

Local deforestation patterns and driving forces in a tropical dry forest in two municipalities of southern Oaxaca, Mexico (1985-2006)

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Abstract. The tropical dry forest is an ecosystem that is undergoing rapid changes. Although global driving forces behind these changes have been addressed at a local scale, spatio-temporal dynamics are still largely unknown. The main objective of this study was to identify the causes governing the dynamics of changes in land use and land cover in the tropical dry forest in two municipalities in Southern México. Satellite imagery and air photographs were used in a GIS context to produce maps of land use and land cover for 1985, 1995 and 2006. A number of statistical methods (Markov chains, general lineal models and regression tree analysis) were applied to identify the proximate and the underlying causes of deforestation, agriculture being the most important one. When agriculture

is mainly for self consumption, topographic factors determine its location. Increasing job opportunities in the tourism sector has resulted in the abandonment of agricultural land; consequently, the forest has recovered. Different studies have examined the dynamics of local deforestation and its driving forces in México; however, this study considered both spatial and temporal elements in order to identify the most important underlying driving forces of deforestation and its dynamics at local scale, and also compared two neighboring municipalities.

Key words: Driving forces, Land-use change, México, Regeneration, Tropical deforestation, Local analysis

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Patrones y conductores de la deforestación a escala local de la selva baja caducifolia en dos municipios a sur de Oaxaca, México (1985-2006)

Resumen. La selva baja caducifolia es un ecosistema que está presentando grandes cambios. A pesar que a nivel global se han estudiado las fuerzas conductoras del cambio de uso de suelo, a escala local las dinámicas espacio-temporales son ampliamente desconocidas. El objetivo principal de este estudio fue identificar las fuerzas conductoras de los cambios de uso y coberturas del suelo en la selva baja caducifolia en dos municipios al Sur de México. Para alcanzar dicho objetivo fueron utilizadas imágenes satelitales y fotografías aéreas dentro de un SIG, para producir los mapas de uso y de coberturas del suelo para los años 1985, 1995 y 2006. Diferentes métodos estadísticos (cadenas de Markov, modelos lineales generalizados y análisis por regresión de árbol) fueron empleados para identificar las causas próximas y subyacentes de la deforestación, donde resalta la agricultura como la más importante de ellas. Las actividades agrícolas,

principalmente la de autoconsumo están delimitadas espacialmente por las características topográficas del terreno. El incremento de las oportunidades de trabajo vinculadas con el sector turístico han resultado en el abandono de las actividades agropecuarias, favoreciendo al regeneración y recuperación del bosque. En México diferentes estudios han examinado las dinámicas locales de la deforestación y las fuerzas conductoras, sin embargo, este estudio considera tanto la escala espacial como la temporal fueron claves para identificar las causas subyacentes más importantes de la deforestación, la dinámicas a escala local y la comparación entre dos municipios vecinos.

Palabras clave: fuerzas conductoras, cambio de uso de suelo, México, regeneración, deforestación en los trópicos, análisis local.

INTRODUCTION

Changes in land cover, including high deforestation rates, are considered to be the main drivers leading to environmental degradation, land fragmentation and loss of biodiversity at a global scale (Lambin *et al.*, 2001). Global deforestation in the tropics is a consequence of changes in land cover at local and regional scales, due to socio-economic, demographic and biophysical factors that explain the spatial land-use patterns in this ecosystem (Pan *et al.*, 2004; Lambin y Mayfroidt, 2011). Spatial differences in the patterns of land use emerge because not all uses are equally profitable; soil quality, access and distance induce revenue losses and differ in each case (Bakker y Veldkamp 2012). Therefore, local-scale analyses are needed to identify the proximate causes and drivers of changes in land use and land cover, and of deforestation (Bonilla-Moheno *et al.*, 2012; Pan *et al.*, 2004). In this context, local-scale studies on land-use and land-cover changes utilize detailed information about productive and/or family units to identify, analyze and/or explain in detail the causes of land-use and land-cover changes, as observed in municipalities.

Lambin *et al.* (2003) suggest that the drivers of land-use and land-cover change in general, and deforestation in particular, can be divided into

proximate and underlying causes. The proximate causes directly affect the vegetation cover; examples include the introduction of agriculture and pastures (Lambin *et al.*, 2003). The underlying causes work at a different scale and influence one or more proximate causes; these include socio-economic, political, technological, natural and cultural factors (Bürgi *et al.*, 2004). Methods for analyzing the dynamics of land-use and land cover change estimate deforestation rates and tendencies, and determine the causes of those changes (Lambin *et al.*, 2003). Although some studies have attempted to explain these dynamics through biophysical variables (Hietel *et al.*, 2005), others have focused on social, political and economic factors (Evangelista *et al.*, 2010; Velasco-Murguía *et al.*, 2014), and some others have integrated spatial and temporal drivers in order to understand land-use and cover change at a local scale (Geoghegan *et al.*, 2004; Chowdhury & Turner 2006; Schoreder & Castillo 2013).

The tropical dry forest (TDF) is the dominant vegetation type among tropical forests (42% of total tropical forest area) (Portillo-Quintero *et al.*, 2010), also being the forest type most severely affected by human-induced environmental degradation (Janzen, 1986). The main threat to TDF is its rapid conversion into agricultural land and cattle ranches (Houghton *et al.*, 1991; Janzen, 1986). In

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