Ecosystem Services 24 (2017) 200–212

Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser

# Forest cover loss in Paraguay and perception of ecosystem services: A case study of the Upper Parana Forest

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ARTICLE INFO

*Article history:*
Received 4 October 2016
Received in revised form 7 March 2017
Accepted 8 March 2017
Available online 16 March 2017

*Keywords:*
Paraguay
Atlantic forest
Forest cover loss
Ecosystem services
Household survey
Perception

ABSTRACT

The Upper Parana Atlantic Forest (BAAPA) in Paraguay is one of the most threatened tropical forests in the world. Relentless agricultural encroachment has left less than 10% of its original cover intact. Many strategies and programs have been initiated, such as Payment for Ecosystem Services (PES) schemes, to halt forest cover loss. While the approach of ecosystem services (ES) has been continuously applied by policy makers, it has not been perceived strongly by the direct users of the forest. This study provides a comprehensive understanding on how landowners in the BAAPA perceive and benefits from ES derived from the forest and examines the influence of farmers on forest conservation. The results were obtained from an extensive household survey performed in the BAAPA region. An understanding of the high ecological value of the forest is common to all farmers. A strong dependency on forest-related products was observed for small and medium landowners whereas large-scale farmers considered the forest's main value to be mostly recreational and cultural. PES appears to be well accepted by forest owners, but it must receive stronger promotion. Understanding the importance of ecosystem services is a valuable contribution toward to conserving natural resources.



## 1. Introduction

Tropical forest cover has fluctuated greatly over recent decades. The continued encroachment of agricultural crops, cattle ranching, and illegal logging has endangered their connectivity, by converting the last remnants of tropical forest into isolated patches. (FAO, 2007). Between the 2000 and 2005 South America has lost over 22 million ha of forest, accounting for almost 60% (22, 3 million ha per year) of total forest cover loss in the world (FAO, 2007, 2010, 2015a). Even though deforestation rates have decreased compared with previous years (WWF, 2013), they remain a crucial concern. Recent studies conducted on a global scale identified Paraguay as one of the countries in Latin America with the highest deforestation rates worldwide (Hansen et al., 2010, 2013). The rapid deforestation rate has resulted in the loss of 90% of the forest cover in the eastern region of the country, where the Upper Parana Forest is situated (Fleytas, 2007). The Upper Parana Forest includes 15 ecoregions that encompass a total area of 471,204 km$^2$. It extends from the Atlantic coast of Brazil, passing through the eastern region of Paraguay and reaching the northwestern side of Argentina (Bitetti et al., 2003). The eco-region has a high level of biodiversity and includes numerous endemic species that are not found anywhere else in the world (Mayers, 1988; Mittermeier et al., 1999; Myers et al., 2000; Olson and Dinerstein, 2002). Before the 1940s, much of the original Upper Parana Atlantic Forest in Paraguay (BAAPA) remained intact covering approximately 55% of the eastern region of the country (nearly 9,000,000 ha), but currently less than 10% of its original cover remains (Fleytas, 2007; Hutchison and Aquino, 2011; Da Ponte et al., 2015). One of the major reasons attributed to deforestation activities in the BAAPA, besides the continuous expansion of mechanized agriculture (particularly soybean production), is the lack of profitable opportunities for forest owners. There are few economical alternatives besides timber and charcoal production. Consequently, the high levels of income obtained from agricultural exports have encouraged the expansion of large-scale crop production, tempting small-scale farmers to lease their land to large companies that are interested solely in single crops such as soy bean and maize. There are several strategies, conventions, and monitoring

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http://dx.doi.org/10.1016/j.ecoser.2017.03.009
2212-0416/

programs that were implemented to halt forest loss. One of the most promising alternatives is the Payments for Ecosystem Services (PES) program, also known as payments for environmental services (WWF, 2015b). The PES compensates farmers with incentives for managing their land to provide any type of environmental service (WWF, 2015b). The described concept has been implemented by the Paraguayan Government under the name of "Valuation and Retribution of Ecosystem Service Law 3001/2006" (PES 3001/2006). The regulation establishes a mechanism in which forests owners receive compensation for preserving their forest reserves and other natural environments, rather than converting their land into other land uses. The Paraguay forest regulation (422/73) requires that properties larger than 20 ha must preserve the natural forest on 25% of its land area. The PES 3001/06 law permits landowners with environmental liabilities to purchase environmental certificates from those who exceed the 25% minimum forest cover required for a renewal period of 5 years (Kernan et al., 2010). The Ministry of Environment in Paraguay (SEAM) has established a fixed cost for environmental certificates based on the eco-region from which the certificate has been issued, and this cost varies between $154 USD (Chaco Meadows) and $885 USD (Central Littoral) per ha.

According to SEAM, of the 20 registered properties, seven are located in the BAAPA, and only one of these forest owners had made a successful transaction for the sale of one certificate for 15 ha ($570 USD per ha) (SEAM, 2016). Ecosystem services (ES) was defined by the Millennium Ecosystem Assessment (2005) as "the benefits that people obtain from ecosystems" (Carpenter, 2005). The ES definition includes provisioning services such as timber and firewood; regulating services such as erosion and climate regulation; supporting services such as nutrient cycling and soil formation; and cultural services such as recreational and spiritual (Fig. 1). ES can be differentiated based on their use value: direct use values (for forest, e.g., the provision of wood and medicine); indirect use values (for forest, e.g., purification of water strands and tourism); option values (for forest, e.g., genetic resources); and existential values (for forest, e.g., educational and spiritual) (Hein et al., 2006).

While the ES approach has increasingly been included within environmental regulations as a way to support biodiversity conservation and sustainable management of ecosystems (e.g., National law 7575/1996 PES in Costa Rica, PES 3001/2006 law in Paraguay, and the 30215 law in Peru) (Bennet and Henninger, 2009; Kernan et al., 2010; Alegría, 2012; Casado-Arzuaga et al., 2013; WWF, 2015a), the comprehension of its concept remains limited (Lamarque et al., 2011). The small number of studies that considered the local peoples' perception of ES prevents effective implementation of proper ES-based conservation initiatives (Sodhi et al., 2009). Awareness about ES differs among sites, based on cultural characteristics, geographic location, life experiences, and use of natural resources (Daily, 1997; Costanza, 2000; Kuenzer and Tuan, 2013; Grima et al., 2016). Thus, case studies are considered to be especially important for capturing these local differences (Lamarque et al., 2011). The goal of this study is to provide a comprehensive understanding of the perception of forest ecosystems services in the BAAPA; the type of landowners who inhabit in the area and their educational background; how the usage of the services derived from the forest differs among different farm types (small, medium, and large); the degree of interest towards to susceptibility to conservation/restoration programs; and the current challenges and threats facing the BAAPA. The outcomes obtained in this study provide useful information when contemplating the importance of social involvement in land-use planning.

## 2. Study area

The Upper Parana Atlantic Forest is located in the eastern region of Paraguay (Fig. 2(*b*)). It encompasses portions of ten departments and 141 districts in the region, accounting for a total area of 86,000 km$^2$ (DGEEC, 2002). The BAAPA contains almost 50% (over 3,167 million inhabitants) of the country's population, who are distributed between 65% (around 2065 million inhabitants) in urban settlements and 35% (over 1102 million inhabitants) in rural areas (DGEEC, 2002). Cities with a larger population in the ecoregion are situated in the East (Ciudad Del Este) and South (Encarnación), whereas the North is less occupied. According to the Landscan Project (Oak Ridge National Laboratory, 2013), in 2010, the average population density outside urban areas varied between 5 and 100 residents per km$^2$ (Oak Ridge National Laboratory, 2013). The climate of the Atlantic Forest is typical for sub-humid tropical zones with frequent rainfall that varies from 1300 to 1800 mm per year. The annual average temperature is 22 °C with a relative humidity of 80%. However, the temperature fluctuates considerably between seasons. During winter months (May–August), temperatures can drastically decrease to 0 °C, whereas in summer, (December–March) they can rise to 42 °C. The main economic activities in the region are cattle ranching, cotton and corn, sugar cane, mate tea (*Ilex paraguariensis*), and soy bean production. Paraguay produces approximately nine millions tons of soy beans per year, accounting for three percent of worldwide production (Markey, 2014). Currently, over 3 million ha (90% of the country's production) of soy bean plantations are located within the boundaries of the BAAPA region (MAG, 2008). However,

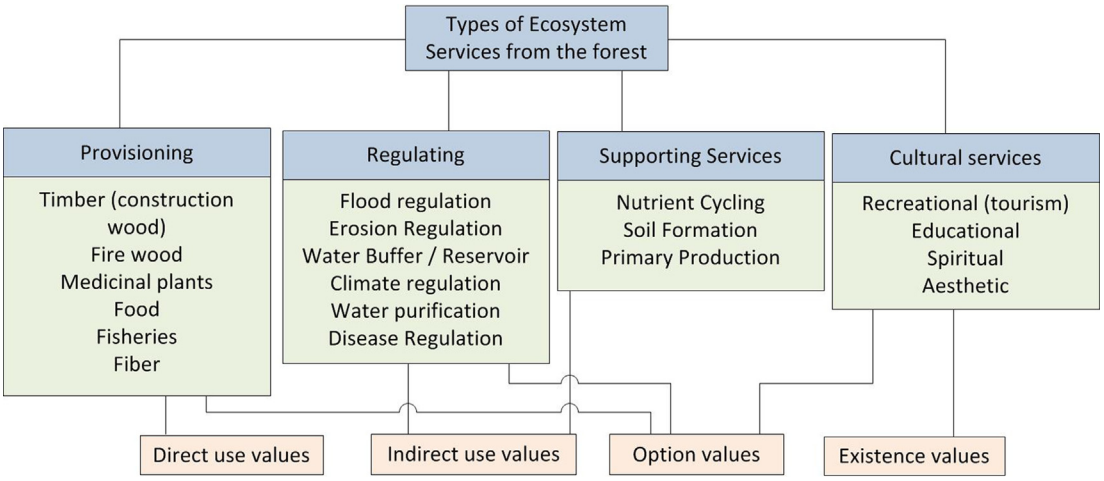


**Fig. 1.** Ecosystem service and ecosystem service value derived from the forest (Adapted from MEA, 20005).