



USAID
FROM THE AMERICAN PEOPLE

THIS WORK WAS FUNDED WITH THE GENEROUS SUPPORT OF THE AMERICAN people through the Leader with Associates Cooperative Agreement No. EPP-A-00-06-00014-00 for implementation of the TransLinks project. The contents of this report are the responsibility of the author and do not necessarily reflect the views of the United States government.

Land Tenure Center

AN INSTITUTE FOR RESEARCH AND EDUCATION ON SOCIAL STRUCTURE, RURAL INSTITUTIONS, RESOURCE USE, AND DEVELOPMENT



TENURE BRIEF

No. 11; SEPTEMBER 2010

UNIVERSITY OF WISCONSIN — MADISON

IMPACT OF PAYMENTS FOR ECOSYSTEM SERVICES ON DEFORESTATION IN MEXICO: Preliminary Lessons for REDD

Jennifer M. Alix-Garcia, University of Wisconsin-Madison
Elizabeth N. Shapiro, Duke University
Katharine R.E. Sims, Amherst College

The brief summarizes an evaluation of the environmental effectiveness of Mexico’s national Payments for Hydrological Services program, which compensates rural landowners for avoided deforestation. The evaluation found that in an early year of implementation Mexico’s program had a small to moderate but significant effect in reducing deforestation, indicating that financial compensation policies can be effective in preventing environmental degradation. The research also suggests that some slippage of deforestation may have occurred, implying that avoided deforestation is best accounted for at a regional or national level.



AS COUNTRIES DEBATE THE MOST effective policy options for reducing greenhouse gas emissions from deforestation and degradation (REDD), an increasingly popular approach is to provide property owners with payments for ecosystem services (PES). Although property owners may gain some direct benefits provided by a healthy ecosystem, most benefits, such as from carbon sequestration, accrue to external parties. In the case of forests, for example, this leaves landholders with little financial incentive to retain the socially optimal

level of forest cover. PES programs attempt to correct this problem by giving cash payments or in-kind compensation to landowners in exchange for their conserving existing forest cover or reforesting cleared land.

REDD policy-makers considering PES schemes need to know whether these programs are effective in conserving forest that otherwise would have been degraded or destroyed. Proponents argue that payments induce landholders to change their behavior and protect resources. Skeptics contend that the payments will primarily compensate landholders who would have undertaken the same conservation efforts regardless. Furthermore,

there is fear that paying for forest conservation on one site will induce increased deforestation in another area, the so-called “slippage” or “leakage” effect that undermines overall impacts.

To date, there have been few rigorous evaluations of the direct environmental impacts of PES programs or slippage effects. In this brief we summarize the analysis we carried out of Mexico’s national Payments for Hydrological Services (PSAH) program, based on data from the 2004 cohort of program recipients. We find that the program has been effective in reducing deforestation, although some slippage may have occurred. We conclude with recommendations for the design of future PES programs.

Mexico’s PSAH program

Mexico’s PSAH program is one of the first large-scale PES programs in a region with significant rates of ongoing deforestation. Implemented by the National Forestry Commission (CONAFOR), the program is designed to incentivize increased production of hydrological services through forest conservation. Between 2003 and 2009, approximately 2.27 million hectares of land were entered into the program.

Under this program, five-year renewable contracts are signed with both individual and communal landowners. Payments are made annually. Verification of forest cover through satellite image analysis or ground visits is conducted annually on approximately half of all enrolled properties. Lands where clearing is detected are removed from the program and payments reduced commensurate with the amount of deforestation.

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.

EMBEDDING PES IN A REDD FRAMEWORK

REDD requires establishing international mechanisms that create incentives for nations to reduce deforestation and forest degradation. National governments then may choose policy mechanisms that influence the incentives for individual land users. The choice of policy type for achieving reductions in deforestation—for example, PES vs. establishing a protected area—has implications for the ultimate environmental effectiveness, efficiency, and equity of outcomes.

A key question in the design of REDD regards the scale at which deforestation credits should be generated. Some proposed approaches rely on rewarding reduced deforestation at a national level, while others use a project-based approach. Nested approaches attempt to bridge these two scales, allowing both project- and national-based credits where necessary, with the eventual goal of transitioning each case to a national scale.

As countries contemplate PES programs as a potential policy tool to reduce greenhouse gas emissions, there is concern that incentivizing landowners to conserve forest in certain areas will increase deforestation in other areas. Such changes should be anticipated in any economy where changes in production in one market are likely to affect production in others.

One proposed solution to account for this “slippage” or “leakage” is to measure avoided deforestation benefits at a regional or national scale rather than at the project level.

Participation is currently targeted to sites with a potential demand for hydrological services, such as those in overexploited watersheds and upstream from population centers of more than 5,000 people.

In 2008, the World Bank cited the success of PSAH as an important factor for selecting Mexico to receive support to develop a national REDD scheme. The program has the potential to be a model for the design of incentive-based mechanisms to ameliorate global environmental degradation and rural poverty.

Evaluating the environmental effectiveness of PES

Our impact evaluation seeks to understand how much deforestation was prevented (“avoided”) as a result of the program. Note that a measure of *avoided deforestation* is different from a measure of *program compliance*. The first measures the environmental effectiveness of the policy, compared to taking no policy action, while the second merely indicates whether or not program recipients fulfilled the program contracts.

Constructing a counterfactual

In order to evaluate the avoided deforestation impacts of a PES program, we must compare how recipients behaved to a reasonable measure of how they *would have* behaved had they not received payments. This is a fundamental problem since it is not possible to directly observe the hypothetical “counterfactual” scenario. In order to evaluate program impacts for the 2004 cohort of recipients, we used two control groups as our best available measure of the deforestation that would have occurred in the absence of the program.

First, we used other applicants in 2004 that were rejected on the basis of missing paperwork or because their property fell outside the eligible zones. Second, we used future recipients of payments from the 2006 round of the program. Because our non-recipient (control) properties were chosen from

the applicant pool for the program, they are likely to be similar to recipient (treated) properties in terms of key unobservable characteristics. Specifically, the rejected properties, future enrollees, and current enrollees all shared the desire to enter into the conservation program and had sufficient institutional capacity to apply.

Recipient and non-recipient properties may, however, still differ with respect to other characteristics. To account for these differences we used spatial overlay analysis to construct a full set of geographic characteristics for each property. We then used matching to choose the controls from the applicant pool most similar to recipient properties. We matched parcels on the basis of:

- *property characteristics* (size of property, tenure type)
- *market access* (road density)
- *baseline forest type*
- *landscape ruggedness* (slope, elevation)
- *region*.

Not all recipient properties had good matches with potential control properties. We therefore limited our analysis to the 80% of the sample with the best matches.

In order to estimate program effects, we compared deforestation rates in recipient and matched control properties. We used data from 2003-06 to calculate deforestation within the boundaries of the areas enrolled or proposed for program enrollment in the treated and control properties. We calculated estimates using bias-adjusted matching and multiple regression analysis to account for remaining differences that may have influenced participation and could be correlated with deforestation

Deforestation indicator

Accurately measuring deforestation is a key challenge in analyzing the impact of PES programs. We employed data from CONAFOR’s “Monitoreo Forestal de Mexico,” which is designed to monitor annual changes in forest

cover across Mexico. The dataset is built from MODIS satellite images (250m), and the classification of deforestation is based on changes in the dry season Normalized Difference Vegetation Index (NDVI) values across time. Although this is the best nationally available indicator of changes in forest cover in Mexico, it can be influenced by weather shocks and may not detect small areas of deforestation. As these errors are in the dependent variable, they are unlikely to be correlated with the treatment conditional on regional controls and thus are unlikely to systematically bias results.

Avoided deforestation results

Our analysis indicates that the PSAH program showed statistically significant although small to moderate avoided deforestation impacts. We found that the program reduced the probability of deforestation by 6-11 percentage points, which represents an approximately 22-44% decrease in this probability. In addition, it reduced the area of deforestation among deforesters (without adjusting for the likelihood of being in this group) by around 2-11%.

We examined whether effects varied by region, property ownership type, or access to markets. We found the largest program impacts in the northeast and north central states. We did not find differences in average impacts by land tenure arrangements (private versus communal properties). We did find that the effects were different for more isolated properties. The results suggest that the program significantly reduced deforestation primarily in areas with higher road density. Plausible explanations are that on-the-ground monitoring of the program is easier where road connectivity is higher, or that pressures on forests are higher where access to markets is better, thereby more heavily influencing landowner behavior.

Tracking slippage

A potential problem for any PES program is “slippage,” which occurs when providing

incentives to conserve in one location unintentionally increases incentives to degrade in other areas. Although slippage is theoretically predicted to occur as a result of any PES program, little has been done to test for or measure it. Our research developed methods to test for two types of slippage: substitution slippage and price slippage.

Substitution slippage occurs when households remove one parcel of land from production to enroll it in the program, but then switch production to another parcel on their property. *Price slippage* occurs if the introduction of payments or the removal of multiple parcels of land from production increases market prices, inducing additional deforestation. Whether or not deforestation due to price slippage will be spatially close to enrolled lands depends on the size of the relevant markets.

Substitution effects, by definition, should occur within the landholdings of the owner who enrolls in the program. Therefore, we compared deforestation in locations close to recipient and control properties. For communal properties, we calculated deforestation within the remaining land area owned by the community. For private properties, because data on the actual boundaries of the private properties were not available, we calculated deforestation within one-, two-, and five-kilometer buffers of the enrolled parcel.

In order to examine potential price spillovers, we calculated the total land area enrolled in the PES program within a 50-kilometer radius of each property in our sample. This gave us a proxy for the effect of the program on the degree of the reduction in the supply of land and/or the magnitude of the total payments. We hypothesized that, all else being equal, where there is more land enrolled in the program, price increases for agricultural goods would be larger and we would therefore see a greater increase in deforestation. The ability to observe this effect, however, depends on markets being sufficiently localized to prevent price changes from being distributed through

the entire national market. We expected that output price effects would only be observable where markets are relatively localized due to low access to transportation infrastructure (low road density) in rural Mexico.

Slippage results

Our analysis of buffers around each private property revealed no evidence of substitution slippage effects, even when considering differences in road density or across regions. We did, however, find evidence of possible substitution slippage effects within more remote communal properties (as measured by road density). This may be explained by the fact that more remote areas are likely to be poorer and be more credit-constrained, both of which could increase substitution slippage effects according to our theoretical model of household land allocation.

We also found evidence consistent with price slippage effects. For both individual and communal properties, having a higher density of other-enrolled properties is significantly related to increases in deforestation. These effects appear smaller as road density increases, which is to be expected since detectable price spillovers would be smaller as connections to markets increase.

Implications for policy

Careful evaluation of PES programs can increase the efficiency of scarce funds dedicated to conservation projects worldwide. Our analysis of Mexico's PSAH program suggests four preliminary lessons relevant for the design of REDD policies.

PES can be an effective policy option for reducing deforestation. Based on analysis of properties for which we had good comparison matches, we found that Mexico's program significantly reduced the probability of deforestation and the amount of forest cleared when deforestation did occur. Given that 2004 was one of the early years of implementation and that payments to later cohorts were targeted

to areas at higher risk of deforestation, payments to future cohorts are likely to demonstrate greater avoided deforestation impacts.

Targeting may improve avoided deforestation effectiveness but could undermine other social goals. We found heterogeneity in estimated impacts by property type and region, which underscores the importance of targeting in order to achieve maximum environmental gains. PSAH policy has changed substantially since 2004; in particular, the targeting strategy was modified to account for deforestation risk. Future research should examine how the changes in the targeting strategy affect program impacts. One concern is that targeting to maximize avoided deforestation benefits could undermine other potential program benefits, such as improving livelihoods for remote communities, if locations with the most avoided deforestation are those better connected to markets.

Slippage is likely to occur in any PES program, so avoided deforestation should be accounted for at a regional or national level.

The problem of slippage through substitution or output price effects is in no way unique to Mexico's program; the issue is likely to occur in any country implementing a PES scheme. Given the possibility for slippage, REDD designers should consider embedding PES programs in larger national systems that track overall deforestation at a regional or national scale rather than attempting a project-based approach. In addition, policy-makers should consider permanent mechanisms for the protection of forests to complement PES approaches.

Better monitoring systems would strengthen the implementation of PES programs. The paucity of data on forest cover change is a major limitation to the implementation of PES programs and research on their effectiveness. CONAFOR has established an excellent monitoring program, but even with its outstanding staff it is inherently limited by available technologies and the expense of satellite imagery. Continued improvements in

technology, lower-cost imagery, and sharing of techniques by agencies responsible for monitoring deforestation are absolutely essential to make such systems consistent and effective. Better monitoring systems could significantly improve international understanding of the effectiveness of both incentive-based and traditional conservation programs that seek to mitigate deforestation.

Related reading

- Alix-Garcia, J., K. Sims, and E.N. Shapiro. 2010. "Forest Conservation and Slippage: Evidence from Mexico's National Payments for Ecosystem Services Program." University of Wisconsin Department of Agricultural and Applied Economics Staff Paper No. 548, August, 2010.
- Angelsen, A., editor. 2008. *Moving Ahead with REDD: Issues, Options, and Implications*. CIFOR. Bogor, Indonesia.
- Bond, I., M. Grieg-Gran, S. Wertz-Kanounnikoff, P. Hazlewood, S. Wunder, and A. Angelsen. 2009. "Incentives to Sustain Forest Ecosystem Services: A Review and Lessons for REDD." *Natural Resource Issues No. 16*. International Institute for Environment and Development.

- Gutman, P. and S. Davidson. 2007. *The Global Environmental Facility and Payments for Ecosystem Services: A Review of Current Initiatives and Recommendations for Future PES Support by GEF and FAO programs*. WWF Macro-economic for Sustainable Development Program Office. Payments for Environmental Services from Agricultural Landscapes-PESAL Papers Series No.1. Rome.
- Menes-Tovar, C.L. 2010. "Análisis del índice normalizado de la vegetación (NDVI) para detección de degradación de la cubierta forestal en México 2008-2009." FRA Working Paper 173.
<http://www.fao.org/forestry/64442/en/>
- Muñoz-Piña, C., A. Guevara, J.M. Torres, and J. Braña. 2008. "Paying for the Hydrological Services of Mexico's Forests: Analysis, Negotiations and Results." *Ecological Economics* 65(4): 725-36.
- Pattanayak, S.K., S. Wunder, and P.J. Ferraro. 2010. "Show Me the Money: Do Payments Supply Ecosystem Services in Developing Countries?" *Review of Environmental Economics and Policy* 4(2): 254-74.
- Plantinga, A. and K. Richards. 2008. "International Forest Carbon Sequestration in a Post-Kyoto Agreement." Discussion Paper 08-11, The Harvard Project on International Climate Agreements.

Acknowledgements

We thank the many people at CONAFOR who helped us gather and interpret data, including but not limited to Leonel Iglesias Gutiérrez, José Armando Alanís de la Rosa, Jesús Gutiérrez Cacique, Rodolfo Valdéz García, Silvia Martínez, Rigoberto Palafox Rivas, Adriana Saldaña Espeje, Paola Bauche Peterson, Sergio Humberto Graf, and Carmen Meneses Tovar. We also thank USAID-Translinks and the International Initiative for Impact Evaluation (3ie) for their financial support.



Published by the **Land Tenure Center**. Comments encouraged:
Land Tenure Center, Nelson Institute of Environmental Studies,
University of Wisconsin, Madison, WI 53706 USA
kdbrown@wisc.edu; tel: +608-262-8029; fax: +608-262-0014
<http://www.ies.wisc.edu/ltc>