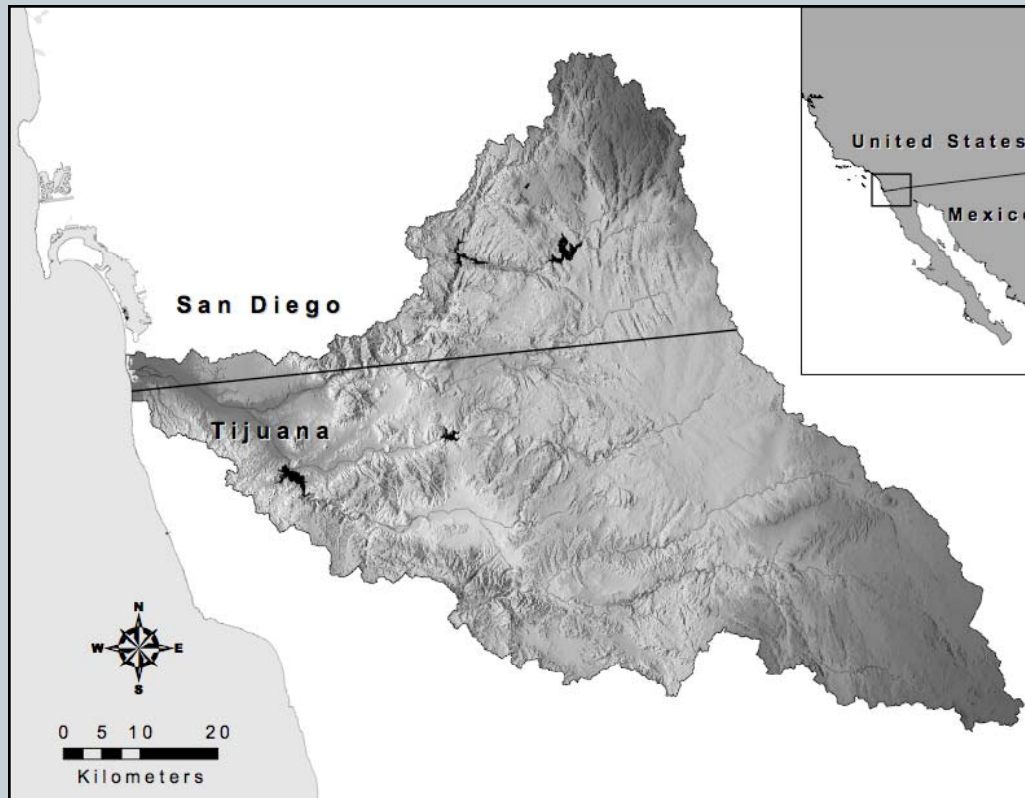


# Land Use-Change in the Ejidos of the Tijuana River Watershed



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**SCERP 2011 ANNUAL TECHNICAL CONFERENCE**  
**TEMPE, AZ**  
**24 JANUARY 2011**

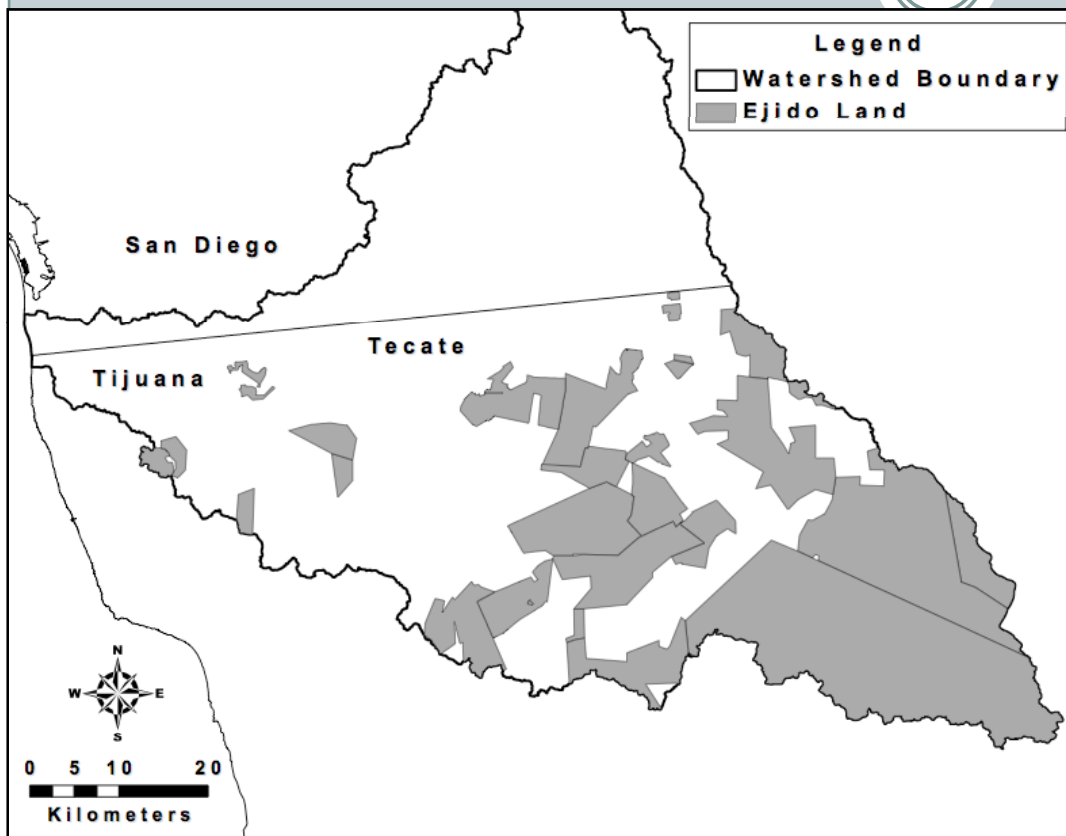
# Context



**4,532 km<sup>2</sup>**

- Tijuana River Watershed: region of high biodiversity and endemism
- In Mexican portion, 43% of the land is ejido land
- Shared resources
  - Tijuana River Estuary
  - Ecosystems habitat for endangered species

# Context



- 1992: Federal agrarian reform policy in response to unequal distribution of land and wealth and stagnating agriculture (ejido system; land could not be sold, rented, offered as collateral)
  - New Agrarian Law allowed privatization and sale of ejido land
- Raised questions about potential effect on physical fragmentation and ownership fragmentation of land

# Context



- Physical fragmentation of the landscape, increases the number of land patches and decreases their mean size
- Increase in the number of land owners and land parcels leads to greater fragmentation, and consequent loss of biodiversity; however, in some cases, large parcels may stay intact even as land is sold or transferred
- Ortega-Huerta and Kral (2007) changes in land tenure can also play an important role in how land is managed, as each tenure system may be associated with particular social, economic, and cultural conditions, all of which influence management and can have implications for biodiversity

# Research questions



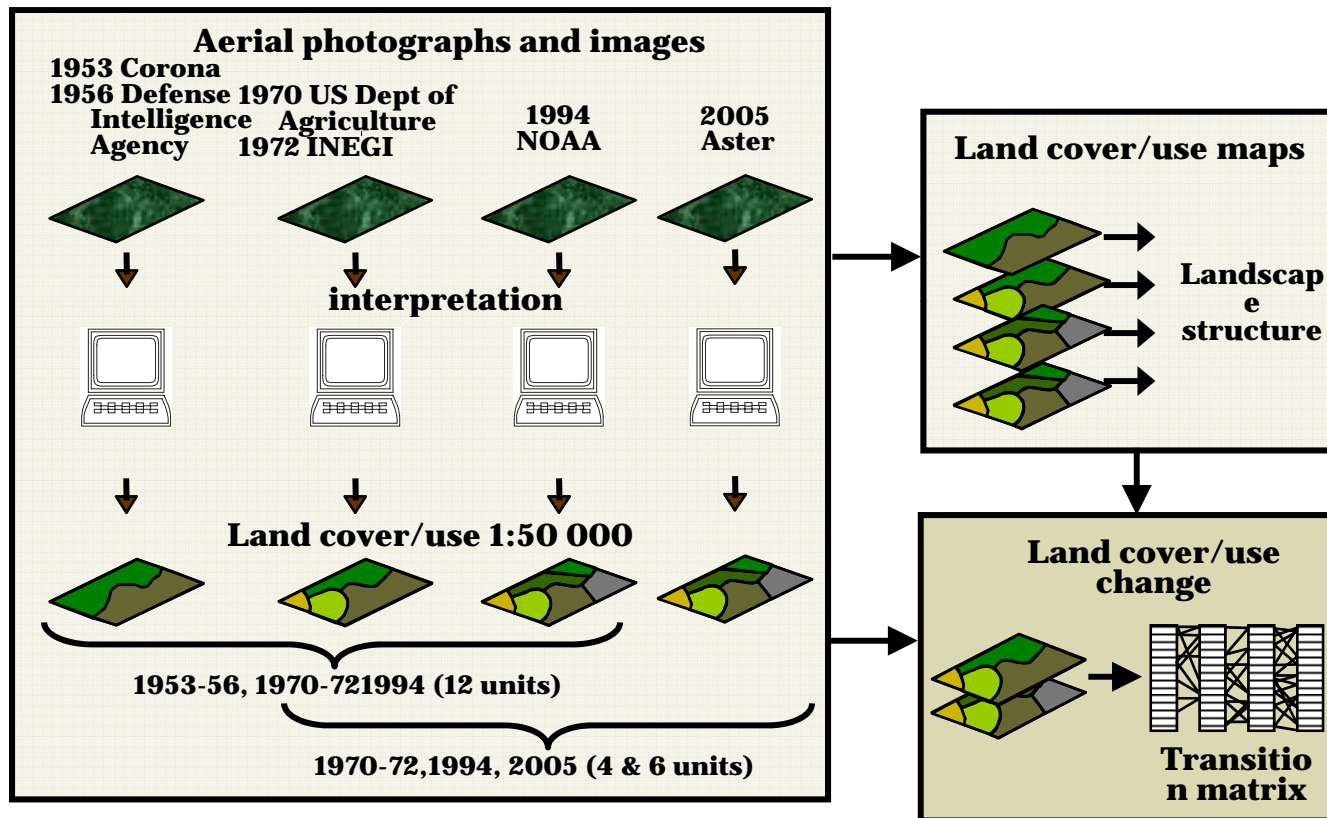
- **What were the dominant changes in land use/cover that occurred in the Tijuana River Watershed between 1994-2005?**
- **What effect has the reform of Article 27 and implementation of the new Agrarian Law had on land tenure across the watershed?**

# Methods: changes in land use and cover



- **Maps constructed from aerial photographs and Aster images**
- **Applied land-cover/use classification developed by O'Leary (2005)**
  - lumped together categories that were not discernible in the oldest aerial photographs
- **Measured changes between 1994-2005**

# Methods: changes in land use and cover



# Methods: landscape structure and change



## **Landscape metrics (Forman 1995)**

### **[1] Structure**

***S<sub>i</sub>* = area per category**

***N<sub>i</sub>* = patch number per category**

### **[2] Change**

**$C_i = (\log S_{i_2} - \log S_{i_1}) / (t_2 - t_1)$**

***Where,***

***C<sub>i</sub>* = change rate per category**

***S<sub>i2</sub>* = category *i* area second date**

***S<sub>i1</sub>* = same category area first date**

***t<sub>1</sub>* = first date**

***t<sub>2</sub>* = second date**

# Methods: changes in land tenure



- Conducted 55 structured interviews with ejidatarios in the watershed
- 1-5 interviews in each of 18 ejidos

# Methods: changes in land tenure



- **Semi-structured interviews with policy officials and conservation organizations**
  - Office of Environmental Protection for the Municipality of Tijuana
  - Office of the General Agrarian Attorney
  - Conservation organizations *Terra Peninsular* and *Pronatura*
  - Real estate attorneys from Baker & McKenzie, LLC in Tijuana
  - Representatives from the Native Cultures Institute of Baja California
- **Collected data from Mexican government sources (INEGI and RAN) on ejido land size, ownership, and sales**
- **Consulted data compiled by *Terra Peninsular***
  - qualitative rankings of rate of land sales in each ejido

# Results: changes in land use/cover



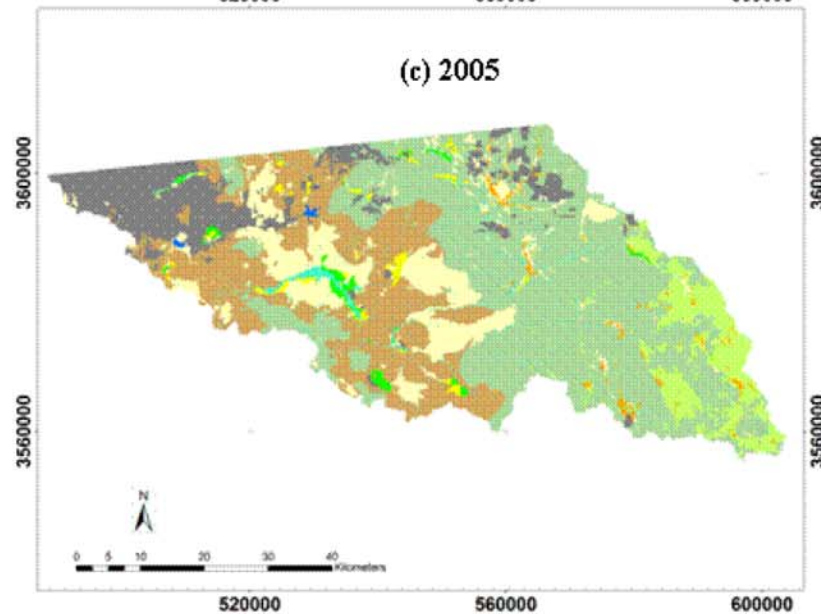
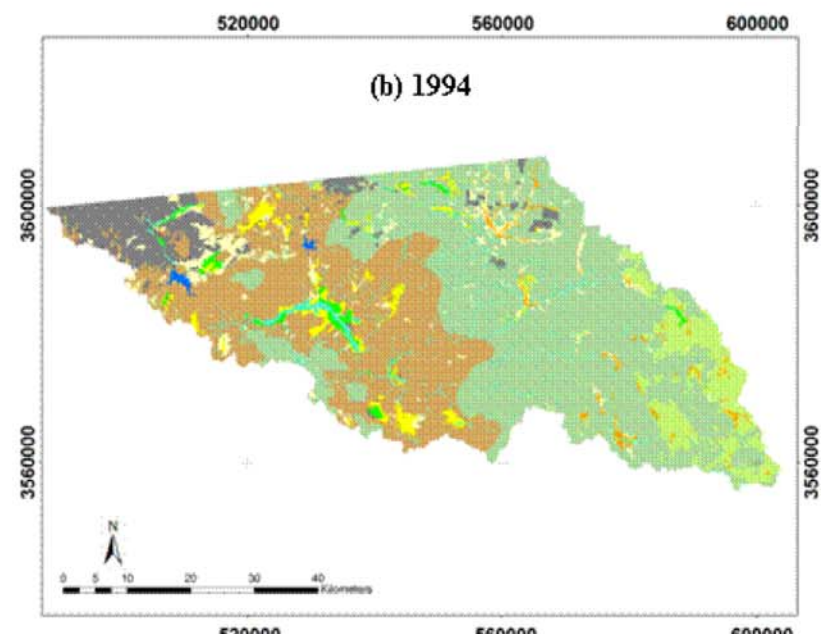
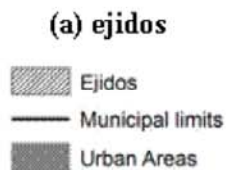
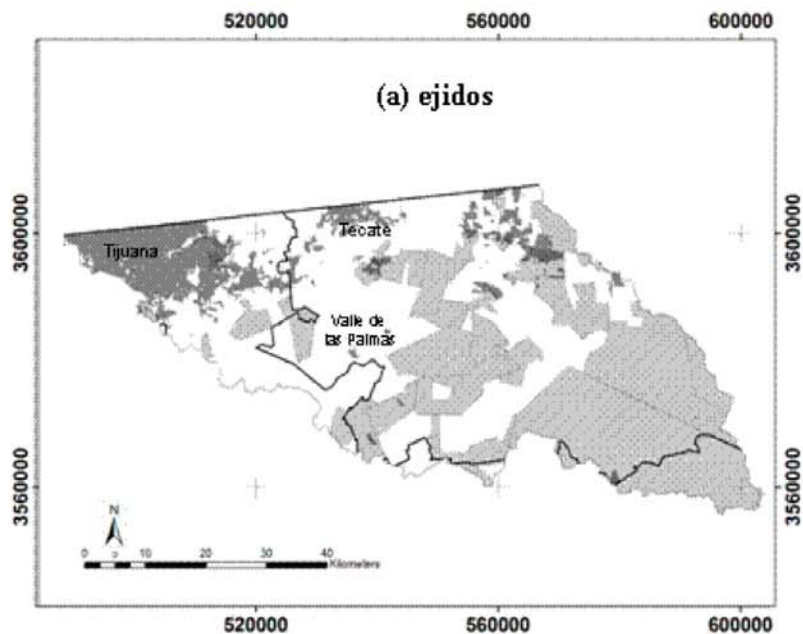
- **Land-use/cover change between 1994 and 2005 dominated by:**
  - Increase in urban area and grasslands
  - Decrease in coastal sage scrub, chaparral, and, to a lesser degree, agriculture
  - Landscape much more fragmented than 1994 due to conversion of coastal sage scrub

# Results: changes in land use/cover



Land cover /use	1994		2005		1994-2005		
	Area (km <sup>2</sup> )	Number of patches	Area (km <sup>2</sup> )	Number of patches	Change in land cover/use, in km <sup>2</sup> (and change in # of patches)	Rate of change rate, area	Rate of change, patches
Juniper scrub	228.52	81	226.11	84	-2.41 (+3)	-0.10	0.33
↓ Chaparral	1,467.96	57	1,360.55	93	-107.41 (+36)	-0.69	4.45
↓ Coastal sage scrub	950.48	47	690.13	82	-260.35 (+35)	-2.91	5.06
Riparian vegetation	79.86	590	76.21	550	-3.65 (-40)	-0.43	-0.64
Mountain meadows	31.14	84	30.35	74	-0.79 (-10)	-0.23	-1.15
↑ Grassland	132.39	414	401.30	377	269.91(-37)	10.08	-0.85
Irrigated agriculture	34.22	53	33.09	43	-1.13 (-10)	-0.30	-1.90
Rain-fed agriculture	87.25	121	31.12	73	-56.13 (-48)	-9.37	-4.59
↑ Urban	221.09	86	387.32	81	166.23 (-5)	5.10	-0.54
Reservoirs	7.39	2	4.08	3	-3.30 (+1)	-5.39	3.69

- Loss of 27% of the area of CSS and 7% of chaparral period
- almost all replaced by urban areas and grasslands (precursor to urban)
- Physical fragmentation: number of patches increased by 63% in chaparral and almost 75% in CSS



urban areas

- barrier
- Fragment
- in ejidos: from 8 to 37 km<sup>2</sup>

# Results: changes in land use/cover



	2005									
Land cover/use	Juniper Scrub	Chaparral	Coastal Sage Scrub	Riparian vegetation	Mountain Meadows	Grasslands	Irrigated Agriculture	Rain-fed Agriculture	Urban	Reservoirs
Juniper Scrub	225.63	0.06	-	0.04	0.54	0.29	0.04	0.01	1.90	-
Chaparral	0.33	1,359.31	0.02	0.67	0.15	59.46	0.06	0.08	47.85	-
Coastal Sage Scrub	-	0.04	689.28	0.31	-	212.30	0.27	0.02	47.99	0.28
Riparian vegetation	0.00	0.20	0.13	73.75	0.00	0.51	0.75	0.18	4.34	-
Mountain Meadows	0.11	0.27	-	0.00	29.35	0.34	0.08	0.06	0.93	-
Grasslands	0.03	0.36	0.04	0.08	0.26	73.01	2.33	0.05	56.21	-
Irrigated Agriculture	0.00	0.06	0.07	0.26	0.04	4.69	22.25	2.79	4.05	-
Rain-fed Agriculture	0.00	0.23	0.04	1.07	0.00	47.15	7.26	27.94	3.57	-
Urban	-	0.02	0.46	0.02	0.01	0.18	0.05	0.00	220.28	0.05
Reservoirs	-	-	0.08	0.02	-	3.38	-	-	0.16	3.76

CSS to grassland (& urban), chaparral to grassland & urban, rain-fed agriculture to grassland, grassland to urban

# Results: changes in land tenure



- Two stages of the certification and titling process
- First stage – obtaining a certificate to a land parcel – very widespread:
  - 22 ejidos
  - 52 of 55 interviewees
  - Amount of land that had been parceled in each ejido varied greatly
    - 0.2% - 100% of the land
- Second stage – conversion to dominio pleno (required to receive full title to the land and to have the ability to rent or sell it):
  - Approximately  $\frac{1}{2}$  of the ejidos and  $\frac{3}{5}$  of individuals interviewed

# Results: changes in land tenure



- **Wide support for changes associated with reform**
  - 43% of respondents in favor of it
- **Reasons were varied and included:**
  - improved security
  - ability to obtain credit
  - ability to form partnerships with producers or investors outside the ejido
  - having one's own land
  - greater freedom
  - ability to buy or rent land and engage in new activities
  - ability to sell land

# Results: changes in land tenure



- Those opposed to the law cited:
  - concern over land becoming concentrated
  - taxes that could be imposed
  - concern that the land could be taken by a bank if it were to be used as collateral for loans
- Responses suggest that people are engaging in the process of parcelization and titling due to a desire for security to a much greater degree than a desire to sell the land
  - May reflect concern over land tenure security
  - May be security of asset that can be sold if needed

# Results: changes in land tenure



- **However...**
  - Wide support for ability to sell among interviewees
  - 59 km<sup>2</sup> belonging to 15 ejidos sold during the last 10 years, mostly in Tecate
    - Land was sold mainly to people outside the ejidos
    - Appears to be primary front of land sales in the watershed

# Results: changes in land tenure



- Full title to the land was obtained in a range of urban and rural settings, rather than primarily on land closest to urban zones
  - Contrasts with studies from other regions of Mexico

For the TRW:

- proximity to urban areas is not necessarily the best predictor of whether people will get title to their land or not.
- reinforces the idea that the ability to sell land and the existence of high land prices in areas close to urban zones may be of less importance in obtaining title than broader questions of land and livelihood security

# Conclusions: physical fragmentation



- **Urban growth at the expense of both natural ecosystems and agricultural land surrounding the urban core**
- **Grasslands in the TRW are often a precursor to urban development**
  - Predict that much of the area southeast of Tijuana that was converted to grasslands between 1994-2005 will likely convert to urban areas over the coming decades

# Conclusions: physical fragmentation



- **Conversion from coastal sage scrub to grassland SE of Tijuana: led to a far more fragmented landscape than existed in 1994**
- **Loss of coastal sage scrub particularly significant**
  - ✦ Unique land cover with large number of endemic species
  - ✦ Provides habitat for numerous rare, threatened, or endangered plants and animals
  - ✦ Priority for conservation
  - ✦ Significant bi-national vegetation type
  - ✦ No land designated to protect it in Mexico

# Conclusions: ownership fragmentation



- **Substantial changes in land tenure**
  - But, degree to which those changes are leading to greater ownership fragmentation is variable across the watershed
- **Areas with high rates of obtaining full title span both urban and rural areas of the watershed, and the primary objective appears to be more centered on tenure security than on plans to sell**
  - Differs from findings of other studies

# Conclusions: ownership fragmentation



- **Relatively high rate of land sales and continued urban expansion in the municipality of Tecate**
  - May continue to be important fronts for urban growth, and for loss and fragmentation of chaparral
  - Much of the land bordering expanding urban areas is ejido land, providing opportunity for land sales and further ownership fragmentation
- **Additional research in this region is needed to help to discern the role ejido land has played so far and is likely to play in the future**

## Conclusions: policy outcomes



- Primary stated purpose of the new Agrarian Law was to revitalize agriculture in the ejido sector
- In the TRW, more land moved out of agriculture than into it, and the primarily land use that appears to be better facilitated is urban development

## Conclusions: policy outcomes



- **Role of conservation organizations, which as a result of the reforms now have the ability to purchase land and conservation easements from ejidatarios, illustrate another unexpected outcome. While these conservation zones also promote a land use very different from increased agricultural production, they provide opportunities for slowing the rates of fragmentation of native vegetation communities that contribute to the high biological importance of the region. Their role in the changing landscape of the TRW also merit further research.**