EUROPEAN SOCIETY FOR ECOLOGIAL ECONOMICS 2015: TRANSFORMATIONS

The 11th International Conference of the European Society for Ecological Economics (ESEE)

Leeds, UK, 30 June- 3 July 2015

Extended abstract

Balancing agricultural development and forest conservation in the Amazonia: Can ecosystem degradation be reversed?

Introduction

The expansion of agricultural land is responsible for most tropical deforestation. Historically, smallholder farming and shifting cultivation has been reported as the main driver of deforestation. However, today's globalized markets and the growing demand for food have boosted the development of medium and large-scale commercial agriculture which is nowadays causing the majority of tropical forest cover loss, particularly in Latin America (Hosonuma et al., 2012). The Amazon basin is the region with the largest deforested area and where deforestation has caused the greatest impact on critical ecosystem services, resulting in biodiversity and biomass loss, carbon release and climate change, and soil and water degradation (Malhi et al., 2008; Davison et al., 2012). In order to avoid these harmful effects, numerous strategies have been designed to preserve and restore tropical forests. Conservation strategies for the Amazon region have traditionally focused on command-and-control measures (logging and deforestation bans) and more recently on economic incentives, such as payments for environmental services (PES) promoted as a REDD+ (Reducing Emissions from Deforestation and Forest Degradation) implementation mechanism. Yet, the evidence shows that this kind of measures are difficult to put into practice, especially in developing countries where the cost of enforcing them is very high (Martín-Ortega et al., 2013; Börner et al., 2014). This paper aims at analyzing the effectiveness of different policy measures (including economic incentives, disincentives and enabling measures) designed to induce ecosystem conservation at farm level in tropical agroforests of the Bolivian Amazon.

Methodology

- A bio-economic modeling approach

To assess the effectiveness of different conservation measures, a bio-economic model was developed and specified for the Guarayos province in the dry southern margin of the Amazon basin (Department of Santa Cruz, Eastern Bolivia). This study site comprises forest protected areas of high ecological value that are being threatened by agricultural expansion and unsustainable logging. Extensive fieldwork, based on a large array of in-depth interviews with farmers and experts, was conducted in 2013 in the study area. Derived empirical data were used to obtain technical data, to characterize the agricultural and forestry sectors and to define farms and farming practices. In total, four types of farm households were identified, ranging from subsistence holdings to large-scale commercial farms, through cluster analysis. The selected farm types were subsequently specified using a multi-period bio-economic optimization model that permits the simulation of different policy measures aimed to conserve ecosystem services.

Bio-economic models have been extensively used for the analysis of agricultural and environmental issues, including agriculture-driven deforestation processes (Walker, 2003; Borner et al., 2007). The bio-economic model developed for this research is a non-linear mathematical programming model that maximizes the discounted value of farmers' expected utility over a period of 15 years (2013-2028) subject to agronomic, biophysical, socio-economic, and policy constraints.

- Model simulations

Table 1 summarizes the different conservation measures simulated in the bio-economic model. These measures have been suggested in the literature as ways to reduce ecosystem disservices (negative externalities) and to augment services (positive externalities) in agro-forestry landscapes (Börner et al. 2007; Börner et al., 2014).

Table 1. Simulated conservation measures.

Measure	Type of measure	Target
Tax on carbon emission (30$/tn CO2 equivalent)	Economic disincentive	To lessen negative externalities from agriculture and deforestation. Reducing carbon emissions from crop production and forest clearing
Quota for carbon emission (5tn CO2/ha)	Command-and-control	To lessen negative externalities from agriculture and deforestation. Reducing carbon emissions from crop production and forest clearing
Prime to forest conservation (950$/ha of primary forest)	Economic incentive	To enhance forest-based ecosystem services. Keeping land in primary forest when it could be converted to agriculture
Prime to reforestation (1175$/ha of secondary forest) & Deforestation ban	Command-and-control & Economic incentive	To enhance forest-based ecosystem services. Keeping land in primary forest and converting agriculture land in secondary forest

Results

Figure 1 and Figure 2 show a selection of results that illustrate the potential effects of the policy measures presented in Table 1 on farm income, carbon emissions, deforestation and crop distribution in a small and a large representative farm, respectively. Results show the comparison of a no-action business as usual scenario with the different measures described in Table 1 for 2028 (last year of the time period considered).

Figure 1. Impacts resulting from the implementation of conservation measures on a small farm (50 ha) in Bolivia.

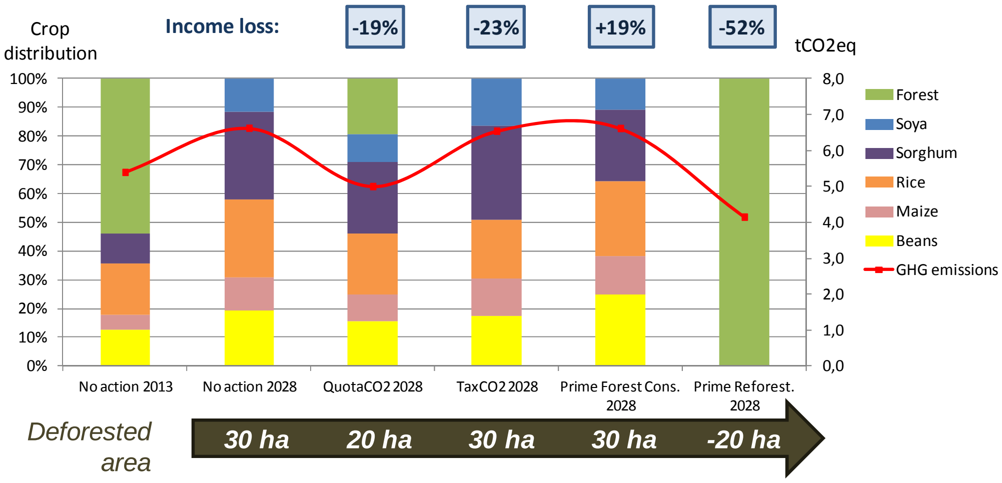
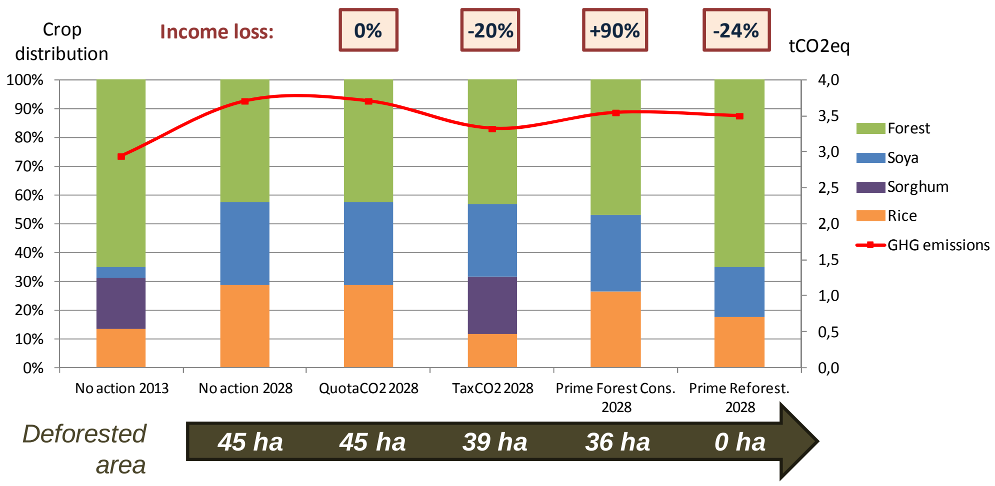


Figure 2. Impacts resulting from the implementation of conservation measures on a large commercial farm (200 ha) in Bolivia.



Results indicate that, if no action is taken, deforestation will continue in the middle-long term as a result of agricultural expansion. Soybean production will contribute to expand the agricultural frontier at the expense of forests, especially in large intensive farms with access to commercial credit. Other studies also suggest that, in a business-as usual scenario, a significant amount of Amazon forests will continue to be converted into agricultural land (Soares et al., 2006). Prevailing conservation approaches, limited to the recognition of public protected areas, seems to be insufficient to stop deforestation. Thus, more efforts should be made to conserve forests on private lands.

In line with Godar et al. (2014), our study suggests that conservation policies should be better tailored toward different contexts and types of farms. The simulation of different conservation measures evidenced differential effects on small and large farms.

Focusing on GHG emissions, results show that a tax to CO2 emissions would be effective only for reducing emissions in large farms but would inflict severe income losses to both large and small farms. On the contrary, the use of quotas to CO2 emissions would only be effective in the case of small farms with a lower share of forest area and higher emissions per hectare than large farms. In this case, the quota would also enhance forest protection as a way to balance CO2 emissions in the farm.

In the case of forest protection measures, granting a prime to forest conservation will have no effect in small farms. However, if a prime for reforestation is granted tied to a ban on deforestation, a significant forest recovery could be expected in these types of farms. Nevertheless, in all cases, providing economic incentives for inducing forest protection would imply significant public costs. In line with Müller et al. (2013), our study highlights that expensive PES programs would be needed to counterweigh the high opportunity cost (measured as foregone profit) of reducing deforestation in profitable agricultural areas, which may hinder the implementation of these types of programs.

Conclusions

Addressing the intertwined challenge of meeting rising demand for food and conserving ecosystems in tropical forest will require maximizing agricultural production while minimizing ecosystem loss. This research demonstrated that policy measures that take into consideration the provision of farm-based ecosystem services beyond food production can contribute to internalize externalities and to minimize social costs. Yet, these policies must be context specific and must consider the specific needs of the different types of farms. In some cases, the implementation of forest protection measures may inflict severe income losses, particularly to smallest and less profitable farms. Compensating farmers for these economic losses would require the expenditure of large public funds. Thus, only a combination of command-and-control with market-based measures will provide a sound balance between rural livelihoods and ecosystem services that can ensure the protection of the Amazon forests.

Acknowledgments

The authors wish to acknowledge the EU project ROBIN (The Role of Biodiversity in Climate Change Mitigation in Latin America, from the EC FP7, nº 283093) and the Spanish project AL14-PID-12 (Biodiversidad y cambio climático en la Amazonía: Perspectivas socio-económicas y ambientales) of the UPM Latin America Cooperation Program for funding this research.

References

Börner, J., Mendoza, A., Vosti, S.A. (2007) Ecosystem services, agriculture, and rural poverty in the Eastern Brazilian Amazon: Interrelationships and policy prescriptions. Ecological Economics 64: 3 5 6 – 3 7 3, doi:10.1016/j.ecolecon.2007.03.001

Börner, J., Wunder, S., Wertz-Kanounnikoff, S., Hyman, G., Nascimento, N. (2014) Forest law enforcement in the Brazilian Amazon: Costs and income effects. Global Environmental Change, doi:10.1016/j.gloenvcha.2014.04.021

Davidson, E.A., de Araújo, A.C., Artaxo, P., Balch, J.K., Brown, I.F., Bustamante, M.M.C., Coe, M.T., de Fries, R.S., Keller, M., Longo, M., Munger, J.W., Schroeder, W., Soares-Filho, B.S., Souza Jr, C.M., Wofsy, S.C. (2012) The Amazon basin in transition. Nature 481(7381):321–328.

Godar, J., Gardner, T.A., Tizado, E.J., Pacheco, P. (2014) Actor-specific contributions to the deforestation slowdown in the Brazilian Amazon. Proceedings of the National Academy of Sciences of the United States of America 111(43):15591–15596, doi:10.1073/pnas.1322825111

Hosonuma, N., Herold, M., de Sy, V., de Fries, R.S., Brockhaus, M., Verchot, L.,Angelsen, A., Romijn, E. (2012) An assessment of deforestation and forest degradation drivers in developing countries. Environmental Research Letters 7(4): 4009, doi:10.1088/1748-9326/7/4/044009.

Malhi, Y., Roberts, J.T., Betts, R.A., Killeen, T.J., Li, W., Nobre, C.A. (2008) Climate change, deforestation, and the fate of the Amazon. Science 319(5860):169–172.

Martín-Ortega, J., Ojea, E., Roux, C. (2013) Payments for Water Ecosystem Services in Latin America: A literature review and conceptual model. Ecosystem Services 6: 122-132, doi:10.1016/j.ecoser.2013.09.008

Müller, R., Pistorius, T., Rohde, S., Gerold, G., Pacheco, P. (2013) Policy options to reduce deforestation based on a systematic analysis of drivers and agents in lowland Bolivia. Land Use Policy, 30, 895–907

Soares-Filho, B.S., Nepstad, D.C., Curran, L.M., Cerqueira, G.C., Garcia, R.A., Ramos, C.A., Voll, E., McDonald, A., Lefebvre, P., Schlesinger, P. (2006) Modelling conservation in the Amazon basin. Nature 440(7083):520-523, doi:10.1038/nature04389

Walker, R. (2003) Mapping Process to Pattern in the Landscape Change of the Amazonian Frontier. Annals of the Association of American Geographers, 93(2), 376–398.