The Southern Yucatán Peninsular Region (SYPR) Project
NASA-LCLUC Report #1

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The SYPR project is a collaboration among the George Perkins Marsh Institute (Clark University), Harvard Forest (Harvard University), and El Colegio de la Frontera Sur (ECOSUR), with assistance and support from the Center for Integrated Studies (Carnegie Mellon University). Its major objectives and three integrated research foci are:

- to further understanding of the dynamics of deforestation and other land-use/cover change in the region; and
- to produce new modes and forms of spatially explicit models that explain these dynamics and project their near-term outcomes under different scenarios.

- Focus 1: Historical and Household Studies for Econometric Models— (1) to create an historical narrative of regional changes in land use and cover, and (2) an in-depth household data base on production systems and decisions; (3) to use these data and information to develop multi-logit models of LCLUC that can be linked to the remotely sensed data of the same; and (4) to assess the robustness and costs of this modeling approach compared to that of Focus 2
- Focus 2: MSS and TM Imagery Studies for Empirical Diagnostic Models—(1)to create a land-cover (and land-use) classification and accuracy assessment and (2) biophysical and social data information layers to couple with the imagery results through the use of GIS; to use these data and information to create probability models of LCLUC; and (4) to assess the robustness and costs of this modeling approach compared to that of Focus 1
- Focus 3: Forest and Land-Cover Ecology—(1) to create a detailed classification of land-covers, including vegetation structure and composition as a function of climate, soils, and disturbance history; (2) to evaluate the ecological impacts of land use on ecosystem structure, composition and function; (3) to link this information as inputs and outputs to the modeling efforts of Foci 1 and 2; and (4) to provide background information for additional and future studies on the long-term history of vegetation, land-use and natural disturbance in the region.

The first phase of the project involved coordinating the various units and establishing a field station in the center of the SYPR. Two workshops were held (Summer 1997; Janurary 1998) in which research, field study, and logistical issues were developed. A field station was established in Zoh Laguna, Campeche, from which the various foci personnel operate while in the field.

Focus 1 Status

First 18 month goals were (1) to develop a sampling scheme and survey instrumentation to elicit household and farmstead information; (2) to complete 60% or more of the sample in the SYRP by June, 1998 and close to 100% by December 1998; (3)

to begin archival and other historical research; and (4) based on initial survey results, to initiate construction of an economic model of LCLUC.

Achievements to date. The Focus 1 unit developed a stratified random sampling scheme; selected *ejidos* (settlements) for study according to that scheme; developed a survey instrument; pretested that instrument; and administered the revised survey to approximately 100 respondents (through April 1998).

The sampling strategy was developed in tandem with ECOSUR researchers developed during a week-long workshop in Chetumal, Mexico in July 1997. Since the large majority of LCLUC is undertaken within ejidos, including government and NGO projects, the sample focused on this land and tenure entity of which about 125 exist in the study region. The sampling aims to represent proportionate to the population the various land managers and land-use strategies in the region (*e.g.,* slash-and-burn, chile, orchards, and pasture). We developed a multistage cluster procedure, using two primary tools: the 1990 government censuses containing population figures for each of the *ejidos*, topographic and environmental maps, and the dates in which the *ejidos* were established.

The population, comprised of household units, was first divided into strata based on the geographic location because it is correlated with a number of other variables that are likely to be important for land use (*e.g.,* distance to road, soil quality, climate, state regulations), thus indirectly improving their representation in the sample. A total of eight strata were identified. Four of these are formed by the intersection of the major highway with the state boundary, dividing the region along north-south and east-west axis. An additional four strata are formed by considering those *ejidos* that border the highway on both its north and south sides within the strata. Ejidos were identified in age as pre-1960, 1960-70, and post 1970. Ten *ejidos* were selected: in Campeche—Chan Laguna (15), Xbonil (8), Alvaro Obregon (Zoh Laguna-25), El Refugio (10), La Lucha (14), and Arroyo Negro (12); in Quintana Roo—Nicolas Bravo (10), Tomas Garrido (14), and Nuevo Becar (8). A weighted random sampling technique is used to select survey households in each ejido. As of May, 1998, the number of survey undertaken by village are listed in ( ) above.

The initial survey instrument was also develop with our colleagues at ECOSUR-Chetumal, aimed at capturing those factors that potentially play a LCLUC decisions (*e.g.,* number of people in household, education level of household head, access to credit) through survey questions, the results of which are useful for econometric modeling of these land-use choices. A survey instrument was designed and is undertaken in Spanish. In addition, the survey involves mapping and obtaining GPS-based coordinates for each sampled households land holdings. During a field workshop held in January 1998, we refined the techniques for sketch map methodology to capture better the history of land-use dynamics on the individual plots. We also further modified a number of the questions in the survey that proved problematic, as well as improved the data entry procedures to assist in future data manipulations that will be an input into the econometric models.

As private ranching is increasing in the SYPR, we have also begun administering the survey to ranchers—5 to date. Sampling design is impeded here because of the prevalence of absentee owners and generally the caretaker cannot provide all the information asked on the survey. Thus, ranches with absentee landlords have thus far

been excluded from the sample, although we are currently considering methodologies to address this problem.

Initial data analysis begins in the summer of 1998.

Focus 2 Status

The first 18 months goals were: (1) to complete a land-use/cover classification and imagery assessment of the latest imagery by Summer 1998 and a classification of all other imagery by December 1998; (2) to create other GIS data layers to couple with imagery-derived information; and (3) to establish the trails for first stage diagnostic, empirical models.

Achievements to date. The majority of Focus 2 effort has been allocated towards image analysis for the control data (most recent image). The most recent images of the study area were taken on 2/5/96 for the western scene (covering 2/3 of the study area) and 1/31/97 for the eastern scene (covering 1/3 of the study area). A preliminary set of GPS points were taken in July 1997 to initiate a distinct set of supervised and unsupervised classification procedures which were followed in the Fall of 1997. A more complete set of field data were collected in January 1998 to label unsupervised classes and to refine the supervised classification. After additional processing, a final classification map for the western scene was produced using each approach. These two maps were overlaid to identify areas of agreement and disagreement, to examine each of the spatial patterns associated with areas of disagreement in order to identify contributions made by spectral vs. training strengths of each classification approach, and ultimately to produce an 11-class map for accuracy assessment.

The accuracy assessment employed a 2-fold approach. Data oriented towards measuring errors of omission have been being collected on an “as-convenient basis” by Focus1 team members throughout their travels in the study area and are currently being summarized. A set of 80+ data points oriented towards evaluating error of commission were selected based upon a random/clustered/stratified approach and have been compiled by ECOSUR. Completion of the classification of the eastern image is planned for completion in May with a smaller set of additional commission points to follow.

Effort has also been allocated to database acquisition and construction, including image, aerial photo, and GIS data. NALC-MSS data already on-hand include 1975, 1985, and 1990 images for the western scene and 1975, 1984, and 1990 images for the eastern scene. In addition to the control images discussed above, data have been acquired for 1987/88 (2 dates required to composite cloud-free coverage), 1992/94, and 1995 for the western portion of the study area and 1984, 1985/87, 1990, and 1993/94 for the eastern portion of the study area. Although extensive effort has been applied to portions of the MSS data by the project, the TM data remain to be processed during the summer and fall. Two sets of aerial photography are now on-hand - (1) Campeche (west) from December 1984 at 1:75,000 scale and (2) Quintana Roo (east) from November 1984 and March 1985 at 1:37,000 scale. The date of the aerial photo coverage is fortuitous as it enables "temporally anchoring" synchronous MSS and TM classifications in the east as well as potentially "filling in" for unavailable TM data in the west. As well, Focus 1 base maps created in the field and linked to GPS measures will be incorporated into the data array in June. .Decisions are underway on the procedures to be used and intensity of these latter data.

Focus 2 has undertaken initial development of its modeling approach. Advances have been made; (1). on the theme of temporal signatures (change categories based upon linked image dates and inferential probabilities where data are missing) as presented at the annual meetings of the ASPRS and AAG; (2) on the theme of enhancing prediction of change categories by using landscape pattern indices (diversity, dominance, and fragmentation) as presented at the annual meetings of the AAG and a recent GCTE-LUCC meeting in Barcelona; and (3) on the theme of mapping uncertainty in the modeling of NALC-MSS data for a subset of the study area. Although exploratory in nature, it is evident that any of these approaches alone, and especially the synergy between them should improve our ability to treat individual LCLUC maps in terms of class membership probabilities and (2) model probabilities of LCLUC categories over time. It is anticipated that field data collected for Focus 2 in January 1999 will be defined by preliminary results from
LCLUC models. It is anticipated that the Clark Focus 2 workshop originally planned for June 1998 with participation by 1 or 2 ECOSUR team members will be delayed until Fall 1998.

Focus 3 Status

First 18 month goals were (1) to survey the general conditions of forest and other major land-covers in the SYPR; (2) to assess the availability aerial photography and other forest assessment data for the SYPR for past times; and (3) to design a strategy of study and sampling, and initiate field studies in the Spring of 1998.

Achievements to date. General field surveys were undertaken in the summer of 1997 and January, 1998, drawing strongly on the expertise of ECOSUR personnel. A search of data sets resulted in the purchase of aerial photographs (mid-1980s) for the region as well as access to more recent photography for the Calakmul Biosphere Reserve undertaken for another project. This information, the general surveys, and an initial field-TM imagery assessment informed the development of the ecological field study, developed with ECOSUR during the project's January field workshop.

The first step underway is the classification and mapping the major types of intact and secondary vegetation with the objective of sampling these for regional variation and for an understanding of ecosystem response to land use. The second steps have just been initiated. These include the following. Within polygons of each important type, plots (25-m diameter) are being established, georeferenced (GPS), and sampled for vascular vegetation in terms of structure and composition. General edaphic factors (*e.g.*, soil physical and chemical properties, slope, drainage) are also being sampled and indications of local land-use history assessed. In a small number of plots, complete analyses of size (diameter) distributions of trees will be sampled. Analysis will utilize standard multivariate approaches (*e.g.*, DCA, Twinspan, CANOCO) and will incorporate all available environmental historical and disturbance variables. The objective remains to assess and interpret the range of variation within a given vegetation type, to evaluate this variation regionally, and to analyze the relationships among vegetation types with an emphasis on biodiversity and vegetation dynamics.