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A meta-analysis of economic valuation of ecosystem services in Mexico

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ABSTRACT

This paper provides a comprehensive review of the literature on the economic values for ecosystem goods and services in Mexico. We analyzed 106 studies that estimated an economic value for any given environmental good or service in the country. In total, we coded and classified 352 values according to the Common International Classification of Ecosystem Services (CICES) and the Economics of Ecosystems and Biodiversity (TEEB) ecosystem classification. We then estimated an econometric model to compare the value of different services in different ecosystems. We show that regulation services are more valuable than cultural and provisioning services, that wetlands are more valuable than forests and cultivated systems, and that deforestation for arable land is not cost-effective, because the regulation services of forests are more valuable than the provisioning services of crops. We also calculate the elasticity between the value of ecosystem services that forests provide in Mexico (in USD/hectare per year) and the supply of each ecosystem (in hectares). This elasticity is statistically significant and equal to −0.37. This estimate is relevant in policy terms, since it adds an economic rationale for conservation to other moral and philosophical criteria, especially in areas currently experiencing a high degree of deforestation and degradation.

1. Introduction

Placing an economic value on nature may be a powerful policy tool since it makes invisible benefits from nature to society visible. When these benefits are invisible, there is a risk that policy decisions are made by assuming they have a value of zero or with a complete unawareness of their real value. According to TEEB (2009), making these values visible makes it possible to: (i) compensate those who provide benefits, (ii) modify subsidies that affect natural capital, (iii) internalize environmental losses by establishing rates and prices or enforcing regulations, (iv) create economic value through protected areas, and (v) invest in ecological infrastructure. In every case, more information on the value of nature enhances the policy making process. Even when economic valuation of ecosystem services is not the only way to inform policy makers, yet is a simple way to communicate the value of nature.

Significant progress has been made in recent years in the economic valuation of ecosystem goods and services as borne out by the Economics of Ecosystems and Biodiversity project (TEEB, 2010b). Moreover, ecosystem services is a "rapidly emerging field, which generated over 2400 papers" between 1990 and 2011 (Costanza & Kubiszewski, 2012). Literature reviews and databases have recently been developed to concentrate and systematize the economic values of nature estimated by thousands of authors. For example, de Groot et al. (2012), provide global estimates of the value of ecosystems and their services in monetary units based on a meta-analysis of over 300 case studies.

To our knowledge, the Environmental Valuation Reference Inventory (EVRI) (Environment Canada, 2016) and the Ecosystem Service Valuation Database (ESVD) (ESP, 2014), are the largest sources of information on the economic values of nature. The ESVD contains 1310 registries[1] drawn from 267 single studies, published between 1966 and 2010 (60% between the years 2000 and 2010). The EVRI database contains registries from 4571 studies published between 1971 and 2016 (70% in 2000–2015; and 49% between 2000 and 2010).

This type of literature is usually concentrated in a few countries. For example, five[2] countries account for 26% of all ESVD registries and two for 45% of all EVRI registries.[3] The literature on the

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[1] Each registry represents one economic value.
[2] USA, China, Spain, Australia and the UK.
[3] USA and Canada.

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economic valuation of environmental services is still uncommon and scattered in countries such as Mexico. Although the ESVD contains 26 registries (2%) for Mexico, they are drawn from just four studies, the latest one being published in 2001 (Adger et al., 1994; Barbier & Strand, 1998; Godoy et al., 1993; Perrot-Maître & Davis, 2001). To date, the EVRI contains registries for Mexico from 135 studies (3%).

The importance of ecosystem services for policy making is recognized at the highest level of the Mexican government; where they are considered a pillar of sustainable development (Gobierno de la República, 2012). Furthermore, government officials from the environment sector have often stated the need to know the economic values of nature in order to increase their bargaining power when supporting policies that enhance environmental sustainability, since they usually compete with other sectors lobbying for policies with high short-term economic benefits, but adverse environmental effects (such mining and unsustainable coast tourism).[4]

In this context, the purpose of this paper is to systematically analyze available studies on the economic values of environmental goods and services provided by ecosystems in Mexico. To this end, we analyzed 106 papers, classifying them and identifying the information gaps. To our knowledge, only Perez-Verdin et al. (2016) have done a similar effort. The authors classified 43 papers to identify information gaps and give insights of future research needs. In this paper, we classified a larger set of studies and developed an econometric model which is aimed to generate specific policy recommendations.

2. Materials and methods

Since the end of 2014 and until the end of 2015, we sought available studies related to the economic valuation of environmental goods and services focused in Mexico. We found a set of 33 papers that had already been recorded in the EVRI and subsequently located another set of 73 papers. The search was conducted online using keywords related to the economic valuation of environmental goods and services in Mexico in both Spanish and English. In our search, we prioritized studies from academic journals; however, we included some academic theses and working documents from government agencies (see Table 1).

Table 1
Types of studies included in the review.

Source	Freq.	Percent	Cum.
Journal	55	51.89%	51.89%
Working paper	19	17.92%	69.81%
Government/non-government report	16	15.09%	84.91%
Thesis	7	6.60%	91.51%
Conference paper	5	4.72%	96.23%
Magazine	4	3.77%	100.00%
Total	106	100.00%	

Source: Compiled by the authors using information from (Environment Canada, 2016).

Most of the papers were very recent. Twenty-seven percent were published in the period between 2010 and 2016, another 48% between 2005 and 2009, and the remaining in previous years (Fig. 1). When comparing the publication date of EVRI papers that value environmental services in countries other than Mexico, we found very different scenarios; in the period 2010 to 2015, only 14% of all the papers located were published (Fig. 1).

On the basis of the 106 studies (see Annex E), we gathered 352 economic values of environmental goods or services for/in Mexico. In average, there were 3.3 values per study, and 54 studies (50%) reported only one value. The most common method is contingent valuation and market prices, also, most studies (70%) use primary data in their analysis, regarding the scope of analysis, 78% are site-specific (see more detail in Table 2 and Fig. 2).

We classified each value according to the type of ecosystem being valued and the ecosystem service it represents. The classification of ecosystem services used was the Common International Classification of Ecosystem Services (CICES) from the Biodiversity Information System for Europe (BISE) (Haines-Young & Potschin, 2013) at a second level. This classification incorporated a number of previous classifications systems such as the Millennium Ecosystem Assessment (MA, 2005) and the TEEB matrix (TEEB, 2010a). Regarding the ecosystem classification, we took the classification of the Economics of Ecosystems and Biodiversity (TEEB, 2010a).

The CICES includes 48 ecosystem services broken down into 20 groups, 8 divisions and 3 sections (Annex A). The TEEB ecosystem classification includes 37 specific ecosystems divided into 11 general ecosystems (Annex B). In other words, the CICES has four levels and the TEEB classification two.

The classification by ecosystem type was made by taking ecosystems as suppliers of goods and services, with the exemption of the four values related to water as a nutrition input, which we assigned to urban ecosystems. The reason of this classification if because there were three studies (four values) that undertook willingness to pay (WTP) studies in having better quality tap water that were made in urban settings.

In the case of lakes and river, we assigned five values (in four studies) to lakes and rivers as providers of clean water or as regulators of the chemical conditions of water, yet the original studies did not establish this link, but we inferred in the text of these studies. We established a link in the studies that valued water as an input for crop production (Margulis, 1992; Scott et al., 2000; Zetina-Espinosa et al., 2013) and as regulators of toxic substances (Qi et al., 2014). Elsewhere, the classification process was straightforward.

There is enormous diversity in the way values are reported in each study. The majority of them (48%) state an economic value per hectare (of a certain ecosystem) per year, 13% per person per year, 9% per household per year, 7% per visit (once), while the rest have another unit. As for the different currencies from various years reported in the studies, we converted all values to December 2015 USD by considering the historical series of the exchange rate for the Mexican peso with other currencies and the historical Mexican price index. This was completed using information from the Central Bank of Mexico (*Banco de México*). The conversion was made by converting the value of year *t* to pesos and then adjusting by the price index of Mexico to 2015.

With this initial dataset, we specified an econometric model that has the economic value of ecosystem services as dependant variable (expressed in 2015 USD per hectare per year), and as independent variables the extent of the area that provides the service, the number of persons that demand it and other indicators (dummies) that distinguish the method of valuation, the type of ecosystem and the service provided, and if the area of study is inside or outside a Natural Protected Area (NPA). We considered only those observations that are expressed in USD per hectare per year (n = 170) to avoid mixing different measurement units. To choose which dummies to include in the model we tabulated the observations for each ecosystem and service to identify for which ecosystem and ecosystem services we had more information.

For the case of ecosystems, we included coastal systems (n = 13), cultivated (n = 24), forests (n = 24), wetlands (n = 38) and other ecosystems (n = 6), which include grass rangeland

[4] Personal communication with officials from the National Commission of Natural Protected Areas (Spanish acronym-CONANP) and the National Institute of Ecology and Climate Change (Spanish acronym INECC).