Ecological Economics 124 (2016) 164–174

Contents lists available at ScienceDirect

Ecological Economics

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

The economic value of wetlands in developing countries: A meta-regression analysis

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ARTICLE INFO

Article history:
Received 28 May 2015
Received in revised form 24 January 2016
Accepted 31 January 2016
Available online 3 March 2016

Keywords:
Ecosystem services
Value transfer
Wetlands
Developing countries

ABSTRACT

This paper presents the first comprehensive synthesis of economic valuations of wetlands in developing countries. Meta-regression analysis (MRA) is applied to 1432 estimates of the economic value of 379 distinct wetlands from 50 countries. We find that wetlands are a normal good, wetland size has a negative effect on wetland values, and urban wetlands and marine wetlands are more valuable than other wetlands. Wetland values estimated by stated preferences are lower than those estimated by market price methods. The MRA benefit transfer function has a median transfer error of 17%. Overall, MRA appears to be useful for deriving the economic value of wetlands at policy sites in developing nations.

1. Introduction

Wetlands are highly productive ecosystems (Bassi et al., 2014), providing numerous goods and services to people living in their periphery, as well as to communities living outside the wetland area (Barbier et al., 1997). However, wetlands are also ecologically sensitive and adaptive systems (Zhao et al., 2005). While there is growing recognition of the need for their conservation, wetlands continue to be lost throughout the world (Turner et al., 2000). A key factor behind their degradation is the difficulty in reflecting the scarcity value of wetland ecosystem services. Consequently, the benefits from wetlands may not be fully considered in commercial development decisions and broader public policy initiatives (Barbier, 2007). Indeed, most wetland ecosystem services have the characteristics of public goods, being generally open-access with ill-defined property rights, leading to over exploitation and degradation.

Economic valuations provide a means for measuring and comparing the various benefits from wetlands and the costs associated with preservation. Valuations also help to understand user preferences and relative values placed on ecosystem services (de Groot et al., 2012). Such values can assist policy-makers and stakeholders to make informed decisions involving wetland resource allocation when faced with competing uses.

However, economic valuations are often not a viable option, especially for developing nations. They are often derived from expensive surveys and survey respondents, particularly from developing countries, might not feel comfortable enough to respond to questionnaires. In addition, conducting primary research in the everyday policy process can be inefficient (Shrestha and Loomis, 2001). Furthermore, many primary studies are limited in their scope (Boyle et al., 1994), especially when their focus is on a single ecosystem or few ecosystem services, potentially leading decision-makers to overlook a wider set of ecosystem service values. This may in turn result in an inefficient allocation of wetland resources (Ghermandi et al., 2008).

One possible alternative to new primary studies is the application of *benefit transfer*, whereby information collected from past surveyed sites is then transferred to unstudied, policy sites. A promising method for conducting benefit transfer is meta-regression analysis (MRA). MRA summarizes information from several primary valuation studies and more importantly it can be used to generate benefit transfer functions that are more widely applicable and less sensitive to the attributes of individual studies (Johnston, 2007). Benefit transfer can be particularly useful for developing countries, as they are less able to afford new original valuation studies due to time and funding constraints, and they often lack the infrastructure for primary research (Shrestha and Loomis, 2001). Such pressures lead to a growing need for benefit transfer as a cost effective means of estimating values (Johnston and Rosenberger, 2010). Moreover, MRA can provide a benefit transfer function that enables the valuation of multiple wetland ecosystem services, supporting multi-objective approaches to ecosystem management.

There are currently 17 wetland valuation meta-analyses: Brouwer et al. (1999); Woodward and Wui (2001); Borisova-Kidder (2006);

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http://dx.doi.org/10.1016/j.ecolecon.2016.01.022
0921-8009/

Brander et al. (2006); Brander et al. (2007); Ghermandi et al. (2008); Liu and Stern (2008); Brouwer (2009); Enjolras and Boisson (2010); Ghermandi et al. (2010); Brander et al. (2012a); Brander et al. (2012b); Chen (2012); Salem and Mercer (2012); Camacho-Valdez et al. (2013); Patton et al. (2013), and Bu and Rosenberger (2014). Several key findings emerge from these meta-studies: wetland valuations are significantly larger for smaller wetlands, wetlands located in richer countries, and wetlands located in high population density areas. While meta-studies have found that most wetland service variables are not statistically significant in meta-regression, it does appear that non-consumptive products tend to have higher values than consumptive goods.

Although the existing 17 MRA studies provide much useful information about the main factors determining wetland values, none have focused on developing countries. Our contribution to the literature is to offer the first MRA focused purely on developing countries. This can potentially offer a more accurate benefit transfer for wetlands in developing countries than a benefit transfer based on data that combines diverse groups of countries. Our data consists of 379 studies of economic valuations of wetlands in developing countries. The primary aims of our meta-analysis are to provide a synthesis of prior research of wetland valuations in developing countries, to identify the factors that influence wetland valuations and to construct a benefit transfer function using MRA.

The paper is organized as follows. The following section discusses our MRA methodology. Section 3 details the construction of the meta-dataset used in the MRA. Section 4 presents and analyses the results of MRA models and the final section concludes and summarizes the main findings.

2. The Meta-regression Methodology

MRA essentially involves regression analysis applied to data collected from prior empirical studies. In the case of wetland valuations, MRA involves regressing the wetland valuations reported in prior primary studies against various covariates relating to policy site characteristics and research design choices made by authors. The dependent variable in the MRA can be either the constant price dollar value per hectare of wetland per year or its natural logarithm transformation (denoted as *lnV*). We follow most prior meta-studies in using *lnV* as the dependent variable. This is evaluated at US$ 2002 prices, purchasing power adjusted. The explanatory variables are classified into three categories: (i) a vector of wetland characteristics, x_w, (ii) a vector of valuation methods, x_m, and (iii) a vector of context characteristics, x_c. These variables are discussed in detail in Section 3 below.

The estimated MRA model takes the following standard trans-logarithmic form[1]:

$$\ln V_{ij} = \beta_0 + \beta_w x_{wij} + \beta_m x_{mij} + \beta_c x_{cij} + u_{ij,} \quad (1)$$

where the subscripts *i* and *j* denote the *i*th estimate from the *j*th study, β_0 is the constant term, β_w, β_m, and β_c contain the estimated coefficients on the respective groups of explanatory variables, and *u* is the error term. The MRA model, Eq. (1), can be used to explain the wide heterogeneity in reported valuations and also to construct the benefit transfer function.

2.1. Estimation

Prior meta-studies of wetland valuations have often applied ordinary least squares (OLS).[2] This can potentially lead to biased estimates, as Eq. (1) should ideally be estimated using weighted least squares (WLS), using the inverse variance as weights. Hedges and Olkin (1985) show that the inverse variance produces optimal weights. That is, ideally, the estimated wetland valuations should not all be treated equally. Instead, valuations that are estimated with greater precision should be assigned a higher weight. Unfortunately, there is a major problem with using WLS for this dataset. The standard error is needed to calculate inverse variance. However, none of the studies report a standard error with the estimated wetland valuation. Hence, it is not possible to use a direct measure of variance for these estimates. Nevertheless, following Stanley and Rosenberger (2009), it is possible to use sample size to construct a proxy for precision. Stanley and Rosenberger (2009) recommend using the inverse of the square root of the sample size as a proxy for an estimate's standard error. Accordingly, the approach taken in this paper is twofold. First, following most prior meta-studies, OLS is applied to all observations included in the meta-dataset (1432 estimates from 379 studies). Second, WLS is applied to those observations for which sample size is reported, with the inverse of the square of sample size used to construct a proxy of precision (1167 estimates from 309 studies).

2.2. Multiple Estimates

The studies included in the meta-dataset (see Section 3 below) report multiple estimates per study depending on whether they used different valuation methods, wetland sites, ecosystem services, or sample groups. The issue of how to best handle data dependence arising from multiple estimates from studies remains unresolved in the meta-analysis literature. One approach is to treat datasets with multiple estimates from each study as panel datasets (Rosenberger and Loomis, 2000 and Stanley and Doucouliagos, 2012). An alternate, and our preferred, approach is to correct standard errors in the MRA for the clustering of estimates within studies. The former applies panel data estimators to meta-data while the later corrects the standard errors from WLS.[3]

2.3. Pooling of Observations

It is important to note that benefit transfer requires commodity consistency (Bergstrom and Taylor, 2006; Nelson and Kennedy, 2009). Commodity consistency is satisfied by including estimated values of goods and services that are similar across studies. In our view, the estimates included in our sample are all comparable. The authors of the included primary studies all attempt to quantify the value of the studied wetlands. These wetlands provide a bundle of goods and services. Our focus is primarily on the *total* value of the goods and services provided by wetlands. However, we also present some MRA estimates of specific service values by analysing sub-sets of the dataset that provide more narrowly defined service estimates. Specifically, we look at direct use values, and also food production valuations and recreation service values as narrower categories. The cost of sub-group analysis is a drastic reduction in available observations. The benefit of pooling all the data is that we can capture and quantify all the various dimensions of the broader meta-frontier. The sub-groups inform on only segments of this frontier.

The MRA, Eq. (1), includes dummy variables for the various service values. Some studies report estimates of some services but not of others. This is a kin to the issue of omitted variable bias that is common in applied econometrics. The MRA coefficients quantify whether the inclusion/exclusion of a particular service makes a difference to valuations. Rather than imposing an a priori restriction that the services cannot be combined, we prefer to pool the estimates and then investigate

[1] All continuous variables have been converted into logarithms. Johnston et al. (2005) note that trans-log functions possess several desirable characteristics.

[2] Woodward and Wui (2001), Brander et al. (2006), Borisova-Kidder (2006), Ghermandi et al. (2008), Brander et al. (2007), Ghermandi et al. (2010), Brander et al. (2012a and b), Camacho-Valdez et al. (2013), and Bu and Rosenberger (2014), all use OLS.

[3] Other options include multi-level modelling and robust variance estimators. Correcting standard errors is valid given the relatively large number of clusters in our dataset (see Oczkowski and Doucouliagos, 2015).