

**Linking Land Use and Policy
in the Tijuana River Watershed**

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Abstract

Changes in land use, including the expansion of urban areas, croplands, pastures, and plantations, have a wide variety of impacts on wildlife, vegetation, and ecological processes. Understanding the causes of changing land use contributes to information on land use dynamics and decision-making practices.

In the case of the binational Tijuana River Watershed, a vital part of the California Floristic Province which has been subject to fragmentation of vegetation and wildlife corridors, there is a lack of information regarding recent causes of land-use change. In this study, I investigated the causes of land-use change in the watershed for 1994-2006. I used two approaches, including: 1) an analysis of policies intended to alter land ownership and land-use practices within the watershed, and 2) an analysis of two communities on either side of the border, which have experienced transitions from agricultural land to urban development.

Interviews with governmental officials, non-governmental officials, and local residents suggest that the two dominant policies related to land-use practices and land tenure play an unexpected role in influencing land-use change in the watershed. This information is valuable for conservation management in the region, specifically the Las Californias Binational Conservation Initiative, since management focused on implementing sustainable land-use planning must take into account causes of land-use change in order for long-term strategies to succeed.

Keywords: U.S.-Mexico border, land-use change, land-use policy, conservation management

Chapter 1: Introduction

The California Floristic Province, stretching from southwest Oregon to northern Baja California, is internationally recognized as one of the world's 25 biodiversity hotspots (Conservation International, 2008; Myers et al., 2000). It encompasses the South Coast Floristic Region, an area along the U.S.-Mexico border known for supporting the highest number of endemic plant species in the California Floristic Province. In the center of this floristic region lies the Tijuana River Watershed, a 4,532 km² basin comprised of portions of northern Baja California and southern San Diego County (Ganster, 2005) (Figure 1).

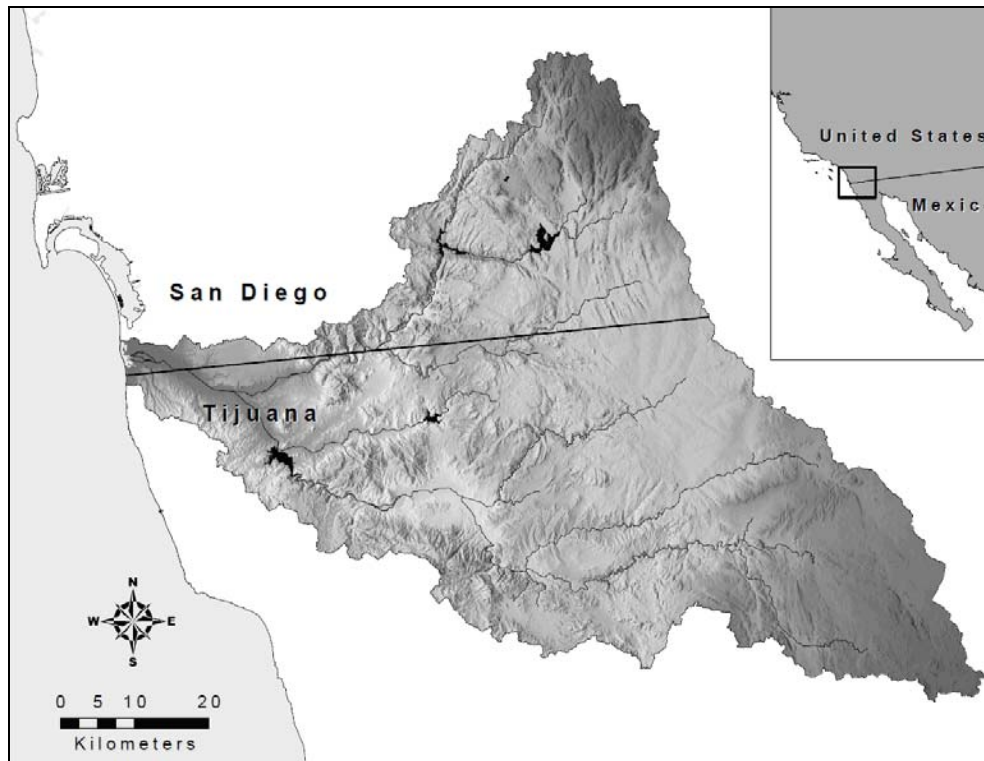


Figure 1. Map of the U.S.-Mexico border between southern California and northern Baja California, including the Tijuana River Watershed and the location of the city of San Diego and Tijuana.

Aside from being part of the California Floristic Province, the Tijuana River Watershed has several key physical characteristics that make it unique. First, it is a binational watershed with one-third of its area in the United States and two-thirds in Mexico (Wright, 2005a). The

headwaters of the river begin in eastern San Diego County and travel south across the border into the city of Tijuana, eventually returning to San Diego where the river drains into the Pacific Ocean. The Tijuana River is one of the many examples of shared resources, including water and ecological resources, which are bisected by an international border. Second, the watershed contains one of the last coastal wetlands in Southern California, the Tijuana River Estuary (Ganster, 2005; Roullard, 2005). The 1,000-hectare publicly owned reserve is located north of the city of Tijuana in San Diego County and is the endpoint for rivers and streams in the watershed as they travel through the estuary into the Pacific Ocean. The estuary also serves as an important rest stop for migratory birds traveling south along the Pacific Flyway (Roullard, 2005). Finally, the Tijuana River Watershed supports a significant number of native plant communities, including a variety of species of coastal sage scrub and chaparral (O'Leary, 2005). These globally rare plant communities provide habitat to a number of threatened and endangered wildlife species (O'Leary, 2005).

The physical characteristics of the Tijuana River Watershed make it an important site for the study of habitat and water resources, especially since in recent decades resources have become severely impacted by humans (Liverman et al., 1999). The distribution of the watershed's 1.4 million inhabitants has been the primary factor affecting the natural environment of the basin (Wright, 2005d). This is because the intensity and location of inhabitants corresponds with the type of land use for residential, economic, recreational, transportation, and commercial purposes (Wright, 2005d). In addition, in recent years land use planning on both sides of the border has allowed for increased urban development (Vela, 2005). This is of particular concern for areas in the Mexican portion of the watershed since urban expansion took place in areas that have a high propensity to erosion, landslides, and flooding (Vela, 2005).

Human impacts have a range of outcomes for the natural environment (Liverman et al., 1999). For the Tijuana River Watershed, water quality, water quantity, and soil erosion have been disturbed (Ganster et al., 2000). For example, in the lower Tijuana River Valley, development practices changed the cycle of erosion due to the increased amount of impervious surfaces. The effect has been that even light rains erode the bare hillsides. This, in turn, causes trash and large amounts of sediment to be carried to the Tijuana River Estuary (Roullard, 2005).

In addition to impacts on water quality and quantity, the single greatest threat to native plant communities in this region has been habitat loss and fragmentation (Conservation Biology Institute, 2004). The two dominant vegetation communities are coastal sage scrub and chaparral, which account for nearly three-quarters of all vegetation in the watershed (O'Leary, 2005). Coastal sage scrub is a low-growing vegetation community that consists of Diegan sage scrub along the coast and Martirian succulent scrub to the south (Westman, 1983 in Conservation Biology Institute, 2004). Chaparral is a hard-leaved vegetation community and in the Tijuana River Watershed it includes mainly dense thickets of shrubs such as red shank chaparral (*Adenostoma sparsifolium*) and chamise chaparral (*Adenostoma fasciculatum*) (Hanes, 1965 in Conservation Biology Institute, 2004). These two communities along with communities of juniper scrub and riparian woodland have been fragmented over time (Ojeda-Revah, 2000). The native vegetation is important because it provides habitat to species such as the California gnatcatcher (*Polioptila californica californica*), southwestern arroyo toad (*Bufo californicus*), light-footed clapper rail (*Rallus longirostris levipes*), and the quino checkerspot butterfly (*Euphydryas editha quino*). Each of these species has been listed as a federally threatened or endangered species (U.S. Fish and Wildlife Service, 2005, 2003, 1993; Zembal et al., 1989).

Causes of Impacts to Habitat

Past work in the watershed has included a brief discussion of the causes of land-use changes from the early settlement of Northern Baja California through 1991 (Minnich & Vizcaino, 1998) and from 1970-1994 during a period of industrialization (Ojeda-Revah et al., 2008). The causes for the disruption of habitat are primarily attributed to residential and industrial development, agricultural development, grazing, and the introduction of exotic species (Ojeda-Revah, 2000; Flather et al. 1998). For the time period 1953-1994, changes in land cover were primarily attributed to factors such as the conversion of lands to agricultural and urban uses (Minnich & Vizcaino, 1998; Ojeda-Revah et al., 2008). In the Mexican portion of the watershed, urban growth during this time period was driven by population growth of migrants from Michoacán, Sonora, Nayarit and Guanajuato due to job creation from national border industrialization policies, poor infrastructure investment which forced populations to move near the outer edges of urban areas, and lack of law enforcement preventing illegal land-use change (Ojeda-Revah et al., 2008; Zenteno, 1992). In the U.S. portion of the watershed, expansion of agricultural and urban uses was caused by population growth, socio-economic encouragement of suburban growth, policies empowering local governments combined with lower taxes in rural areas, and infrastructure construction (Ojeda-Revah et al., 2008).

Although these studies suggest potential influences on land-use change, identifying causes was not the primary purpose of these studies. Furthermore, little work has been done since 1994 to update information on dominant land-use changes that have taken place, and there has been no work done that investigates the causes of any recent changes. Further population growth, urban development, and increased transportation infrastructure in recent years on both sides of the border suggest that land use has changed in the Tijuana River Watershed and

warrants further investigation. The purpose of this study is to assess the dominant types of land-use change that have occurred since 1994 and identify and analyze the causes of changes in land use.

Contributions of this Study

Research has been done that is primarily focused on the city of Tijuana's growing urban population and the effects this may have for the natural environment (Higuera et al., 1993; Sanchez 1993). However, the Tijuana River Watershed encompasses much land in the United States and Mexico that is outside of the city of Tijuana. It includes areas of irrigated and rainfed agriculture, grasslands, forest, scrubland, and rural development (Ojeda-Revah et al., 2008; Wright, 2005c). In order to understand the complexities of changing land use in such varied areas, I studied land use throughout the watershed. There is great need for watershed scale research, especially for watersheds that span international borders, so that information regarding interconnected ecological processes and human activities is available (Brown, 2003).

The contributions of this work are twofold: 1) to advance the theoretical framework for understanding the causes of changing land use at a watershed scale, and 2) to contribute practical applications to the Las Californias Binational Conservation Initiative by identifying the causes of land-use change throughout the watershed. The Conservation Biology Institute, in partnership with Pronatura and The Nature Conservancy, initiated a habitat conservation project in 2004 titled The Las Californias Binational Conservation Initiative. The objective of their work is to develop landscape-scale conservation strategies, sustainable land use planning and long-term management programs for the border region (Conservation Biology Institute, 2004). Among the goals for the Las Californias Program are identifying threats to maintaining an interconnected

conservation network, identifying large, intact wildlands that represent the region's biodiversity, linking protected areas to facilitate wildlife movement, promoting collaboration in implementing land protection strategies, and laying the foundation for a binational park system that connects the Parque Constitución de 1857 in Mexico to wilderness areas, forests and park land in the United States (Conservation Biology Institute, 2004). In order for long-term planning strategies to occur and succeed there must first be an understanding of the types of land-use change that took place in recent years and an understanding of the causes of such changes.

Past conservation planning has met with some difficulty due to the fact that land use and land ownership patterns differ markedly between the two sides of the border (Conservation Biology Institute, 2004). An initial goal of this project is to classify and update knowledge of changing patterns of land use and ownership on both sides of the border. In addition, a major goal of the Las Californias initiative is to "identify threats to maintaining an interconnected conservation network and sustaining ecosystem processes" (Conservation Biology Institute, 2004, p. 4). Assessing causes of changing land use will contribute to an understanding of the human activities that are currently playing dominant roles in disturbances to local wildlife populations and native vegetation cover.

In the following chapters, I will describe the context, approach, and results of this study. The next chapter provides an overview of the concept of 'drivers' of land-use change, a background of the relevant characteristics of the study area, and the framework for approaching land-use change in the watershed. The third chapter gives a detailed explanation of methods that were employed. Following this, two chapters are used to present the findings and a detailed discussion of land-use change on both sides of the border. Finally, the remaining chapter ties

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together the themes of this research and makes recommendations for those involved with continuing the Las Californias Binational Conservation Initiative.

Chapter 2: Background

Drivers of land-use change

Human activities such as forest clearing, subsistence agriculture, farmland expansion, and the expansion of urban centers, are examples of the many ways that human land uses have altered the world's landscapes. In recent decades, changing land use practices, mainly the expansion of croplands, pastures, plantations, and urban areas, have gained attention due to their impacts on the environment (Defries et al., 2006; Foley et al., 2005). Many researchers have focused on explaining the causes of these changes in an effort to understand changing land-use patterns in areas around the world (Mena et al., 2006; Campbell et al., 2005; Liu et al., 2005; Homewood et al., 2001). Although studies range greatly, from geographic location to the type of land-use change under investigation, there are general trends among these land-use change studies. In most cases, there is not a single cause of land-use change but rather a variety of factors that are influential (Geist & Lambin, 2002). For instance, institutional factors such as state policies aimed at economic development (i.e., credits or low taxation) may lead to the expansion of commercial crops and pastures, which may lead to deforestation. In the same instance, demographic factors such as in-migration and population growth may also drive the expansion of commercial crops and pastures in order to meet the needs of a growing population (Geist & Lambin, 2002).

Formal policies, particularly those directly or indirectly restructuring land uses, have strong potential to drive land-use change. In their study of forest conservation in the central Vietnamese province of Thua Thien Hue, Thiha et al. (2007), focus on a series forest management policies that increase people's forest access, which accounts for a decrease in forest cover in the region. Thiha et al. (2007) chose to investigate these policies further because they were particularly relevant for land use in the region. In another study of coastal land

transformation in Sonora, Mexico, Luers et al. (2006) link the reform of the agricultural sector to land-tenure changes and the pattern of growth of the shrimp farming industry. Both studies take advantage of a singular dominant policy driver and successfully validate its relationship to changes in forest cover and land tenure changes. I use a similar approach to look at changes in land use in the Tijuana River Watershed.

In the Tijuana River Watershed, two major policies associated with land use were instituted since the last mapping of the watershed. On the U.S. side of the border, a county-level policy in San Diego titled the Multiple Species Conservation Program proposed to protect over 75,000 hectares of land from development in effort to create a preserve system throughout the county. This policy proposed to acquire privately owned lands that were developed, planned development, or agricultural land in order to convert these lands to publicly owned open space (County of San Diego Department of Planning and Land Use, 1998). And on the Mexican side of the border, a national-level policy titled *Ley Agraria* reformed the agrarian sector, targeting communal plots of land known as *ejidos*. In the case of this policy, the federal government rewrote an article of the Mexican Constitution so that land that was once communally owned could be parceled and individually owned, and owners were granted the opportunity to rent or sell their land (Cornelius et al., 1998).

Framework

Complementary approaches and methods are necessary for studying human-environment relations, including anthropogenic causes of land-use change (Young et al., 2006). To understand how the Multiple Species Conservation Program and *Ley Agraria* influence land use, I set up a framework with two approaches: 1) an investigation of specific political and institutional factors

and 2) case studies of two different communities on either side of the border (Figure 2). The first approach emphasized the role of top-down forces that impact land use. For this approach I investigated how specific policies instituted at the national- and county-level act as ‘underlying forces’ (Geist & Lambin, 2002), which indirectly impact land use in a broad region over a long period of time. In past studies, these have included population dynamics or national policies instituted at the state level (Schneider et al., 2005; Campbell et al., 2005; Brannstrom et al., 2008). To complement the top-down approach, the second part emphasized a bottom-up approach. For this, I conducted case studies in smaller communities on each side of the border in order to examine ‘proximate causes’ (Geist & Lambin, 2002) occurring at the community level. Such causes have a more immediate and direct impact on land use in a concentrated area and include factors such as local infrastructure expansion or local physical characteristics.

This framework addresses the issue of scale since it is often difficult to assess how policies influence land use. This is because there can be different effects at multiple spatial scales (Campbell et al., 2005). For instance, a national-level policy may have implications at the national level and at the local level. Past studies attempted to separate exogenous forces at the national level from community-level proximate causes by analyzing the various factors that work at different scales (Geist & Lambin, 2002; Campbell et al., 2005). This has been accomplished in such ways as narrowing the spatial scale of the study to investigate local drivers of change in a small community (Carr, 2008).

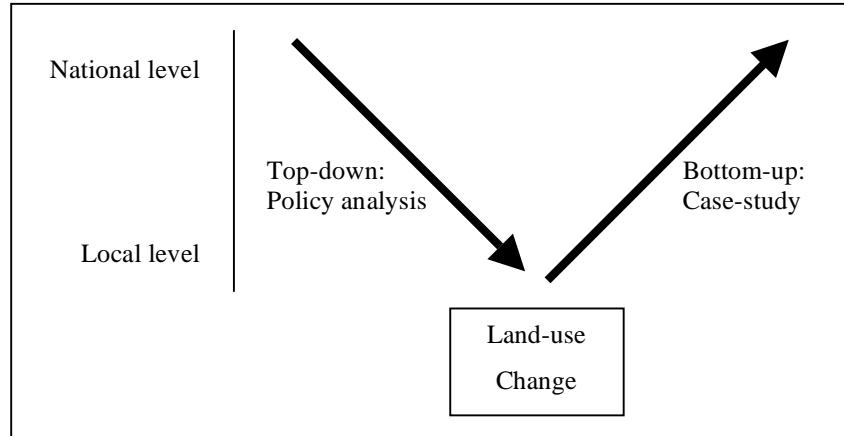


Figure 2. A methodological approach for analyzing policy and other potential drivers of land-use change in the Tijuana River Watershed.

The following sections provide a background for understanding why these specific policies warrant further investigation. To do so, I present each of my research questions with the necessary background information. I start with a background of past land-use change in the watershed as a way to approach the land-use changes that took place between 1994 and 2006. Then, I discuss each policy in depth and explain its potential to influence land-use change during the study period. Finally, I give a detailed description of two communities that have undergone changes in land use in recent years and discuss why they were included as a key part of this study.

Research Questions and Background

Research Question 1: What are the dominant land-use changes that took place from 1994-2006 in the Tijuana River Watershed?

The Tijuana River Watershed has undergone extensive mapping for the years 1953, 1970, and 1994 (Ojeda-Revah et al., 2008). During the period 1970-1994, urban expansion was the dominant change in land use, with urban areas covering 2.4% of the watershed in 1970 and eventually covering 6.9% of the watershed in 1994. During this period, urban areas increased

more than 200 km² throughout the watershed, with 74.7% of this growth occurring in Mexico. Within Mexico, urban areas developed mainly from areas of coastal sage scrub, chaparral, and grasslands (Ojeda-Revah et al., 2008). Within the U.S. portions of the watershed, urban areas developed mainly from areas of chaparral, irrigated agriculture and grasslands (Ojeda-Revah et al., 2008).

Extensive urban expansion took place in the city of Tijuana from 1970-1994. The spatial evolution of cities suggests that there is a process of urban growth that has implications for land use. First, there is the expansion of an urban center followed by growth dispersal to new, smaller urban centers (Dietzel et al., 2005). These smaller urban areas can be important with respect to land-use change because they may reach a point where they “begin to coalesce towards a saturated urban landscape” (Dietzel et al., 2005, p. 178). Because potential growth of Tijuana and San Diego is constrained by the Pacific Ocean and the international border, this process may proceed in areas to the east of both cities and in areas north of San Diego and south of Tijuana. Specifically in the case of Tijuana, it is expected that over time the urban fringe will expand and reach smaller clustered communities to the east and south of Tijuana, eventually connecting and forming a continuous strip (Wright, 2005b). More importantly, studies have shown that in many cases of urban growth in developing countries these urban patches come at the expense of cultivated lands that once existed in areas surrounding the urban core (Seto & Fragkias, 2005).

The national-level agrarian policy in Mexico, *Ley Agraria*, and the county-level conservation policy in San Diego may have contributed to changes in land use since both proposed to substantially change land tenure regimes throughout the watershed. *Ley Agraria* proposed the privatization of communal land, and MSCP proposed to increase the amount of government-owned public land in San Diego County for conservation purposes. Studies on the

relationship between land tenure and land use found that the privatization of communal lands often leads to greater fragmentation and subsequent degradation (Walker et al., 2008; Kakembo, 2001). This is because parcels of private land are often managed individually instead of collectively and land management practices often vary with land tenure systems (Kakembo, 2003; Kakembo & Rowntree, 2001). However, it is not always true that changing the land tenure status translates into a change in land use. In some cases the land tenure label may change but nothing else about the land (Pressey et al., 1996). I investigated whether this was true in the case of MSCP and *Ley Agraria*.

Research Question 2a: How have the Multiple Species Conservation Program (MSCP) and Ley Agraria influenced land-use change in the Tijuana River Watershed? How does this differ on either side of the border?

Multiple Species Conservation Program (MSCP)

The 4,200 miles that make up the County of San Diego encompass a wide range of habitats: coastal, scrub, chaparral, grassland, forest and desert. Within these habitats is a number of plant and animal species that are considered threatened or endangered. The county is home to more “species of concern” than any other county in the continental United States (County of San Diego Department of Planning and Land Use, 2009a). Under the federal Endangered Species Act and the state of California’s Environmental Quality Act, development projects that may cause significant adverse impacts to threatened or endangered species must mitigate these impacts either by modifying the project or by providing long-term conservation and management (White et al., 2004). Often times mitigation occurs on a project-by-project basis, resulting in fragmentation of habitats. However, in 1991, the state of California adopted the Natural

Communities Conservation Planning Act (NCCP), which allows for local jurisdictions to create comprehensive land use plans. NCCP is similar to the federal-level Habitat Conservation Plan (HCP) under the Endangered Species Act, which is prepared in order to demonstrate long-term habitat and species conservation actions (County of San Diego Department of Planning and Land Use, 2009a).

In order to conserve the habitat of endangered and threatened species, the City and County of San Diego set up two joint NCCP/HCP plans, together called the Multiple Species Conservation Program (MSCP). The plans cover approximately 2,300 km² in San Diego County and include the City of San Diego, portions of the unincorporated County of San Diego, and ten additional city jurisdictions (County of San Diego Department of Planning and Land Use, 1998). Although the City of San Diego and County of San Diego have separate plans, each shares substantial overlap with the Tijuana River Watershed (Figure 3). In total, this plan proposes to protect over 75,000 hectares of land in San Diego through acquisitions and easements (County of San Diego Department of Planning and Land Use, 1998).

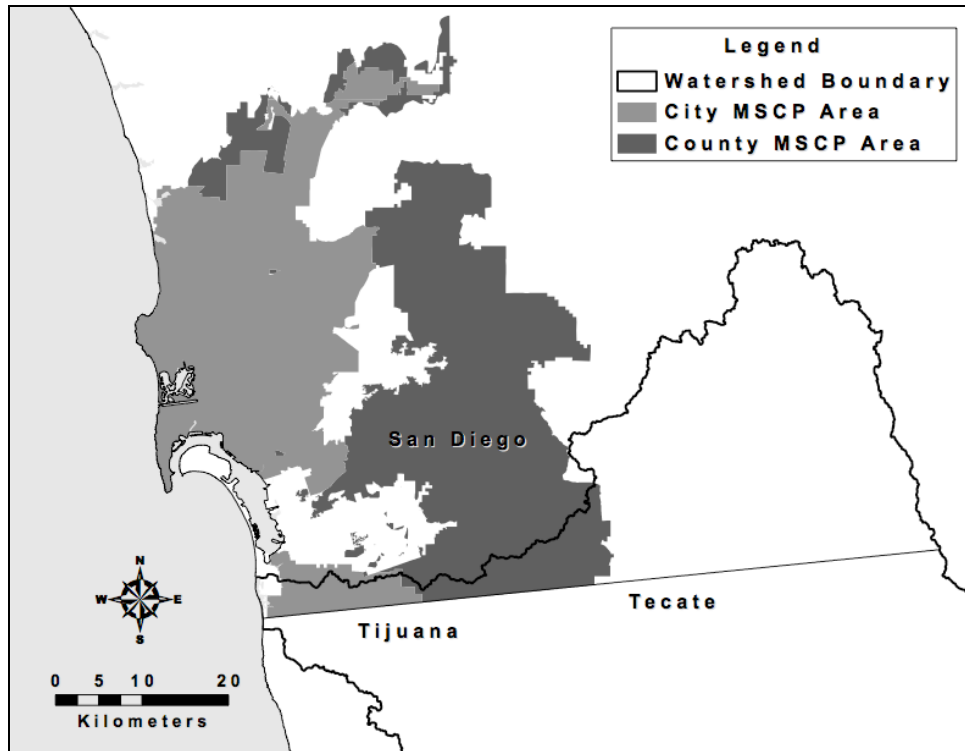


Figure 3. City and County of San Diego MSCP planning areas showing overlapping boundaries with the Tijuana River Watershed.

The plan has two primary goals: 1) to establish a comprehensive conservation program for the City and County of San Diego, and 2) to streamline the permitting process for development projects (T. Oberbauer, MSCP Chief Planner, County of San Diego Department of Planning and Land Use, in-person interview, 10 February 2009). The first of these goals is achieved through land acquisition by a public land agency or environmental trust and conservation easements that dedicate the land for open space (County of San Diego Department of Planning and Land Use, 2009a).

The City of San Diego's MSCP Subarea Plan was adopted by the City Council on March 18, 1997 and was officially implemented on July 17, 1997. In the designated NCCP boundary for the San Diego region the City of San Diego includes 83,415 hectares of land. Of this land, the City of San Diego plans to conserve 21,049 hectares, which is called the Multiple Habitat

Planning Area (MHPA) (City of San Diego Planning Department, 1997). Land within the MHPA can be conserved through conservation of existing public lands, land use restrictions of property through zoning regulations, mitigation banks, open space previously set aside on private lands for conservation as part of the development process, or through public acquisition of private lands (City of San Diego Planning Department, 1997). Of the total lands committed to permanent conservation under the plan, approximately 2,350 hectares are owned by the federal and state governments, approximately 13,385 hectares are public lands owned by the City of San Diego and other local jurisdictions, 2,028 hectares consist of negotiated open space on private lands, approximately 3,198 hectares are expected to be preserved through future application of zoning regulations, and the remaining 971 hectares are anticipated to be acquired with public funds and by application of mitigation requirements for development impacts outside the MHPA (City of San Diego, 1997).

In addition to the City of San Diego's plan, there is a separate plan for the County of San Diego. The County's MSCP plan was approved by the San Diego County Board of Supervisors on October 22, 1997 and was implemented soon after on March 17, 1998 (County of San Diego Department of Planning and Land Use, 2009a). In the designated NCCP boundary for the San Diego region the County of San Diego includes 98,087 hectares of land (Figure 3). The habitat conservation goal for the County of San Diego's MSCP plan includes 39,813 hectares (County of San Diego Department of Planning and Land Use, 1997). Approximately 73% of this land (74,000 hectares) was open space land in 1997, and 27% (27,500 hectares) was disturbed, developed, or agricultural land that was considered to have little or no habitat value (County of San Diego Department of Planning and Land Use, 1997). In order to achieve the conservation goal, "preservation may take the form of conservation easements that dedicate the land for open

space in perpetuity, or the actual fee title by a public agency or environmental land trust” (County of San Diego Department of Planning and Land Use, 2009a).

The County of San Diego hopes to add 52,000 hectares of unincorporated land to the regional preserve through other subarea plans in the future. These include the North County Subarea Plan and the East County Subarea Plan, which are currently engaged in the planning process. The North County Plan includes the cities of Oceanside, Encinitas, San Marcos, Vista, and Escondido. The East County Plan will be comprised of the areas that are east of Alpine and will extend to the county boundary, including Cleveland National Forest (County of San Diego Department of Planning and Land Use, 2009a). The Department of Planning and Land Use for San Diego County has stated that the North and East County Subarea Plans are proposed to have an implementing date during 2010 (T. Oberbauer, in-person interview, 10 February 2009).

The second overall goal of MSCP is to make the development process more efficient (T. Oberbauer, in-person interview, 10 February 2009). Prior to MSCP, if an endangered species was located on private property, landowners were required to apply to the County of San Diego for development approval as well as the California Department of Fish and Game and the U.S. Fish and Wildlife Service. Since the implementation of MSCP, landowners are now required to go only to the County of San Diego for development permits (T. Oberbauer, in-person interview, 10 February 2009). However, development projects must conform with the Biological Mitigation Ordinance (BMO), which “outlines sensitive resources of concern” (County of San Diego Department of Planning and Land Use, 2009a). For instance, the BMO limits impacts to rare and endangered species to no more than 20% of a population and also requires that a minimum amount of mitigation must occur (S. Wynn, Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, in-person interview, 24 February 2009).

MSCP Potential Influence on Land Use

Because MSCP land makes up approximately 14% (16,800 hectares) of the U.S. portion of the watershed it is important to consider its influence on land use. Since the implementation of MSCP in 1997, it had the potential to impact land use in several different ways. As a conservation policy, it proposes to acquire privately owned lands for the sake of making these lands publicly owned open space. A substantial amount of the private land in the U.S. portion of the Tijuana River Watershed is developed, planned development, or agricultural land. The acquisition of this land may lead to changes in land use from either agricultural or developed land to areas of open space. A second potential influence is that the preserve area guides land use because it consolidates areas such as urban development while creating open space land use in other areas. Thus, it plays a key role in overall development patterns throughout the county.

Finally, the county's MSCP subarea plan is closely aligned with the implementation of the county's updated General Plan for zoning and land-use planning in unincorporated portions of the county. The San Diego County General Plan Update is multi-year project intended to establish the future growth and development patterns for the unincorporated areas of the county, which account for 84% of the total land area of San Diego County (County of San Diego Department of Planning and Land Use, 2009b). The update to the General Plan begun in 1998, which was the first time it had been updated since 1979 (San Diego County Department of Planning and Land Use, 2009b). There was a great need to update the plan because considerable growth and change took place in unincorporated portions of San Diego County during 1979-1998. The MSCP uses the zoning information from the county's new General Plan in the unincorporated areas in order to decide the targets for protected areas. Although the General Plan Update and MSCP do not directly dictate land use in the unincorporated parts of the county, the

Department of Planning and Land Use for the County of San Diego has stated that MSCP and the San Diego General Plan will “significantly alter land-use densities and patterns in the future” (L. Carmichael, Land Use Planning Manager, County of San Diego Department of Planning and Land Use, personal communication, 13 August 2008). By setting land-use densities, which are then used by MSCP planners for acquisition purposes, the General Plan Update and MSCP indirectly influence land use. Because of this it is necessary to investigate the relationship between the policies and changes in land use in the Tijuana River Watershed.

Ley Agraria

On the Mexican side of the border, the amendment of Article 27 of Mexico’s Constitution in 1992 established a new agrarian policy. This policy focused on reforming the traditional land ownership system throughout Mexico. The original system of land ownership was established in 1917 in response to the 1910 Mexican Revolution. Prior to the revolution, there was a concentration of landholdings with 87% of the land in the hands of 0.2% of the population (Assies, 2008). After a seven year civil war the government introduced Article 27 into the national constitution, which stated that all land and waters originally belong to the nation, and therefore the nation could do with this land what it saw fit (Assies, 2008). Mexico established a system whereby communities or groups of peasants could petition for land, and the land would be granted to the group as an *ejido*. A stipulation of Article 27 was that this land could not be sold or transferred, *ejidatarios* (the term for a communal *ejido* owner) could not work their land with hired labor, nor could they leave their *ejido* land for a period longer than two years without risking the loss of *ejidal* rights (Johnson, 2001).

The new Article of the Constitution not only addressed concerns over land rights but was also a way to help foster agricultural activity across all of Mexico. Since an *ejido* could include hundreds or even thousands of families, many formed large-scale collectively farmed *ejidos* (Assies, 2008). Thus, the government seized the opportunity to increase agricultural productivity and supply instead of simply subsistence production. *Ejidors* were supported with technical assistance, credit, and supply of seeds, in addition to improvement of rural education, medical care, roads and other facilities (Assies, 2008).

By the late-1980's, however, the *ejido* system was threatened by Mexico's stagnating agricultural sector and a global focus on market reform and international competitiveness. The growth rate of Mexico's agricultural production had become negative (Johnson, 2001), and agriculture only accounted for 6.3% of GDP (Cornelius et al., 1998). In addition, the government was in the process of introducing a series of privatization and liberalization policies as part of the Mexican economy's integration into the North American Free Trade Agreement (NAFTA) (Luers et al., 2006; Johnson, 2001). In an effort to integrate Mexico into the global economy as well as address issues of agricultural productivity, the government reformed the *ejido* system. The goal of agrarian reform was to encourage private investment because it was thought that competition in rural markets would allow for more efficient use of resources (Wiggins et al., 2002). Until this point farming had been protected by the state through subsidies and crop insurance from oil revenues, which became far too costly during a debt crisis in the 1982 (Wiggins et al., 2002). In 1992, the Mexican government amended Article 27 of Mexico's Constitution and introduced *Ley Agraria*:

“A fundamental goal of the 1992 reform of Article 27 was to increase productivity and efficiency in the rural economy by allowing the market to allocate resources. The reform

was also intended to increase investment in the *ejido* sector by encouraging private *ejido* partnerships and creating greater credit opportunities for the *ejido* sector by providing them a legal form of collateral. However, critics argued that the new law would lead to the mass sale of *ejido* lands, a return to the pre- revolution *Latifundista* (large estates) era, and increased poverty in the land-reform communities” (cited in Luers, 2006 et al., p. 437; Collier, 1994 and Stanford, 1994).

The amendment of Article 27, referred to as *Ley Agraria*, changed the *ejido* system in several ways. The following summarize such changes (see Cornelius, 1998, p. 2; Assies, 2008, p. 51):

- 1) The government is no longer obliged to distribute land to residents’ petitions,
- 2) Private landowners can make investments into their land without the risk of having their land reclassified and subsequently expropriated,
- 3) Land rights disputes between *ejidos* or *ejidatarios* will be settled by decentralized Agrarian Tribunals instead of the federal Ministry of Agrarian Reform,
- 4) *Ejidatarios* can obtain individual certificates of their land rights if their *ejido* agrees to participate in the *Programa de Certificación de Derechos Ejidales y Titulación de Solares* (PROCEDE, Program for the Certification of Ejido Land Rights and the Tiling of Urban Housing Plots),
- 5) *Ejidatarios* who have the boundaries of their parcels certified have the right to legally sell, rent, sharecrop or mortgage their land as collateral for loans,
- 6) *Ejidatarios* are no longer required to work the land personally in order to keep it,

7) The government will continue to enforce legal limits on maximum property size (individual farmers are limited to 100 hectares of irrigation land and corporate entities are limited to 2,500 hectares of irrigation land),

8) *Ejidatarios* who decide not to sell or rent their land can enter into joint ventures with outside investors or form associations among themselves,

9) The *ejido* sector is open to foreign direct investment.

Several new institutions and programs were set up to carry out the reform. One of the programs was the *Programa de Certificación de Derechos Ejidales y Titulación de Solares* (PROCEDE, Program for the Certification of Ejido Land Rights and the Tiling of Urban Housing Plots), a land regularization program that measures and maps boundaries of communal lands and individual plots (Snyder & Torres, 1998). *Ejidors* must first have their land surveyed and boundaries solidified by PROCEDE and the *Instituto Nacional de Estadística y Geografía* (INEGI, National Institute for Statistics, Geography, and Informatics) in order to receive a certificate for their land. There are three types land that make up any *ejido*: urban land (a very small, concentrated portion of the common use land originally designed for human settlement), parceled land (each individual parcel is assigned to an individual *ejidatario* who decides the use of the land), and common use land (joint ownership between all *ejidatarios*; any decisions require the agreement of the ejido assembly) (A. Pedrin, Real Estate Attorney, Baker & McKenzie Associates, LLC, in-person interview, 23 February 2009). The type of *ejido* land that has the potential to be sold is the parceled land under the discretion of individual *ejidatarios* and the common use land if the ejido assembly decides upon it (A. Pedrin, in-person interview, 23 February 2009).

Once a certificate for land is obtained, *ejidos* may then apply to the *Registro Agrarian Nacional* (RAN, Agrarian National Registry), which issues titles for *ejido* land and *Procurduría Agraria* (Office of the Agrarian Attorney General), which is in charge of paying subsidies to *ejidos* (Pedrin, 2009). According to the *Registro Agrarian Nacional*, 95% of all *ejidos* throughout Mexico are involved in some phase of the detailed 10-step process required to obtain the title to their land (Assies, 2008; Pedrin, 2009). *Ejidatarios* can transfer certificates and titles to someone else in the family or someone within the *ejido*. Or, if they want to sell the land and convert the certificate to a private property title, the entire *ejido* assembly must approve the sale through majority approval. Once permission is granted and a title is issued, the land can be sold to anyone outside of the *ejido* (Snyder & Torres, 1998).

***Ley Agraria* Potential Influence on Land Use**

Ejido land makes up approximately 43% (140,500 hectares) of the Mexican portion of the watershed. In the Tijuana River Watershed the implementation of *Ley Agraria* had the potential to impact land use in several different ways. There are 24 different *ejidos* within the Tijuana River Watershed, and they include approximately 140,500 hectares of land in the watershed (Figure 4). Since fewer and fewer *ejidatarios* live and work primarily on *ejido* land, there is the potential for portions of this land to be sold. Furthermore, with ample demand for land from development agencies and conservation organizations, land use has the potential to change substantially.

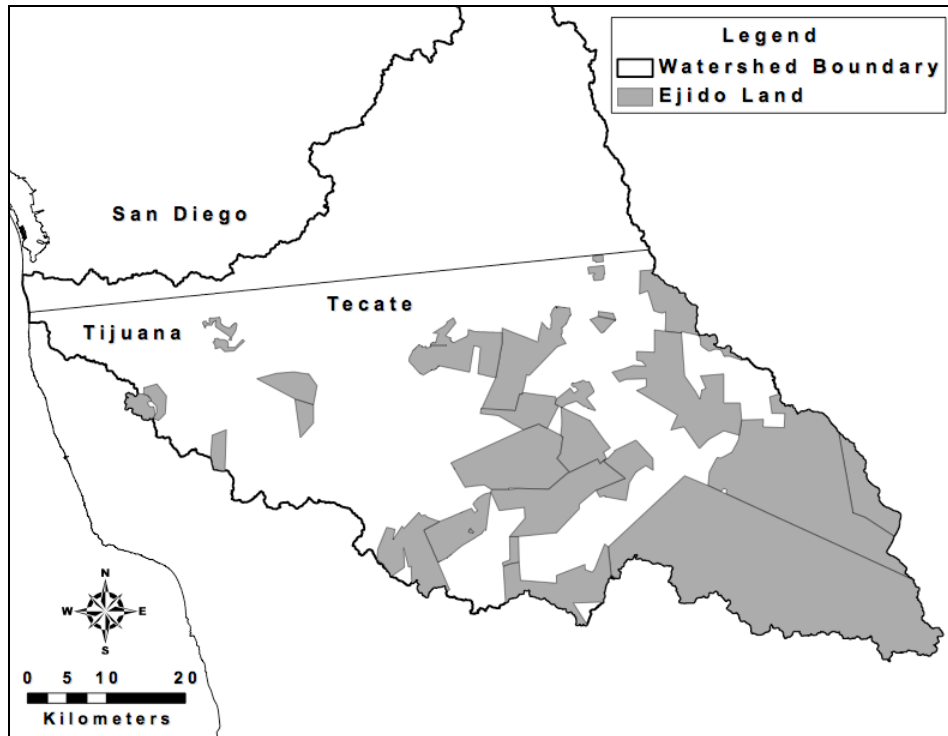


Figure 4. Ejido land in the Tijuana River Watershed, representing 24 ejidos (342,138 hectares).

Research Question 2b: In areas experiencing rapid land-use change from agriculture to urban what are the proximate causes of such changes? How does this differ on either side of the border?

A critical area of study in land-use change literature is the urban-rural linkage (Lambin, et al., 2001). This is particularly relevant for the Tijuana River Watershed where unincorporated rural lands in the east surround the City of San Diego, and in the Mexican portion of the watershed Tijuana is surrounded by rural land to the east and to the south. The type of land-use change that most often occurs at the interface between urban and rural lands is the replacement of agricultural land by urban development, especially low-density residential and commercial use (Long et al., 2009; Theobald, 2001). Given the amount of predicted urban development in smaller urban centers in the watershed, I expected that the transition from areas of agriculture to urban development was the type of land-use change that was most likely to have occurred during

the study period. I also expected that this type of land-use change would be more apparent in the Mexican portion of the watershed because the loss of agricultural land to urban development is more severe in low- to middle-income cities (Fazal, 2000).

The transition from agricultural land to urban is difficult to study at county or state level because land use dynamics for this type of land-use change occur at a finer scale (Theobald, 2001). Thus, I chose to study two communities on both sides of the border since past studies have predicted changes in agricultural intensification and urban population growth for some communities on the urban fringe (Ojeda-Revah et al., 2008). On the U.S. side of the border is Campo, a growing community located in an unincorporated portion of San Diego County with a population slightly more than 3,000 (San Diego Association of Governments, 2008a). Campo has a strong history of cattle ranching and includes the oldest, continually operating ranch in San Diego (Star Ranch, LLC, 2008). In recent years the town was zoned for a series of multiple low-density and rural development projects by the General Plan Update for the County of San Diego (K. Zuppiger, East County MSCP Planning Manager, County of San Diego Department of Planning and Land Use, personal communication, 20 August 2008). In addition, although MSCP plans for this specific area in the watershed are still in the planning phases, the County of San Diego's MSCP plan already began to focus conservation efforts in Campo and surrounding area due to the large number of development projects and proposed development plans. Until now, no one has studied how MSCP and the General Plan impact this community.

On the Mexican side of the border, in an area south of Tijuana, the community of Valle de Las Palmas has traditionally been an area of intensive agriculture due to its location in an interior valley, which has a reliable source of water to irrigate crops (Wright, 2005a). In more recent years the area gained a reputation of having a great deal of urban development since it is

located on the outskirts of Tijuana. Past studies projected that Valle de Las Palmas would one day connect to Tijuana and become a much larger population center (Ojeda-Revah et al., 2008; Wright, 2005a). Because of the projections for urban development in Valle de Las Palmas I expected that urban land use would encroach on agricultural land because of the finite amount of land that is actually flat in this area.

The following chapter will give a detailed description of the methods I used to study these two communities and the other methods necessary for analyzing the influence of MSCP and *Ley Agraria* on land use.

Chapter 3: Research Methods

Much of the work that has been done on investigating drivers of land-use change emphasizes the need for multiple methods in order to assess and explain changing patterns of land use and their causes (Turner, 2003; Campbell et al., 2005; Young et al., 2006). This study includes a variety of methods: map analysis, semi-structured interviews, structured questionnaires, and archival research. The first set of methods, which addressed the initial research question, took a quantitative approach to assess the extent and magnitude of land-use change using land-use maps and satellite imagery. The second set of methods, which addressed the second research question, took a qualitative approach in order to analyze the key policies associated with changes in land use. These methods incorporated archival research and interviews with public officials, local residents, and other key informants as well as a case study analysis consisting of semi-structured interviews and structured questionnaires with local residents and landowners. Because the two sets of methods are different, they are presented in separate sections of this chapter. These combined methods served as a way to understand the patterns and causes of land-use change in the Tijuana River Watershed.

Methods for Research Question 1

Geographic Information Systems (GIS) and remotely sensed imagery have become valuable tools in the study of land-use change (Turner, 2003). They are used to gain knowledge of a large extent of land, and, in many cases, to quantify classes of land cover in order to measure change over time. The first set of methods were used to address the research question: what are the dominant land-use changes that have taken place from 1994-2006 in the Tijuana River Watershed? The objective was to measure changes in area for each land use class and determine

the dominant types of change (i.e. from one class to another class) that took place between 1994 and 2006. This information is a crucial part of the study since it is necessary to first measure the presence and magnitude of change in the watershed before conducting an analysis of the causes of change.

The data I used to measure changes in land use were a series of land-used maps created by researchers at El Colegio de la Frontera Norte (COLEF), who conducted all land-use mapping for the watershed since 1953. The data included were the land-use maps they created for the years 1994 and 2006, consisting of a set of 4-class land-use maps. The maps were created using 1994 National Oceanic and Atmospheric Administration color aerial photographs, 1994 SPOT 10m panchromatic imagery, and 2005 ASTER 5m and 15m imagery (Ojeda-Revah et al., 2008; Ojeda-Revah, in preparation). The set of maps includes four broad land use categories: urban, agriculture, vegetation, and reservoirs.

I analyzed the land-use maps in a geographic information system (GIS), using ArcGIS 9.3 and following methods for calculating land-use change set out by Ojeda-Revah et al. (2008). First, I calculated the area of each land-use class using the field calculator to select all polygons for each class and the corresponding attribute table. Then, I calculated the difference in raw area (hectares) and percentage of total land use in the watershed for each map, 1994 and 2006. Next, I calculated the dominant types of land-use change from 1994-2006, using the frequency statistics function in ArcGIS 9.3. For each polygon in 1994, I calculated what the polygon became in 2005, allowing for land use to potentially remain the same for each year. It should be noted that the polygons did not remain static in size, shape, or number between the two years. The output was a table that indicated all possible combinations of change in land use, the total area (hectares) of change, and the total number of polygons included in this change. Finally, I

calculated the difference in changes in the U.S. portion of the watershed versus the Mexican portion of the watershed.

Methods for Research Question 2

Land-use change detected using GIS and satellite imagery was the foundation for approaching the next portion of the study, which was to analyze drivers of change. The combination of these methods serves as a way to better understand a physical phenomenon in the context of social science (Homewood et al., 2001; Turner, 2003). In order to understand policy drivers of land-use change, “the linkage of policy factors with landscape transformation may not be directly captured by quantitative means because policy factors are fundamental, underlying and inherently qualitative” (Thiha et al., 2007, p.170). This section and set of research methods addressed the inherently qualitative nature of such change.

Beginning with the investigation of specific political and institutional factors, a policy analysis of Mexico’s *Ley Agraria* and the Multiple Species Conservation Program in San Diego was conducted to address the question: How have the Multiple Species Conservation Program (MSCP) and *Ley Agraria* influenced land-use change in the Tijuana River Watershed? The objective of this work was to assess the relationship between these specific policies and changes in land-use throughout the watershed.

For the Mexican portion of the watershed, I first gathered data on the population and size of each *ejido*, the amount of land that is common use and that which is parceled, and the rate of land sales for that *ejido*. I collected data from INEGI and the conservation organization *Terra Peninsular* since both have a fair amount of land use data. The amount of available data for each *ejido* varied and there were often gaps of ‘no data’ for some relatively small *ejidos* and those in

the rural parts of the watershed. For the data that was available the information revealed whether land sales in each *ejido* were relatively ‘high’ or ‘low’ and whether there had been a substantial increase or decrease in population. This, in turn, gave some indication of changes in land use since *ejidos* that had high selling rates coupled with an increase in population would most likely have transitioned from open space or agriculture land use to residential land use.

Next, I conducted semi-structured interviews with policy officials from *Dirección de Protección del Ambiente del Municipio de Tijuana* (Office of Environmental Protection for the Municipality of Tijuana) and *Procuraduría Agraria* (Office of the Agrarian Attorney General), officials from the conservation organizations *Terra Peninsular* and *Pronatura*, real estate attorneys from Baker & McKenzie, LLC in Tijuana, and representatives from *Instituto de Culturas Nativas de Baja California* (CUNA, Native Cultures Institute of Baja California). The interviews included questions about the recent land-use history of Tijuana, Tecate, Sierra Juárez, Valle de Las Palmas and surrounding areas, how *ejido* land had generally been used during the early 1990’s, the implementation of *Ley Agraria* in 1992, and whether land use had changed since the implementation of *Ley Agraria*. The interviews served as a way to build a land-use history for the Mexican portion of the watershed and confirm consistencies with the population and land sale data. In some cases, these interviews were the only data available for a specific *ejido*.

In addition to interviewing policy officials, I interviewed *ejidatarios* in the watershed. To do so, I used contacts from the Universidad Autónoma de Baja California (UABC) who had previously worked with *ejidatarios* on habitat conservation issues. I conducted structured interviews with *ejidatarios* from Ejido Gustavo Aubanel Vallejo, Ejido Héroes de Desierto, Ejido Juntas de Nejí, Ejido Felipe Ángeles, Ejido Ojo de Agua, Ejido Mesa Redonda, Ejido Mí

Ranchito, and Ejido Nueva Colonia Hindú. I chose these specific *ejidos* because they were accessible and had *ejidatarios* who had lived on the land for at least the past 20 years. This was not the case for other *ejidos*, especially those located in the city of Tijuana and *ejidos* located in remote parts of the watershed such as Sierra Juárez. For this portion of the study I used questionnaires for the interview process, which allowed for comparability of data. Since *ejidos* varied in size, population, and type of land use it was useful to have a set of questions that provided consistent structure and topics for the interviews. Questionnaires were also the most appropriate data collection method because I wanted to travel to one *ejido* and hold several interviews within a short period of time and visit at least two *ejidos* per day, and many of these *ejidos* were located in parts of the watershed that were less accessible because of road conditions.

Questions for interviews with *ejidatarios* were much more specific and included asking detailed questions about the amount and types of crops, irrigated versus non-irrigated land, and urban dwellings on the land, whether interviewees participated in *ejido* assemblies, their knowledge of subsidy payments, and whether sold parcels of land had been converted to different land uses. At the end of the questionnaire, there was a series of open-ended questions regarding the traditional land uses for that *ejido* and whether any changes had taken place on the *ejido* since 1994.

In the U.S. portion of the watershed, I analyzed the effects of a regional conservation policy, the Multiple Species Conservation Program (MSCP), on land use in the watershed. The analysis included a review of the annual MSCP reports for San Diego County and City reports for 1997-2006. These contain data on the amount and location of habitat preserved each year, the amount and location of land that was granted a take-permit and therefore considered a loss of habitat, and the type of land use that was previously on the land. In addition, I conducted semi-

structured interviews with officials at local government agencies who were involved with the development of MSCP. These agencies included the San Diego County Department of Planning and Land Use, the U.S. Fish and Wildlife Service, Conservation Biology Institute, and the City of San Diego Planning Department.

My research in the Mexican portion of the watershed included policy officials and landowners (*ejidatarios*), and the inclusion of landowners in the study created a more comprehensive view of the recent land-use history in that portion of the watershed. Therefore, for the U.S. portion of the watershed I also conducted semi-structured interviews with landowners and ranch managers in the towns of Alpine, Dulzura, and Campo. These three towns contain some of the largest populations in the watershed (San Diego Association of Governments, 2000), and similar to the areas where I interviewed *ejidatarios*, they are on the periphery of the large urban center where land use had the potential to change most. In these interviews, I spoke with people who owned or managed parcels of land greater than two hectares and who had lived in the area for over 20 years. In Alpine and Dulzura, I used contacts I had from the Botany Department at the San Diego Natural History Museum. Since the department often does sampling on the land in these towns, they had an extensive database of people I could contact. In Campo, I contacted representatives for the Campo Community Council, who then introduced me to residents in the area. Interviews with policy officials and residents were used in a similar way as interviews with officials and *ejidatarios* in Mexico. The interviews served as a way to build a land-use history throughout various areas of the watershed and provide a great context of changing land use that was not given in the annual reports.

Altogether, interviews with policy officials, non-governmental officials, residents, and *ejidatarios* provided the information necessary to draw conclusions about the intentions of

MSCP and *Ley Agraria* throughout the watershed. However, it was also necessary to analyze how the intentions of MSCP and *Ley Agraria* played out. Thus, I chose to take a two-pronged approach and complement this information with two case studies on each side of the border. A case-study approach, which addresses the characteristics of land-use change in particular communities and districts within a given region (Homewood et al., 2001; Campbell et al., 2005), allowed for an investigation of how these policies have played out in specific communities. Thus, the final part of this study addressed the question: in communities experiencing rapid land-use change from agriculture to urban, what are the proximate causes of such changes?

To address this question two community case studies were carried out on both sides of the border in Campo, California and Valle de Las Palmas, Baja California. The objective of the case studies was to gather information regarding how *Ley Agraria* and MSCP have played out in these communities. Policy officials and residents in other parts of the watershed may have a different view on the intentions and influences of these two policies. However, residents in Campo and Las Palmas who have extensive knowledge of the community land-use history may have insight as to how the policies have played out or whether they even have a substantial influence on land use.

Work in Valle de Las Palmas included semi-structured interviews with local residents and landowners who had resided in the area for at least 20 years. Interview questions included topics such as community and population growth, changes in community infrastructure, urban growth, and whether U.S. citizens had become a substantial presence in the area. Unlike interviews with policy officials, talk of *Ley Agraria* was not a large part of the interview. Instead, I asked their opinion regarding what they thought were the reasons for any changes in land use in the area.

Work in Campo included semi-structured interviews with local residents and landowners who had resided in the area for at least the past 20 years. As with the residents in Valle de Las Palmas, interview questions were focused less on the topic of MSCP, and more on patterns and causes of land-use change in the community. In addition to the interviews, census data and land-use data from the San Diego Association of Governments (SANDAG) was used for the years 1990-2030 for the Campo case study (SANDAG projects future growth up to the year 2030). This data was used in order to gain an understanding of demographic and economic factors that may potentially play a role in influencing land-use change in the area.

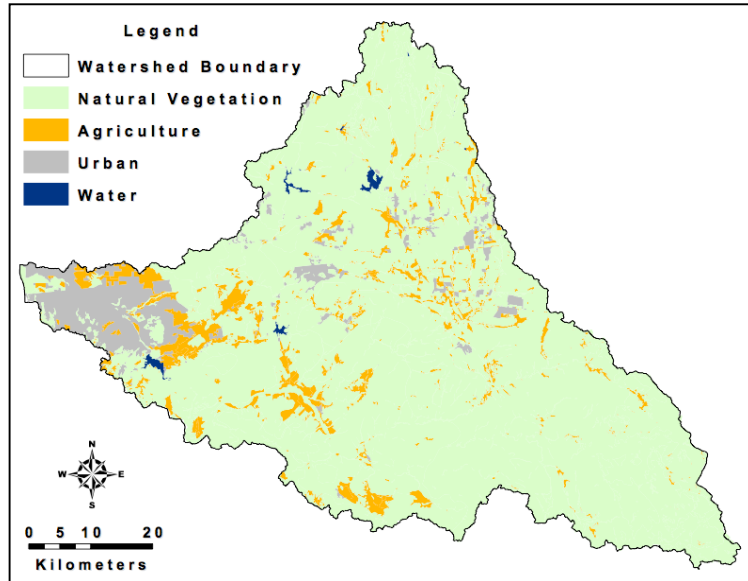
In total, I conducted 43 interviews with a variety of policy officials, non-governmental officials, residents, landowners, and *ejidatarios* throughout the Tijuana River Watershed. This included 21 interviews in the Mexican portion of the watershed and 22 interviews in the U.S. portion of the watershed. The interviews, supplemented with demographic and land use data, were used to identify the influence both policies had on land use. The following chapters describe the results in detail.

Chapter 4: MSCP in San Diego

This chapter begins with a discussion of all land-use change in the Tijuana River Watershed from 1994-2006 followed by a discussion of the quantity and location of lands affected by MSCP since its implementation in 1997. This includes the dominant types of land-use change that took place during this time. Next, the discussion focuses on the large-scale policy impacts MSCP had on land use throughout the watershed followed by a more in-depth analysis of one community. Together, the policy analysis and the community analysis show how drivers of land-use change operate in this case and highlight the importance of scale in the study of drivers. Finally, this chapter concludes with a brief discussion of the future implications of MSCP in the watershed.

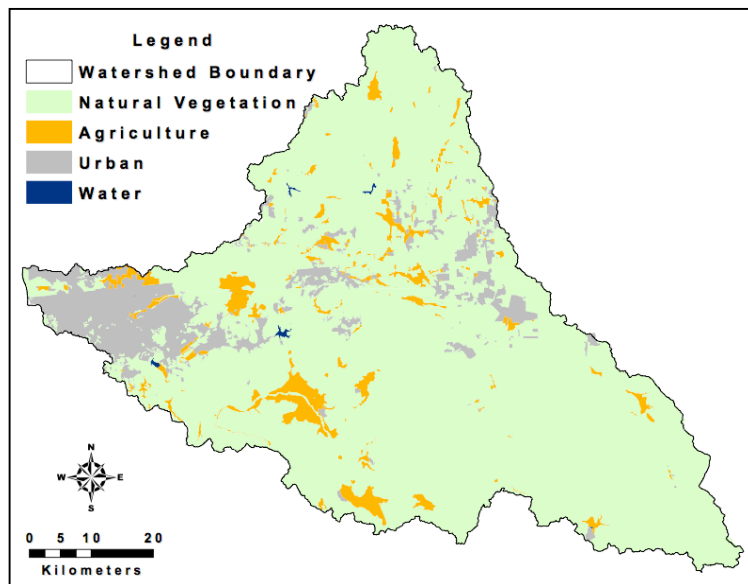
Land Use Changes

In 1994, the watershed consisted of the following land uses: 85.3% natural vegetation, 7.6% agriculture, 6.6% urban area, and 0.4% water (reservoirs) (Figure 5). In 2006, land use in the Tijuana River Watershed included: 84% natural vegetation, 5.4% agriculture, 10.3% urban area, and 0.1% water (reservoirs) (Figure 6).



1994 Land Use	Area (Ha)	% of Total Land Use
Natural Vegetation	379,750	85.3 %
Agriculture	34,039	7.6 %
Urban	29,405	6.6 %
Water	1,757	0.4 %

Figure 5. Map of land use in the Tijuana River Watershed for 1994, consisting of the land-use classes: urban, agriculture, natural vegetation, and water. The raw area of each land use class (hectares) and the percentage of each land use class is listed in the adjacent table.



2006 Land Use	Area (Ha)	% of Total Land Use
Natural Vegetation	373,980	84.0 %
Agriculture	24,369	5.5 %
Urban	46,019	10.3 %
Water	577	0.1 %

Figure 6. Map of land use in the Tijuana River Watershed for 2006, consisting of the land-use classes: urban, agriculture, natural vegetation, and water. The raw area of each land use class (hectares) and the percentage of each land use class is listed in the adjacent table.

The land use maps from 1994 and 2006 highlight important changes that took place over the entire watershed during the study period. Overall, there was a 3.7% increase (16,614 hectares) in urban area, a 2.2% decrease (9,669 hectares) in agricultural land, and a 1.3% decrease (5,770 hectares) in natural vegetation (Figures 5 and 6). However, only 3.7% of all change in the Tijuana River Watershed occurred in the U.S. portion.

Although only a small fraction of change occurred in the watershed, it is important to consider the types of change that occurred. In the U.S. portion of the watershed the major land-use change was from natural vegetation to urban development (1,293 hectares) (Table 1).

Although it appears as if changes from natural vegetation to agriculture were dominant (3,279 hectares), this is not the case because nearly the same amount of land changed from agriculture to vegetation (3,532 hectares). It is as if these changes in land use cancel each other out.

The dominant change from natural vegetation to urban development was not what I had expected. I expected that the major land-use change would be from agricultural areas to urban development. However, this type of change only included 293 hectares of land (Table 1).

Land use 1994	Land use 2005	Change in U.S. (Ha)	Change in TRW (Ha)
Agriculture	Urban	293	5,929
Agriculture	Vegetation	3,532	14,244
Water	Agriculture	20	195
Water	Urban	1	14
Water	Vegetation	794	1,026
Urban	Agriculture	24	38
Urban	Water	-	5
Urban	Vegetation	174	624
Vegetation	Agriculture	3,279	10,270
Vegetation	Water	10	51
Vegetation	Urban	1,293	11,338

Table 1. Dominant types of land-use change in the U.S. portion of the watershed compared to changes in all of the watershed during the years 1994-2006. The table includes all potential combinations of change from one class to another during the study period. (Land-use change from Agriculture in 1994 to Water in 2005 is not included in the table because the change was less than 1 hectare.)

MSCP Affected Lands

For land-use change that occurred in the U.S. portion of the watershed, I analyzed the role that MSCP played in influencing change. The City of San Diego’s total habitat conservation goal was 21,049 hectares (City of San Diego, 1997). Between 1997 and 2006, the City of San Diego conserved a total of 13,420 hectares in the MHPA, 62.9% of the City’s conservation target. This included the acquisition of 440 hectares of agricultural land (3.3% of conserved land), 333

hectares of urban/developed land (2.5% of conserved land), and 687 hectares of “disturbed land” (5% of conserved land) (City of San Diego, *2006 MSCP Annual Report*, 2007, p. 16). It is important to note that prior to 1997, 6,058 hectares (45.2%) had already been preserved and acted as baseline preserve when the City’s MSCP was implemented.

The total habitat conservation goal for the County of San Diego was 39,813 hectares of land (County of San Diego Department of Planning and Land Use, 2008). Between 1998 and 2007, the County achieved 66% of its conservation goal with the preservation of 26,391 hectares by acquisition, dedication of easements, and baseline preserve. Of this land, 526 hectares were agriculture (2%), 172 hectares were urban (0.7%), and 321 hectares were “disturbed habitat” (1.2%). Prior to 1998, 15,161 hectares (57.5%) were already set aside as baseline preserve when the County’s MSCP was implemented.

Of the total conserved lands in the City and County of San Diego’s MSCP (39,811 hectares), 13,780 hectares (35%) were in the Tijuana River Watershed (Table 2). The conserved land occurred in the western most portion of the watershed on the U.S.-side in the Tijuana River Valley, Imperial Beach, Dulzura, and Otay (Figure 7).

Year	Habitat Preserved in the TRW (Ha)	Habitat Loss in the TRW (Ha)
1997	9,913	-
1998	176	34
1999	2,713	3,083
2000	60	2
2001	444	47
2002	119	32
2003	192	3
2004	145	8
2005	17	12
2006	1	75
2007	-	24
Total	13,780	3,320

Table 2. Total habitat preservation and loss by the City and County of San Diego in the Tijuana River Watershed 1997-2007.

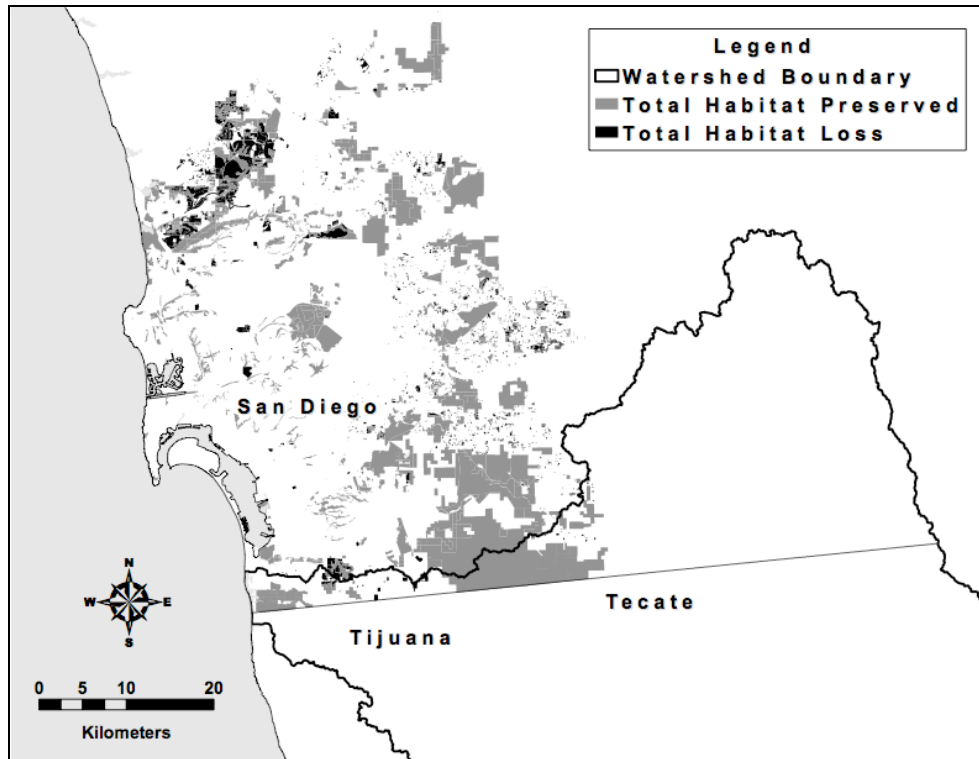


Figure 7. Map of habitat preservation and loss by the City and County of San Diego in the Tijuana River Watershed 1997-2007.

Discussion of MSCP and Land Use

Data suggest that although 35% of land conserved by MSCP was in the Tijuana River Watershed, at a watershed level MSCP has not substantially impacted land use. The primary reason for this is that although conservation relied on the acquisition of private land, the majority of acquisitions were lands that were already open space. However, at a community level, the impacts of MSCP have been much more substantial. Several communities throughout the watershed became targets for conservation, which impacted land use through changing land use densities and the dedication of this land as open space. In this section I discuss the specific amount and location of land that had the potential to be affected by MSCP, and then discuss why MSCP did not have a substantial impact on these lands.

When MSCP was implemented in 1997, the City of San Diego was prepared to acquire 3,000 hectares of privately owned land (City of San Diego, 1997). Additionally, when the County's MSCP plan was proposed, 7,628 hectares of privately owned lands were expected to be available for acquisition with federal, state, and local public funds (County of San Diego, 1998). I expected there to be a change in land use once these lands were acquired because of the change in land tenure from private to public. However, acquiring private land was only one part of meeting conservation goals. The main focus of MSCP has been to include undeveloped public lands that are already under federal, state, and local ownership so that a comprehensive preserve system could be established with minimal effort. According to the County of San Diego Planning Department, "the MSCP preserve system incorporates public lands to the greatest extent possible to minimize the need to acquire private lands and to avoid increasing exactions on private land development beyond the existing requirements of local, state, and federal regulations" (County of San Diego Department of Planning and Land Use, 1997, p. 29). More importantly, even in the case of private land acquisition, most of the privately owned land was previously open space and grazing land (City of San Diego, 1997; County of San Diego, 1998).

Although land acquisitions have not impacted land use as I had expected, causing land to change from one use to another, the primary watershed-scale impact MSCP had on land use has been the *prevention* of substantial portions of land from undergoing changes in use. Although a primary goal of MSCP has been to make development more efficient for developers, the City and County of San Diego focused conservation efforts on proposed development projects (County of San Diego Department of Planning and Land Use, 1997; City of San Diego Planning Department, 1997). A large focus for the City's plans for conservation have been the Otay Mesa area (Dennery Canyon and Spring Canyon), located east of I-805 and south of Otay River

Valley, running all the way to the border. This area consists mainly of slopes and wide, deep canyons, containing maritime sage scrub and coastal sage scrub vegetation communities.

According to the City of San Diego, in 1997 this area was, “highly constrained by planned and approved development that completely surrounded and in some areas encroached into the canyon areas” (City of San Diego Planning Department, 1997, p. 5). The U.S. Fish and Wildlife Service, the California Department of Fish and Game, and the Bureau of Land Management have acquired portions of this land. With the acquired land, they have created the San Diego National Wildlife Refuge (17,806 hectares with approximately 2,900 hectares in the Tijuana River Watershed) and the Rancho Jamul Ecological Reserve (1,922 hectares) (S. Wynn, in-person interview, 24 February 2009; U.S. Fish and Wildlife Service, 2009; California Department of Fish and Game, 2009). Thus, in the case of the city’s conservation plans, there was a change in land tenure for more than 4,800 hectares of land even though this did not change land use.

The County’s plan focused on several private development projects in order to accomplish their conservation goals. Most of these development projects occurred in a portion of the County’s plan, known as the South County segment, which overlaps with the Tijuana River Watershed. Within this area, there were five private development projects occurring when the MSCP was first implemented: Otay Ranch, Hidden Valley Estates, Pointe San Diego, Las Montañas, and Loma de Sol. Together these sites account for almost all of the private preserved area in the South County segment. According to the county’s subarea plan that evaluated land use before MSCP was implemented, urban, agricultural, and developed lands made up about 11% (3,371 hectares) of this land and the remainder was either open space or grazing land. Each one of these projects was bought out by MSCP. In the instance of the Otay Ranch Project, which had 4,450 hectares of open space associated with it, MSCP acquired a substantial portion of this

land, including the proposed development of Rancho San Miguel, reducing development significantly (T. Oberbauer, in-person interview, 10 February 2009). Overall, because almost 90% of the total land for these development projects was either open space or grazing land, there was a significant change in land tenure but not in land use.

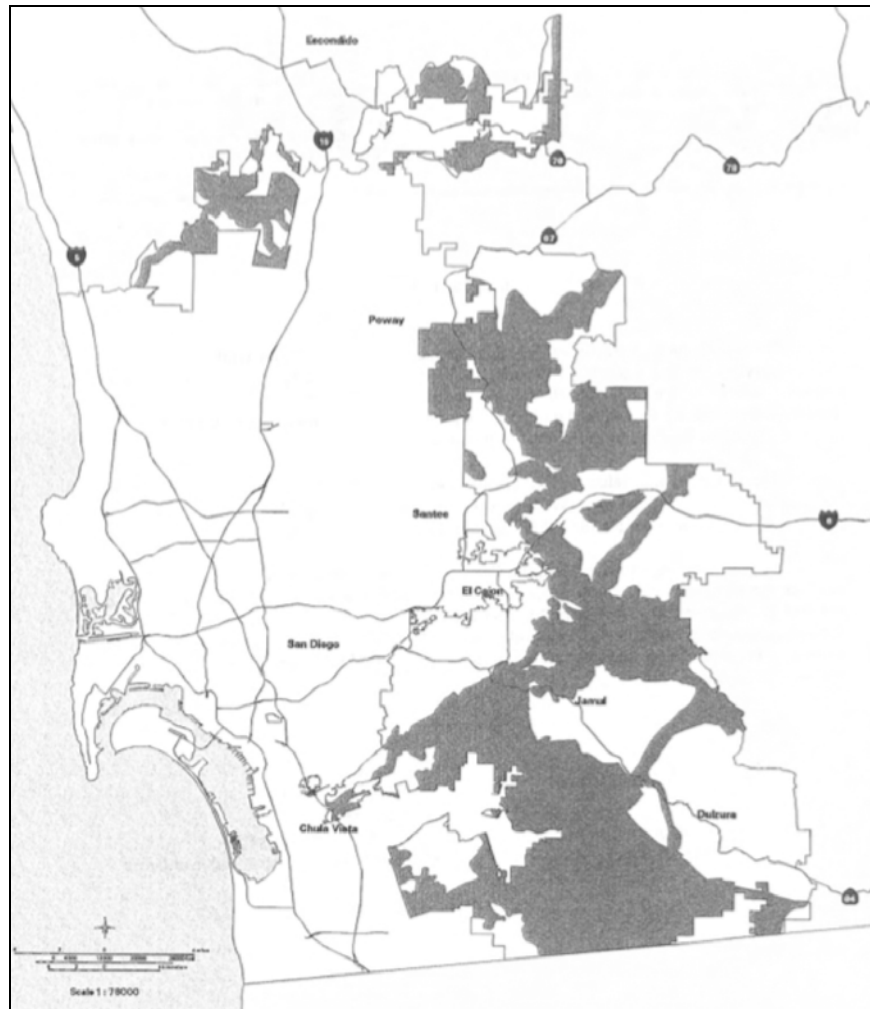
Much of the land that would otherwise be developed has been acquired and preserved as a result of the fact that it is within the MSCP planning area. Therefore, the county and city MSCP plans prevented substantial portions of land from undergoing land-use change from natural vegetation (open space) or agriculture (grazing land) to urban development. This finding is consistent with the land-use change maps for 1994-2006, where only 3.7% of all change in the Tijuana River Watershed occurred in the U.S. portion of the watershed.

Community Analysis: Campo, California

Although land-use change only occurred on a small fraction of land in the watershed, it included 16,588 hectares of land. At a finer scale this amount of land is substantial, so it was important to recognize whether change in land use occurred in a concentrated or fragmented manner. I found that at a community scale MSCP had a much stronger influence on land use in the watershed.

This is because the overall goal of MSCP is to establish an interconnected preserve system with appropriate habitat corridors; therefore, the policy focuses on concentrated areas (Figure 8). If a community is located in such an area, the community as a whole has the potential to be impacted the most, relative to surrounding communities that are not targeted. An example of one such community is Proctor Valley, located in the Tijuana River Watershed approximately 40 km southeast of the City of San Diego. In 2003, 592 hectares (slightly less than 6 km²) were acquired in Proctor Valley with state funding (County of San Diego Department of Planning and Land

Use, 2003 MSCP Annual Report, 2004, p. 9). This acquisition was almost half (45%) of the total area of Proctor Valley (1,327 hectares). Prior to the acquisition, the land was mixed-use development with 906 residential units and facilities for commercial use planned for the near future. After the acquisition, nearly all planned development halted (S. Wynn, in-person interview, 24 February 2009). Because Proctor Valley is located on the urban fringe of the City of San Diego and the City of El Cajon, which have both developed to the edges of their city's boundaries, development in Proctor Valley and other similar communities may play an important role determining future growth of San Diego County.



Source: County of San Diego Department of Planning and Land Use

Figure 8. Biological resource core areas and linkages identified by the County of San Diego, which are targeted as part of the comprehensive preserve system for MSCP (City of San Diego core biological areas are not shown).

Another community greatly affected by the MSCP plan has been Campo, located in an unincorporated portion of the county approximately 80 km southeast of the City of San Diego. Campo is a community known for its agricultural history, mainly in cattle ranching (B. Buchanan, Supervising Park Ranger, Lake Morena Community Park, in-person interview, 10 March 2009; R. Chalberg, Director, Campo-Lake Morena Historical Society, personal

communication, 11 March 2009). In recent years, the community has grown to include more residential areas to accommodate current and anticipated population growth. It reached a peak in 2000 with the construction of Campo Hills, a 222-home development project in the center of Campo (R. Chalberg, personal communication, 11 March 2009).

The populations in the unincorporated areas of the county, which account for 84% of the total land area of San Diego County (County of San Diego, 2009) are expected to accommodate 23% of the new population. It is expected that, as a whole, the unincorporated areas will increase by 55% from the current population of 467,728 to 723,392 by 2030 (San Diego Association of Governments, 2008a). Campo and the surrounding towns have already experienced an increase in population and are expected to inherit an even larger portion of this growth in the future (Table 3) (T. Bowes, Planning Manager, San Diego County Parks and Recreation, personal communication, 2 August 2008).

Year	Population	Single Family Housing Units	Multiple Family Housing Units	Low Density Single Family Housing (acres)	Commercial Land Use (acres)	Agricultural Land Use (acres)	Agricultural Industry (%)
1990	2,713	764	35	-	-	-	6%
2000	3,163	920	29	-	-	-	3%
2004	3,222	920	243	7,023	49	3,131	-
2008	3,533	1,082	204	7,624	51	3,122	-
2010	3,702	1,082	243	10,139	141	2,572	-
2020	4,296	1,093	243	23,784	224	786	-
2030	6,401	1,705	243	-	-	-	-

Source: San Diego Association of governments (SANDAG)

Table 3. Demographic and land use data for Campo, CA for 1990-2030.

Although Campo lies just outside the border of the South County MSCP boundary, land use there has already been affected by MSCP. In this area, MSCP operates in conjunction with the County’s new General Plan, which establishes the future growth and development patterns for the unincorporated areas of the county. According to a representative from the U.S. Fish and

Wildlife Service, “For East County MSCP, right now the General Plan is the thing most influencing land use, whereas for the South County [MSCP] and San Diego City portions of MSCP, the General Plan is not as influential as MSCP since MSCP has been approved in this area” (S. Wynn, in-person interview, 24 February 2009). This means that in the case of Campo the General Plan plays a primary role in influencing land use. Additionally, because MSCP plans for the future are closely aligned with the General Plan, it is important to recognize how they both impacted land use in recent years and what this means for future years.

Under the county’s new General Plan, almost all of the land in Campo has been down-zoned, meaning land parcels that would have allowed for a density of one home per 2, 4, 8, or 16 acres (approximately 0.8, 1.6, 3.2, or 6.4 hectares, respectively) would now allow only one home per 20, 40, 80, or 160 acres (approximately 8, 16, 32, or 64 hectares, respectively). Also, under the old General Plan the county would have allowed for the subdivision of parcels to accommodate more residential housing; however, under the new General Plan no such subdivisions may take place.

The planners involved in the new General Plan and the planners for MSCP work together to design both plans to ensure that their maps align (T. Oberbauer, in-person interview, 10 February 2009), and many residents of Campo stated that this approach only benefits MSCP (S. Carmody, President, Mountain Empire Resource Information Taskforce, in-person interview, 11 March 2009; B. Esry, Chairperson, Campo Community Planning Group, in-person interview, 11 March 2009; R. Lenick, President, Home Owners for the Preservation and Enhancement of the Mountain Empire, in-person interview, 16 March 2009). These residents argued that if most of the land in Campo is down-zoned and they are not allowed to develop it, then it benefits MSCP. MSCP would not have to worry about using funds to purchase the land because it has been so

severely down-zoned that there is no threat of development (S. Carmody, in-person interview, 11 March 2009; B. Esry, in-person interview, 11 March 2009; R. Lenick, in-person interview, 16 March 2009). Under the new General Plan, if an area has low density zoning then planners for the MSCP will attempt to figure out a way to do monitoring on adjacent property that is publicly owned. However, for areas with high-density zoning, MSCP would use more traditional practices of acquiring land (T. Oberbauer, in-person interview, 10 February 2009).

In response to the County General Plan Update and MSCP, plans for urban development surged in 2002 before the new zoning was ready to be approved. Residents were given a deadline to propose development projects, which, if approved, could be “grandfathered in” under the rules of the old General Plan (R. Lenick, in-person interview, 16 March 2009). And, on September 17, 2003 one of the largest projects proposed was Star Ranch, an 875-hectare development in Campo (Figure 9) (G. Vick, Ranch Manager, Star Ranch, in-person interview, 16 March 2009). Formerly, this area had been the oldest continually operating ranch in San Diego. The new community development plan includes 172 quarter-hectare lots, 125 single-family lots, 66 condominium units, 60 senior housing units, 25 one and three-hectare equestrian estate lots, 12 one-hectare estate lots, and 14.7 hectares for commercial, medical, and recreation purposes (Star Ranch Company, LLC, 2008). Star Ranch is currently awaiting approval for development, and if approved it will initiate development within one year. Many in the Campo community believe that future development depends on the approval of Star Ranch (B. Buchanan, in-person interview, 10 March 2009; R. Chalberg, 11 March 2009). They believe that if Star Ranch gets approved there will be a slough of developments projects in Campo and in surrounding areas (B. Buchanan, in-person interview, 10 March 2009; R. Chalberg, 11 March 2009; R. Lenick, in-person interview, 16 March 2009).

Although land use on Star Ranch did not change, it is an example that contradicts the overall goals of MSCP. If there are communities throughout the watershed that have similar responses, the result could be a severe hindrance for creating a connected preserve system in San Diego County. Furthermore, because Campo lies adjacent to the border, the issue could also be a hindrance for creating a binational preserve system across the border.



Source: Star Ranch Company, LLC (2008)

Figure 9. Satellite image of southern San Diego County, including the city of Campo (red) and the Star Ranch development project (yellow).

Future Implications of MSCP

In 2010, the County will officially include Campo in its plans as it extends the MSCP boundary to include the East County Subarea plan, an area that shares more overlap with Tijuana River Watershed than the current city and county MSCP plans combined. The land within the East County Subarea plan is primarily natural vegetation and agriculture with some low-density rural development (S. Wynn, in-person interview, 24 February 2009). A large majority of biological core areas and habitat linkages identified as conservation targets are in the East County portion of MSCP (T. Oberbauer, in-person interview, 10 February 2009). County MSCP planners are

currently discussing various management options and whether this will include a substantial amount of acquisition or monitoring. However, if acquisition is necessary, planners agree that this will include agricultural land and naturally vegetated open space land since this is the primary land use for this portion of the county (T. Oberbauer, in-person interview, 10 February 2009).

It remains to be seen whether communities in the East County Subarea, including Barrett Junction, Potrero, Boulevard, and Jacumba, will have a similar response to Campo. These communities also lie adjacent to border and are already the focus of binational conservation efforts by the Las Californias Binational Conservation Initiative (Conservation Biology Institute, 2004; K. Viatella, Senior Project Director for the Nature Conservancy, 2 October 2009). If Barrett Junction, Potrero, Boulevard, and Jacumba do initiate development in response to MSCP and the county's new General Plan, this could make building a binational preserve system very difficult.

Chapter 5: Ley Agraria in Mexico

This chapter begins by presenting the land-use changes in the Mexican portion of the watershed for 1994-2006, including the dominant types of land-use change that took place. I discuss three primary areas that were impacted in distinct ways since the implementation of *Ley Agraria*. The effects in these three areas show that *Ley Agraria* impacted land use through the direct sale and conversion of land but also in the way it has redefined *ejido* land. This is followed by an analysis of one community, Valle de Las Palmas, which is an example of how the policy and other secondary factors work together synergistically as drivers of land-use change. Finally, this chapter concludes with a brief discussion of the future implications of *Ley Agraria* in the watershed.

Land-Use Change

The land use maps from 1994 and 2006 highlight important changes that took place over the entire watershed during the study period (Figures 5 and 6). Overall, there was a 3.7% increase (16,614 hectares) in urban area, a 2.2% decrease (9,669 hectares) in agricultural land, and a 1.3% decrease (5,770 hectares) in natural vegetation. Most importantly, 96.3% of all changes occurred in the Mexican portion of the watershed. This is consistent with a previous study that found that 70% of changes from 1970-1994 took place in Mexico (Ojeda-Revah et al., 2008).

In the Mexican portion of the watershed the major land-use changes were from natural vegetation to urban (10,046 hectares), agriculture to urban (5,637 hectares), and agriculture to natural vegetation (10,712 hectares) (Table 4). I expected the changes from natural vegetation and agricultural to urban development given past rates of urban development in areas near Tijuana (Ojeda-Revah et al., 2008). However, I did not expect such a substantial amount of land

(10,712 hectares) to change from agriculture to natural vegetation. The reason for is that overall there was a decrease in agriculture of 9,669 hectares, and it appears in the maps that in the remote parts of the Mexican portion of the watershed the agricultural land became naturally vegetated land.

Land-use changes from natural vegetation and agriculture to urban are consistent with previous land-use changes between 1970-1994, where nearly all urban development occurred over areas of natural vegetation (Ojeda-Revah et al., 2008). The major difference is that for this study is that, in addition to changes from natural vegetation to urban development, much more land changed from agriculture to urban development (5,637 hectares) than in the previous study (1,233 hectares) (Ojeda-Revah et al., 2008). This suggests that land-use change from agricultural land to urban development for the Mexican portion of the watershed is important to pay attention to for 1994-2006 and possibly for future studies.

Land use 1994	Land use 2005	Change in Mexico (Ha)	Change in TRW (Ha)
Agriculture	Urban	5,637	5,929
Agriculture	Vegetation	10,712	14,244
Water	Agriculture	175	195
Water	Urban	13	14
Water	Vegetation	232	1,026
Urban	Agriculture	13	38
Urban	Water	5	5
Urban	Vegetation	450	624
Vegetation	Agriculture	6,991	10,270
Vegetation	Water	41	51
Vegetation	Urban	10,046	11,338

Table 4. Dominant types of land-use change in the Mexican portion of the watershed compared to changes in all of the watershed during the years 1994-2006. The table includes all potential combinations of change from one class to another during the study period. (Land-use change from Agriculture in 1994 to Water in 2005 is not included in the table because the change was less than 1 hectare.)

***Ley Agraria* Affected Land**

It is necessary to consider the land-use changes that took place between 1994 and 2006 in the context of *Ley Agraria* and *ejido* land. In the Tijuana River Watershed, 24 *ejidos* are at different

stages of the detailed titling process with PROCEDE, INEGI, and the Agrarian National Registry (J. Zatarain, Assistant Director, *Terra Peninsular*, in-person interview, 2 February 2009). Some *ejidos* gained titles soon after *Ley Agraria* was implemented in 1992 while some *ejidos* remain in the first few stages of the process (A. Robles, Legal Assessor, *Procuraduría Agraria*, in-person interview, 11 February 2009). Since there are varied rates of titling occurring, there are also varied rates of land sales throughout the watershed (Table 5). The amount of parceled land is an indication of how much land has been titled, and therefore, how much land has the potential to be sold (A. Robles, in-person interview, 11 February 2009). In many cases, I found that if the selling rates were high then there is a large portion of parceled land.

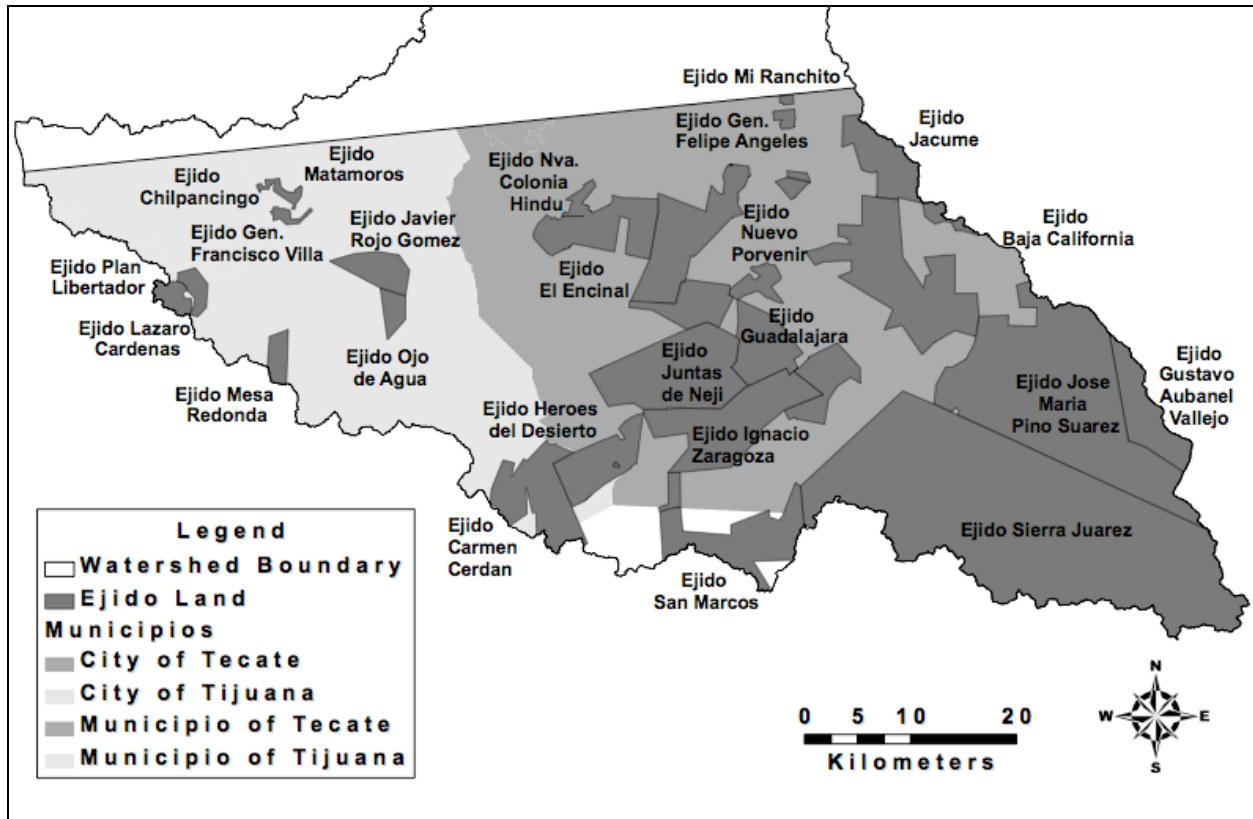
Municipio	Ejido	Total Land (Ha)	Common Use Land		Parceled Land		Land Sales (Very high, High, Medium, Low)
			(Ha)	(%)	(Ha)	(%)	
Tecate	Baja California	10,110.55	5,958.19	58.9	4,152.36	41.1	Very High
Tecate	El Encinal	5,645.68	3,387.41	60.0	2,258.27	40.0	Very High
Tecate	Nueva Colonia Hindú	6,632.44	5,305.95	80.0	1,326.49	20.0	High
Tecate	Mí Ranchito	341.76	236.16	69.1	105.59	30.9	High
Tecate	Gustavo Aubanel Vallejo	35,221.21	32,645.48	92.7	2,575.73	7.3	Medium
Tecate	Jacume	24,958.45	22,554.10	90.4	2,404.35	9.6	Medium
Tecate	Héroes del Desierto	3,911.90	3,911.90	100.0	0.0	0.0	Medium
Tecate	Carmen Cerdán	6,280.17	6,280.17	100.0	0.0	0.0	Low
Tecate	Juntas de Nejí	11,172.68	11,172.68	100.0	0.0	0.0	Low
Tecate	Guadalajara	3,247.79	3,247.79	100.0	0.0	0.0	Low
Tecate	General Felipe Ángeles	478.57	----	----	----	----	----
Tecate	Nuevo Porvenir	985.99	----	----	----	----	----
Tecate	Ignacio Zaragoza	10,271.93	----	----	----	----	----
Tecate	San Marcos	10,779.04	----	----	----	----	----
Tecate	Sierra de Juárez	174,633.64	136,875.37	78.4	36,063.24	20.7	High
Tecate	José María Piño Suárez	26,508.62	26,294.15	99.2	214.47	0.8	Low
Tijuana	Javier Rojo Gomez	1,091.05	----	----	----	----	Very High
Tijuana	Mesa Redondo	1,478.89	----	----	----	----	Very High
Tijuana	General Francisco Villa	283.42	----	----	----	----	Very High
Tijuana	Matamoros	786.76	----	----	----	----	Very High
Tijuana	Chilpancingo	60.16	----	----	----	----	Very High
Tijuana	El Ojo de Agua	4,289.45	----	----	----	----	----
Playas de Rosarito	Lárazo Cárdenas	1,068.16	----	----	----	----	----
Playas de Rosarito	Plan Libertador	1,900.55	----	----	----	----	----

Source: Terra Peninsular (2008)

Table 5. Land sales of ejido land in the Tijuana River Watershed. The table includes the total amount of land in the ejido (hectares), the amount of common use land in the ejido (hectares), the amount of parceled land in the ejido (hectares), and the amount of land sales for the ejido's lands (Very high, High, Medium, Low). The amount of land sales was based on observation by the organization Terra Peninsular ('----' indicates that there is no available data).

Since the rates of land sales in the Tijuana River Watershed are so varied, it is easiest to conceptualize three groups of *ejido* land (Figure 10). First, there is *ejido* land in the *municipio* of Tijuana. Nearly all *ejido* land in this area has been sold and developed for industrial and residential uses (A. Pedrin, in-person interview, 23 February 2009). For example, Baker, McKenzie & Associates LLC, a real estate firm representing American clients who wish to purchase land in Mexico, has purchased substantial amounts of *ejido* land for clients in the following areas: Ejido Chilpancingo, Ejido Matamoros, and Ejido General Francisco Villa.

Currently, the *ejido* land in Tijuana is nearly all residential and industrial (A. Pedrin, in-person interview, 23 February 2009).



Source: Terra Peninsular and Universidad Autónoma de Baja California

Figure 10. *Ejidos* in the Tijuana River Watershed are shown, including *ejidos* in the municipio of Tijuana and *ejidos* in the *municipio* of Tecate.

Although land use has changed in the *municipio* of Tijuana, it is important to note that *ejido* land in this area has been bought and sold since the 1970's (Cornelius et al., 1998), so many of the changes in land use in Tijuana occurred years before *Ley Agraria* was passed in 1992 (A. Pedrin, in-person interview, 23 February 2009). In the case of Ejido Chilpancingo, Ejido Matamoros and Ejido General Francisco Villa in Tijuana, when large portions of these *ejidos* were bought by the real estate company Baker, Mckenzie & Associates, LLC, the land had already passed through the hands of five different buyers. In addition, most of it had already become urban or industrial development when it was acquired (A. Pedrin, in-person interview,

23 February 2009). Therefore, the passage of *Ley Agraria* did not actually have much of an effect on *ejido* land in urban Tijuana since most of them had already been sold illegally before agrarian reform. The population rate since 1990 reflects the growth in residential and industrial development after they were sold in the 1970's and 1980's. *Ejid*os in urban Tijuana for which there is available population data show an average population increase of 87.5% (Table 6) since converted to residential and industrial land uses.

Ejid os in the <i>Municipio</i> of Tijuana	1990 Population	2000 Population	2005 Population	Change in Population (%)
Ejido Ojo de Agua	327	962	1,090	70.0%
Ejido Plan Libertador	22	552	2,005	98.9%
Ejido Chilpancingo	142	No data	795	82.1%
Ejido Francisco Villa	No data	10	1069	99.1%
Ejido Matamoros	3,476	No data	No data	No data
Ejido Mesa Redondo	No data	No data	2	No data

Table 6. Population trends for *ejidos* in the *municipio* of Tijuana in the Tijuana River Watershed for the years 1990, 2000, and 2005 (Instituto Nacional de Estadística y Geografía). The increase or decrease in population is given for *ejidos* with sufficient data.

The second area of *ejido* land affected by *Ley Agraria* is on the periphery of urban Tijuana, in the *municipio* of Tecate. There is *ejido* land directly east near the city of Tecate and *ejido* land directly south near the town of Valle de Las Palmas (Figure 10). Populations in the majority of these lands have increased steadily since 1990 (Table 9), and there have been recent land sales, increased tourist activity, and less livestock activity (A. Robles, Legal Assessor, *Procuraduría Agraria*, in-person interview, 11 February 2009; J. Zatarain, Assistant Director, *Terra Peninsular*, in-person interview, 2 February 2009). Ejido Mí Ranchito, Ejido El Encinal, Ejido Baja California and Ejido Nueva Colonia Hindú are prime examples of *ejido* land that has slowly been converted to residential and, in some cases, industrial land uses. In each of these *ejidos*, parceled land accounts for approximately 20-40% of the total *ejido* (Table 5), and the majority of this parceled land has been sold and subsequently developed since the passage of *Ley Agraria*. The reason the *municipio* of Tecate remains distinct from the *ejidos* in the *municipio* of

Tijuana is because *ejido* land here has traditionally been used for agriculture, whereas *ejido* land in Tijuana has been urban for decades.

Ejidos in the <i>Municipio</i> of Tecate	1990 Population	2000 Population	2005 Population	Change in Population (%)
Ejido Felipe Ángeles	108	260	184	41.3%
Ejido Mí Ranchito	238	576	545	56.3%
Ejido Nueva Colonia Hindú	1,375	3,251	4,018	65.8%
Ejido Carmen Cerdán	206	218	202	5.5%
Ejido El Encinal	125	306	231	45.9%
Ejido Jacume	286	251	205	-39.5%
Ejido Nuevo Porvenir	No data	13	10	-30.0%

Source: Instituto Nacional de Estadística y Geografía (INEGI)

Table 7. Population trends for ejidos in the *municipio* of Tecate in the Tijuana River Watershed for the years 1990, 2000, and 2005. The increase or decrease in population is given for ejidos with sufficient data.

The third area of affected *ejido* land is in the remote areas of the *municipio* of Tecate. *Ejidos* in this area have been the focus of conservation efforts for conservation organizations such as Terra Peninsular since most of this land is undeveloped and undisturbed. *Ley Agraria* has allowed for conservation organizations to acquire *ejido* land that could not have otherwise been acquired (M. Vargas Tellez, Assistant Director, *Pronatura Noroeste*, in-person interview, 11 February, 2009; J. Zatarain, in-person interview, 2 February 2009). Ejido Sierra de Juárez had high rates of land sales because many of the parcels belong to older generations of *ejidatarios* who no longer live on the land and do not rely on the land for income. The population of this *ejido* has decreased from 59 persons in 1990 to just 9 persons in 2005 (Instituto Nacional de Estadística y Geografía, 1990, 2005).

In the past, conservation has not been a primary issue on the federal agenda in Mexico (M. Vargas Tellez, in-person interview, 11 February, 2009; J. Zatarain, in-person interview, 2 February 2009). Recently, the conservation groups *Pronatura* and *Terra Peninsular* made habitat conservation a primary concern at the state level with hopes of eventually influencing policy at the federal level. Their work is specifically dedicated to the conservation of private and *ejido*

land in the peninsula of Baja California (J. Zatarain, in-person interview, 2 February 2009). Prior to the implementation of *Ley Agraria* conservation groups not only struggled with funding but also with finding land that was available for acquisition. With the passage of *Ley Agraria*, *ejido* land became available to them, which served as a benefit because this land had originally been used for grazing or was undeveloped altogether. In the Tijuana River Watershed, conservation groups focused on areas such as Ejido Sierra Juárez and Ejido José María Piño Suárez. In the case of Ejido Sierra Juárez there are 136,875 hectares of common use land and 36,063 hectares of parceled land available, and it remains undisturbed (J. Zatarain, in-person interview, 2 February 2009). Once these groups acquired or placed easements on the land, the land use remained the same in order to preserve the habitat (J. Zatarain, in-person interview, 2 February 2009). Similar to the case of *ejidos* in urban Tijuana, *Ley Agraria* did not actually play a key role in changing the land use since it did not change after acquisition. However, *Ley Agraria* has played a key role in maintaining land use in Ejido Sierra Juárez Ejido José María Piño Suárez through preventing potential development here.

Discussion of *Ley Agraria* and Land Use

As is exemplified by land on the periphery of Tijuana and in Sierra Juárez, the primary way *Ley Agraria* drove changes in land use was to make parcels of land available for sale. The reform of Article 27 put new institutions in place to facilitate boundary setting, parceling, and selling. However, the implementation of this reform did not necessarily translate into a direct change in land use, as is shown in the case of Tijuana since changes here occurred prior to agrarian reform. This is also true for remote areas such as Sierra Juárez, which were the focus of conservation efforts. *Ley Agraria* appears to have only really influenced land-use change in the case of land on

the periphery of urban Tijuana in the populated areas of the *municipio* of Tecate. Yet, even in this case although there is an overall trend towards residential and industrial development in the *ejidos* in the *municipio* of Tecate, some *ejidos* experienced few changes in land use. These are represented by *ejidos* such as Ejido José María Piño Suárez, Ejido Jacume and Ejido Carmen Cerdán. An important question is why land use in and surrounding these *ejidos* remains the same while other nearby *ejidos* experienced rapid changes in land use. The response to this question highlights the importance of secondary factors that play a role in land-use changes. *Ley Agraria* has been the primary driver of change in land use in the *municipio* of Tecate, however, there are other secondary drivers of change that also play a crucial role:

Accessibility. Infrastructural factors such as roads played a key role in changes in land use for these *ejidos*. The location of *ejidos* next to main roads connecting Tijuana with other growing population centers has made these lands more accessible and more attractive to buyers (J. Zatarain, in-person interview, 2 February 2009). Ejido José María Piño Suárez and Ejido Jacume are much further from Tijuana and Tecate and much less accessible via main highways, whereas *ejidos* that experienced the highest selling rates and the most profound changes in land use (Ejido Mí Ranchito, Ejido El Encinal, Ejido Baja California, Ejido Nueva Colonia Hindú) are near main highways. In an interview with Jesus Zatarain from Terra Peninsular, he stated, “*A través de las principales vías carreteras, Tijuana-Tecate, Tecate-La Rumorosa, Tecate-Ensenada, la tendencia más marcada es hacia la notificación para uso urbano (habitacional y comercio).*” [Among the main roads connecting Tijuana and Tecate, Tecate and La Rumorosa, and Tecate and Ensenada the most pronounced trend is toward urban use (residential and commercial).] Zatarain continued by explaining that *ejidos* which are not close to main highways tend to maintain other uses. The trend for these *ejidos* is to be used as agricultural or grazing

land, extraction sites for materials such as sand, gravel, granite, limestone, stone, and flagstone, and tourism and recreational projects such as ranches with grills, cabanas, swimming pools, and areas for all terrain vehicles (J. Zatarain, in-person interview, 2 February 2009).

Proximity to the border. *Ejid*os close to the border have grown and changed over the years because they create easier access for persons working in the U.S. Ejido Mí Ranchito is a relatively small *ejido* (341 hectares) located adjacent to the U.S.-Mexico border near the Tecate border crossing. The tendency for this *ejido* has been the conversion from open space and cattle ranching to residential use (O. Quintero, President, Ejido Gustavo Aubanel Vallejo, in-person interview, 14 March 2009). *Ejidatarios* in surrounding communities claim that its proximity to the border is the primary reason that a substantial amount of land has been sold here (105 hectares) and converted to residential use (O. Quintero, in-person interview, 14 March 2009).

Population growth. Population growth has played an important role in land-use change. Two primary examples of this are Ejido El Encinal and Ejido Nueva Colonia Hindú (Table 7). The population in and around these *ejidos* has been steadily growing during the study period. Between 1990 and 2005, Ejido El Encinal had an 45.9% increase in population and Ejido Nueva Colonia Hindú had a 65.8% increase in population (Instituto Nacional de Estadística y Geografía 1990, 2000, 2005). These areas had to accommodate growing communities in and around these *ejidos* by creating more residential land use.

Size. In general, *ejidos* in the *municipio* of Tecate and throughout northern Baja California are some of the largest *ejidos* in Mexico, yet they have some of the smallest populations. In many *ejidos* in southern parts of Mexico, it is common to find 1,000 hectares of land that has a population of 400-600, whereas in northern Baja California most *ejidos* are over 10,000 hectares and only have a population around 200 (A. Robles, in-person interview, 11

February 2009). Because of the ratio of land to the population of *ejidatarios*, it gives them the opportunity to keep land for themselves and their families while still selling a substantial portion of it if they desire (O. Quintero, in-person interview, 14 March 2009).

Accessibility, population growth, size and proximity to the border all act as secondary drivers that affect land use. However, it is also interesting to consider the factors that deter changing land uses in some *ejidos*. In the context of this study, these deterrent factors are biophysical factors and the bureaucracy of *Ley Agraria*. In the case of Ejido Carmen Cerdán, a large *ejido* near a main road, not much of the land has developed or changed because it is located on such steep slopes. Activities in this *ejido* are confined to one concentrated area because of this, and there is not much room for growth (J. Zatarain, in-person interview, 2 February 2009). In the case of Ejido José María Piño Suárez, very little of the land has been parceled and even less has been sold because the *ejido* assembly has been in disagreement until now about the future of the land (J. Zatarain, in-person interview, 2 February 2009). Any decisions regarding the sale or conversion of common use land in this *ejido* requires 75% of the vote in the *ejido* assembly (Assies, 2008). Because of these deterrent factors very little, if any, land in these *ejidos* has been parceled or sold.

Redefining *Ejido* Land

The direct sale of land and subsequent conversion appears to be the primary way that *Ley Agraria* drove changes in land use. When *Ley Agraria* was passed in 1992, many believed that the parceling and selling of land would occur quickly in almost every *ejido* throughout Mexico (Collier, 1994; Stanford, 1994). The assumption was that the mere opportunity to sell *ejido* land would be taken advantage of by all *ejidatarios*. However, this has not been the case for many

ejidos. Although 95% of *ejidos* in Mexico are involved in some phase of the titling process, not all *ejidatarios* are doing so with the intention of selling their land. In other parts of Mexico, such as Yucatán, *ejidatarios* did not join PROCEDE with the goal of obtaining property title in order to sell their land but instead thought that if they did not participate in the land titling program they would lose access to assistance from government agencies (Snyder & Torres, 1998). In addition, PROCEDE only accepted applications from *ejidos* until 2004 (O. Quintero, in-person interview, 14 March 2009). As long as an application was approved and began the titling process with PROCEDE it was possible to take as long as necessary to obtain title to the land. However, after 2004, *ejidos* could no longer be involved in the titling process. Many *ejidos* applied to PROCEDE because they knew that after a given amount of time they would no longer have that option available to them (O. Quintero, in-person interview, 14 March 2009).

The claim that the opportunity to sell *ejido* land results in the abandonment of that land is an oversimplification of *Ley Agraria*. Beyond the direct selling of land parcels, *Ley Agraria* has redefined *ejido* land. Originally, *ejido* land was created with the intention of appeasing a landless population and invigorating agriculture throughout Mexico (Cornelius et al., 1998). This communal land became a source of income for most *ejidatarios* and a way for families to pass the land onto a younger generation. Now, few *ejidatarios* live on the land year-round and allow it to be their sole source of income. The *ejidatarios* I interviewed in Ejido Gustavo Aubanel Vallejo, Ejido Heroes del Desierto, and Ejido Juntas de Nejí, discussed how many *ejidatarios* choose to work in more urban areas and no longer live on *ejido* land (O. Quintero, in-person interview, 14 March 2009; S. Ruelos, *Ejidatario*, Ejido Gustavo Aubanel Vallejo, in-person interview, 14 March 2009; V. López, *Ejidatario*, Ejido Gustavo Aubanel Vallejo, in-person interview, 14 March 2009). Furthermore, younger generations are no longer interested in

pursuing jobs that involve working on *ejido* land (O. Quintero, in-person interview, 14 March 2009). Because of this *ejidos* appear to have a new role, which is to provide a supplementary income and serve as a supplementary place of residence for *ejidatarios*. *Ley Agraria* facilitated this by allowing *ejidatarios* to sell, rent, sharecrop or mortgage their land and no longer requiring them to work the land personally in order to keep it.

Community Analysis: Valle de Las Palmas, Baja California

The new role of the *ejido* has caused many *ejidatarios* to move to more urban and residential locations outside *ejido* land. One community that *ejidatarios* migrated to was Valle de Las Palmas, a community southwest of the city of Tijuana. In Valle de Las Palmas, many residents moved from adjacent *ejidos* and *ejidos* in southern parts of Mexico. However, the reform of the *ejido* sector was not the sole cause of changes in land use. Secondary drivers such as population growth, residential development, and infrastructural growth have also played a role in land-use change in this community.

Valle de Las Palmas is a *colonia* (residential area) surrounded by Ejido Carmen Cerdán, Ejido Héroes del Desierto, Ejido Juntas de Nejí, and Ejido San Marcos (Figure 10).

Traditionally, it has been an area principally used for agriculture, particularly for harvesting alfalfa and cattle ranching (F. Coutreras, Resident of Valle de Las Palmas, in-person interview, 26 April 2009; N. Meza, Resident of Valle de Las Palmas, in-person interview, 26 April 2009; G. Ortiz Aguilar, Resident of Valle de Las Palmas, in-person interview, 26 April 2009). In the past fifteen years, Valle de Las Palmas experienced a decrease in ranching, from 150 ranches to approximately 30 ranches (F. Coutreras, in-person interview, 26 April 2009) and an increase in

urban development (G. Ortiz Aguilar, in-person interview, 26 April 2009; N. Meza, in-person interview, 26 April 2009).

Many have moved from adjacent *ejidos* to Valle de Las Palmas, and a substantial number of people migrated to the area from *ejidos* in the southern states of Jalisco, Veracruz, and Morelos (G. Ortiz Aguilar, in-person interview, 26 April 2009). The reason for their migration was to look for work in *maquiladoras* (factories) in and near Valle de Las Palmas because ranching and agriculture diminished. In Valle de Las Palmas there are *maquiladoras de ropa* (clothing factories), *maquiladoras de muebles* (furniture factories), and *maquiladoras de mango* (mango packaging factories) (F. Coutreras, in-person interview, 26 April 2009). Also, in the case of residents coming from Ejido Juntas de Nejí, the reason was to find better schools for their children (F. Coutreras, in-person interview, 26 April 2009; N. Meza, in-person interview, 26 April 2009; G. Ortiz Aguilar, in-person interview, 26 April 2009).

Few of the people who came to live in Valle de Las Palmas were from the city of Tijuana, which challenges expectations of the area being an extension of urban Tijuana. Past studies projected that residents would migrate from Tijuana to Valle de Las Palmas and that the area and Tijuana would connect, turning it into a larger population center (Ojeda-Revah et al., 2008; Wright, 2005a). However, it appears that Valle de Las Palmas is not part of an urban expansion of Tijuana, but rather an independent area of urban growth. This is a key observation because one might assume that land-use in Valle de Las Palmas can be attributed to the expansion of the city of Tijuana, yet there are other factors at work.

In the past ten years, according to residents and landowners, the population of Valle de Las Palmas has at least doubled (O. Arguiles, Rancher in Valle de Las Palmas, in-person interview, 26 April 2009; N. Meza, in-person interview, 26 April 2009). Residents agree that

because of the population growth in Las Palmas, the response has been to create more urban developments in the area (O. Arguiles, in-person interview, 26 April 2009; N. Meza, in-person interview, 26 April 2009). In response to population growth, three new urban developments (*colonias*) were built: Colonia Pueblo, Colonia Buena Vista (also known as Colonia Polvorín), and Colonia Gobierno (O. Arguiles, in-person interview, 26 April 2009). These *colonias* house nearly half of the new residents in Valle de Las Palmas (O. Arguiles, in-person interview, 26 April 2009). In addition to the new *colonias*, an extension of the Universidad Autónoma de Baja California in Ensenada is being built in Valle de Las Palmas. The university is expected to open in the fall of 2009, creating even more potential for further development in the future (R. Eaton, Faculty, Universidad Autónoma de Baja California in Ensenada, personal communication, 26 April 2009).

The addition of urban developments was not the direct cause of land-use change in Valle de Las Palmas, rather the rise in population has put a strain on the area's most limiting resource – water (O. Arguiles, in-person interview, 26 April 2009; F. Coutreras, in-person interview, 26 April 2009; R. Cruz, Resident in Valle de Las Palmas, in-person interview, 4 April 2009). Although the area has much more water than other parts of Baja California, it still has a limited water supply. Because of the recent growth in the urban population, there is a much greater demand for water. In response to this, water rights are being transferred from the agricultural areas to the urban areas, and agricultural landowners are being forced to depend on less water (O. Arguiles, in-person interview, 26 April 2009; R. Cruz, Resident in Valle de Las Palmas, in-person interview, 4 April 2009). Many owners of agricultural land who have lived in Valle de Las Palmas for decades are selling their land because they are having to reduce the amount of agricultural land they manage, which is not profitable for them (O. Arguiles, in-person interview,

26 April 2009; F. Coutreras, in-person interview, 26 April 2009). More importantly, those who are purchasing agricultural land are not retaining the former land use. In many cases, those purchasing agricultural land in Valle de Las Palmas are interested in the development of new urban areas such as Colonia Pueblo, Colonia Buena Vista, and Colonia Gobierno or in the development of recreational land for activities such as camping and for all terrain vehicles (O. Arguiles, in-person interview, 26 April 2009; F. Coutreras, in-person interview, 26 April 2009; N. Meza, in-person interview, 26 April 2009; G. Ortiz Aguilar, in-person interview, 26 April 2009).

Valle de Las Palmas is an interesting example of the far-reaching effects of *Ley Agraria* in one community. Migration from surrounding *ejidos* and *ejidos* in southern parts of Mexico combined with infrastructure and residential development put a strain on water resources in the community, which eventually impacted agriculture. This remains an unintended consequence of *Ley Agraria*, which had a fundamental goal of increasing productivity in the rural economy (Luers, 2006 et al., Collier, 1994; Stanford, 1994).

Future Implications of Ley Agraria

Because there is such a heavily bureaucratic process associated with gaining title and with the institution PROCEDE, the affects of *Ley Agraria* are only recently becoming apparent. The studies that were conducted in the immediate years after the implementation of *Ley Agraria* suggested that the policy had not had a significant impact on land in Mexico (Cornelius et al., 1998; Snyder & Torres, 1998). However, I found that in the 14 years since its implementation *Ley Agraria* has affected *ejido* land as well as land adjacent to *ejidos* like in the case of Valle de Las Palmas. The passage of *Ley Agraria* in 1992 caused *ejido* land to become available to people

outside the *ejido* community such as conservation organizations, Mexican developers, and foreign citizens. In some cases the result has been an unexpected one from a conservation perspective, such as the case of Sierra Juárez. Land that had been previously unattainable for conservation organizations became available for acquisition or easements for conservation purposes. This land has, for the most part, retained its original land use. However, in areas such as Tijuana and the periphery of Tijuana, land use has changed since the implementation of *Ley Agraria*. The majority of *ejidos* in urban Tijuana have transitioned to residential and urban land uses with many other *ejidos* on the outskirts of the city slowly following a similar path. It remains to be seen whether all the *ejidos* in the Tijuana River Watershed will complete the detailed process of obtaining land titles and having the *ejido* assembly approve the sale of the common use land. However, if the past 14 years are an indication of the future of *ejido* land, there will be far fewer *ejidos* in the Tijuana River Watershed that retain their original land use in the coming decades.

Chapter 6: Conclusion

The findings of this study make an important contribution to the theory and methods in the drivers of land-use change literature but also lend insight to binational conservation efforts. After discussing these contributions, I conclude my study by presenting future research prospects for studying land use in the Tijuana River Watershed.

Findings for the Drivers Literature

As a study focused on the concept of drivers, this work highlights several key issues for the study of drivers of land-use change. The literature on drivers emphasizes the importance of scale (Carr, 2008; Campbell et al., 2005; Geist & Lambin, 2002). As is clearly exemplified in the case of MSCP, studying how drivers act at a watershed scale leads to different results in comparison to how drivers act at a community scale. Therefore, it is crucial for those engaged in the study of drivers to not only consider conducting studies from various scales but also include the appropriate methods in the research design. In doing so, it becomes apparent how drivers operate at different scales.

I addressed the issue of scale by including one set of interviewees at the county level who were asked questions regarding the approach and implementation of MSCP throughout the entire county versus another set of interviewees who were asked questions about the specific implications of MSCP for one community. Since I conducted archival research for MSCP prior to interviews, at the county level the interviews were useful in clarifying specific details of the policy and the implications this may have. However, interviews at the community level revealed much more new information that had not been apparent when reviewing public records. These interviews highlighted the importance of the relationship between the county's conservation

plans and zoning practices in the new General Plan. There was a contrast between the intentions of MSCP and how it has actually played out, which may have not been as clear if the research design had not been set up with this complementary approach. The importance of the community analysis may be similar for other policies regarding land use and therefore an integral part of the study of drivers of land-use change.

Although the complementary approach was useful for analyzing policy, there were limitations to the research design. First, I only investigated one community on each side of the border. Interviews may have revealed a different result if I had investigated three or four different communities on each side of the border. Just as I expect that not every small community in the U.S. portion of the watershed was impacted by MSCP and the county's new General Plan, I expect that some small agricultural communities are actually benefiting from *Ley Agraria*. If these expectations were confirmed, it might be a significant addition to the study of land use in the Tijuana River Watershed. In addition to this limitation, the research design did not include analyzing drivers beyond the watershed scale. Although it was appropriate to study drivers at a watershed scale, insight could be gained from analyzing how this compares to drivers at the state or federal level, especially in the case of *Ley Agraria*. Because agrarian reform was instituted at the federal level it would be useful to study how the policy impacted land use throughout different parts of Mexico and compare this to drivers at the watershed and community level.

Another fundamental issue for the drivers literature is the importance of secondary drivers of land-use change. This is clearly highlighted by the policy and community analyses in the Mexican portion of the watershed. It is argued that there is often not a sole driver acting to change land use (Carr, 2008; Geist & Lambin, 2002). However, some drivers may play much

more dominant roles; thus, it would be useful to consider them in terms of primary and secondary drivers. In this study, *Ley Agraria* was the primary mechanism in place that created an opportunity to change land use, but other secondary factors such as population growth and infrastructure development played a crucial role in determining whether land use then actually changed.

The identification of primary and secondary drivers is also important for decision makers. In the case of conservation it is important for planners to recognize that in remote areas like Sierra Juárez, *ejido* land would not have been available for conservation purposes if *Ley Agraria* had not been implemented. Once land was available, secondary drivers became important. For instance, conservation organizations chose to focus on *ejido* land that was located further from main roads because there was less potential for development here and in the surrounding areas. Decisions like this have certainly been the case for Terra Peninsular, a conservation organization whose efforts focused on *ejido* land in Sierra Juárez. This is just one of the many ways that the concept of ‘driving forces of land-use change’ is able to contribute to efforts towards binational conservation.

Contributions to Binational Conservation

Although this study is able to contribute to the literature on drivers of land-use change, it also sought to have practical applications for the sake of binational conservation management. One of the most striking findings was the unintended consequence of policy at a community level. In the case of MSCP, it was surprising to see that a policy intended to enhance conservation efforts resulted in heightened development in one community. This information is useful not only for the City and County of San Diego but for other counties who also choose to implement regional

habitat conservation plans. It is crucial for them to recognize the need for increased efforts for ongoing dialogues with these communities. In the process of my research, I attended several steering committee meetings that were intended to gather public input. However, public participation was low due little advertising effort, and for those who did attend, their reason for participation was that they received a generic letter from the county stating that their land was potentially going to be acquired. The tension I witnessed between landowners and public officials may be avoided in future circumstances if committee meetings were held more than once or twice during the entire year, held closer to communities who are targets for preserve land, and are not advertised via announcements that the county is interested in buying their land. Instead, it may be in the county's interest to hold educational workshops in some of these communities so that landowners are well informed regarding the county's conservation plans.

Another striking finding is that policies that facilitate the privatization of land in Mexico are actually aiding conservation efforts more so than policies focused on increasing public land in the U.S. In the case of MSCP, the county did not anticipate the response of the Campo community to increase urban development. Although Campo is only one example of the unintended consequences of MSCP, it reveals the potential of other communities to react similarly. This is important for the City and County of San Diego to recognize since they are planning to incorporate 52,000 hectares of land into the preserve system in the next five years. In the case of *Ley Agraria*, the federal government did not necessarily assume that conservation organizations would take advantage of agrarian reform and specifically focus on *ejido* land for conservation. Because of this privatization of communal land had a positive outcome for conservation efforts in some portions of the watershed. This challenges traditional views that privatization of communal land often leads to biodiversity degradation (Walker et al., 2008;

Kakembo, 2001). Overall, the analysis of MSCP and *Ley Agraria* provides an unexpected narrative of how policy can play out and possess a dominant role in land-use change.

The *ejido* land that is the focus for *Terra Peninsular* and *Pronatura* and the private land that is the focus for MSCP efforts are crucial for initiating and maintaining a conservation network throughout watershed (Conservation Biology Institute, 2004; J. Zatarain, in-person interview, 2 February 2009). I have shown that it is important to understand the policies that are associated with land use for *ejido* land in the Mexican portion of the watershed and private land in conservation areas in the U.S. portion of the watershed. Understanding how these policies are related to changes in land use, whether it is as a primary causal mechanism or part of an unexpected result, is constructive for binational conservation efforts.

Future Research

There are a number of different research avenues that could add to my study of land-use change while making further contributions to the drivers literature and the study of binational conservation management in the Tijuana River Watershed. For the U.S. portion of the watershed, it would be useful to conduct several community analyses regarding the General Plan Update for the unincorporated portions of San Diego County. This information will be crucial because, based on the study of Campo, I expect that the relationship between land-use zoning and conservation in San Diego County will become a contentious one in the near future. For the Mexican portion of the watershed, it would be useful to compare the trends in the three parts of the watershed to other areas of Mexico, especially since *Ley Agraria* is a federal level policy. This analysis would be important for the study of conservation in Mexico since it would reveal whether other areas are taking advantage of *ejido* land for conservation purposes.

Future studies and the research I conducted are a vital part of understanding the complexities of changing land use in the Tijuana River Watershed. In a basin that supports a range of land uses and a variety of endemic plant and wildlife species, changing land use is a critical issue to understand.

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