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Ecosystem services and tree plantations in Uruguay: A reply to Vihervaara et al. (2012)

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ABSTRACT

The expansion of industrial tree plantations in South America is a case of land transformation that has already generated conflicts at the local, national and international levels. In a recent article, Vihervaara et al. (2012) present a controversial analysis, mainly for the potential use of some of their results; they suggest that the general attitude among the local people toward an increment in tree plantations and toward the forest industry is positive. In this article I discuss the results and conclusions of the Vihervaara et al. article, particularly those related to the definition of the ecosystem services concept, the definition of stakeholders and the approaches to deriving their perception, and the available evidence on the impacts of grassland afforestation in Uruguay.

1. Introduction

The article from Vihervaara et al. (2012) recently published in Forest Policy and Economics tackles a very important issue in environmental science: the stakeholder's perception of the impact of land use/land cover transformation on the level of provision of ecosystem services (ES). Ecosystem services are an anthropogenic concept (Goulden and Kennedy, 1997), and therefore the perception of local stakeholders becomes critical. The focus of their article is on a particular land cover transition: the afforestation of natural grasslands in Uruguay. The expansion of industrial tree plantations in South America is a case of land transformation that has already generated conflicts at the local, national and international levels (Altesor et al., 2008; Bachetta, 2008; Reboratti, 2010). Almost 1,500,000 ha have been afforested in Argentina and Uruguay (Braier, 2004; Petraglia and Dell`Acqua, 2006), and the expansion of *Eucalyptus* and/or *Pinus* plantations is one of the most noticeable land use changes in the Río de la Plata Grasslands (Jobbágy and Jackson, 2003; Paruelo et al., 2007). *Eucalyptus* and *Pinus* plantations in South America are profitable activities, with high internal rates of returns (Cubbage et al., 2007; Cubbage et al., 2010). High growth rates, low land and labor costs, and active public policies have also accounted for the expansion of forest plantations in these grasslands. Additionally, the development of a carbon market represents a new incentive for afforestation in the region (Wright et al., 2000).

The Vihervaara et al. (2012) article presents a controversial analysis, mainly for the potential use of some of their results; they suggest that the general attitude among the local people toward an increment in tree plantations and toward the forest industry is positive. The study, aside from a basic analysis of land use changes, was based on interviews of two different groups: the local population and "experts." Vihervaara et al. (2012) provide a view of the consequences of tree plantation expansion associated with a particular ideological framework. Some of the building blocks of such an ideological perspective are presented in the article and, basically and schematically, are linked to the perspective of the multinational forest corporations, which is to maximize the production of commodities for the global market (e.g. cellulosic pulp) at the lowest cost. The strategy to reduce costs includes free-tax ("zonas francas" in Uruguay) and investment protection agreements, and the externalization of environmental costs. Aside from the interest and values that guide the study, several conceptual gaps and methodological problems of the analyses may result in important biases. As the results presented may have important policy implications, a proper discussion in an academic forum is needed. My article intends to open the debate on several issues raised by the Vihervaara et al. (2012) paper:

a. The definition of the ecosystem services concept
b. The definition of stakeholders and the approaches for deriving their perception
c. The available evidence on the impacts of afforestation.

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2. The definition of the ecosystem services (ES) concept

Vihervaara et al. began by defining ES as the benefits that people obtain from ecosystems (M.E.A., 2005). If such a definition is assumed, the questions of the interviews should point to the evaluation of the benefits derived from the ecosystems being replaced. The questions presented (see Appendices 1 and 2 of the original article) were not coherent with the M.E.A. (2005) definition. For example, question 5 (Appendix 2) referred to the influence of tree plantations on ecosystem services, and the list presented included agricultural and non-agricultural goods, services and feelings. Some of these are also listed as "ecological and social stuffs of nature" (*cosas ecológicas y sociales de la naturaleza*) under the sub-title ecosystem services. The listed items do not correspond to any of the available ES classification schemes (i.e. M.E.A., 2005; Wallace, 2007; Fisher et al., 2009) nor do they fulfill the requirements outlined by Wallace (2007) for an effective typology of ecosystem services: "a minimum set of sharply defined terms that effectively encompass the topic, clarity concerning the terms used to characterize services and specification of the point at which linked processes deliver a service or a benefit." The list by Vihervaara et al. mixes vegetation types (riparian forests, wetlands, etc.), recreational activities (horseback-riding), land uses (orchards, vineyards) and individual species (*Ñandues, Rhea americana*). It is difficult to get an accurate opinion on ES if the items presented are not clearly organized. Providing a clear and unambiguous definition of ES to the interviewees is critical to assess the stakeholder's perception of their changes.

In the Introduction, and also in the Discussion, the authors put a strong emphasis on carbon (C) sequestration as a key ecosystem service and also on the cultural benefits provided by forests. The discussion of C sequestration is odd, because it was not included as an item to be evaluated by the people interviewed. There are several references in the article regarding the importance of tree plantations as providers of ES produced by native forests. A statement on the importance of forests as providers of regulation and cultural services, and on the forest transition theory in the case of Uruguay is misleading. It is well known that grasslands and not forests are the native biome of the area studied (Soriano, 1991; Paruelo et al., 2007). Additionally, it is controversial to consider tree plantations as forests (cornfields, for example, are not considered to be grasslands). The key point to highlight is that in Uruguay fast-growing tree plantations are not replacing native forests but grasslands.

3. The definition of stakeholders and the approaches for deriving their perception

A change in land use modifies the provisions of several ES. Land transformation alters the structure and functioning of the ecosystems, and therefore the benefits that humans derive from them change. Some ecosystem services are provided at higher levels than before the transformation (e.g. global market commodities such as cellulose pulp or soybeans), but others are at lower levels (e.g. water provision, climate regulation, biodiversity conservation) (Jobbágy et al., 2008).

A critical point in evaluating the impact of changes in the level of provisions of ES is to define the appropriation matrix (Paruelo, 2011): how much of the benefits derived from the different ES is appropriated by each stakeholder. Scheffer et al. (2000) differentiated two basic types of stakeholders: "affectors" and "enjoyers." Affectors are those that have the authority and capacity to change land cover/land uses, and enjoyers are a diffuse conglomerate that benefits from the previous non-modified situation. To define relatively homogeneous groups of stakeholders (among affectors and enjoyers) is not a trivial task (Grimble and Wellard, 1997; Reed et al., 2009; Swallow et al., 2009). However, it is essential in order to identify different views and perspectives among stakeholders. Vihervaara et al., in their survey of local populations, did not differentiate the categories of the local stakeholders. This may seriously bias their results because ES perception is context dependent, and the relationships of individuals to the forest activity define an important context dimension. Most recent studies on ES perception conducted their surveys on different groups. For example, Lamarque et al. (2011) in a similar analysis of European agroecosystems define three groups based on their roles as affectors of beneficiaries of the target services. Kijazi and Kant (2010) in an analysis of forest stakeholders' value preferences in Mount Kilimanjaro, Tanzania, defined five groups. Lumping the population into just one group may avoid the perception of critical differences among people that have different relationships with the forest activity, as well as diverse interests and values.

In small towns where most of the local inhabitants have a direct or indirect economic relationship with the major provider of employment, it is important to identify the degree of potential conflicts of interest (i.e. to highlight the problems derived from the activities of the company that provides the unique source of income to stakeholders). The problem of biases is even worse, because the interviews were not anonymous (see Appendices 1 and 2 in the Vihervaara et al. article; though the interview for the general public did not include the name, it did require the address). How many of the persons interviewed were employees of Stora Enso or of their contractors? A proper identification of the relationships of the interviewed people and the company is critical to weight the individual answers.

Regarding the other group interviewed (academics, government officers, professionals, etc.), it is surprising that none of the well known scientists from the Universidad de la República of Uruguay who publically stated their concerns about the ecological and social consequences of the expansion of tree plantations, had been interviewed (I personally asked most of them if they were interviewed or informed of the Vihervaara et al. study). It is even more surprising that the people who work and publish on issues related to ecosystem services and biodiversity in the Rio de la Plata Grasslands were not contacted, not cited or cited incorrectly (see for example the authors and co-authors of the following articles: Carrasco-Letelier et al., 2004; Nosetto et al., 2005; Altesor et al., 2006; Carámbula and Piñeiro, 2006; Farley et al., 2008; Jobbágy et al., 2008; Céspedes-Payret et al., 2009; Piñeiro et al., 2009). This is particularly surprising given the relatively small size of the academic community working on these issues in Uruguay.

4. The available evidence on the impacts of afforestation

As we stated previously, the opinions on the effects of the expansion of tree plantations have to be founded on an adequate level of information. The local and global evidence of the negative impacts of tree plantations on the level of provisions of regulation and support ecosystem services are overwhelming. The impacts on the hydrological yields of watersheds have been documented for Uruguay (Farley et al., 2008; Jobbágy et al., 2008; Silveira and Alonso, 2008) and for many areas of the world (see Farley et al., 2005 and Jackson et al., 2005 as examples). In the area of the Uruguay River, tree plantations evapotranspired 80% more than the grasslands that they replaced (Nosetto et al., 2005). Such levels of evapotranspiration led to not only a reduction in water yields but also an increased consumption of groundwater (Jobbágy and Jackson, 2004; Engel et al., 2005). In the Río de la Plata grasslands the available data for paired watersheds (in Uruguay and Argentina) suggest a reduction in water discharge of almost 50% after planting trees. The afforestation of a quarter of a large watershed (~2000 km^2) originally occupied by grasslands in northern Uruguay showed a significant reduction of the hydrological yields, mainly in summer (Silveira et al., 2006; Silveira and Alonso, 2008). Vihervaara et al. quote some of the articles that present the impacts of tree plantations on runoff in Uruguayan watersheds; however in the same paragraph they say that "yet there has been no evidence of such an effect in Uruguay." For Uruguay, a reduction of hydrological yield may have some important consequences at the

local level (e.g. water provision) and the national level through the impact on hydroelectric power generation. Uruguay has the greatest dependency on hydroelectricity (20% for 2007) among the Mercosur countries (Brazil, Argentina, Uruguay and Paraguay) (Cefir, 2008).

In afforested soils of the Rio de la Plata grasslands nutrient redistribution, salinization and acidification processes have been reported for several areas (Jobbágy and Jackson, 2001; Jackson et al., 2005; Farley et al., 2008). Jobbágy and Jackson (2003) indicate that the differences in soil acidity observed in the Rio de la Plata grasslands matched the observations from afforested grasslands of Africa and New Zealand (Davis and Lang, 1991; Musto, 1991; Alfredsson et al., 1998), although the magnitude of forest/grassland differences was greater in the South American grasslands. The level of acidification observed due to cation sequestration and redistribution by trees is similar to that of soils from heavily industrialized areas affected by acid rain (Jobbágy and Jackson, 2003). Soil acidification increases the mobility and bioavailability of Mn, potentially leading to Mn toxicity. Such effects were observed in afforested areas of the Rio de la Plata grasslands (Jobbágy and Jackson, 2003). The cation exchange capacity of soils is a critical aspect of soil fertility that may drive future modifications in afforested grasslands. Soils under eucalypt plantations showed a decline in effective exchange capacity (Jobbágy and Jackson, 2003). Effective cation exchange capacity declines could trigger irreversible nutrient losses in the future. Afforestation also leads to changes in the distribution of organic C in the soil profile (Jobbágy and Jackson, 2000) and net losses of soil organic C (Guo and Gifford, 2002; Carrasco-Letelier et al., 2004; Delgado et al., 2006). Carrasco-Letelier et al. (2004) suggested the existence of a podzolization process in afforested grasslands of Uruguay.

Aside from the above-listed effects, grassland afforestation may change the albedo, surface temperature and roughness (Betts et al., 2007). These changes may determine important climatic changes at the local level (Jackson et al., 2002; Pielke et al., 2007) and particularly in the Rio de la Plata grasslands (Beltrán-Przekurat et al., 2011). Additionally the replacement of grassland communities with a tree monoculture implies a decline in biodiversity throughout the entire food web. Besides the obvious impact on primary producers, a decrease in consumer (Matthews et al., 2002) and decomposer diversity was also observed (Berthrong et al., 2009).

The impacts of afforestation of the Uruguayan grasslands also have effects on social issues. Carámbula and Piñeiro (2006) explored the social effects derived from the expansion of tree plantations and observed that living standards did not change in towns where the forestry activity increased. Moreover, they observed a decrease in the employment conditions.

Most of the evidence listed above was not included by Vihervaara et al. (2012) in their analyses, nor presented to the people interviewed. Conflicts arise when the level of lost benefits associated with a given land cover change is not accepted by a given group of stakeholders. In order to perceive such change, a particular group of stakeholders has to either experience the loss or be well informed of the future consequences of the present changes. As in human health issues, non-informed people have no chance to understand or perceive future consequences. Awareness is derived from intense public campaigns where the scientific evidence is translated into a more accessible language. Just to provide an example, the relationship between smoking tobacco and lung cancer was not obvious until aggressive campaigns from health institutions informed the general public. The perception of future consequences of forestation is directly linked to the level of information provided to the people interviewed.

5. Concluding remarks

The debate on the effects of land transformation on ES provisions is important, because it can determine the relative impact that such changes will have on the well-being of different social groups over long time periods. Such debate includes many objective facts: e.g. how much the hydrological yield of a watershed would change if a given proportion of it were planted. To present such evidence to the stakeholders is a prerequisite for a fair evaluation of their perception. Moreover, stakeholder heterogeneity needs to be included in the evaluation of people's opinions on the processes of forest expansion.

The debate on fast-growing tree plantations also incorporates many subjective elements related to values, ideology and interests. Aside from some technical issues that can be discussed and eventually solved, the article from Vihervaara et al. is driven by a particular view of ES management. Though not explicitly presented as the conceptual basis of the article, the study assumes that ES can be transformed into commodities and be sold. The authors state in the Introduction that the way a corporation perceives "the links between business objectives and ecosystem services are shaped by the markets, by regulatory and legal frameworks, by financing, and by matters of image." This conceptual perspective shows that the article is providing the view of the "affectors" but not of the "enjoyers." This should be kept in mind when the conclusions of the Vihervaara et al. article are used to make decisions or define public policies.

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