Integrated land history and global change science: the example of the Southern Yucatán Peninsular Region project

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Abstract

Land histories originate in multiple disciplines. The corpus of this research, however, does not link well to the science of global environmental change, despite explicit recognition by that science to incorporate land history. History and global change science would both benefit from such linkages, which necessitates the development of “integrated land history.” This interdisciplinary research subject is identified here, illustrated through the Southern Yucatán Peninsular Region project. This project addresses tropical deforestation and agricultural change in a frontier “hot spot” of biotic diversity. It seeks to inform environmental and global change science, including its human and modeling dimensions. Emphasis is placed on the mutual benefits for both land history and global change studies created by the integration in question. © 2001 Elsevier Science Ltd. All rights reserved.

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Connecting land/environmental history to global change science

Landscapes are created by human-environment or nature-society conditions. As these conditions change, so do landscapes. Recognition of this basic relationship is nothing new. The 19th century romanticist Henry Thoreau detailed the interdependence between human actions and natural processes for understanding forest succession in Massachusetts (Foster, 1999), and Marsh (1864) included historical assessments in his inventory of the human transformation of the earth. The historical landscape was the pivot of Sauer’s (1925) geography of the middle of the 20th century, matched by Darby’s (1864) reconstruction of English woodlands from 8000 B.C. forward. Environmental historians — Cronon (1983), Worster (1985), Crosby (1986), and Pyne (1991), among others — have followed suit, although their thematic focus tends toward the social side of the human-environment condition. And, increasingly, ecologists call upon human history to understand environmental processes (Foster, 1992; Russell, 1997; Whitney, 1994).

Contemporary global and environmental change research highlights the need to expand the temporal dimensions of its assessments, particularly those focused on land-use and land-cover change. With the exception of long-term climatic shifts, land-cover change is driven largely by changes in land use. The history of human-environment relationships, therefore, is essential to the interests of natural and social scientists who research land change (Batterbury and Bebbington, 1999; IGBP–IHDP, 1999; Lambin, 1994; Turner, 1990). Various research projects of the International Geosphere–Biosphere Programme (IGBP) and the International Human Dimensions Programme (IHDP) engage historical analysis. The core projects, Past Global Changes (PAGES) and Global Change and Terrestrial Ecology (GCTE), for example, address specific components of the history of human-environment conditions in regard to the paleoecological record and ecological processes. The IGBP–IHDP Land-Use/Cover Change (LUCC) project goes further and identifies explicitly the significance of human-environment histories for informing explanations and projections of land change (IGBP–IHDP, 1999; Turner et al., 1995a).
Despite the rich scholarship on changing human-environment conditions and landscapes, there are few connections between this historical-based research, including that focused on terrestrial ecology, and the science of global and environmental change (but see McNeill, 1992; Meyer, 1996; Richards, 1990). Differing substantive, theoretical, and explanatory interests help to explain the paucity of these connections (Turner, 1997). Yet, these barriers must be overcome if land-change projects are to reach their objectives within global change science. Improving the research ties requires human-environment and landscape histories to be made more compatible with the goals and needs of global change science. These linkages promise to benefit the core interests of the different historical perspectives, as well, although, here we focus on the integration of historical perspectives into the LUCC agenda. We use the Southern Yucatan Peninsula Region (SYPR) project as an example of a way to tie concretely works of environmental or land history to global change science, with benefits accruing to all research interests.

Exemplified in this volume of Land Use Policy, land-change histories remain robust with several examples of direct linkages to the goals of the international LUCC project (e.g., Meyer, 1996; Richards, 1990; Turner and Butzer, 1992; Turner et al., 1995b). Yet, for the most part, the community interested in land-change history remains largely unaware of the potential mutual benefits to be derived by connecting its interest and expertise to those of global change science. This circumstance is due, in part, to the way in which the LUCC project was created. Stimulated by the focus of the natural sciences on understanding the present, only one of LUCC’s five broad research questions specifically identifies the importance of the past, and none appeal directly to the social themes of the historical human sciences and humanities.1

The five broad research questions that guide the LUCC Science Plan (Turner et al., 1995a) are designed to address various “big issues” — transition to a sustainable world, biogeochemical cycles and biodiversity, and critical regions and vulnerable places (IGBP–IHDP, 1999) — confronting an expanded global change science agenda within the natural and human sciences. The five questions are:

How has land cover been changed by human use over the last 300 years?
What are the major human causes of land-use change in different geographical and historical contexts?
How will changes in land use affect land cover in the next 50–100 years?
How do immediate human and biophysical dynamics affect the sustainability of specific types of land uses?
How might changes in climate and global biogeochemistry affect both land use and land cover, and vice versa?

Despite the first question, the large majority of research undertaken within the LUCC umbrella emphasizes short-term landscape histories. This shallow temporal depth follows from four factors in land-use/land-cover change research: (i) a need to connect land-change research directly to issues and models of climate change, biotic diversity, landscape fragmentation, and other natural science efforts focused on the present and near-term future; (ii) the fact that the more robust models of human behavior and social structures do not work well beyond the specific economic sectors or the political economic and technological episode on which they are based; (iii) the role of satellite imagery in providing geographical coverage for spatially explicit analysis biases much work to the last 20–30 years when the temporal and spatial resolution of the imagery increased; and (iv) absence, for the most part, of rich data bases that extend into the distant past. For these and other reasons, land studies within global change science initially avoided issues of changing political economies, environmental feedbacks on land use, stochastic processes and events, and external shocks to the modeled system (Lambin, 1994; Turner, 1994).

It is precisely these issues, however, that drive the creation of land-use histories and that stimulate the interests of social science researchers in land-use dynamics (Blaikie and Brookfield, 1987; Kasperson et al., 1995). LUCC scientists recognize that these deficiencies in model-based work must be addressed to achieve broader understanding. This recognition notwithstanding, data limitations restrict much of the LUCC project to temporal dimensions insufficient to capture the imagination of environmental historians. Yet, the long-term view remains an essential foundation of understanding land change. In the absence of this view, for example, many mature or old growth land covers might be identified mistakenly as “natural”, when in fact they constitute the remnants of historic, even ancient, land uses (e.g., Devenan, 1992; Meyer et al., 1998; Turner and Butzer, 1992; Whitmore and Turner, 1992), or the role of infrequent but significant human actions in maintaining certain land covers might be missed (e.g., Leach and Mearns, 1996). Finally, the need to backcast (i.e., to use models to “predict” the recent past, thus testing the strength of the models and their parameters) requires historical analysis and addresses the first question in the LUCC Science plan (above).

1 John F. Richards, one of few environmental historians to work directly with global change scientists, noted this disconnect in his presentation before the first Open Science Meeting of LUCC (January 29–31, 1996 Amsterdam). Unfortunately, his subsequent written statement for that meeting omitted his cogent comments (Richards, 1997).
Environmental (land) history

The study of environmental history is highly interdisciplinary, although, the bulk of its practitioners emanate from the fields of history, geography, and ecology where land or terrestrial change constitutes a major research concern. Of the three major fields of study, ecology and physical geography focus on biogeophysical processes and the resulting structure and function of ecosystems associated with land-cover change, no matter how large or small the human imprint (Butzer and Butzer, 1997; Foster, 1992; Pasqualetti, 1997; Whitney, 1994; Vale, 1998; Zimmerer and Young, 1998). Pollen and macro-botanical remains, soil chemistry, climate reconstruction, various physical dating techniques (e.g., radio carbon), cadastral information, and vegetation inventories are combined with field work to provide empirical assessments of vegetation, landscapes, and ecosystems. Much of this work is linked directly to global change science, and that which is not tends to offer results in forms easily integrated into that science. Overall, however, most of this work focuses on the magnitude or character of land-cover change but makes minimal attempts to map these changes in fine-tuned, spatially explicit ways.

Practice in history and human-environment geography is another matter. Here, the research questions switch from land cover to land use and its ties to such large themes as the impacts of changing economic and political eras on the land (e.g., Butzer, 1976; Cronon, 1991; Crosby, 1986; Richards, 1986), and the role of culture, perception, and values in shaping interactions between society and nature and land (e.g., Butlin, 1993; Conzen, 1990; Crumley and Marquart, 1987; Glantz, 1994; Leighly, 1963; Merchant, 1989; Pasqualetti, 1997; Sporrong, 1990; Thomas, 1956; Worster, 1988). While some data sources are shared with the ecology and physical geography studies, information pertinent to cultures, societies, and political economies prevail and are usually presented in an interpretive and rich narrative (e.g., Cronon, 1983; Leach and Mearns, 1996; Meyer et al., 1998). These narratives are informative for many purposes, but the outputs are specified insufficiently to be incorporated into global change science (but see Turner et al., 1990). The power of the narrative to inform land-change science, therefore, is diminished because the problem definition and research results simply fail to connect adequately with the questions and research needs of different communities.

Integrated land history

Environmental research that promotes and incorporates multiple research traditions, perspectives, and methodologies is increasing (see Batterbury and Bebbington, 1999). Land history should not stand by passively in the face of these dynamics, but is likely to do so as long as the physical-social split in problem framing remains and the community of practitioners are reluctant to engage relevant connections to major research agendas. The various land histories identified here would benefit if their shared substantive interests were integrated better with one another and with global change science (Fig. 1). This integration or “integrated land history” should constitute one of the pillars upon which land-use and land-cover change research is based. Absent an historical component, such research runs the danger of excessive simplification and erroneous interpretation, focused as it is on the present and the immediate past and future. The specific objectives of integrated land history are to inform land-change science of the changing human-environment conditions that have shaped the landscapes in question, and to distill from these changes those dynamics cross-cutting different eras or episodes of use and occupation and those unique to individual episodes. The usefulness of this effort increases when integrated land history is empirically and quantitatively rich, specifies the pace, magnitude, and kinds of land change in question, and is made geographically specific at the micro-spatial scale.

For example, land-use histories identify well extra-local events and processes that shape local structural conditions and behavior and, hence, use of terrestrial resources. Land-cover histories, in turn, demonstrate the ecological impacts of different land uses and their implications for the use systems and landscape recovery. Integrated in the way outlined here, both land-use change and land-cover change research have the potential to reveal the dynamic character and complexity of human-environment conditions that lead to land change as well as the non-linearity and scalar inconsistencies of processes acting upon the land. In turn, the historically informed land-change science offers to land history three benefits of integration: analysis of the strength of different theories and explanations by historical episode; provision of the geographical extent to which different kinds of change and the pace of the change are applicable, at least for the years for which aerial photography and satellite imagery is available; and the role of biophysical feedbacks on the use systems (e.g., rates of soil and vegetation recovery). Of course, the synergy that follows from this integration leads to multiple checks on empirical

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2“The new cultural geography” also addresses some of these themes historically. Of this emerging subfield, much engages the built or urban environment (e.g., Cosgrove and Daniels, 1988; but see Shyter, 1999) and most focuses almost wholly on social-theoretic themes, such as discourses and the social construction of nature (e.g., Demeritt, 1994). While such work may offer important insights to land histories, minimal, if any attempt is made within it to connect to the goals of global change science, and practitioners may be dismissive of science in general. For this reason and space limitation, we do not consider this literature here.
information (e.g., archival-based estimates of land clearance versus vegetation indicators) and fosters new hypotheses and understanding. In short, as powerful as historical analogy may be (Meyer et al., 1998), integrated land history offers the potential to achieve more.

The Southern Yucatán Peninsular Region and project

The Southern Yucatán Peninsular Region encompasses approximately 22,000 km², of which 18,700 km² of ejido lands (communally based and usufruct tenure) constitutes the main area of study (ejido assessment region) (Fig. 2). The region is part of the largest contiguous tropical forest remaining in Mexico and Central America. It contains Mexico’s largest biosphere reserve, Calakmul, and constitutes part of El Mundo Maya (The Maya World), an effort to create an international archeological-ecotourism zone (Primack et al., 1998). These circumstances notwithstanding, the region is a “hot spot” of tropical deforestation, as identified by the Tropical Ecosystem Environment Observations by Satellites (TREES) project, and maintains a population growth rate approaching 4% per annum (Ericson et al., 1999). These changes are the result of various national policies designed to develop the region, including the creation of infrastructure to expand El Mundo Maya.

The Southern Yucatán Peninsular Region project seeks to explain, model, and project the location and magnitude of land-use and land-cover change, focusing on deforestation and agricultural expansion in the tropical forest frontier of southern Campeche and Quintana Roo, Mexico (Fig. 2). To these ends, the project integrates multiple disciplinary research interests: the structure and function of land covers and associated nutrient cycles; hurricane history, micro-scale climate reconstruction, and terrain characterization; household and regional economics, population, culture and ethnicity; political organization and resource institutions; regional infrastructure and external linkages; land uses at the household, village, and regional scales; and the history of all of the above as it sets the conditions and potential paths of current changes.

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3 The Southern Yucatán Peninsular Region project has core sponsorship from NASA’s LCLUC (land-cover and land-use change) program (NAG 56406) and the Center for Integrated Studies on Global Change, Carnegie Mellon University (CIS-CMU; NSF-SBR 95-21914), as well as sponsorship from various sources for specific elements of project study. Additional funding from NASA’s New Investigator Program (NAG5-8559) also supported the specific research in this article. SYPR is a collaboration of El Colegio de la Frontera Sur (ECOSUR), Harvard Forest — Harvard University, the George Perkins Marsh Institute — Clark University, and CIS-CMU. See http://earth.clarku.edu/lcluc/

4 A TREES hot spot is a forest subject to major change in the past five years or with expected major change in the short term (Achard et al., 1998). Mas Causel (1996) estimates the annual tropical deforestation rate for the state of Campeche, in which part of the Southern Yucatán Peninsular Region is located, to have been an extremely high 4.5% between 1978/80 and 1992. Twenty five percent of the forested area of the state was cleared and 39% was fragmented (i.e., with 50% forest cover) during this time. The rate of deforestation for the SYPR project’s study region is less densely populated and, until recently, more isolated.
Here we emphasize one component of that history, the changing human-environment conditions that lead to different kinds and paces of land-use and land-cover change. Historical analysis defines the major episodes of human-environment conditions, identifies the external shocks to the regional conditions within any episode, some of which trigger a change in episodes, and reconstructs past land uses and land covers for specific locations. In so doing, this part of the integrated land history establishes the temporal limits for particular behavioral and structural explanations, informs modeling about the role of stochastic events, serves as a baseline for land-use and land-cover assessments, and identifies path-dependent qualities of the overall system. This history is not undertaken in isolation from the remainder of the project; rather, historical research shares in household surveys and incorporates remotely sensed imagery and other spatial data. In this cooperation, land history research helps to invent novel ways of gaining the kind of information needed to improve the historical narrative and linkages to land-change science.

The early history

Despite the region's designation as a hot spot, use and occupation of this karstic upland dominated by semi-evergreen tropical forests is not limited to the last few decades of the 20th century. Rather, the region experienced one long-wave of boom-bust occupation and has apparently entered another (Whitmore et al., 1990) (Fig. 3). The first wave took place millennia ago when Maya people entered the area, ultimately occupying thousands of masonry-constructed settlements of various sizes and using virtually every niche in some way. Average population densities approach 100 people/km² throughout and the forest was essentially denuded (Turner, 1990). By A.D. 800–1000, however, the civilization collapsed for reasons in debate, and the central and southern Maya lowlands, of which the Southern Yucatán Peninsula Region is part, were abandoned. For the next 1000 years, the region was sparsely occupied at best, serving as refuge for northern and coastal Maya who fled from the Spaniards during the colonial and early Mexican periods (Jones, 1989; Turner, 1990). During this millennium, a Maya-altered, mature forest reasserted its domain, presumably affected from time to time by hurricanes, which frequent the peninsula. Interestingly, it is the products remaining from this early history that forms the bases for the contemporary El Mundo Maya: both the exceptional abundance of ruins (e.g., Becan, Calakmul, Rio Bec) and the biotic diversity within the forestlands.

Modern attention to the forest resources of the region began in earnest at the end of the 19th century when
shifts in Mexican policy encouraged entrepreneurs to open abutting areas for logging, starting what has become and will likely remain the second long wave of the region’s use and occupation (Whitmore et al., 1990). Intensive forest extraction began in the region proper in the 1880s under the auspices of national and international industries in search of logwood (Haematoxyylon campechianum L., used for dye), chicle (Manilkara zapota L. Van Royen, formerly Achras zapota L., the resin of which is used for chewing gum), and tropical hardwoods. Forestry dominated land use through most of the 20th century, although the zenith of selective logging of hardwoods, primarily, mahogany (Swietenia macrophylla King) and cedar (Cedrela odorata L.), began in the mid-1940s and ended by the 1960s when the marketable supply of hardwoods was diminished. From the end of the logging boom until the present, national policy shifted to regional development of agriculture and tourism. These relatively recent activities have led to a new round of tropical deforestation in the region, one that has the potential to match the scale of deforestation created by the ancient Maya.

The longer-term land history of the Southern Yucatán Peninsular Region reflects importantly on issues of forest composition and structure. The imprint of the Classic Maya on the forest and terrain remains. The agroforestry and orchard-gardens of the ancient occupants apparently left an abundance of economically useful species (Lundell, 1934; Whitmore and Turner, 1992) and the abandonment of Maya cities and settlements made of limestone and plaster left numerous niches for species favoring such edaphic conditions to invade (Lambert and Arnason, 1981). Thus, the forests encountered at the beginning of the second wave of use and occupation in the late 19th century were not pristine, but the intentional and unintentional products of past land changes. The forests were modified further by the severe depletion of precious hardwoods during the episode of forest extraction in the middle of the 20th century, particularly, in the central portion of the region (Fig. 4) (Klepeis, 2000). The impacts of timber extraction on the structure of the forest are under investigation by the SYPR project. Initial forest inventories, however, indicate the paucity of remaining hardwoods in the central area, save those planted by recent reforestation programs.5

Recent history

Natural forces of deforestation remain important in the region. No single event or cluster of events has greater impact over the short-term than the disturbance of the hurricanes Janet, Gilbert, and Roxanne in 1955, 1987, and 1995, respectively. Not only were large tracts of forests knocked down but, subsequently, the dried biomass served as fodder that burned adjacent, intact forest. After the forestry episode (Fig. 3), however, the most persistent human-induced land changes have been registered by colonization and the growth of small-holder subsistence or swidden cultivation, aided by less persistent but influential large-scale agricultural projects, cattle ranching, conservation land in the biosphere reserve, and infrastructure development (e.g., improved roads, electrification, water provision systems). These proximate causes of land change are themselves driven by distal and broader-operating forces, primarily national policies towards resettlement, land tenure, and large development projects as well as the market.

The isolation of this “empty quarter” of Mexico — the inland, frontier forest of the Southern Yucatán

5 This work is undertaken primarily by project members Diego Perez Salicrup (Universidad Nacional Autonoma de Mexico) and Deborah Lawrence (University of Virginia).
Peninsular Region (Edwards, 1957) including the capital of Quintana Roo, Chetumal (Fig. 2) — was revealed by relief efforts after Hurricane Janet. The hurricane and the marked decline in forestry production in the 1960s led local and federal officials to re-evaluate the regional economy. A new strategy emerged to link the region directly to central Mexico by way of a paved highway (Route 186 as opposed to the circum-peninsula route, Fig. 2) constructed over former logging roads, and to promote colonization of the territory, thereby increasing its population and qualifying Quintana Roo for statehood (a minimum of 80,000 people was needed). Completed in 1967, the new highway opened the episode of “Big Projects and Forest Clearing” (1970–1980s) (Fig. 3). Two national policy decisions were especially important for land change at this time. The first decision increased awards of ejido lands to groups from other parts of the peninsula and Mexico, lands largely used for subsistence, swidden cultivation. Many of these groups came to the region as part of government-sponsored colonization schemes. The second decision, fueled by Mexico’s role in the international oil boom of the 1970s, involved the development of large-scale rice and cattle projects in seasonal wetlands. Together, these decisions led to a flood of colonists and dramatic increase in the region’s population (Fig. 5). Between 1970 and 1982, 40 new ejidos were added to the 14 ejidos already present, creating approximately 7500 km² of ejido lands, large portions of which were available for cultivation. In just four ejidos within the demarcation of the SYPR project limits, over 8000 ha of forest were cleared for rice cultivation and pasture between 1972 and 1982 (Cortina et al., 1999; Ogneva-Himmelberger, 1998). All of the rice projects within these limits failed, and the oil bust of 1982 both reduced the capacity and sapped the enthusiasm of the Mexican government to continue investing in these

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6 A modest number of private ranches were also purchased during this time, but their total area was small. Examination of their role in the regional land change is not yet complete.

7 These figures represent ejidos occupied and used daily. Large tracts of unoccupied ejido lands exist in the southwestern portion of the study area, which are forestry set-asides for ejidos elsewhere in Campeche and are not included in the count of ejidos provided in the text. Between 1982 and the present, at least an additional 55 ejidos in active use were established in the Southern Yucatán Peninsular Region, bringing the total area in the ejido assessment region (excluding the forestry set-asides) to approximately 10,000 km² or 53% of the region’s area (Fig. 2).
capital-intensive projects. Most of cleared rice lands were turned over to pasture. The short-lived episode of “Big Projects and Forest Clearing” ended with a few modest cattle operations and significant numbers of subsistence farmers, but the scale of human-induced deforestation was the largest since ancient Maya times.

Most recently, the episode of “Tourism and Land-Use Diversification” (1989–present) is marked by the establishment of the huge Calakmul Biosphere Reserve (723, 185 ha), the initiation of El Mundo Maya, a substantial network of NGO-sponsored sustainable development programs, and experimentation by farmers with various market crops. The reserve is part of Mexico’s commitment to preserve biodiversity in response to international conventions. It sets up various rules intended to reduce land change within its boundaries, which includes ejido as well as private lands. Increased land pressures outside the reserve, however, coincide with growing rates of land change. These pressures mount from increased immigration, pushed from elsewhere in Mexico and pulled both by land availability and improvements in infrastructure accompanying El Mundo Maya, including a major new roadway into El Petén, Guatemala, electrification of local villages, and various labor opportunities associated with development in general. To date, however, neither off-farm employment nor market cultivation has been sufficiently lucrative to warrant the abandonment of subsistence cultivation, and almost every household continues to crop maize, beans, and squash for household consumption. Many households, especially those with less off-farm opportunities, have begun to grow substantial quantities of jalapeño chili and various fruits and vegetables for the market. Interestingly, chili production may have a serious impact on rates of deforestation; initial information indicates that farmers may prefer to cut more mature growth for chili cultivation.8 Our survey results show that the percentage of ejidatarios (smallholders with land rights in the ejido) engaged in chili production rose from 19.0% in 1986 to 52.6% in 1997.

**Integrated land history**

The reconstruction of the land and resource use history of the Southern Yucatán Peninsular Region reveals one long-wave of forest and land transformation and the emergence of a new wave, primarily in the latter half of the 20th century. At least three distinct human-environment conditions or episodes are identified in the new wave. The older long wave is important for understanding the character of land cover in the region by forest structure and composition, and the three recent episodes inform various attempts to backcast explanations and models of land change in the region. In short, the applicability of the SYPR project models — constructed from current human-environment conditions — for assessing the past are revealed, as is the powerful role of federal policy changes in transforming the very character of the human-environment conditions and, hence, the suitability of the model’s construction.

Use of land histories in this way is not novel, but integrated land history has the potential for more. Properly tied to the reconstruction of different land uses and land covers, it provides the basis for examining the relative roles of purported drivers of land change as they cross different human-environment episodes. Thus, while economic analysis of land change identifies the importance of infrastructure and household demographics for assessing land change within the current episode (Geoghegan et al., nd), it is not clear that these factors would track well across the previous two episodes. Furthermore, integrated land history permits assessments of stochastic events, the consideration of which might otherwise misinform various tests of SYPR models. For example, by not accounting for the disturbance linked to Hurricane Janet, the pace and scale of land change attributed to subsequent colonization of the region might

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8 Eric Keys (SYPR project) is undertaking a study of the origins, character, and impacts of chili cultivation in the region.
be overestimated. For example, aerial photography and satellite imagery used to estimate re-growth becomes available after the hurricane and during the colonization period, such that large areas of secondary growth created by the storm might be attributed to occupation. While this example may seem self-evident, others need not be. For example, the pace and kind of regional deforestation (wetland forest) was affected significantly by several large-scale projects during the late 1970s and early 1980s, but the forces triggering this land change were external to local and regional occupants and created a land-change shock, a shock akin to that of Hurricane Janet.  

In contrast to the spatial explicitness of remotely sensed data that captures land change in the past 25–30 years, reconstruction of land transformation for the more distant past is based primarily on archival data that often lack a fine-scale spatial component. Disaggregate spatial data are commonly unavailable for these temporally distant periods, enabling only generalized characterizations of land transformation. To avoid this impediment requires incorporating multiple data sources, both spatial and otherwise, that in combination allow the creation of spatially explicit characterizations of change. The case of logging in the Southern Yucatán Peninsula Regional exemplifies. Published data on the volume of hardwoods extracted for specific time periods are recorded at the state level providing little indication of where within the large states of Campeche and Quintana Roo the activity took place (Fig. 2). To identify the specific areas within the study region that underwent intensive logging and to estimate the volumes extracted, various indicators of human activity were gleaned from survey and archival sources: forest concession boundaries; locations of settlements and forestry centers; population census data; road and trail networks; natural features, such as bajos (seasonally inundated wetlands) and rivers; areas that were affected by hurricane events, which inhibited logging activity in the short term; information on when, where, and how much forestry activity occurred based on surveys with former loggers living in the region today; and evidence taken from both published ethnographic evidence and gray literature (e.g., logging company reports) (Klepeis, 2000). When pieced together, these indicators facilitate the identification of probable areas in which intensive logging occurred (Fig. 4). And, this assessment can be checked against current forest inventory work. By identifying key areas of forest degradation in a more spatially refined way for the more distant past, distinguishing between natural and anthropogenic drivers of change becomes more feasible. It is possible, therefore, to distinguish between forest that has been degraded by long-term human use and that which has not.

Reconstruction of recent or short-term land history may be a relatively simple matter in data-rich conditions, but for much of the world, and in locations of major interest to the global change community, such information must be created by the researcher. Land history research can be aided in this task by direct involvement in surveys and ethnography, drawing upon the memory of land managers and households in question (e.g., Leach and Mearns, 1996; Turner, 1996). Careful field approaches and sufficiently large and detailed surveys offer checks on the biases of individual memories and, depending on the approach used, can lead to fine-grained spatial outputs. One method not frequently used in land history is the creation of sketch maps of landholdings and the past uses of it, which is linked to the household survey data of specific small-holders (Fig. 6). Time consuming, such sketch maps involve accompanying the land manager to his or her fields and documenting current and past land conditions and uses. The various plots are located by using geographical positioning systems (GPS) and linked to aerial photography and satellite imagery, which serve as checks on the manager’s claims.

This exercise was undertaken during the course of the SYPR project's stratified random sample of 188 ejidatarios (small-holders with usufruct rights on ejido land) in 11 ejidos (administered in 1997 and 1998). Designed primarily as an instrument for the data needs of the project beyond its historical component, the survey also addressed land-use decision-making and land-use change over the last 20 years (Table 1), including informal, open-ended exploration of small-holder perceptions of land use, government policy, and land tenure reform. All 188 ejidatarios accompanied project researchers to their lands, recreating parcel use and confirming plots for GPS measure. The survey and sketch map data are linked to specific locations or pixels in Landsat Thematic Mapper (see Geoghegan et al., 1998).

The survey and mapping exercise provide the land history with spatially explicit characterizations of land change as well as insights gained from the land manager's history. In turn, this field exercise produces invaluable information for image classification, permitting the researcher to train on the pixels in the mapped plots to provide the range of signals indicative of different uses, and successional and invading vegetation of different ages as they change over time. The SYPR project, for example, has been able to provide a detailed level of classification uncommon in most TM imagery based.

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9 The initial SYPR project survey and sketch mapping was undertaken primarily by Peter Klepeis and Colin Vance with assistance from Birgit Schmook and Eric Keys.

10 This exercise as well as the goal of the international LUCC project to make land assessments spatially fine-tuned raises issues about household confidentiality that the global change community has not adequately addressed.
Land Use History (>20 yrs) via sketch-map

Fig. 6. Sketch maps of surveyed household fields and links to imagery classification (SYPR, 2000).

Table 1
Example of sketch map information recorded for one plot in a parcel [confirmed by imagery classification] (SYPR, 2000)

<table>
<thead>
<tr>
<th>Year</th>
<th>Land-use</th>
<th>Size (ha)</th>
<th>Chemical</th>
<th>Credit/</th>
<th>Hired</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>inputs</td>
<td>subsidies</td>
<td>labor</td>
</tr>
<tr>
<td>1996–1997</td>
<td><em>Milpa</em></td>
<td>4</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>1995</td>
<td>Jalapeño chili</td>
<td>4</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>1988–1994</td>
<td>Secondary growth</td>
<td></td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>1984–1987</td>
<td><em>Milpa</em></td>
<td>4</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>1983</td>
<td>Old growth</td>
<td>4</td>
<td></td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

*Selva Mediana* is forest between 15–30 m tall on well-drained lands, usually in excess of 20–25 years in age.

*Milpa* is a traditional slash and burn agricultural system, in which maize is the dominant crop. Chili cultivation employs capital inputs, primarily for pesticides and herbicides.

Table 2
Vegetated land covers and land uses in the Southern Yucatán Peninsula Region (SYPR, 2000)

<table>
<thead>
<tr>
<th>Land covers classified from LANDSAT 5 TM Imagery</th>
<th>Corresponding land uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetland forest (<em>Selva baja</em>)</td>
<td>Abandoned rice projects, modest cattle, minor timber extraction</td>
</tr>
<tr>
<td>Upland forest (<em>Selva mediana</em>)</td>
<td>Forest product extraction</td>
</tr>
<tr>
<td>Secondary growth (4–15 years)</td>
<td>Fallowed and abandoned cropland</td>
</tr>
</tbody>
</table>

Agricultural land

Pasture

*Selva baja* is forest between 4 and 14 m tall found on seasonally inundated bajos, which are depressions dominated by clay soils (vertisols and gleysols).

Cropland

Herbaceous vegetation

(1–3 year re-growth)

Bracken fern (*Pteridium aquilinum* (L.) Kuhn)

Inundated savannas

Pasture and modest small stock

Principally *milpa* and chili

Fallowed cropland or scrub pasture

Fallowed abandoned for unspecified period

Occasional grazing

*Selva baja* is forest between 4 and 14 m tall found on seasonally inundated bajos, which are depressions dominated by clay soils (vertisols and gleysols).


drained maps (but see Moran and Brondizio, 1998) (Table 2). Synergies of this kind do not end here, however. Given the detailed classification and further analysis, older TM images can be used as checks on the sketch maps and the information provided by the farmers, thus informing the land history.

Sketch maps, surveys, and imagery analysis exemplify the kinds of methods and tools that can enhance land histories. They permit more fine-grained scales of analysis, potentially illuminating critical facets of the land...
history that might otherwise remain hidden, and quantita-
tive tests of some of the claims and concepts identified in
the narrative. The SYPR project has benefited in at least
three ways by incorporating the techniques and data
associated with land-change science. First, the survey
exposed small-holder perceptions about past land uses
and the forces that shaped them. Interviews reveal that
one reason the large rice projects of the late 1970s failed
was because officials did not heed local expertise about
the environment of the bajos or seasonal wetlands. “Offi-
cials” expected a seasonal water regime with somewhat
regular timing and depth, discounting local knowledge of
the extreme flux in these qualities. Second, the historical
assessment indicates the role that external shocks — for-
ces emanating from outside the region and on which the
regional population had little or no control, such as state
changes in policy in regard to tenure and development
trajectories — have on the internal dynamics of the
region. The rich spatial data derived from sketch maps,
surveys, and imagery analysis permits this claim to be
tested quantitatively for the more recent periods, poten-
tially strengthening the overall thesis of the narrative
(Klepeis and Vance, 2000). Finally, these techniques and
data will aid the project in its interpretations of various
conceptual themes that pervade historical and social
science analysis. For example, that *lattifundios* (large land
monopolies) create more land-cover disturbance than
*minifundios* (small land holdings in peasant control) con-
stitutes a prominent theme in environmental history of
Latin America.\(^{12}\) Integrated land history permits this
theme to be tested quantitatively for the Southern
Yucatán Peninsula Region.

Conclusion

The rich traditions of land-history studies should serve
to inform the big issues confronting society and the
research of the academy at large. One such research issue
is the role of land-use and land-cover change as it applies
to global change and sustainability science. To make this
linkage explicit does not negate the importance of prob-
lem framing and interests of extant land histories. It
requires, however, engagement with approaches consist-
ent with integrated land history, a willingness to pro-
duce information specific to the needs of research beyond
history, and, perhaps most importantly, the ability to
work cooperatively in team-based research. This last
attribute, of course, stands in contrast to much of the
history tradition, save perhaps for that in ecology. The
SYPR project attempts to do this by inserting a land
history component squarely within a large, multidisci-
plinary study in which various research components work
in tandem. By immersing the historical researcher in
household survey work, parcel sketch mapping, and im-
agey analysis, historical analysis and contributions are
enlarged and results are more easily incorporated by
land-change science. Land history, thus, becomes a criti-
cal element in the parameterization, backcasting, and
projection needs of global change science, while gaining
a level of specificity and understanding that is often
missing in historical assessments alone.

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\(^{12}\) The term *lattifundio* is used somewhat liberally here, referring to
large international and national forest concessions, large rice projects
where the government usurped ejido land rights, and the biosphere
reserve. In all three of these cases, land control was taken from the
inhabitants of the forest and concentrated in a land monopoly in
the control of an economic elite. Traditionally, *lattifundios* refer to *haciendas* or
plantations that focus on agriculture or ranching.


