International Initiative for Impact Evaluation (3ie)

http://www.3ieimpact.org

The personal data provided on this form will be processed by 3ie, and may be held on computerised database and/or manual files. It will be used by 3ie solely for the purposes of grant review, and will not be placed in the public domain without the prior permission of the applicant(s).

Grant Application Form

Please read 'Instructions for proposals' before completing this form

Email completed application to *proposals@3ieimpact.org*

Note: Please submit the form in English language only.

Application Type:

Please check

New	**X**
Continuation/extension of a previous 3ie award (please provide previous grant number)	
Resubmission	

Study title

Environmental and Socioeconomic Impacts of Mexico's Payments for Ecosystem Services Program

Organization type where the grant would be held *(Please check .If other, please specify)*

Government agency	
NGO	
Research body / think tank / university	**X**
Other	

Organisation where the Grant would be held

Organisation	**University of Wisconsin-Madison**
Division or Department	**Agricultural and Applied Economics**
Organisation website	**http://www.aae.wisc.edu/**

Legal Status of Organization where the grant would be held

What is the organization's legal status (e.g. nationally registered NGO)?	**University**
What is the organization's legal tax status?	**not for profit, tax exempt**
Is the organization legally eligible to receive overseas grants?	**Yes**

Name of project/intervention being evaluated

Project/intervention	**National Payments for Environmental Services Program**
Implementing agency	**CONAFOR: Mexican National Forestry Commission**
Project or agency website	**http://www.conafor.gob.mx/**
Country(ies) of implementation	**Mexico**

Contact person details

Contact Name	**Jennifer Alix-Garcia**
Title	**Assistant Professor, Agricultural and Applied Economics**
Address	**417 Taylor Hall** **University of Madison-Wisconsin** **Madison, WI 53706**

Name & Designation of Contract Signatory *(If different to contact person)*	Name: **Cheryl Gest**	Designation: **Managing Officer, UW Research and Sponsored Programs**

Government approval

Does the study propose to collect primary data?			**Yes**
Does the study propose to seek access to secondary materials for which government approval(s) in the country (ies) where the proposed study is being implemented is required?			**Yes**
Does the Implementing organization(s) have government approval(s) in the country (ies) where the proposed study is being implemented?	**CONAFOR is a government agency. We are currently updating a collaborative agreement with them to share data.**	Reference Number:	**Previous Institutional Collaborative Agreement between USF and CONAFOR, July, 2008**

The implementing agency, CONAFOR is a government agency and has been running the Payments for Environmental Services Program since 2003. We are working with CONAFOR under the terms of an officially approved collaborative agreement signed in July, 2008 (See Annex B). Please note that Jennifer Alix-Garcia has recently moved from USF to Wisconsin-Madison, so we are in the process of updating the institutional affiliations on this letter.

In case the request for government approval(s) is under process, mention estimate of time period for approval (*please provide supporting document(s)*)	*Approx. Time period:* **Update to institutional affiliations: March 2010**

Start Date and Duration

a. Proposed start date	**May, 2010**	b. Duration of the grant (months)	**36 months (3 years)**

Principal Investigator(s): See ANNEX A FOR CVs OF ALL PERSONS LISTED HERE

Name	Organisation	How many days will the investigator work on the project?
Primary PI:		
Jennifer Alix-Garcia	University of Wisconsin Madison, Agricultural and Applied Economics	11 % time (28 days) per year * 3 years
CO-PIs:		
Elizabeth Shapiro	University of California Berkeley, Environmental Science Policy and Management	50 days per year * 3 years
Katharine R. E. Sims	Amherst College, Economics and Environmental Studies	12% time (30 days) per year * 3 years
Volker Radeloff	University of Wisconsin Madison, Forestry/ Remote Sensing	5% time (14 days) per year * 3 years

NOTE: The number of days listed for each investigator is approximate and is provided for information only. The University of Wisconsin-Madison will not track or report effort on the basis of days worked, but rather on the basis of percent of total effort.

Staff Duties: *Summarise the roles and responsibilities of each post (including PI's mentioned above) for which funding is sought (give name where known, or state post, e.g. 'Research Assistant', where appointment is not yet made)*

Primary PI:
Jennifer Alix-Garcia will supervise and coordinate program evaluation methods and will develop economic theory relevant to the project. She will also supervise the graduate student researcher in economics.

Co-PIs:
The project has three Co-PIs. Each is responsible for one of the main elements of this interdisciplinary project.

Elizabeth Shapiro will supervise the collection of primary data at the village and household level. She will design and implement the qualitative analysis, support data analysis and supervise student assistants. She will also facilitate contact with CONAFOR.

Katharine Sims will supervise the collection and analysis of secondary national program level data on participants from CONAFOR. She will maintain and analyze the spatial database necessary to evaluate the program. She will supervise a research assistant assisting with the spatial and econometric evaluation.

Volker Radeloff will design and supervise the analysis of satellite data in order to measure deforestation outcomes. He will supervise the student research assistant in remote sensing.

All PIs will participate in travel to Mexico to work with CONAFOR, to supervise the field surveys, to facilitate the final workshop and to conferences in order to disseminate the results.

Involvement of developing country researchers/evaluators *(Developing country researchers are defined as developing country nationals resident in that country)*

Will there be substantive involvement of developing country researchers/evaluators in the study team?	**Yes**

If yes, specify

We are and will continue to work closely with researchers/practitioners at the Mexican National Forestry Commission (CONAFOR). CONAFOR's Environmental Services Division has primary responsibility for PES program implementation. Division staff are also substantially involved in efforts to evaluate the social and environmental impacts of PES programs and to apply this knowledge for the design of REDD programs within Mexico and globally (de Jong, Iglesias Gutiérrez and Alanís de la Rosa 2008).

Our research team has travelled twice to the CONAFOR central offices in Jalisco and we have hosted members of CONAFOR's staff at a meeting in the U.S in February, 2009. In these meetings we have collaboratively developed a methodology and plan for program evaluation and have worked together to implement a preliminary pilot analysis of the program. CONAFOR's team has provided input on developing appropriate evaluation questions and designing the study methodology, including comments on the best available control groups and appropriate geographic controls. We have worked together to adapt their remote sensing methodologies to measure baseline levels of forest and forest cover changes and they are interested in developing new methods of remote sensing to improve program monitoring.

We look forward to continuing to work with this team and others in Mexico. We believe that working directly with CONAFOR rather than through additional university researchers in Mexico will ensure direct communication and project feasibility. However, we will employ a Mexican researcher/evaluator as Survey Coordinator and will hire Mexican postgraduate students on our survey team.

The principal members of the CONAFOR team who have contributed to the evaluation design and pilot analysis are:

<u>CONAFOR Environmental Services Division</u>

Ing. Leonel Iglesias Gutiérrez (Director)
José Armando Alanís de la Rosa (Sub-Director)
Jesús Gutiérrez Cacique (Sub-Director of Operations)
Rodolfo Valdez Garcia (Technical Director)
Silvia Martinez (Technical Analyst)

<u>CONAFOR Geospatial Team</u>

Rigoberto Palafox Rivas (Director)
Carmen Meneses Tovar (Sub-Director of Spatial Detection)

Description of the intervention

Our goal is to evaluate the socioeconomic and environmental impacts of Mexico's National Payments for Environmental Services Program. The program is touted as a model for large-scale incentive programs that can both slow deforestation and reduce poverty, yet few rigorous studies have been done to evaluate its impacts.

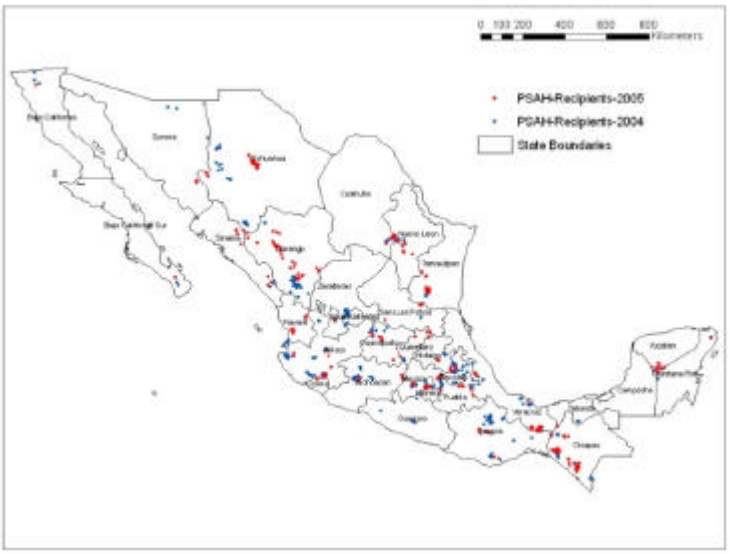
Mexico's program represents one of the first efforts to implement a national-scale payments for environmental services (PES) program in a developing country (See Figure 1). The program compensates landowners in exchange for land use practices that enhance the production of environmental services. Between 2003 and 2009, approximately 2.27 million hectares of forestland were entered into the program. More than US$360 million of federal funds were distributed to 4,893 communal or smallholder private property participants, making the program one of the largest in the world (CONAFOR 2009).

Mexico's program compensates both individual property owners and communal landowners. In contrast to many countries where most forested land is held privately or by the state, approximately 80 percent of forestland in Mexico remains under collective ownership by peasant associations known as *ejidos* or by indigenous communities. Since the payments for environmental service programs use forest cover as a proxy for the production of ES, they must necessarily focus on communal lands.

Our evaluation will focus on the PSA-H (Pago por Servicios Ambientales – Hidrológicos – PES – Hydrological) program, which is designed to incentivize the production of hydrological services. The program plans to continue enrolling new hectares at a rate of approximately 130,000 per year. Five-year contracts are signed with communal and smallholder private property owners. According to the contracts, payments are made annually after verification by satellite image or ground visits that the enrolled land remains forested. Lands where clearing is detected are removed from the program and payments are reduced proportionally. Payment rates were originally based on approximate calculations of the average opportunity cost of land conversion from forest to maize crops. Rates are fixed, with slightly higher per hectare payments for cloud forest than for other forest types. Participation is currently targeted to sites with a potential demand for hydrological services, i.e., in overexploited watersheds and upstream from population centers > 5,000 (McAfee & Shapiro Forthcoming).

Mexico's PSA-H program has the potential to serve as a key model for the design of incentive-based mechanisms to ameliorate global environmental degradation and rural poverty. It is one of the first large-scale PES programs to take place in a region with significant rates of deforestation. Lessons from this program could play an important role in the design of global REDD (reduced emissions from deforestation and degradation) agreements currently being negotiated under the UNFCCC (UNFCCC 2007). In 2008, the World Bank's Forest Carbon Fund cited the success of the PES program as an important factor for selecting Mexico as one of only fourteen countries slated to develop national REDD schemes. The PES division of CONAFOR, with whom we are working, was designated to develop the program. Additional insights from a rigorous impact evaluation of the program would support their efforts to develop a REDD scheme. Because of its scope and scale, a rigorous evaluation of lessons learned from Mexico's national program would also have substantial benefits for the global community.

Figure 1: Location of PSA-H recipients in 2004 and 2005



Evaluation question(s)

List the main evaluation question(s) to be addressed by the proposed study [up to 250 words]

We propose to evaluate the environmental and socioeconomic impacts of Mexico's National Payments for Hydrological Services program.

1) Environmental effectiveness: The primary goal of the PSA-H program is to maintain forest cover in order to enhance hydrological services. Our evaluation therefore aims to answer:

a. Did property owners who received payments reduce their rates of deforestation for enrolled properties (compared to the assumed counterfactual of no payments)?

b. Did the program cause significant displacement, or "leakage" of deforestation from enrolled properties to nearby un-enrolled properties, possibly undermining environmental benefits?

c. How does the program's effectiveness in preventing deforestation vary according to the socioeconomic and geographic characteristics of the recipients, such as degree of initial levels of poverty, distance to markets, private vs. communal land ownership, and institutional capacity?

2) Socioeconomic impacts: Although the primary goal of the program is environmental, PES programs have been promoted in Mexico and elsewhere for their potential to improve incomes for rural communities, particularly for the rural poor. Our evaluation therefore aims to answer:

a. What and how large are the socioeconomic benefits of the program for recipients and non-recipients in participating communities?

b. What and how large are the associated transaction costs of program participation at the household and community levels?

c. In what ways has the PSA-H program changed local forest resource management planning and behavior for individuals and for local institutions? Is there evidence that participation in the program has increased institutional capacity to manage local environmental services?

d. Are the observed socioeconomic and behavioral impacts likely to be sustained after payments end?

e. How do program socioeconomic impacts vary according to such factors as ecotype, resource base, initial levels of poverty, distance to markets, private vs. communal land ownership, and institutional capacity?

3) Policy implications: Mexico's program has the potential to serve as an important model for global efforts to scale up PES programs generally and as part of REDD initiatives. Our project therefore also seeks to answer:

a. What lessons can we draw from Mexico's experience for the design of REDD agreements? E.g. what do measured "leakage" amounts suggest about the ability of these programs to effect substantial forest conservation and the advantages of national versus regionally targeted programs? What do the costs of transacting with small landholders and of monitoring and evaluation tell us about feasibility of other REDD programs?

b. What does the observed heterogeneity of socioeconomic and environmental impacts suggest for the targeting of future PES programs according to such variables as resource base, initial levels of poverty and inequity, land tenure type, institutional capacity, market integration, etc.?

c. What does Mexico's experience suggest about meeting dual goals of environmental and socioeconomic benefits? Can PES improve the livelihoods of the rural poor while enhancing environmental services?

Summary

Environmental services are the functions provided by healthy ecosystems, including carbon sequestration, watershed protection, and biodiversity conservation. Although property owners benefit from environmental services, the majority of benefits accrue to external parties. This difference in private and social benefits results in a classic market failure: without changes in the structure of economic incentives, land owners will provide too little of these socially valuable services.

Payments for environmental services (PES) programs aim to correct this incentive problem by compensating land owners in exchange for land use practices that protect or enhance environmental services. PES programs have generated significant excitement among policymakers because of their potential to deliver cost-effective environmental protection while increasing income for rural communities, particularly the rural poor (FAO 2007, Pagiola et al. 2005, Landell-Mills and Porras 2002).

Mexico's National Payments for Environmental Services Program is one of the first large-scale PES programs in a developing country. The program pays both individual and community landholders under five year contracts to conserve forest, a proxy for the production of environmental services. The program has enrolled more than 2.27 million hectares of forested land to date. Mexico's PES program will provide a key learning opportunity for the global community. Although economic theory provides some lessons for the design of effective payments for environmental services programs (Jack, Kousky and Sims 2008), there is very little empirical work to guide global efforts to design and implement these programs.

Our proposed study will rigorously evaluate the environmental and socioeconomic impacts of Mexico's National Payments for Hydrological Services program, with the goal of drawing lessons relevant for the design of future PES programs. The study will answer questions including: Did Mexico's program succeed in reducing deforestation rates? Did it induce additional deforestation on nearby properties ("leakage")? What were the primary socioeconomic benefits and costs of the program and did the program change environmental management practices or local institutional capacity? How did each of these impacts vary across socioeconomic and environmental dimensions and what does this impact heterogeneity suggest for the targeting of future PES programs?

Ultimately, our assessment of Mexico's innovative Payments for Environmental Service program will enable the global community to more effectively design other large-scale incentive-based conservation efforts including global agreements for REDD (Reduced Emissions from Deforestation and Degradation) under a new international climate treaty.

Justification

Existing evidence and knowledge gap: Our project will provide a rigorous analysis of environmental and socioeconomic impacts of PES programs, thus filling a significant gap in research on PES.

Environmental effectiveness: Proponents of PES argue that payments can induce landholders to change behavior and protect resources that would have been degraded. Sceptics contend that current PES programs pay landholders who would have undertaken conservation regardless of payments or whose low potential profits meant little deforestation risk. Annex C reviews the relevant research findings to date. There has been no rigorous quantitative evaluation of the environmental effectiveness of Mexico's program and little assessment of similar programs. As highlighted by Ferraro and Pattanyak (2006) and Wunder (2007), this type of evaluation will help increase efficiency of the scarce funds dedicated to conservation projects.

Socioeconomic effectiveness: Although the primary goal of the PSA-H program is to decrease deforestation, PES programs have also been promoted for their potential to increase incomes of the rural poor. Many disagree, claiming that targeting PES to the rural poor may weaken its ability to promote conservation goals (Wunder 2007). Our evaluation will shed new light on this question by carefully examining the potential socioeconomic and social benefits of Mexico's program. Currently there is a significant gap in the empirical literature with respect to the conditions under which PES may jointly achieve social and environmental goals.

National policy relevance and stakeholder engagement:
Our evaluation will provide direct feedback to the managers of the PSA-H program. CONAFOR has been a strong innovator in this field and this evaluation will support CONAFOR's capacity to learn from the program by ensuring a more detailed and rigorous assessment than would be feasible given their own resources. CONAFOR has demonstrated significant commitment to this project (see also box on "Involvement of Developing Country Researchers"). While maintaining independence with respect to final results, we will continue to work closely with CONAFOR. CONAFOR has already shared substantial data and expertise. We have collaborated on a preliminary evaluation designed to inform the World Bank's "midterm review" of Mexico's program (February 2010) and to pilot our methodology. CONAFOR and the World Bank have demonstrated interest in these preliminary results to inform the evolution of the PES program. CONAFOR's team is currently working to develop a national plan to participate in global REDD agreements, a process to which this evaluation will contribute.

Global policy relevance:
PES programs will play an important role in any international climate change mitigation agreement through REDD. A primary goal of our evaluation is to draw lessons relevant to the design of REDD programs, including what "leakage" amounts suggest about the ability of these programs to effect substantial forest conservation, what are the advantages of national versus regionally targeted programs, and what do the costs of transacting with small landholders and of monitoring and evaluation tell us about feasibility of other REDD programs. The results of this research will also have broader implications for the design of incentive-based conservation mechanisms. Simple models of household responses to incentive changes generally focus on individual economic benefits and ignore community norms and institutions. By combining quantitative evaluation of program effectiveness with a qualitative, detailed examination of case studies, we will illuminate how social and institutional context shapes responses to incentive-based conservation programs.

Our proposed project questions are outlined in the "Evaluation Questions" box on p. 6 above.

In order to answer the evaluation questions, we will collect and analyze data from multiple sources at different scales. The questions are nested; we will use the matching methodology and results of our analysis of deforestation to select our sample for the investigation of socioeconomic impact. This strategy will allow us to examine the interaction between environmental and socioeconomic impacts. The data types and empirical strategies for each question are explained below.

1) Environmental Effectiveness

Question 1a: To evaluate whether property owners enrolled in the program reduced their rates of deforestation compared to the assumed counterfactual of no payments, we need to: i) gather program data on participants; ii) construct a valid control group; and iii) measure rates of deforestation.

i: Data on program participants

We have data sets from CONAFOR on program participants for each year beginning in 2003. Our ongoing preliminary analysis focuses on the 2004 cohort. If funded, we will expand the analysis to program cohorts from 2003, 2004, 2005, 2006, and 2007. The participant database includes spatially referenced information on the boundaries of each property, property ownership types, region, amount of payments, and forest type. The number of properties enrolled in the PSA-H program (our maximum N treated) for each year is: 2003 (272); 2004 (352); 2005 (257); 2006 (241); 2007 (627).

ii: Constructing the counterfactual

For administrative reasons, CONAFOR could not randomize contracts, so the "ideal" control group is not possible. We will therefore rely on a comparison to several plausible control groups as our best measures of the counterfactual. First, we use applicants who were rejected on the basis of administrative or geographic details (i.e. missing paperwork, part of property outside the eligible zones). We have already gathered data on the rejected applicants from 2004 (N=208) and 2005 (N=228). Our second control will be constructed from applicants to future rounds of the program. We have employed both of these selection methods in choosing controls for our current pilot analysis and they match well on observable characteristics. If funded, our full analysis would use rejected applicants and appropriate future applicants for each of the cohorts.

Enrolled and control properties are likely to be similar with respect to key unobservable characteristics (i.e. selection into treatment; institutional capacity to apply), but may still be different with respect to geographic characteristics. For each control and treated property, we will use spatial overlay analysis to construct a full set of geographic characteristics. We will use these characteristics in matching (propensity score or Mahalonobis) or regression based analysis to ensure that we are controlling for observables as that could have influenced both selection into treatment and outcomes. These characteristics include ownership type, historical deforestation trends, nearby population density, slope, elevation, forest type, poverty rates, and market access (distance to roads and cities). We have already collected these layers and calculated these characteristics for our pilot analysis.

iii: Measuring rates of deforestation

Accurately measuring deforestation is technically challenging; the development of robust and accurate methods for comparison is necessary for this study, but would also be of significant use to CONAFOR for future evaluation and to the global community in the development of monitoring REDD agreements.

Our pilot analysis uses two types of deforestation analysis. The first relies on a new set of high resolution (10 m) images from the “SPOT” satellite to measure deforestation. Images from the dry season at least two years apart were collected and classified using the same methodology developed by CONAFOR to assess baseline forest cover and program eligibility. The second uses an annual forest cover change monitoring data set constructed by CONAFOR's geospatial team ("Monitoreo analysis"). This data is available for the whole country but uses lower resolution MODIS satellite images (500 m) and so is less accurate in detecting smaller areas of forest cover change.

For the full project, Co-PI Radeloff will supervise the development of improved, automated approaches to measure deforestation with 30-m resolution Landsat satellite images. In the past, deforestation studies relied on change detection methods that compared few (often just two) images spaced five, ten, or even more years apart. The drawback of these approaches is that succession after deforestation events may mask deforestation. And subtle changes in forest cover, such as selective logging, are also easily missed.

The solution to these problems is to analyze dense time-series of at least annual Landsat images. We will also explore the use of multiple Landsat images for each year to capture phenology. Analyzing such

dense time stacks has just recently become possible, due to better image availability, and new, automated approaches for image georectification (i.e., the alignment of all images to a common spatial reference system), and cloud detection. The main advantages of these dense time series are that even small changes in forest density are detectable, and that clear-cuts can be mapped with very high accuracy. The use of dense time-stacks is a very recent innovation and the methodology has not yet been tested for tropical or subtropical forests. We are thus excited about the potential of this type of remote sensing analysis for our project, and about the contribution that our satellite analysis would make to deforestation monitoring in tropical and subtropical forests in general.

The satellite analysis will be complemented with an accuracy assessment based on independent data collected in the field. The accuracy assessment will measure both commission (i.e. false deforestation event) and omission errors (i.e. missed deforestation events). Using the property boundaries provided by CONAFOR, we will then calculate deforestation rates for each property enrolled in the PSA-H program, and for our control group.

Question 1b: The second key question regarding the environmental effectiveness of the program is whether payments caused significant displacement, or "leakage" of deforestation from enrolled properties to nearby un-enrolled properties, possibly undermining impacts. Our analysis will explicitly measure leakage using the satellite measurements of deforestation and summarizing these for surrounding properties.

To do this, we construct buffer areas around each property, including: i) the area of the community's land (where appropriate); ii) all land within a distance of 1 km, 2km, and 5 km away from the property. We then compare deforestation rates in buffers around treated and control properties to test for localized displacement effects.

Preliminary results from our pilot analysis suggest that displacement effects may differ by access to markets. In communities without access to markets, the removal of potential land from production, and the increased demand for goods caused by the income effect of receiving payments are more likely to have local effects. We will test for these effects using interactions with data on roads and distance to markets. Data from the household surveys and case study analysis will aid in explaining these results.

Question 1c: The cost-effectiveness of a PES program is likely to depend on the targeting of the program to areas where payments can change environmental behavior on the margin and where land owners had a high risk of deforestation. The importance of targeting has been established theoretically (Alix-Garcia, 2008) but there is little empirical evidence. In addition, the theory is ambiguous with respect to the effects of some key variables, such as communal versus individual property type.

Our analysis would allow us to explore heterogeneity in program impact on deforestation rates across several dimensions, including the degree of initial levels of poverty, distance to markets, private vs. communal land ownership, and institutional capacity. Mexico's program has evolved across time; changes in the targeting strategy across different cohorts of the program would allow for further exploration of the heterogeneity of impacts according to program design, controlling for other changes across time.

2) Socioeconomic Impacts

To evaluate these questions we will employ an innovative combination of quantitative and qualitative methods: a household-level survey to gather quantitative data on program impact on recipient's welfare and their forest management behavior and case study analysis to gain a qualitative understanding of local level drivers and dynamics.

Sampling design*:* We will divide the country into four geographic regions based on CONAFOR's eight administrative divisions. A total of 2 common properties and 3 private properties enrolled in the program and stratified by program impacts on deforestation will be randomly selected from each of the four regions. To serve as controls, 2 non-enrolled common properties and 2 non-enrolled private properties from each region will be randomly selected according to the spatial matching strategy from each region, using geographic and socioeconomic characteristics, as well as baseline deforestation rates. 20 households will be randomly selected in each of the common properties and 1 household for each private property. For each household, the survey will be administered separately to the female and male heads of household in order to differentiate impacts according to gender. Within communally owned properties, the sample will be stratified by households who have legally recognized rights to the communal land (*ejidatarios* or *comuneros*) vs. those with only provisional rights (*avecindados*) in order to analyze differences in program impacts according to type and strength of land rights. This sampling strategy will result in a total of 680 household surveys conducted in 36 different properties. Case study analyses will be conducted in all of the 20 enrolled properties sampled.

Contact with the property owners will be made through CONAFOR's regional offices and the in-country

survey coordinator will visit each property before the survey team arrives. Household level survey instruments and case study semi-structured interview sheets will be pre-tested in four properties in which co-PI Shapiro has previously conducted research (Shapiro Forthcoming).

Household surveys will gather data on livelihood strategies, income sources, resource management and use activities, and local governance of forest resources. With these data we will analyze the local level drivers of deforestation and if and how they are mitigated by the PSA-H program. We will also be able to analyze the direct socioeconomic impact of the program at the household and community levels. Community-level information regarding the method of distribution of payments and the choice of the distribution rules will be gathered from community leaders concurrently with the household level surveys.

Impacts to welfare at the household level:

- Distribution of payments and direct changes in wealth indicators of recipient relative to non-recipient households.
- Indirect impacts to household welfare from improvements to community services or infrastructure.
- Impacts to household's ability to access either subsistence or market products.

Impacts to resource management behavior:

- Impact to the household's type and scale of resource management activities (i.e. agricultural, pastoral, forestry, etc.).
- Impact to time spent and financial expenditure on management activities for forest conservation (i.e. fire break maintenance, reforestation, etc.).
- Impact to the household's spatial and temporal patterns of land use.
- Plans for management of the enrolled forestland after the program ends.

Perception of program effectiveness:

- Trust in and reliance on community and external institutions during program implementation.
- Fairness and transparency in the distribution of the payments.
- Understanding of program objectives.

We will employ a difference in difference approach to analyze the impact of the program on welfare and resource management behaviors, using changes in the control communities over time to control for general time trends, and estimating impact using the difference between trends in the recipient and control communities. We will also use matching at the household level to insure that comparisons are being made between households with similar characteristics. Variation in perception of program effectiveness will be analyzed across only recipient households, with an eye towards understanding how these perceptions vary according to land tenure, household, and community characteristics.

Case study analysis will be conducted contiguously with the household surveys in the 20 enrolled properties sampled. Semi-structured interviews conducted with key actors in project implementation, including private property owners, community leaders, technical advisors, and CONAFOR extension agents, will allow us to acquire in-depth, qualitative knowledge of drivers and mechanisms to explain observed results. Qualitative data will be gathered on the following:

- Factors considered in decision to enter program.
- Conflicts over selection of land to enter into the program and the distribution and use of funds.
- Distribution of benefits and costs among program participation.
- Impact of program on resource governance and management.
- Perception of the drivers of deforestation in enrolled and adjacent properties.
- Beliefs regarding program's long-term socioeconomic and environmental impacts.
- Suggestions for how the program could be better designed and implemented.

Qualitative interview data will be coded and analyzed using Atlas-ti software and Q-Methodology, which provides a quantitative measure of subjectivity (i.e. beliefs, attitudes, opinions, etc).

3) Policy implications

Using the insights gained from our study, we will develop a series of program improvement recommendations, with the ultimate goal of informing CONAFOR's targeting of scarce program resources to participants with the highest likelihood of achieving program goals. More general results will be incorporated into a policy brief, published in English and Spanish, and into academic articles.

Data Collection

Will the research proposed in this application produce new datasets? (If no, leave the remainder of this section blank)	YES: 1. Satellite remote sensing analysis of deforestation rates 2. Household and community surveys See "Evaluation Design" above
Indicate how existing datasets have been reviewed and state why currently available datasets are inadequate for the proposed research.	Existing data sets will be incorporated to the fullest extent possible: 1. Programmatic data on participants from CONAFOR 2. National deforestation data (CONAFOR "Monitoreo") 3. Geographic layers on poverty, deforestation risk, roads, distance to cities, slope, elevation, etc. from Mexican state databases 4. Case study impact analysis from Shapiro's prior investigation 5. Data on forest-owning communities from Jen Alix-Garcia's prior survey New data sets above are necessary to measure deforestation more accurately, to assess the socioeconomic impacts of the program, and to understand the mechanisms and channels that could explain impacts and leakage effects.
Describe the design of the data collection (instruments, sample design and size, power calculations, timing, attention on socially marginalized groups)	Our analysis relies on two major types of data: First, to evaluate program impacts at the national scale, we will gather spatial data on program participants and appropriate control groups, rates of deforestation, and geospatial characteristics. Second, to explore the possible mechanisms behind impacts, we will use household and community level data: we will employ a household-level survey to gather quantitative data on program impact on recipient's welfare and resource management behavior and case study analysis to gain a qualitative understanding of local level drivers and dynamics. See "Evaluation Design" above.

Impact heterogeneity and diversity

It is a primary goal of our evaluation to understand how program impact varies among subgroups of the population. Heterogeneity of impacts has significant implications for the future targeting of this and other PES programs and for possible tradeoffs or complementarities between environmental effectiveness and socioeconomic benefits. Our evaluation questions (see previous box) 1c, 2e, and 3b explicitly address impact heterogeneity and our evaluation design (see previous box) includes analysis of several dimensions of possible heterogeneity in impacts. These dimensions and the ways in which we will measure them include:

Property level data (analysis of demographic data & satellite images):

- Land tenure type (private versus common properties)
- Market access (distance to nearest major city, distance to locality with population > 5000, distance to roads, density of roads)
- Poverty rates (locality and municipal level poverty index)
- Forest type (global eco-region type; National Forest Inventory baseline land use)
- Landscape ruggedness (slope and elevation, road density)

Household & community-level data (analysis of household survey data & case studies):

- Gender (male versus female head of household)
- Land tenure security (legally recognized common property holders versus those with unofficial access to common properties)
- Land tenure type (private versus common properties)
- Institutional capacity (frequency of meetings, institutional structures)
- Household livelihood strategies (degree of dependence on forestry or agriculture activities)

In the quantitative analysis, we will test for impact heterogeneity using interactions with treatment. We will use the additional information from the household surveys and case study analysis to understand how dynamics at the household and community levels might drive observed heterogeneity in impact. The sample for the household surveys and case studies will be selected so as to gather data across the relevant dimensions of diversity.

Cost Effectiveness

The primary goal of the PSA-H program is to achieve additional environmental benefits from reduced deforestation and forest degradation. Currently, although program managers can easily calculate the area of forest enrolled in the program, there is no measure of the additional environmental benefits of the program (compared to the counterfactual of no program). By measuring the "additionality" of environmental benefits we will be able to more accurately assess the cost at which these benefits are achieved.

Our study will also address how targeting of funds might improve the environmental benefits achieved for a fixed program budget. Increased understanding of the settings in which the program was most and least effective will improve targeting and facilitate future cost-effectiveness of the program. However, we will also consider the extent to which targeting on the basis of environmental cost-effectiveness might or might not be compatible with socioeconomic development by examining program impact to rural incomes and development. We will explore whether or not these secondary socioeconomic benefits would coincide with environmentally cost-effective targeting.

Mexico has devoted substantial financial resources to the PSA-H program - US$360 million between 2003-2009 (CONAFOR 2009). These recommendations could offer a significant increase in program efficiency for the Mexican government, as well as demonstrating ways and means that other countries and international agencies could reduce costs for future PES projects and other incentive-based conservation programs in their portfolio.

Sustainability

To what extent are the benefits associated with the intervention likely to continue beyond the period of the research or if scaled up? [up to 400 words]

Sustainability of the program within Mexico:

Between 2003 and 2009, approximately 2.27 million hectares of forested land were entered into the program and more than US$360 million in Mexican federal funds were distributed to 4,893 communal or smallholder private property participants, making the program one of the largest in the world (CONAFOR 2009). All indications are that the Mexican government intends to continue this program in the future, reaching additional landholders. The program will likely expand even further if Mexico joins an international agreement to reduce carbon emissions from deforestation and degradation (REDD).

In the immediate future, the lessons from this proposed evaluation would help CONAFOR improve its targeting scheme to make future payments more efficient and to design them in such a way so as to maximize positive environmental and social impacts. Mexico is currently working on ways to ensure the financial sustainability of the program as well as ways to create local or regional markets for environmental services that would require less direct government intervention. Some communities who have neared the end of their contract periods have been able to sell carbon credits on international exchanges, a potentially sustainable source of long term payments. To the extent that the program has improved local management structures related to forests, it is likely that there are sustainable positive changes in how communities view and manage environmental services.

Sustainability at the global level:

Despite hundreds of small-scale PES programs worldwide, there are only a few national-scale programs. An evaluation of Mexico's program therefore can serve as a valuable model to the global community for the design of large-scale incentive-based conservation programs, including REDD initiatives. Despite the growing use of PES programs, there is little empirical evidence on their effectiveness to guide multilateral agencies, NGO's or host-country national and implementing agencies. Understanding how households and communities react to conditional cash transfers also provides information about human behavior that is fundamental to the design of anti-poverty, education, and other policies intended to improve human welfare.

Target audience

There are four target audiences for the study: 1) Policymakers in Mexico; 2) Stakeholders in Mexico, primarily the affected communities; 3) Global policymakers involved in incentive-based conservation including the design of REDD mechanisms for climate change mitigation; 4) Researchers in the academic community concerned with conservation and development.

Target Audience, Communications Plan and User Engagement

1) *Policymakers in Mexico:* This target audience includes CONAFOR, the Ministry of the Environment (the head agency in the Mexican Federal Government) and the Mexican federal policy makers who determine the funding and provide direction for the national PES programs. We will be working in close collaboration with the CONAFOR staff and administration throughout the research process. We have built funds for travel and a final workshop into the budget to ensure that we effectively disseminate our results. We will write up results in a policy brief format that will be translated into Spanish. This brief will be targeted specifically to reach other relevant policy makers at the federal level in Mexico. The workshop will include a discussion between CONAFOR, the researchers, and the environmental policy community in Mexico.

2) *Stakeholders in Mexico:* This second audience includes regional offices of CONAFOR, regional and local NGOs, and the private and communal landholders themselves. Shapiro conducted a multi-sited ethnography of the program from 2005-2007 (Shapiro Forthcoming). We will draw upon her contacts with community-based NGOs, agencies and academic institutions to disseminate our results. This target audience will be reached through meetings and conversations with organizations and communities. We will disseminate copies of the report in Spanish to these actors as well as a shorter brochure for participants and potential participants that will include results most relevant at the community level.

3) *Global Policymakers:* The third audience we will target is the policy makers involved in promoting and implementing PES programs globally, including REDD initiatives. The English version of the policy brief will be our primary means of communicating our results to this audience. Versions of these will be published in policy-oriented journals and websites that regularly cover issues of PES such as the Ecosystem Marketplace and the International Institute for Environment and Development (IIED). In order to more effectively reach the broader Latin American Audience, we will publish the Spanish version of the policy paper through the *Instituto Nacional de Ecología*, Mexico's environmental policy research institute, in their journal *Gaceta Ecológica*.

4) *Academic Community:* Our fourth targeted audience is the global academic community concerned with environmental policy and market-based mechanisms for land conservation. We plan to publish our results in peer-reviewed academic journals relevant to our respective fields (economics, remote sensing, environmental policy or geography). We will present the results at academic conferences (we have already submitted to present the results from the pilot study at the World Congress of Environmental Economists in July 2010). In addition, both undergraduate and graduate students at Amherst College and University of Wisconsin will be trained in impact evaluation through their participation in this project. The results from this project will be used in teaching environmental economics and environmental studies courses at both the undergraduate and master's level.

Level	Audience	Communication Objective(s)	Format of Information	Means of Dissemination
Local	Local CONAFOR offices, NGOs, payment recipients	See description above: 1) and 2)	Policy paper; brochures, presentation	Meetings, final workshop, calls
National	CONAFOR	See description above: 1) and 2)	Policy paper	Final workshop, *Gaceta Ecológica*.
Global	Policy-makers	See description above: 3) and 4)	Policy paper, academic papers	Conferences, journals, posting to Ecosystem Marketplace, etc.
Academic	Geographers, remote sensors, economists, policy analysis	See description above: 3) and 4)	Academic papers, curriculum development	Publication in academic journals, conferences

Ethical issues

Please explain what, if any, ethical issues you believe are relevant to the proposed research project. If you believe that an ethics review is not necessary, please also use this space to explain your view.

We are seeking human subjects review of our project. **We have already submitted an intent to apply for human subjects approval with the institutional review board (IRB) of the University of Wisconsin, Madison.** We anticipate that the IRB will determine our study to be exempt as our topic is not controversial and participation should in no way compromise or endanger our subjects. However, we will engage in the review process to ensure ethical standards are met. Whatever the determination of the IRB, we will take all measures necessary to ensure that the identity of our subjects remains confidential. Because we are collaborating directly with a Mexican federal agency we will not be required to go through human subjects review in Mexico.

Have all necessary ethical approvals been sought from relevant government authorities in:

	(Choose yes/No)
(a) Country of collaborating/partnering organization(s)/institution(s)?	**Yes**
(b) Country where the proposed project/study is being implemented?	**Yes**

Deliverables (nature and due date)

Deliverable	Due date
Pilot analysis	7/1/10
Results of pilot analysis	7/1/10
Policy brief: pilot analysis	8/1/10
Spatial database construction-national program information	8/1/10
Household and community surveys completed	6/1/11
Analysis of data	9/1/11
Results: Policy brief in English	3/1/12
Policy brief in Spanish	5/1/12
Workshop at CONAFOR headquarters	7/1/12
Publications	9/1/12

Timetable estimates of the start and end dates for the following stages:

Stage	**Start date**	**End date**
Preparation and design work	9/1/07	5/1/10
Fieldwork or material/information/data collection phase of study	5/15/10	9/15/10
Analysis phase of study	5/1/10	9/1/11
Writing-up of the research	9/15/10	1/1/13
Preparation of any new datasets for archiving	5/1/12	5/1/13
Dissemination	5/1/12	5/1/13