membership. Under the new system, membership has replaced citizenship as the defining criterion for establishing rights to farm *ejido* lands. Laws governing the inheritance of land stipulate that only one son can inherit the legal rights to a father's land, making any other sons legally landless. In practice, though, these landless sons often work farmland held by family members who hold legal title, in exchange for labor, a share in the harvest, or cash (Buckles and Erenstein, 1996: 5). In San Pedro Soteapan, the number of legally landless *avecindados* equals the number of *ejidatarios*, while in Ocotal Chico, only 40% of farmers are *ejidatarios* (Blanco, 1994a: appendix, table 6.42).

This lack of legal rights to land for a large percentage of the population ultimately has implications for environmental conservation and the prevention of wildfires. *Avecindados* may not be as motivated as *ejidatarios* to follow safe burning techniques and preserve the land, since they do not legally 'own' it and cannot therefore pass it on to their descendants. Their 'stake' in the land has been weakened, and with it the incentive to save it for future generations. More recent applications of the Agrarian Reform laws have

contributed further to this erosion of the conservation ethic. Land in San Pedro Soteapan and Ocotal Chico is only now undergoing the legal process of parcelization and redistribution, and there are no guarantees that farmers will be allotted the land that they are currently farming. Motivation to burn plots carefully may therefore be lacking in that farmers may be reluctant to invest work in preserving land that they may be forced to move from in the near future.

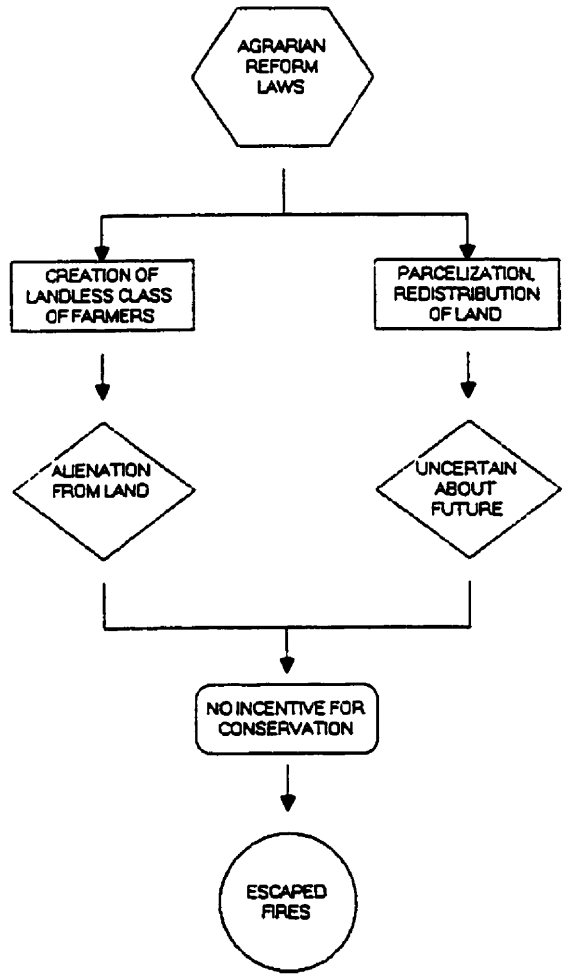


Figure 7: Agrarian Reform and its Effect on Fire Control, Municipality of Soteapan, Veracruz, Mexico

Key: cause indicated by hexagon; problems by rectangles; outcomes by diamonds; and effects by ovals and circle

As Buckles and Barreto put it, "farmers are not disposed to invest in a resource conservation technology that will produce long-term benefits if they don't have secure access to a farm plot" (1995: 280).

The sale of property is also adding to the decline of family and community solidarity. Land that traditionally had to pass from father to son can now be sold for cash to the highest bidder, resulting in intense rivalries within and between families as relatives compete with each other to purchase land (PSSM, 1996: 3-16). For example, I know of one incident where two brothers became embroiled in a machete fight over who would take over their father's plot, with one brother losing a hand.

5.3 Effects of Christianity and State Education

Finally, the transfer and imposition of European religion, language and values as well has had an effect on the traditional conservation ethic and motivations to follow safe burning practices. Local people, particularly children, are being alienated from the traditional values and spiritual beliefs of their ancestors, resulting in grave consequences for the environment and its preservation. Respect for nature and, indeed, respect for traditional spirituality has been greatly eroded by these powerful social forces, helping to foster an attitude of apathy towards control of wildfires.

Christianity

The Spanish began the process of converting the indigenous population of Southern Veracruz to Christianity almost immediately upon their arrival in the early sixteenth century.

Only a few years after the *conquistadores* landed, there is evidence that missionaries were encouraging indigenous groups such as the Zoque-Popoluca to abandon traditional spiritual belief systems in favor of Christian doctrine (Félix-Báez, 1973: 65). By 1534 the parish of Oaxaca, which included the south of present-day Veracruz, was founded, and reference is made to five Christian friars who were sent to the town of Coatzacoalcos to convert indigenous peoples (ibid: 65). Christianity continued to spread and flourish throughout Mexico over the next few centuries. In the Sierra, while there were few Spanish colonists actually settling in the region, infiltration of the new religion was still very much a reality, as evidenced by the large bell in the Catholic church of San Pedro Soteapan, which is inscribed with the date of its arrival in the town in the 1780s (ibid: 73). Today, the people of the Sierra are considered to be Christian, although there are a variety of denominations and sects represented. In San Pedro Soteapan, 80% of the population is Catholic and 20% Pentecostal, while in Ocotal Chico, Protestantism dominates (Jimenez-Lopez, 1993: 9).

The introduction of Christianity, with its doctrine denouncing all other forms of faith has had, needless to say, an overwhelmingly negative impact on the traditional worldview of the Zoque-Popoluca (Félix-Báez, 1973: 184). For example, Christian missionaries quickly moved to replace what they perceived to be immoral matrimonial practices, banning cross-cousin marriage outright as "incestuous" and denouncing polygyny as offensive to Christian morality, leading to a significant decrease in these forms of union (ibid.). Other areas of traditional spirituality were also attacked as immoral and denounced, and few but Elders still follow or will admit to knowledge of the ancient gods and spirits. Sacred rituals which in the past played an integral role in spiritual life are being forgotten or practiced in

an attenuated form. For example, as early as 1940, Foster argued that the Virgin Carmen had supplanted *Homshuk*, the God of Corn as the most powerful patron of good crops, with farmers traveling to Catemaco every year at Easter to pay their respects to her (Foster, 1940: 42). During fieldwork in 1972, Félix-Báez observed that, although the ritual associated with corn planting, *La Siembra de la Siete Dias*, was still being practiced, it was only being done by the eldest men of the community, and its overall importance had been greatly reduced (1973: 98). According to Stuart, younger men were often ignoring the traditional custom of asking permission from the *Chaneco* before hunting in the forest (1978: 189). Elders, in fact, are increasingly held in contempt by the younger generations for clinging to what the young see as outdated beliefs. Blanco describes the recent tension in San Pedro Soteapan between Elders who still believe it necessary to follow traditional rituals such as the ceremony of the *Xocas*, and the younger men belonging to a Catholic sect who feel it a waste of time and money, saying that "only the old people still believe in praying to natural spirits" (1994a: 19).

State Education

Along with European religion, state-run schools have been another major means of culturally assimilating indigenous populations throughout Mexico (Chevalier and Buckles, 1995: 262). Schools emphasizing the Spanish language and *mestizo* values are common now in many towns of the Sierra, and virtually all of the indigenous population is now considered to be bilingual. According to researchers, formal education has been used by the government as an instrument to integrate the indigenous people of the Sierra into the

national culture (PSSM, 1996: 4-10).

While state-run schools have been established in both San Pedro Soteapan and Ocotal Chico, there are more schools, higher rates of literacy and slightly higher rates of bilingualism (Spanish and Popoluca) in San Pedro Soteapan, leading one to believe that enculturation through formal education has been felt more strongly here. San Pedro Soteapan has five schools—two preschools, two primary schools and one secondary school—which had a total student population of 900 in 1992 (Jiminez-Lopez, 1993:28). As Table 3 below indicates, the rate of literacy for children between the ages of six and fourteen stood at 65% in 1990, with 98% of the population considered as bilingual. Ocotal Chico, on the other hand, has only one preschool and one primary school, with only one young man attending secondary school at the time of my fieldwork. The rate of literacy for those between the ages of six and fourteen was significantly lower than that of San Pedro Soteapan in 1990, with bilingualism rates slightly less as well (ibid.).

Table 3: Rates of Literacy and Bilingualism in San Pedro Soteapan and Ocotal Chico, 1990

	San Pedro Soteapan	Ocotal Chico
literacy (6 to 14 yrs.)	65%	38%
literacy (over 15 yrs.)	49%	45%
bilingualism	98%	89%

Source: Blanco, 1994a: Table 6.30 and 6.41, appendix

The growing use of television and radio in the last few years has increased exposure to national culture even further. A significant number of households now have radios, and more and more are purchasing television sets, particularly in San Pedro Soteapan, so that virtually all have some degree of access to local and national broadcasts. For example, during my fieldwork I was struck by the popularity of nationally-produced 'soap operas', and recall on several occasions how people would cluster around t.v. sets when such shows aired. Television and radio are fast becoming a primary means of socialization, usurping the role that the telling of traditional myths and legends by Elders once played in imparting values to the young.

The educational system has had, like the church, a detrimental effect upon fundamental aspects of indigenous culture. By stressing the teaching of the national language and system of values, schools are fostering growing feelings of shame and embarrassment among children over their own ethnic heritage (Chevalier and Buckles, 1995: 262). In San Pedro Soteapan in particular, adolescents refuse to speak the Popoluca tongue. A complete lack of respect for many aspects of traditional culture is developing, making children less receptive to traditional ethics and spirituality as taught by Elders. A barrier is forming between the older and younger generations, making the oral transference of traditional beliefs and values that much more difficult, a difficulty compounded by the fact that, with children attending school, there is simply less opportunity to spend time teaching and socializing young people.

The Loss of Traditional Spirituality and the Conservation Ethic

This erosion of indigenous culture and the traditional worldview through the influence of national religion and education has had, in turn, far-reaching consequences for the environment and fire control. As described earlier, Zoque-Popoluca beliefs about nature and rules governing its use are embodied in myths and rituals associated with gods and natural spirits such as *Homshuk* and *Chaneco*. Through these myths and rituals, the Zoque-Popoluca affirmed and passed on their ancient respect for the environment to the next generation. In superimposing itself upon a traditional belief system which saw nature as sacred and humans as intimately interrelated with all species, the Christian church is contributing to a philosophy which places humans at the apex of a hierarchical classification of nature, separating them from the natural world and giving them dominion over all of its parts (Livingston, 1994: 57-58). More and more this philosophy, so fundamental a part of the ideology of capitalism, is undermining traditional Zoque-Popoluca relationships to nature, especially amongst children too young to have been fully socialized into ancient ways of thinking. Under its influence, as Suzuki puts it, the natural world is conceptualized increasingly as an object *sui generis*, towards which there is little respect:

> We are strangers in the world; we no longer belong. Because it is separated from us we can act on it, abstract from it, use it, take it apart; we can wreck it, because it is *another*, it is *alien*. (1997: 191)

People are becoming disconnected from the environment and their traditional community values, and with this disconnection comes a lack of empathy. People care less about preventing ecological damage, and are less inclined to devote time and energy to

conservation measures such as fire control. In the more isolated towns such as Ocotal Chico, where there is less participation in the market economy and schools and more reliance on making a living from the land, the effect would be mitigated to a certain degree.

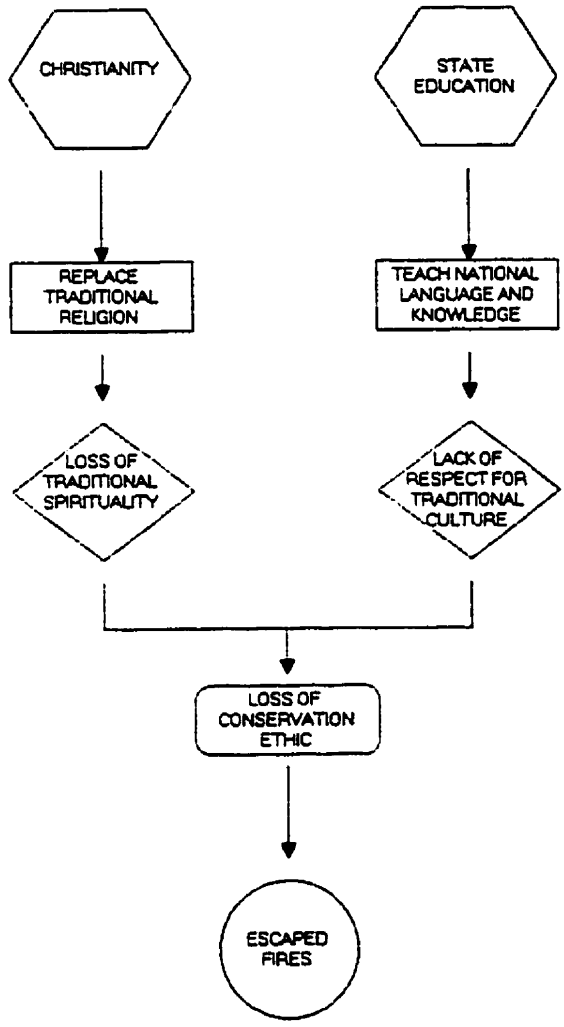


Figure 8: Christianity and State Education and their Effect on Fire Control, Municipality of Soteapan, Veracruz, Mexico

Key: Causes indicated by hexagons; problems by rectangles; outcomes by diamonds; and effects by ovals and circle

In fact, farmers from both villages describe people from Ocotal Chico as being more 'knowledgeable' in a traditional sense about the environment and its preservation than people from San Pedro Soteapan.

Such a situation might explain allegations by local farmers that people, particularly young boys, are deliberately setting fires either as a diversion from boredom or for the simple enjoyment of starting a fire. These people are said to toss matches or lit cigarettes into the flammable vegetation of a recently cut *milpa* or other stands of dry vegetation as they pass along a road or path. Farmers believe once again that this occurs more frequently in San Pedro Soteapan, both because of the careless attitude of its citizens and its proximity to the heavily-traveled main road.

It should be pointed out that researchers in the area give little credence to such claims, saying that such malicious behavior just doesn't seem to fit with the overall character of the people of the Sierra. However, it is difficult to simply dismiss such assertions. *Everyone* I spoke to in the two villages gave this as an important reason for wildfires occurring, and at least one researcher in the area claims to have seen a young boy attempting to start a fire in a field of grass, running away when he realized he had been observed (Perales, 1992:44). Stuart's Nahua collaborators also gave this as a major reason for wildfires, explaining that passing travelers will set grass fires as they pass, simply "for their pleasure" (Stuart, 1978:127). It is interesting to note that this problem has also been mentioned by researchers in other parts of tropical Latin America, for example by Janzen in Honduras (1995). In my own research, I did not find anyone who had actually witnessed someone setting a fire, nor had any of the farmers I spoke to ever heard of anybody being

caught in the act, although this may have been due to the fact that farmers would be hesitant to share such sensitive information with an outsider.

5.4 Summary

Fires in San Pedro Soteapan and Ocotal Chico are not only the result of environmental change, but of cultural change as well. As wider economic, political and social forces exert their influence on the Zoque-Popoluca, key aspects of traditional culture are being transformed, leading ultimately to a weakening of the conservation ethic and motivations to properly control fire. Participation in the regional cash economy, particularly in San Pedro Soteapan, has resulted in the breakdown of community solidarity and a decline in labor reciprocity, making it difficult for farmers to gather together enough helpers to carry out safe burning. Decreasing reliance on subsistence agriculture, again more so in San Pedro Soteapan than in Ocotal Chico, has weakened the ancient connection between people and the natural environment, undermining motivations to protect the land from wildfires. Agrarian reform legislation in both communities has disrupted the traditional system of land tenure and inheritance, creating a class of legally landless farmers who may not be as motivated as those who hold legal rights to land to follow safe burning practices and preserve the land for future generations. Land parcelization and redistribution has made farmers reluctant to invest time and energy on conservation practices such as fire control, since there is no guarantee that they will be allotted the land that they are currently farming. Finally, the influence of state religion and education in both communities has eroded the traditional worldview, alienating people from the spiritual beliefs and values of their

ancestors which stressed interdependency and respect between humans and the natural environment. Generally speaking, it appears that the inhabitants of Ocotal Chico have been relatively more successful in preserving cultural traditions such as community solidarity, labor reciprocity and the conservation ethic than the people of San Pedro Soteapan. Ocotal Chico is more isolated and farmers and their families participate to a somewhat lesser degree in introduced activities such as wage labor and state education programs. Farmers say that it is the continuing sense of 'community' which makes fires less likely to occur in Ocotal Chico than in San Pedro Soteapan.

Chapter 6

CONCLUSION

How, then, can the problem of wildfires be dealt with? In this concluding chapter, I summarize the arguments put forth in this thesis regarding the causes of wildfires in San Pedro Soteapan and Ocotal Chico, and discuss some ways in which the problem can be addressed. Because the causes of wildfires are complex, solutions must be complex as well, and must involve both indigenous people and outside institutions at all levels. Previous government programs to deal with fire and other environmentally destructive phenomena in the Sierra have been poorly designed, underfunded and ineffective, and in some cases have contributed to the problems they were supposed to address. The non-government organization Proyecto Sierra de Santa Marta (PSSM) has begun to address some of the problems associated with environmental degradation in the Sierra de Santa Marta, including the problem of wildfires. An essential aspect of this approach has been the participation of local people and the use of their knowledge.

6.1 Why *Milpa* Burns are Escaping

In the past, wildfires caused by escaped *milpa* burns were rare in San Pedro Soteapan and Ocotal Chico for two basic reasons. First, the natural resource management strategies of the Zoque-Popoluca were based upon a worldview which included a strong conservation ethic. In the case of *milpa* burning, detailed knowledge associated with effective fire control was passed from generation to generation in order to protect the land from wildfires.

Second, the rainforest ecology of the time, which was well-maintained by the conservation practices of local farmers, was naturally resistant to fire. The mature, intact forests and fallows created a wet, humid environment which simply did not support combustion for most of the year.

However, over the last few decades, escaped *milpa* burns have become much more frequent, particularly around San Pedro Soteapan. Deforestation and its accompanying effects have drastically altered the natural environment, destroying it's natural resistance to fire and creating a landscape much more susceptible to wildfires. Traditional techniques of fire control, adequate under past ecological conditions, have become increasingly unsuited to the changing environment. The relatively higher level of degradation to forests and fallows in San Pedro Soteapan means that it is much more difficult to control *milpa* burning here than in the less degraded area surrounding Ocotal Chico, making it more likely that fires will escape.

As well, wider economic, political and social forces have transformed key aspects of Zoque-Popoluca culture, leading ultimately to a weakening of the traditional conservation ethic and motivations to properly control fire. People are not as willing to help each other to carry out safe burning techniques, are in some cases not as dependent on the land for their survival, are losing their commitment to conservation measures through the loss of land rights, and have less respect for traditional spirituality and the environment through a fundamental shift in worldview. The residents of Ocotal Chico, with their physical isolation and lower participation rate in introduced activities such as wage labor and state education, have been relatively more successful in preserving a sense of 'community' and motivations

to burn carefully than the residents of San Pedro Soteapan, making it less likely that fires will escape control.

6.2 Solutions to Deforestation

Following the arguments presented regarding the effects of deforestation on fire control, it seems that there are two possibilities for intervention: (1) forest conservation and reforestation, which would begin to address some of the ecological conditions conducive to fire; and (2) new approaches to reducing and controlling fires, which would address the inadequacy of traditional techniques in the altered environment. Unfortunately, government assistance and support for such programs has been either ineffective or non-existent, due mainly to the national fiscal crisis and the marginalization of agriculture from the political and economic agenda (Buckles and Erenstein, 1996: 16). Numerous state programs for rural development have collapsed over the last few decades and SAGDR, the federal agency responsible for agriculture, has virtually no presence in the Sierra de Santa Marta (ibid.). The PSSM is the only organization working in the Sierra to promote forest conservation (Chevalier and Buckles, 1995: 344). Since 1991, they have been involved in a number of activities directly related to fire prevention and control.

Forest Conservation and Reforestation

Efforts have been made to protect what remains of the old-growth forests in the Sierra. In 1980, some 82,000 Ha of highland forest were formally declared a protected area (Chevalier and Buckles, 1995: 347). By 1986, the Mexican government and the United

Nations recognized the area as a Special Biosphere Reserve. Unfortunately, these declarations remained unknown to both indigenous people and many government agencies (ibid.). Major land use projects have completely ignored these official conservation policies, and the population continues to encroach on the reserve without restriction. Part of the work of the PSSM has been to pressure government authorities to strengthen the implementation of the reserve principles (ibid.). However, application of the declaration has been difficult due to the vagueness of some of these principles and on the number of stakeholders which must be consulted, since land can be either privately owned, owned by an *ejido*, or be of indeterminate ownership (PSSM, 1996: 5-9).

While the government has sponsored a few reforestation programs in the Sierra, such efforts have been small-scale and largely ineffective (Buckles and Erenstein, 1996: 16). A tree planting program launched by the PSSM, however, seems to hold more promise. The initial priority area for the program is the land adjacent to rivers and streams, because of the importance of protecting hydrological resources from siltation caused by run-off. The project has focussed on planting species which have commercial or domestic use value so that farmers will have a greater incentive to protect the newly reforested areas. In severely degraded lands, the PSSM plans to employ two techniques to prepare the land for reforestation: (1) construct ditches (sp. *tienas ciegas*) on slopes to catch water and limit soil erosion; and (2) plant green manure crops to quickly restore soil fertility to a level which can support tree growth (PSSM, 1996: 5-10).

Preliminary evaluations of the reforestation program have been positive (Sanchez and Wind, 1998: 27). Local people throughout the Sierra have played a central role in the

program's implementation, and there seems to be a high degree of motivation and commitment on their part to continue these efforts. According to the PSSM, 340 people in 7 communities were involved in reforestation in 1996-97 (ibid.). For example, in the villages of El Pescador and El Mangal to the east of San Pedro Soteapan, community members have planted 200,000 trees around rivers to protect watersheds and have begun to reforest the mangrove swamp around the Laguna de Ostion (ibid.). People in this area have also begun to plant dense rows of trees to create a living fence for the local deer population. Despite these successes, however, project researchers point out that reforestation still faces some important obstacles, including the long time period before such a program can show its economic viability to farmers and the significant amount of land that needs to be reforested (PSSM, 1996: 5-12).

To address the problem of deforestation related to over-farming, the PSSM has explored alternative techniques of cultivation which would (1) increase soil fertility and erosion control so that farmers would not have to rotate their fields and clear new land and burn as often; and (2) eliminate the need to burn altogether, so that land could no longer be damaged through repeated agricultural burning and escaping fires (Sanchez and Wind, 1998: 27). As mentioned earlier, the use of green manure cover crops, which involves planting velvetbean in a fallowed plot, slashing it and allowing it to decompose without burning to fertilize soil for planting, appears promising. The technology has been introduced to more than 3,000 farmers in the region through a campaign featuring local farmer extensionists, and the project is well-known throughout the region (Chevalier and Buckles, 1995: 344).

The PSSM has also experimented with the use of contoured hedgerows, a technique which involves planting rows of *Gliricidia sepium*, a leguminous tree species native to the region, at periodic intervals in a plot to protect against soil erosion (Buckles and Erenstein, 1996: 23). This technique is also associated with a decrease in agricultural burning, since farmers do not want to destroy the hedgerow with fire (ibid.). However, both of these programs have experienced some difficulty in overcoming the deeply ingrained traditional custom of burning prior to planting. Some farmers continue to burn even if green manure or hedgerows have been planted, while others have had these crops destroyed when fires escape from neighboring *milpas*. For example, during my fieldwork in Ocotal Chico, I learned that of the 12 farmers growing green manure crops in this area, 4 of them had deliberately burned it, with one claiming that burning was necessary to get rid of a weed that had invaded his plot.

Control of Fires

Raising public awareness about the dangers posed by wildfires has been a major priority for the PSSM since 1991, a year, as mentioned earlier, in which fire destroyed thousands of hectares of forest and agricultural land in the Sierra (Sanchez and Wind, 1998: 27). To combat the problem of wildfires, the PSSM has encouraged farmers to either not burn at all, or at least to follow traditional fire control practices, delivering this message through community workshops, assemblies, and a video which was shown widely throughout the Sierra (ibid.). The video, featuring indigenous farmers, describes traditional techniques of fire control and clearly outlines the threat that fires pose to local resources

(PSSM, 1994). Flyers and posters featuring similar information have also been distributed widely throughout the Sierra, in the hope that local people will be stimulated to practice more careful burning practices.

According to evaluations, the campaign, seems to have been successful in at least raising awareness of the importance of preventing wildfires (Sanchez and Wind, 1998: 28). The PSSM claims that 270 people from 7 communities participated in the campaign to prevent fires, and 260 people in 10 communities did not use fire to prepare their plots for planting (ibid.). Several local farmers working as extensionists for the PSSM have commented that they consider the prevention of wildfires to be the most important impact they have had on their communities. For example, one man from El Pescador noted that "It was a giant step. It made us aware of the need to control fires, so they don't run wild. Nature began to heal itself" (ibid.). Another man, from Santa Rosa de Hueyapan, explains the impact the PSSM campaign has had in his village:

> Before, coffee plantations would also catch fire. Medicinal plants had disappeared. From that time, people began to try and prevent wildfires. Now people practice 'half burns' or they burn their whole fields but they let others in surrounding *parcelas* know and take precautions. Fire doesn't run free any more. Wildfires were stopped and reforestation came in ... medicinal plants started to come back. This was an important achievement in terms of health (ibid.).

While the program appears to be having an impact on the problem of wildfires, it is based on what I consider to be the mistaken assumption that fires occur mainly because indigenous people have 'lost' the technical knowledge associated with fire control (Paré, 1991: 2). Many experts, in fact, believe that this is a primary cause of wildfires throughout

tropical Mexico. For example, Flores argues that the increasing incidence of fires in Chiapas is "...due to the lack of knowledge of controlled burning techniques and the lack of adopting the minimal measures of safety necessary to avoid fires escaping human control" (Flores, 1994: 53). However, as I have argued, from a technical standpoint the problem seems to be more one of continued use of techniques that are no longer adequate to control fire in the new environmental conditions which now prevail, than a loss of fire control knowledge. This program could thus be strengthened by stressing that traditional techniques, particularly the lax fire control measures when burning established *milpa* or immature fallows, may no longer be adequate in the changing environment of the Sierra. Farmers need to be reminded that even more care must be taken now than in the past, and that new approaches must be found which take into consideration the drier, windier conditions and the greater flammability of the degraded fallows and forests. For example, as some farmers suggested to me, it should be emphasized that firebreaks should always be built regardless of the type of terrain that one is burning, and that enough helpers be on hand to properly control the fire. As well, additional techniques such as constructing large fire breaks in particularly susceptible areas to protect *milpas* from approaching fires could also be emphasized.

The PSSM also recommends establishing a properly-equipped volunteer fire brigade of about 12 men in each community of the Sierra de Santa Marta to work in fire prevention and fire fighting (PSSM, 1996: 5-27). They suggest that the larger towns such as San Pedro Soteapan should have at least two brigades available, to fight the larger fires that often occur in these areas (ibid.). These brigades, which would operate over the five months of the year in which fires are most common, could also provide education and training to other

inhabitants of the Sierra about fire and fire control. Other proposed measures include establishing observation towers for detecting fires, a communication network, and an operations plan to effectively coordinate fire-fighting efforts, particularly for larger fires (ibid.). Another way of controlling fires is through legislation. However, federal legislation to control fire hasn't had a major impact in the Sierra de Santa Marta, mainly because there is no way to enforce such laws (ibid: 5-26). A more meaningful approach encouraged by the PSSM calls for communities to draft and enforce their own laws. For example, in the town of Pajapan, the communal assembly passed a resolution prohibiting the burning of land (Sanchez and Wind, 1998: 28). As well, as mentioned earlier, farmers in Ocotal Chico have implemented an informal fine system which forces those who allow their fires to escape to pay compensation to any farmer whose coffee *finca* is damaged. Such experiences could be extended to other towns such as San Pedro Soteapan, accompanied by the additional measures suggested above.

6.3 Addressing the Effects of Cultural Change

The problems faced by the Zoque-Popoluca with respect to the transformation of their culture and the resulting weakening of the traditional conservation ethic are, unfortunately, common in many indigenous areas throughout the world (Grenier, 1998: 4-5). With respect to economic and land issues, the clock cannot be turned back—new institutional arrangements based on present conditions must be developed to address environmental problems such as wildfires. On the other hand, reestablishing traditional spirituality and respect for nature is perhaps possible through programs that are compatible

with current religious beliefs and educational practices. In any case, such issues cannot be ignored—the efforts outlined above will fall short if they are not backed by a strong ideology stressing community solidarity and conservation.

With the decline of traditional labour reciprocity, farmers in the Sierra need to develop new collective arrangements for controlling fire. According to Ostrom (1992: 301), individuals will tend to switch from independent strategies for exploiting common property resources to more coordinated strategies if they share a common understanding that:

- continuing independent strategies will seriously harm the resource
- coordinated strategies exist that can reduce the risk of harm to the resource
- others can be counted on to change strategies if they promise to do so
- the cost of future coordinated strategies is less than the benefits to be derived from adopting coordinated strategies

There is evidence that such common understandings are becoming prevalent in the Sierra, mainly through the work of the PSSM and their emphasis on public education and community involvement. For example, in Ocotal Chico local farmers have established a group to control fires, and they strictly enforce rules designed to ensure that no fires get out of control (Sanchez and Wind, 1998: 28). In 1995, a group from Ocotal Chico actually went out and fought a nearby forest fire, an example of an important shift in attitude since communities, as mentioned earlier, have not been active in fighting fires (ibid: 27). As well, the PSSM has encouraged local people to form several community-based organizations

which have recently become involved in environmental conservation issues. These include the Network of Extensionists (sp. *Red de Promotores*), ecological committees, women's groups, and product-specific groups like palm and vanilla producers (ibid: 33). The Extensionists, in fact, claim to have already had significant impacts in fire prevention and control (ibid: 35).

In an attempt to reestablish a conservation ethic, the public awareness campaign has also emphasized the still considerable dependency that local people have on the rainforest for their subsistence. For example, the PSSM video and accompanying pamphlet reminds people that the rainforest plays a key role in maintaining sources of water such as rivers and springs, creates a favorable environment for farming and cattle ranching, and provides building material and wild sources of food (PSSM, 1994). People are also reminded of the traditional belief that each generation has a responsibility and obligation to preserve the land for the benefit of their children.

However, as mentioned earlier, a conservation ethic is also contingent on farmers feeling assured that they have secure, long-term access to land. While completion of the land parcelization scheme will settle the matter for those with legal title to land, those without will continue to face an uncertain future with regards to land access, a fact which will no doubt continue to undermine efforts to reestablish motivations for conservation.

While such considerations are important aspects of the effort to improve resource management in the Sierra, the revival of traditional spirituality could hold the key to changing the destructive attitudes which have developed over the last few decades. Religion can be a powerful motivator and, some argue, the *only* cultural force powerful enough to

create the 'paradigm shift' necessary to overcome the environmentally-destructive philosophies which have developed throughout the world through the influence of global capitalism (Suzuki, 1998: 206). However, reestablishing traditional spirituality in the Sierra in light of recent national and international pressures presents an enormous challenge. As discussed earlier, the denigration of 'things indigenous' is very strong, and the homogenization of cultural values through globalization is a powerful force. Nevertheless, the continuing reliance on subsistence agriculture for the majority of the indigenous population of the Sierra may be the key. People have not been completely alienated from the environment, and much traditional knowledge still exists. As well, the Popoluca language is still widely used, a crucial factor when one considers the important link between language preservation and cultural survival. An approach which integrates indigenous language and knowledge into the school curriculum could be a positive first step in reviving traditional culture.

Changing environmental conditions and attitudes are behind the increase in wildfires in San Pedro Soteapan and Ocotal Chico. There has been a 'loss' of indigenous knowledge associated with fire control— but a loss up until now more at a spiritual or ethical level than at a technical one. The increasing incidence of escaped *milpa* fires must be seen as a symptom of the overall problem of the breakdown and transformation of both a local ecology and a traditional way of life.

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