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

Mayula Chaikumbung, Chris Doucouliagos and Helen Scarborough

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Mayula Chaikumbung
Faculty of Liberal Arts and Management Science
Kasetsart University, Thailand. csnmlc@ku.ac.th

Hristos Doucouliagos*
Department of Economics
Deakin University, Australia. chris.doucouliagos@deakin.edu.au

Helen Scarborough
Department of Economics
Deakin University, Australia. helen.scarborough@deakin.edu.au

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. We find that wetland size has a negative effect on wetland values, marine wetlands are more valuable than estuarine wetlands, and per capita GDP has a positive effect on wetland values. Wetland services for water treatment and biodiversity are valued more highly than recreation. Wetland values estimated by stated preferences are lower than those estimated by market price methods. The MRA benefit transfer function has an average transfer error of 31%, with 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.

Keywords: meta-regression analysis, valuing ecosystem services, value transfer, wetlands

JEL codes: Q25, Q51, Q57

* Corresponding author: Hristos Doucouliagos, Deakin Business School, Deakin University, Burwood Campus, 221 Burwood Highway, Burwood, 3125, Victoria, Australia.

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 seventeen wetland valuation meta-analyses: Brouwer *et al.* (1999), Woodward and Wui (2001), Borisova-Kidder (2006), 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, $\mathbf{x}_{\mathrm{w}}$, (ii) a vector of valuation methods, $\mathbf{x}_{m}$, and (iii) a vector of context characteristics, $\mathbf{x}_{c}$. These variables are discussed in detail in Section 3 below.

The estimated MRA model takes the following standard semi-logarithmic form:

$$\ln V_{ij} = \beta_0 + \beta_w \mathbf{x}_{wij} + \beta_m \mathbf{x}_{mij} + \beta_c \mathbf{x}_{cij} + u_{ij}\,, \tag{1}$$

where the subscripts *i* and *j* denote the ith estimate from the jth 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, Eqn. (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 evaluations have often applied ordinary least squares (OLS).[1] This can potentially lead to biased estimates, as Eqn. (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

[1] 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.* (2012), Camacho-Valdez *et al,* (2013), and Bu and Rosenberger (2014), all use OLS.

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.[2]

3. The data and MRA variables

Our data collection and reporting followed the MAER-NET protocols for meta-analysis in economics (Stanley *et al.* 2013).

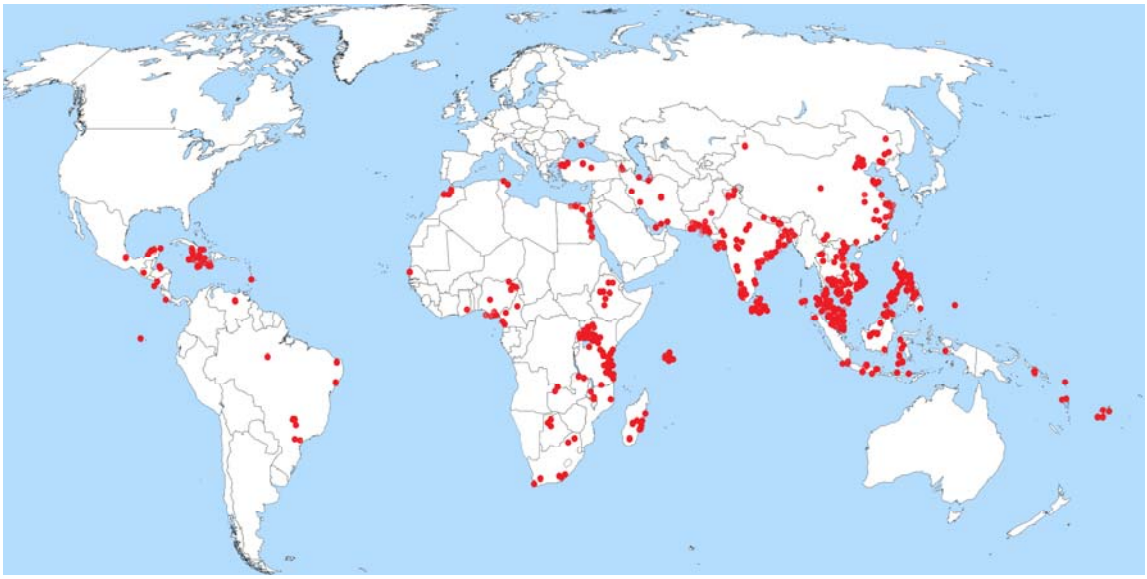
3.1 Data

We compiled a total 379 studies with 1432 observations. All studies considered are primary valuation studies conducted in developing countries. The studies were collected from book chapters, journal articles, working papers, project reports, Masters theses, and Ph.D dissertations. The earliest study is Christensen's (1982) valuation of Thai mangroves and the

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

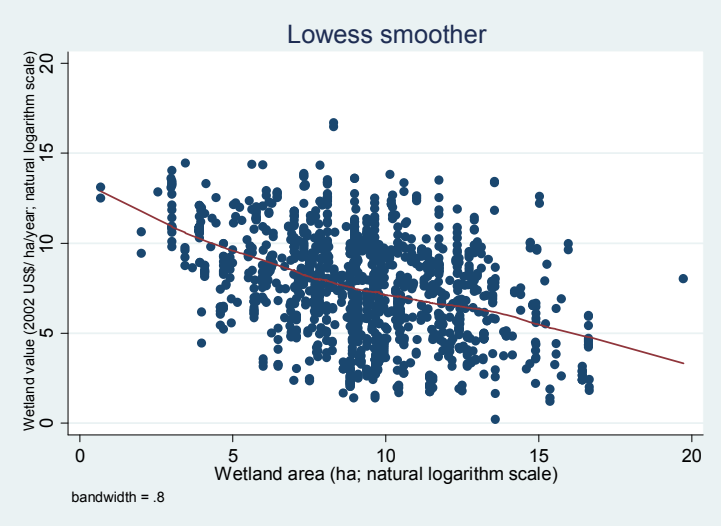
most recent study was published in 2014. There are 342 wetland sites included in the data set, spanning 50 developing countries in Asia, Africa, Latin America, and the Pacific Islands. The study sites included in the meta-analysis are illustrated in Figure 1. The largest number of studies relate to India (with 38 studies), followed by China with 37 studies, Thailand with 35 studies, and Malaysia with 30 studies. The average wetland value is 1,998 US$ (2002 prices) per hectare per annum.

Figure 1: Geographical distribution of wetlands covered in the meta-analysis



The wetland sites included in the dataset are very diverse. The smallest wetland site is the Ras Mohammed mangrove with 2 hectares from Egypt. The median wetland sites range between 3,000 and 30,000 ha. It is expected that wetland size may influence wetland value, although there is no clear *a prior* anticipation of the sign of this relationship. Figure 2 plots wetland size against the wetland value per hectare per annum (both in natural logarithms). There appears to be a clear negative relationship between wetland value per hectare and wetland area. Prior meta-studies have also found this relationship.

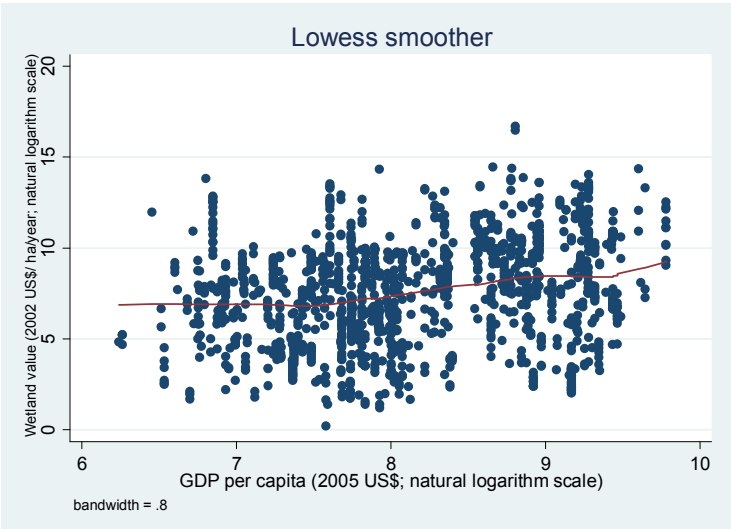
Figure 2: Wetland value per hectare and wetland size



Note: The plotted curve is a lowess regression line

All the countries included in the meta-dataset are classified as developing countries by the World Bank, with Mozambique being the poorest nation in our sample, with a per capita GDP of 470 US$. Differences in per capita GDP might result in differences in wetland values. Figure 3 plots the natural logarithm of wetland value per hectare per annum against the natural logarithm of GDP per capita, suggesting a possible positive relationship between these two variables.

Figure 3: Wetland value per hectare and GDP per capita



Note: The plotted curve is a lowess regression line

3.2 MRA variables

The names, definitions and descriptive statistics of the variables included in the meta-data set are presented in Table 1.

The dependent variable

The values of wetlands reported by primary studies used different metrics, currencies and refer to different years (e.g., WTP per household per annum, WTP per visit, and mean value per acre per annum). However, using WTP is limiting, since some valuation techniques used to estimate wetland values (e.g. market price method, replacement cost, avoided damage cost, etc.) cannot capture WTP. On the other hand, if WTP is available, then the value per hectare can be calculated with knowledge of the relevant population and wetland area. Hence, instead of WTP, it is the average annual value per hectare in US$ 2002 that is used as the key value of wetland for this study. Following Woodward and Wui (2001), Brander *et al.* (2006) and Ghermandi *et al*. (2010), all wetland values were converted into a comparable measure using purchasing power indices and expressed in US$ 2002.

Wetland characteristics vector ($\mathbf{x}_w$)

The key characteristics of wetland sites are wetland size, wetland types and wetland ecosystem services. We classify wetlands into seven types based on the RAMSAR and IUCN definitions. The largest number of studies relate to estuarine wetlands (with 165 studies and 592 observations) followed by marine, lacustrine, riverine, palustrine, and constructed wetlands respectively. For the purposes of the MRA, estuarine wetlands are chosen as the baseline category.

Wetland ecosystems provide a diverse range of goods and services. We classify these into twelve categories of ecosystem services, following the definitions of Barbier *et al*.

(1997), Costanza *et al.* (1997), de Groot *et al.* (2002) and Millennium Ecosystem Assessment (2005). These are: direct use value (food production, raw materials, water supply and recreation), indirect use value (disturbance regulation, water regulation, nutrient cycling, erosion control, water treatment and carbon sequestration) and non-use value (habitat, biodiversity and culture). Biodiversity and habitat are highly correlated with each other, thus these two services are combined into a single habitat-biodiversity variable. The largest number of studies are for food production with 188 studies and 586 observations, followed by recreation with 153 studies and 687 observations and habitat-biodiversity with 140 studies and 427 observations. Recreation is chosen as the baseline category.

Valuation method vector ($\mathbf{x}_m$)

Various economic valuation methods are employed to estimate wetland values in developing countries. These include market-based methods (market prices (Mkt), replacement cost (RC), avoided damage cost (DC), opportunity cost (OC), net factor income (NFI) and production function (Pf)), revealed preference methods (travel cost method (TCM) and hedonic pricing (HP)), and stated preference methods (contingent valuation method (CVM) and choice experiment (CE)). The various methods are grouped into nine techniques, combining NFI and Pf into a single NFI-PF variable. Mkt was the most frequently used method by about 204 studies and 634 observations, followed by contingent valuation method (CVM) with 155 studies and 603 observations, while hedonic pricing (HP) is the least used method with 2 studies and 2 observations.

Table 1: Variable definitions and descriptive statistics

Variable names	Variable Description	Studies	Obs.	Mean	Std.
Dependent variable					
Annual value (y)	Annual value per hectare in 2002 US$ in logarithmic form	379	1432	7.60	2.82
Independent variables					
Wetland characteristics (x_w)					
Wetland size	Area of wetland site in logarithmic form	379	1432	9.17	2.86
Wetland types					
Estuarine	Rivers meet the sea or tidal partly enclosed by land, including tidal marshes, seagrass and mangrove, lagoon Baseline category	165	592	0. 41	0.49
Riverine	Wetlands along river or streams BD =1: Study of riverine wetlands	45	172	0.12	0.32
Marine	Coastal wetlands, including rocky shore and coral reefs BD =1: Study of marine wetlands	54	280	0. 19	0.39
Constructed	An artificial wetlands or dam, marsh, pond BD =1: Study of constructed wetlands	15	42	0.03	0.16
Lacustrine	Wetlands associated with lakes BD =1: Study of lacustrine wetlands	53	181	0.13	0.33
Palustrine	Wetlands associated with marshes, swamps and bogs BD =1: Study of palustrine wetlands	36	121	0.08	0.28
Other	Combined wetlands, watershed, catchment area BD =1: Study of other wetlands	24	44	0.03	0.17
Wetland ecosystem services					
Recreation	Providing opportunities for recreational activities Baseline category	153	687	0.48	0.49
Disturbance regulation	Storm or flood protection BD =1: Study of disturbance regulation	77	218	0.15	0.36
Water regulation	Irrigation, hydroelectric power, water transportation BD =1: Study of water regulation	42	111	0.07	0.26
Water supply	Consumptive water for household, industrial activities BD =1: Study of water supply	69	169	0.12	0.32
Nutrient cycling	Nitrogen fixation, phosphorus, potassium, and other elemental cycling BD =1: Study of nutrient cycling	11	14	0.01	0.09
Erosion control	Prevention of soil loss by wind, runoff process, storage of silt in the lake and wetland BD =1: Study of erosion control	43	102	0.07	0.25
Gas regulation	Carbon sequestration BD =1: Study of carbon sequestration	50	133	0.09	0.29
Water treatment	Pollution control/detoxification, filtering of dust particles BD =1: Study of water treatment	73	308	0.21	0.41
Biodiversity-Habitat	Nurseries, habitat for migratory species, regional habitat and degree of life form BD =1: Study of habitat -biodiversity	140	427	0.30	0.46
Food production	Gross primary production extractable as food BD =1: Study of food production	188	586	0.41	0.49
Raw materials	Gross primary production extractable as raw materials BD =1: Study of raw materials	134	371	0.26	0.44
Culture	Providing opportunities for non-commercial uses BD =1: Study of culture	29	64	0.04	0.21
Valuation method (x_m)					
Market price method (Mkt)	Assigns the value of goods and services traded in the market Baseline category	204	634	0.44	0.49
Replacement cost (RC)	Cost of providing substitutes for ecosystem services BD =1: Study applies RC	85	247	0.17	0.37
Contingent Value (CVM)	Hypothetical question to obtain WTP BD=1: Study applies CVM	155	603	0.42	0.49

Table 1: (Continued)

Variable names	Variable Description	Studie	Obs.	Mean	Std.
Choice Experiment (CE)	Estimate WTP based on eliciting individual preferences through survey BD =1: Study applies CE	24	105	0.08	0.27
Travel Cost method (TCM)	Estimate WTP via amount of money and time individuals expend for the visiting recreation site BD =1: Study applies TCM	43	213	0.15	0.35
Net factor income and Production function (NFIPf)	Estimate effect of ecosystem services loss or gain in earning or productivity BD =1: Study applies NFIPf	18	65	0.04	0.20
Opportunity Cost (OC)	Value of next best alternative use of resources BD =1: Study applies OC	17	67	0.05	0.21
Hedonic Pricing (HP)	Estimate WTP uses the price difference in property of related products BD =1: Study applies HP	2	2	0.002	0.05
Avoided damage cost (DC)	Estimate the expenditure to repair the damage incurred with the loss of the wetland area BD =1: Study applies DC	70	218	0.15	0.36
Publication status					
Published paper	Study of wetland valuation is published in a journal BD =1: study is a journal article	173	698	0.48	0.49
Impact factor	5-year impact factor of each journal	111	515	0.82	1.27
Year of survey	The year of the survey (normalized to the year 2000)	379	1432	2.50	5.66
Thesis	BD =1: study is thesis /Dissertation	25	101	0.07	0.25
Wetland context characteristics (x_c)					
GDP per capita	Real GDP per capita (in year of survey) in logarithmic form	379	1432	8.21	0.83
Ramsar site	Ramsar sites are wetlands of international importance, designated under the Ramsar Convention BD =1: Study site designated as RAMSAR	75	236	0.16	0.37
Protected Area	Wetlands provide any other legal protection by government (e.g. non-hunting area, national park, nature reserve) BD = 1: Study site is protected area	52	277	0.19	0.39
Urban	Wetlands located in urban areas BD =1: Study site is urban wetland	27	104	0.07	0.25
South East Asia	BD =1: wetland located in South East Asia	174	785	0.55	0.50
MENA	BD =1: wetland located in the Middle East and Northern Africa	22	80	0.06	0.23
South Asia	BD =1: wetland located in South Asia	68	174	0.12	0.32
Africa	BD =1: wetland located in Africa, except MENA countries	81	245	0.17	0.38
Latin America	BD =1: wetland located in Latin America	33	145	0.10	0.30
Eastern Europe	BD =1: wetland located in Eastern Europe	1	3	0.003	0.05
Latitude	Latitude in absolute value	379	1432	15.01	10.81
Population density	Population density in logarithmic form	379	1432	5.59	1.83

Note: BD denotes a binary variable.

Wetland context vector ($\mathbf{x}_c$)

Several wetland context variables were included in the meta-data set: real GDP per capita at constant price 2005, Ramsar site, protected area, urban wetland, population density, latitude and location. Wetlands in different countries are categorized into the following six groups of locations: Southeast Asian with 174 studies, Africa with 81 studies, South Asia with 68 studies, Latin America with 33 studies Middle East Asia and North Africa (MENA) with 22 studies, and 1 study from Eastern Europe.

In addition to coding data derived directly from the studies themselves, data were also collected from sources that were either partially or totally external to the studies. The first variable is the size of the wetland. The second variable is population density and the third variable is latitude. These were in some cases reported in the studies. In other cases, the information had to be collected from external sources. The fourth external data source variable is income, as proxied by GDP per capita. These data was collected from the World Bank Development Indicators.

The year of survey variable was also included in the meta-dataset to capture possible change of preference in time and temporal effects involving the specific valuation method. Finally, we control for whether a study has been published and the Impact Factor of the journal in which a study was published.

4. Results and discussion

4.1 Meta-regression analysis

The meta-regression results are presented in Table 2. Column 1 reports the general model with all moderator variables included and estimated using OLS with standard errors adjusted for clustering of observations within studies (within study dependence). These results are our baseline estimates. In column 2 we use WLS, using sample size as the

weight.[3] In this model larger studies are assigned greater weight as these will, *ceteris paribus*, report estimates that are more precise. With a couple of exceptions, the OLS and WLS results identify the same set of moderator variables as important to the benefit transfer function; we discuss these below.

We explore the robustness of the results in several ways. In column 3 we apply a general-to-specific modelling strategy to reduce the MRA to a more parsimonious model, as recommended by Stanley and Doucouliagos (2012). We do this by removing 15 variables that had a p-value greater than 0.3 in the general model. An F-test confirms that the removed variables are redundant (F = 0.58, p-value = 0.89). In column 4 we report results using random-effects weights, where again we proxy standard error using inverse of square root of sample size. The random-effects MRA uses weights that include τ^2, the random-effects variance or excess, between-study heterogeneity variance. Following (Stanley and Doucouliagos 2012, 2013), we prefer the unrestricted WLS model to the random effects model.[4] Nevertheless, since random effects models are popular, we present the MRA for this model, as well as the associated benefit transfer. In column 5 we estimate a fixed effect panel MRA. This model essentially reports within study estimates. Hence, it is not as useful for benefit transfer.[5]

The adjusted R^2 value of the various models is relatively high, varying between .47 and .93, indicating that at least half of the variation in reported wetland values is explained by the MRA models. The coefficient on *lnArea* is consistently negative and statistically

[3] This is known as the *unrestricted* WLS model (Stanley and Doucouliagos 2013, 2015). It estimates a fixed effect model but does not constrain WLS's common variance term, σ^2, to be equal to one.

[4] One complication is that the random effects model requires an estimate of the between study variance and this is estimated with error. This is made more challenging in the case for wetland valuations where, as already noted, a proxy for standard error is needed. An emerging literature reveals several other problems with random effects models, see for example Al Khalaf *et al*. (2011).

[5] In unreported regressions we also re-estimated the MRA after removing the bottom 5% and top 5% of wetland values. This produced a similar benefit transfer function with slightly higher benefit transfer errors: 33% compared to 31% from column 2.

significant across all models. This is a common finding in the literature. For developing countries, it appears that an increase in wetland size of 1% leads to a fall in the average wetland value by about .36% to .41%. This elasticity is significantly larger than the findings of prior meta-studies of wetland valuations: Woodward and Wui (2001) and Brander *et al* (2006) report an elasticity of 0.16%, Ghermandi *et al.* (2008) report an elasticity of 0.24%, Ghermandi *et al.* (2010) and Camacho-Valdez *et al.* (2013) report an elasticity of 0.25% and 0.20%, respectively.

Six dummies represent the different types of wetlands. Of these, marine wetlands produce a higher value than the baseline, estuarine wetlands. One explanation for this is that in developing countries, coral reefs are particularly important given their contribution to local economies, especially commercial fishing and tourism (Reid-Grant and Bhat 2009). Coral reefs also attract a relatively large number of foreign tourists, *i.e*. they produce internationally traded goods and services which raise the value of these wetlands (Salem and Mercer 2012). At the same time we find that palustrine wetlands have a lower value than estuarine wetlands. This result is similar to the findings of Ghermandi *et al.* (2008).

Most ecosystem service variables are not statistically significant in the MRA. However, water regulation, water treatment and biodiversity-habitat are statistically significant in most models, with the estimates suggesting that wetlands providing these services are more highly valued than those used for recreation. In contrast, water supply services are less valued. One explanation for this finding is that water quality degradation has a closer direct impact on human life, leading to greater concerns about water conservation in developing countries. It is also possible that people might better understand that an imbalanced ecosystem caused by destruction of habitat and extinction of plant and animal species not only results in reduced food supply, but also other dimensions, such as flooding and drought. Hence they may be more conscious of environmental conservation.

The MRA controls for nine types of valuation methods. Wetland values estimated by stated preference methods (CVM, CE) generate significantly lower values than those estimated by market price methods. This might reflect tighter budget constraints associated with lower incomes and reduced ability to pay (Korsgaard and Schou 2010). Wetland values estimated by hedonic pricing methods also produce lower values.

Published studies report lower values than unpublished studies, consistent with the findings of Enjolras and Biosson (2010) and Camacho-Valdez *et al*. (2013). Estimates published in journal articles are subject to peer review and perhaps this process results in more conservative valuations. The result for the year the survey was conducted suggests that wetland values have been falling by approximately 10% to 13% annually. One explanation for this might be that preferences are changing, with respondents becoming less willing to pay for wetland conservation in developing countries. An alternative, and arguably more plausible, explanation is that perhaps the more valuable wetlands have been surveyed first. Subsequent studies may have explored wetlands of inherently less value generating a time trend in the values. A third explanation is that perhaps this is another example of the "declining effect" (Lehrer 2010); earlier studies report artificially inflated estimates to increase the prospects of publication but subsequent research reports more accurate estimates.

Urban wetlands are more valuable than rural wetlands. One explanation for this finding is that urban residents have a higher income than rural dwellers (Khan 2000), and wealthier citizens have a higher willingness to pay to protect wetlands. Wetlands designated as protected areas are more valuable than those from other sites, though this is not always statistically significant. A possible explanation for this is that most protected areas are coral reef areas and national parks, which mostly produce internationally traded goods and services. Wetlands designated as Ramsar sites tend to be less valuable than other sites. However, this finding is not robustly statistically significant.

Table 2: MRA of Economic Valuations of Wetlands, Developing Countries

Variable	General OLS cluster SE (1)	General WLS cluster SE (2)	Reduced WLS cluster SE (3)	Random effects (4)	Panel (5)
Constant	5.126*	5.018*	4.405**	5.571***	
	(2.488)	(3.010)	(2.135)	(1.206)	
Size (lnArea)	-. 391***	-.374***	-.363***	-.412***	-.751***
	(0.061)	(0.080)	(0.078)	(0.029)	(0.084)
Riverine wetland	.538	.481		.734**	4.287*
	(0.542)	(0.571)		(0.283)	(2.574)
Marine wetlands	1.496***	1.137*	.911*	1.615***	1.500***
	(0.429)	(0.527)	(0.529)	(0.211)	(0.538)
Constructed wetlands	-. 891	-.729		-.739*	-2.467
	(0.625)	(1.006)		(0.413)	(8.820)
Lacustrine wetlands	-. 227	-.017		.372	7.072
	(0.622)	(.739)		(0.251)	(3.072)
Palustrine wetlands	-1.375*	-1.471*	-1.184*	-0.996***	1.731
	(0.542)	(0.781)	(0.672)	(0.317)	(3.386)
Other wetlands	-.074	.087		-.079	-1.952
	(0.494)	(0.614)		(0.421)	(1.454)
Disturbance regulation	-.083	.465		.428	.341
	(0.358)	(0.515)		(0.272)	(0.600)
Water regulation	. 988*	1.944**	1.560**	.945**	-11.006
	(0.475)	(0.703)	(0.696)	(0.333)	(9.845)
Water Supply	-. 127	-1.070*	-1.296**	-.584**	-3.645***
	(0.473)	(0.595)	(0.612)	(0.263)	(0.943)
Nutrient cycling	.698	1.475		.468	14.798
	(1.077)	(1.418)		(0.655)	(9.563)
Erosion control	.086	.433		.118	-1.853***
	(0.480)	(0.650)		(0.308)	(0.575)
Carbon sequestration	-.442	-1.148	-.647	-.553	-.931
	(0.422)	(0.711)	(0.682)	(0.371)	(0.742)
Water treatment	.848*	.723	.693	.901***	2.025*
	(0.406)	(0.481)	(0.464)	(0.217)	(1.038)
Biodiversity-Habitat	1.538***	1.474***	1.441***	1.535***	-.314
	(0.303)	(0.413)	(0.437)	(0.179)	(0.309)
Food production	. 359	-.698	-.331	.239	.509
	(0.367)	(0.507)	(0.439)	(0.212)	(0.363)
Raw materials	. 137	.619		.017	-.301
	(0.313)	(0.478)		(0.234)	(0.389)
Culture	-.419	-.028		.141	-.618
	(0.498)	(0.701)		(0.394)	(0.416)
RC	.108	.786	1.022**	.050	2.321***
	(0.402)	(0.585)	(0.476)	(0.242)	(0.511)
CVM	-1.179***	-1.746***	-1.665***	-1.333***	1.556***
	(0.307)	(0.493)	(0.465)	(0.192)	(0.507)
CE	-1.055 ***	-1.182*	-1.303**	-1.160***	-3.948
	(.490)	(0.658)	(0.650)	(0.293)	(16.683)

Variable	General OLS cluster SE (1)	General WLS cluster SE (2)	Reduced general WLS cluster SE (3)	Random effects (4)	Panel (5)
TCM	.283	.178		.120	2.013***
	(0.689)	(0.650)		(0.222)	(0.495)
NFIPF	.981	1.027	1.002	.609*	-8.7281
	(0.638)	(0.724)	(0.625)	(0.355)	(15.203)
OC	-.905	-1.476	-1.445	-1.617***	1.680**
	(0.672)	(0.962)	(0.938)	(0.374)	(0.821)
HP	-2.814***	-2.048*	-2.114*	-2.609	-
	(0.761)	(1.184)	(1.186)	(2.127)	
DC	.146	.739	1.029***	.804***	2.596***
	(0.388)	(0.495)	(0.372)	(0.309)	(0.512)
Impact factor	.610	-.057		.006	3.257
	(0.158)	(0.154)		(0.063)	(2.667)
Published	-1.111**	-.781*	-.707**	-.946***	.759
	(0.414)	(0.417)	(0.335)	(0.185)	(1.558)
Thesis	-.838*	-.714		-.805**	5.793
	(0.469)	(0.563)		(0.275)	(5.817)
Year of survey	-.126***	-.099**	-.102***	-.134***	-.0079
	(0.025)	(0.035)	(0.037)	(0.015)	(0.982)
Protected area	.836*	1.023	.857	.958***	1.208
	(0.371)	(0.647)	(0.655)	(0.219)	(20.138)
Ramsar	-.490	-.752	-.923*	-.491**	-4.126*
	(0.390)	(0.489)	(0.485)	(0.204)	(2.421)
Urban	1.673**	1.672*	1.422**	1.377***	1.311
	(0.615)	(0.728)	(0.642)	(0.325)	(0.717)
ln GDP per capita	. 688*	.694***	.726***	.622***	1.688
	(0.288)	(0.285)	(0.248)	(0.121)	(4.023)
Absolute Latitude	.041*	.043*	0.046	.046***	.665
	(0.016)	(0.019)	(0.018)	(0.008)	(0.512)
ln Population density	-0.070	-.039		-.047	-.174
	(0.092)	(.127)		(0.046)	(0.473)
MENA	-.189	.-321		.316	-9.377
	(0.763)	(0.994)		(0.368)	(12.812)
South Asia	-.104	-.232		.067	4.405
	(0.433)	(0.525)		(0.229)	(12.720)
Africa	1.277**	1.341**	1.320**	1.444***	-4.880
	(0.443)	(0.495)	(0.557)	(0.237)	(19.541)
Latin America	.456	.819	1.045*	.655***	4.0639
	(0.508)	(0.611)	(0.626)	(0.261)	(22.907)
Eastern Europe	1.486**	1.781*	1.109	-1.647	-14.283
	(0.860)	(1.004)	(0.728)	(1.263)	(11.674)
No. of observations	1432	1167	1167	1167	1167
No. of studies	379	309	309	309	309
Adjusted R^2	.473	.556	.547	0.483	0.925

Notes: Figures in brackets are standard errors. Cluster SE denotes standard errors adjusted for clustering of observations within studies. *,**, ***, denote statistical significance at the 10%, 5%, and 1% levels, respectively. Column 1 uses OLS. WLS is used for columns 2 to 5, using sample size as weights. Column 4 reports random effects estimated using REML. Column 5 reports a fixed effect panel data model.

The coefficient on GDP per capita is positive and statistically significant. Hence, if GDP per capita increases by 1%, wetland values increase by approximately .69% to .73%. That is, wetlands are a normal good and wetland values in developing countries are income inelastic. This result is similar to the findings of Ghermandi *et al.* (2008), Liu and Stern (2008), Ghermandi *et al*. (2010), Brouwer (1999), Brander *et al*. (2012b), and Salem and Mercer (2012) for developed countries.

The MRA includes dummy variables for six geographic locations. Of these, African wetlands are more valuable than those in Southeast Asia. The coefficient for Latin America is positive suggesting that Latin American wetlands are more valuable than those in Southeast Asia, however, this is not always statistically significant. There appears to be no difference in wetland values between the Middle East and North Africa, South Asia and Southeast Asia.[6] The coefficient on latitude is positive but it is not always statistically significant.

4.2 Value Transfer

As noted in the introduction, one of the potential benefits of MRA is that it might be useful for deriving valuations for policy sites. The idea is to use the coefficients from MRA to estimate the value of wetlands that were not part of the data used to derive the MRA coefficients. The key advantage of this is that it by-passes the need to conduct fresh surveys for policy sites, with significant savings for developing countries. Hence, in this section we explore the usefulness of the MRA for benefit transfer. We use Mean Absolute Percentage Error (MAPE) to calculate the transfer error rate.[7] The transfer error rates are presented in

[6] The Eastern Europe dummy reflects the results from only one country. The coefficient is not robust.

[7] $MAPE = \sum \left[\left| \frac{V_{observed} - V_{estimated}}{V_{observed}} \right| .100 \right] \Big/ n$, where $V_{estimated}$ is the transferred (predicted) wetland value from the MRA, $V_{observed}$ is the wetland value as reported in a primary study, and n is the number of estimates.

Table 3. The average MAPE for all models is about 31%: on average the transferred values miss the benchmark value by approximately 31%.

Table 3: The in-sample MAPE of MRA models

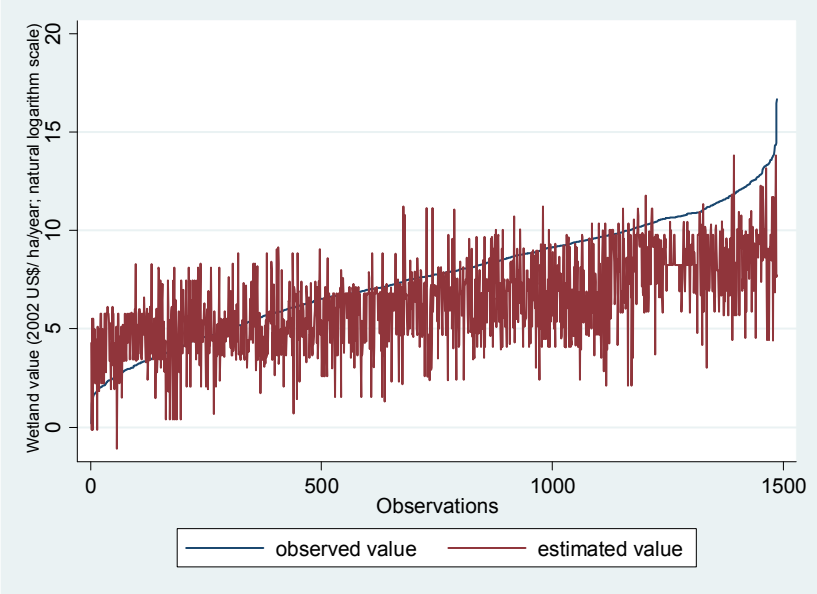
MAPE (%)	General OLS (1)	General Unrestricted WLS (2)	General Random effects WLS (3)
Average	30.28	31.32	31.34
Median	15.73	17.29	15.87
Maximum	2,198	2,774	2,898
Minimum	.037	0	0

Notes: Column 1 uses the OLS results from column 1, Table 2. Column 2 uses the WLS results from column 2, Table 2. Column 3 uses the random-effects results from column 4, Table 2.

Figures 4 and 5 graph the observed and estimated wetland values and the associated transfer errors, respectively from the general unrestricted WLS model. Even though the average MAPE listed in Table 3 might at first blush appear to be relatively high, these models perform relatively well when compared to many prior meta-studies of wetland valuations. For example, Brander *et al.* (2006) report an average MAPE value of 58%, Brander *et al.* (2007)) report a value of 186%, Brouwer *et al.* (2009) reports a value of 85%, Enjolras and Boisson (2010) report a value of 87%, and Salem and Mercer (2012) reports average MAPE value of 35%.

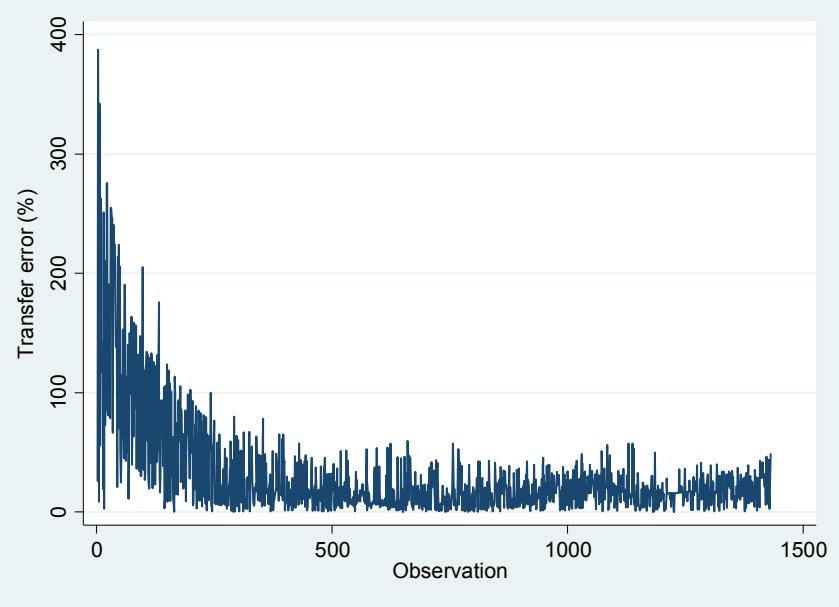
As can be seen from Table 3, the median transfer error rate ranges between 15% and 17%. We find that 73% of the sample has an error rate of less than 30% and 82% of the sample has an error rate less than 40%.[8] However, 6% of the sample has an error rate greater than 100%. Hence, caution is necessary as some of the individual transfer errors are very large. Nevertheless, our general assessment is that the MRA benefit transfer functions can be used to estimate the value of wetlands at policy sites for developing countries.

Figure 4: Observed and estimated wetland values, General WLS MRA



[8] Obviously, the greater the similarity between study and policy sites the smaller the error. However, we expect a non-zero transfer error, as values of actual sites are themselves estimated with error, *e.g.*, two identical sites can be assigned different values purely because of sampling and measurement error and this will manifest in transfer error.

Figure 5: Transfer errors, General WLS MRA



Note: A single observation is outside the frame of the figure.

4 Conclusion

This paper presents a meta-regression analysis of wetland valuations from developing countries. The aims of the MRA are to identify the important factors that determine wetland values and to use meta-regression to construct a benefit transfer function. We find that wetland characteristics, valuation methods, and wetland contexts all influence wetland values. Wetland size is very robust in having a negative effect on wetland values. Wetlands that produce internationally traded goods and services are consistently more valuable than other wetlands. A case in point is marine wetlands. Higher GDP per capita countries have higher wetland per hectare values.

An interesting result is that wetlands providing water treatment and habitat-biodiversity are consistently more valuable than those used for recreation. This means that converting wetlands for tourism development will reduce their valuation, while conservation increases valuation. Values estimated by stated preference studies are lower than those using

market-based methods. As well as reflecting budget constraints, it is possible that this reflects a limited understanding by the community of the ecosystem values of wetlands. Urban wetlands produce higher values than non-urban sites.

By focusing exclusively on wetlands in developing countries, this research finds that MRA does a reasonably good job at benefit transfer, with error rates that are lower than most prior meta-studies. Hence, MRA appears to offer a cost effective policy tool for the development and analysis of wetland management policy options in developing nations.

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Appendix: List of Studies included in the meta-analysis

Study	Author(s)	Type of publication	Year of Survey	No. of Observations
1	Barbier 1994	Journal article (Land Economics)	1989	5
2	Barbier & Strand 1995	Journal article (Environmental and Resource Economics)	1990	1
3	Barbier 2007	Journal article (Economic Policy)	2006	14
4	Yang *et al.* 2008	Journal article (Ecological Economics)	2005	7
5	Ndung'u 2009	Research Report (HOAREC)	2006	1
6	Nissapa *et al.* 2002	Book Chapter	2002	1
7	Sathirathai & Barbier 2001	Journal article (Contemporary Economic Policy)	1998	13
8	Emerton &Kekulandala	IUCN report	1999	1
9	GÜRLÜK 2010	Journal article (J. BIOL. ENVIRON. SCI)	2004	2
10	Carvalho, 2007	Journal article (Braz. J. Biol)	1999	10
11	Gerrard 2004	Research Report (IUCN)	2002	1
12	Emana 2009	Book Chapter	2007	1
13	Do & Bennet	Journal article (Environment and Development Economics)	2006	16
14	Verma 2001	Research Report	1999	1
15	Schuijt 2002	Research Report	1999	1
16	Emerton *et al*. 1998	Research Report (IUCN)	1998	4
17	Kumar & Kumar 2002	Book Chapter	1996	1
18	Guo *et al*. 2001	Journal article (Ecological Economics)	2000	1
19	Gu *et al* . 2010	Ecological Economic (Ecological Economy)	2009	1
20	Azmi *et al.* 2009	Conference Proceedings	2009	1
21	Hagreaves-Allen 2004	MSc thesis	2004	4
22	White *et al.* 2000	Research Report (CRMP)	1999	4
23	Seyam *et al.* 2001	Conference Proceedings	2001	1
24	Turpine *et al.* 1998	Journal article (Ecological Economics)	1996	3
25	Eaton & Sarch 1997	Journal article (Ecological Economics)	1995	1
26	Achrya & Babier 1999	Journal article(Agricultural Economics)	1996	1
27	Han et al 2011	Journal article (Environ Monit Assess)	2009	1
28	Gustavson, 1998	Journal article (Ecological Economics)	1996	3
29	Guunawardana & Rowan	Journal article(Environmental Management)	2002	6
30	Chen *et al* . 2009	Journal article (Commun Nonlinear Sci Number Simulate)	2004	4
31	Jenkarkit 2004	Research Report	2003	1
32	Alam 2006	Journal article (Asia Pacific Journal on Environment and Development)	2001	3
33	Seenprachawong,2001	Research Report (EEPSEA)	2002	5
34	Seenprachawong 2002	Research Report (EEPSEA)	2002	1
35	Sathirathai 1998	Research Report (EEPSEA)	1996	9
36	Chuenpagdee 1998	Research Report (EEPSEA)	1997	2
37	Edward 2009	Journal article (Marine Policy)	2008	4
38	Cesar *et al.* 2003	Research Report	2002	2
39	Ruitenbeek *et al.* 1999	Journal article (Coral Reefs)	1998	6
40	Cesar *et al.* 2000	Research Report (CORDIO)	2000	2
41	EMU 2001	Research Report	2000	2
42	Hodgso & Dixon 1986	Research Report (CMBP)	1985	9
43	Spash 2000	Research Report (CORDIO)	1998	3
44	Tong C *et al* . 2007	Journal article (ecological engineering)	2002	2
45	Dehlavi *et al*. 2007	Book Chapter	2007	8

Study	Author(s)	Type of publication	Year of Survey	No. of Observations
46	Do & Bennett 2005	Working paper	2001	9
47	Nam & Son 2001	Research Report (UNEPSCS)	2001	6
48	Yeo 2005	Research Report (Worldfishcenter)	1998	3
49	Ngazy *et al.* 2005	Research Report (Worldfishcenter)	2001	1
50	Ahmed m *et al.* 2007	Journal article (Ocean & Coastal Management)	2000	4
51	Burke *et al.* 2008	Research Report	2005	6
52	Dehghani et al. 2010	Journal article (Int. J. Environ. Res)	2006	1
53	Cesar 2003	Research Report	2002	12
54	Christiernsson 2003	MSc thesis	2002	3
55	Emerton 2003	Research Report (IUCN)	2003	4
56	Benessaiah 1998	eBook	1998	3
57	Lopez 2003	Journal article (Ecological Economics)	2002	4
58	Vidanag *et al.* 2005	Research Report (IUCN)	2003	3
59	Tapsuwan 2005	Working Paper	2004	6
60	Nhuang et al 2003	Research Report	2002	33
61	Emerton 1997	Research Report (IUCN)	1996	1
62	Kasthala *et al.* 2008	Research Report (IUCN)	2006	1
63	van Beukering *et al.* 2008	Research Report (IVM)	2007	2
64	Birol & Das 2010	Journal article (Journal of Environmental Management)	2008	2
65	Othman *et al.* (2003)	Journal article (Analysis)	2000	3
66	Maharana *et al.* 2000	Journal article (Environmental Conservation)	1998	8
67	Waite *et al.* 2011	Research Report (WRI)	2011	2
68	Gammage 1997	Working Paper	1992	3
69	Bennett & Reynolds 1993	Journal article (Biodiversity & Conservation)	1992	1
70	Ruiteenbeek 1992	Research Report (EMDI)	1991	1
71	Lal 1990	Working Paper	1990	1
72	Turpie *et al.,* 1999	Research Report (IUCN)	2003	13
73	Yan *et al.* 2010	Conference Proceedings	2008	1
74	Yacob *et al.* 2009	Journal article (Journal of Sustainable development)	2007	90
75	Yacob *et al* .2009	Journal article (World Applied Sciences Journal)	2007	3
76	Adams *et al.* 2008	Journal article (Ecological Economics)	2006	2
77	Cruz-Trinidad *et al.* 2011	Journal article (Ocean & Coastal Management)	2010	1
78	Bann 1999	Research Report (IUCN)	1999	2
79	Oumou *et al* . 2003	Research Report (IUCN)	2003	16
80	Wattage & Mardle 2008	Journal article (Wetlands Ecol Manage)	2007	1
81	Mukherjee 2008	Working paper	2008	1
82	Chattopadhyay 1998	Conference Proceedings	1999	1
83	Benitez 2001	Research Report	1999	3
84	Prasher *et al.* 2006	Research Report	2002	1
85	Abdulah 2011	Research Report	2010	1
86	Chopra 1998	Research Report (IUCN)	1997	1
87	IUCN 2003	Research Report (IUCN)	2003	3
88	IUCN 2004	Research Report (IUCN)	2002	1
89	Khalil 1999	Research Report (IUCN)	1997	1
90	Gan *et al.* 2011	Journal article (Journal of Applied Ichthyology)	2010	1
91	Zheng et al. 2008	Journal article (International Journal of Sustainable Development & World Ecology)	2004	1

Study	Author(s)	Type of publication	Year of Survey	No. of Observations
92	Hong *et al* .2000	Research Report (UNESO)	1999	11
93	Nam *et al.* 2005	Working paper	2005	4
94	Tuan *et al*.2009	Journal article (Ocean & Coastal Management)	2006	2
95	Do 2007	Research Report (EEPSEA)	2006	3
96	Tapvong & Kruavan 2003	Research Report (EEPSEA)	1998	3
97	Lerdrit 2007	MSc thesis	2006	3
98	Sathapanasupakul 2006	MSc thesis	2005	2
99	Lauchorsriri & Saelim	Journal article (Kasetsart University Journal)	2002	1
100	Siammai 2009	MSc thesis	2007	1
101	Kamlang-EK 2008	Journal article (Kasetsart University Journal)	2007	2
102	Kampoo & Runtawanreungsri 2008	Journal article (Kasetsart University Journal)	2006	1
103	Praneetvatakul 2008	Journal article (Kasetsart University Journal)	2008	1
104	Sherestha *et al*. 2007	Journal article (Environment, Development and Sustainability)	1994	4
105	WALPOLE *et al.* 2001	Journal article (Conservation Biology)	1995	1
106	Pattanayak &	Journal article (Water Resources Research)	1996	1
107	Subade 2005	Research Report (EEPSEA)	2002	2
108	Subade & Francisco 2014	Journal article (Ecological Economics)	2002	15
109	Wang *et al.* 2011	Working Paper	2007	1
110	Chen *et al.* 2003	Journal article (China Economic Review)	1999	2
111	Yaping 1998	Research Report (EEPSEA)	1996	21
112	Hadker *et al.* 1997	Journal article (Ecological Economics)	1995	3
113	van Beukering *et al.* 2003	Journal article (Ecological Economics)	2001	3
114	Amponin *et al.* 2007	Research Report (PREM)	2006	4
115	Choe *et al.* 1996	Journal article (Land Economics)	1992	21
116	Abilia & Othina 2006	Research Report	2005	1
117	Hai &Najam 2003	Research Report	2001	2
118	icem 2002	Research Report (ICEM)	2000	1
119	Foreverindus 2010	Research Report	2008	2
120	Chong 2005	Research Report (IUCN)	2004	3
121	Ramachandra *et al.* 2005	Journal article (Journal of Environment Biology)	1995	1
122	Christensen 1982	Conference Proceedings	1981	1
123	Wang *et al.* 2004	Research Report	2000	12
124	Imandoust 2011	Research Report	2010	4
125	Imandoust & Gadam 2007	Journal article (Int. J. Environ. Sci. Tech)	2005	2
126	Brouwer *et al.* 2006	Working Paper	2005	4
127	Hang & An 1999	Research Report	1997	1
128	Camille Bann 1997	Research Report	1997	2
129	Mingab *et al*.2007	Journal article (Ecological Economics)	2004	1
130	Das 2007	Research Report	1999	3
131	Bhatt & Abdullah 2011	Research Report	2010	1
132	Hussain & Badola 2008	Journal article (Wetlands Ecol Manage)	2007	1
133	Hussain & Badola 2010	Journal article (Wetlands Ecol Manage)	2009	1
134	Badolar& Hussain 2005	Journal article (Environmental Conservation)	2003	1
135	Badolar& Hussain 2003	Working paper	2001	1
136	Sreeraman 2009	Research Report	2009	1

Study	Author(s)	Type of publication	Year of Survey	No. of Observations
137	Selassie & Kountouris 2010	Research Report	2006	6
138	Naylor & Drew 1998	Journal article (Environment and Development Economics)	1996	2
139	Day & Mourato 1998	Journal article (Journal of Environmental Science)	1997	4
140	Maille & Mendelsohn 1993	Journal article (Journal of Environmental Management)	1991	5
141	Turpie *et al.* 1999	Research Report (IUCN)	1999	4
142	Tupie 2000	Working Paper	2000	1
143	Zahabu *et al.* 2003	Working Paper	2001	2
144	Hepewa *et al.* 2011	Research Report	2009	1
145	Edwards 2009	Ph.D. Dissertation	2008	4
146	Viswanathan 2011	Research Report	2010	1
147	Abou-Ali & Carlsson 2004	Working Paper	2002	2
148	Pan *et al.* 2012	Journal article (Environment and Pollution)	2011	1
149	Hope *et al.* 2006	Working Papers	2006	12
150	Turpie *et al.* 2010	Research Report	2008	3
151	Celeste 2009	Research Report	2008	2
152	Janssen & Padillla 1999	Journal article (Environmental and Resource Economics)	1995	7
153	Radam & Mansor 2005	Journal article (Journal of Social Sciences & Humanities)	2003	2
154	Liu *et al.* 2009	Research Report	2007	3
155	Meclean *et al.* 2003	Working Paper	2002	1
156	Mercer *et al.*1995	Journal article (Journal of Forest Economics)	1991	12
157	Navrud & Mungatana 1994	Journal article (Ecological Economics)	1991	22
158	Mathieu *et al.*2003	Journal article (Environment and Development Economics)	1998	10
159	Mwakubo *et al.* 2007	Journal article (Wetlands Ecol Manage)	2005	2
160	Bann 1996	Research Report	1995	1
161	Dharmaratne *et al*. 2000	Journal article (Annals of Tourism Research)	1998	5
162	Shultz *et al.* 1998	Journal article (Environment and Development Economics)	1995	2
163	Kramer *et al*. 1997	Journal article (Journal of Environmental Management)	1995	1
164	Spurgeon 2002	Research Report	2002	2
165	Hegazy *et al.* 2002	Research Report (EEPP-PSU)	2001	1
166	Ezebilo *et al.* 2010	Journal article(Journal of Sustainable development)	2008	1
167	ZHU *et al.* 2001	Journal article (Chin. Geogra. Sci)	2007	1
168	Dehlavi *et al.* 2011	Working Paper	2009	1
169	Mmopelwa 2006	MSc thesis	2003	2
170	Turpie *et al.* 2006	Research Report	2005	2
171	Turpie 2000	Research Report	2000	5
172	Zhou *et al.* 2011	Conference Proceedings	2007	1
173	Lei *et al.* 2008	Journal article (China)	2007	7
174	Ozesni 2003	Journal article (Human Ecology)	1998	1
175	Gurluk & Rehber 2008	Journal article (Journal of Environmental Management)	2001	16
176	Dadaser-Celi *et al.* 2009	Journal article (Ecological Economics)	2005	6
177	Amirnezhad *et al*. 2010	Journal article (Journal of Environmental Studies)	2008	1
178	Souza *et al.* 2011	Journal article (J Coast Conserve)	2007	1
179	Kaffashi *et al.* 2011	Journal article (Reg Environ Change)	2009	2
180	Juan *et al.* 2010	Conference Proceedings	2008	3

Study	Author(s)	Type of publication	Year of Survey	No. of Observations
181	Awetaireho & Getzner 2011	Journal article (International Journal of Biodiversity Science)	2008	1
182	Gurluk & Rehber 2006	Journal article (WETLANDS)	2004	2
183	Su & Zhang 2007	Journal article (Chinese Science Bulletin)	2007	3
184	Zhu *et al.*2010	Conference Proceedings	2007	1
185	Gunawardena 2009	Journal article (Journal of Humanities and Social Science)	2004	1
186	Zi 2010	Journal article (Advanced Material Research)	2006	1
187	O'Garra 2012	Journal article (Ocean & Coastal Management)	2006	2
188	Jame *et al.* 2011	Book Chapter	2008	4
189	Ransom & Magi 2010	Journal article (Environmental Management)	2007	4
190	ZHANG 2011	Journal article (Journal of Applied Physics & Engineering)	2008	3
191	Han *et al*. 2012	Journal article (Chin. Geogra. Sci)	2009	2
192	Casey *et al*. 2006	Journal article (Ecological Economics)	2001	5
193	Enyew 2003	MSc thesis	2003	3
194	Adekola *et al.* 2008	Conference Proceedings	2006	1
195	Achrya & Babier 2002	Journal article (American Journal of Agricultural Economics)	1999	1
196	Sangkapitux *et al.* 2010	Journal article (International Journal of the Commons)	2010	3
197	North & Griffin 1993	FAO Document Repository	1978	1
198	Renwick 2001	Research Report (IWMI)	1999	4
199	Acharya & Barbier 2000	Journal article (Agricultural Economics)	1996	2
200	Wright 1995	Working Paper	1994	4
201	Reid-Grant & Bhat 2009	Journal article (Marine Policy)	2005	2
202	Han *et al*. 2008	Book Chapter	2005	1
203	Boominathan *et al*. 2008	Research Report (ENVIS)	2007	1
204	Gupta & Mythili 2008	Conference Proceedings	2007	2
205	Othman *et al.* 2004	Journal article (Environment and Development Economics)	1999	4
206	Nalukenge et al.2009	Book Chapter	2006	4
207	Dixon 2001	Book Chapter	1997	1
208	Othman & Rahajeng 2002	Research Report	2001	2
209	Zareen & Sumon 2007	Research Report	2006	5
210	Whittington *et al.* 1992	Journal article (Water Resources Research)	1989	1
211	Adhikari *et al*.2010	Journal article (The Journal of Environment & Development)	*1999*	3
212	Marikan *et al*.2006	Working Paper	2005	2
213	Keawapichai 2000	Research Report	1999	2
214	Bandyopadhyay *et al*. 2005	Conference Proceedings	2004	2
215	Xie 2006	Research Report	2004	5
216	Acharya 2000	Journal article (Ecological Economics)	1996	1
217	IUCN 2006	Research Report (IUCN)	2002	1
218	IUCN 2007	Research Report (IUCN)	2003	1
219	IUCN 2003	Research Report (IUCN)	2002	3
220	Simonit & Perrings 2011	Journal article (Ecological Economics)	2006	1
221	Zhou *et al.* 2011	Journal article (J. Urban Plann. Dev)	2004	2
222	Samonte-Tan et al 2007	Journal article (Coastal Management)	2004	5
223	Tongson & Dygico 2001	Research Report	1999	3
224	Arin & Kramer2002	Journal article (Ocean & Coastal Management)	1994	9
225	Ahlheim *et al.* 2006	Journal article (Quarterly journal of international agriculture)	2004	2

Study	Author(s)	Type of publication	Year of Survey	No. of Observations
226	Lange & Jiddawi 2009	Journal article (Ocean & Coastal Management)	2004	2
227	UNEP 2011	Research Report (UNEP)	2010	1
228	Wang *et al.* 2009	Journal article (Tourism economics)	2007	3
229	Ringler 2001	Working paper	1999	5
230	Cabrera *et al.* 1998	Journal article (Intercoast Network)	*1997*	4
231	Munasinghe 1993	Journal article (Ambio)	1992	8
232	Gammage 1998	Working paper	1997	3
233	Kaplowtiz & Hoehn 1998	Conference Proceedings	1996	3
234	Minten 2003	Working paper	2001	2
235	Anoop *et al.*2008	Conference Proceedings	1994	1
236	Tri *et al.* 1996	Working Paper	*1995*	2
237	Guman 2002	Journal article (Journal of Latin American Studies)	2004	2
238	Sathyapalan & Iyenga 2007	Research Report	2007	7
239	Das & Mukherjee 2008	Research Report	2007	7
240	Lannas *et al.* 2009	Journal article (Ecology & Society)	2005	2
241	Mamiit &Wijayaweera 2006	Research Report (IUCN)	2006	2
242	Onjala & Oguge 2008	Research Report	2008	1
243	NARO 2010	Research Report	2010	1
244	ADB 1999	Journal article (Phase ADB)	1999	4
245	Othman 1990	Research Report (AWB/WWFM)	1991	4
246	van Beukering *et al.* 2007	Research Report	2006	1
247	Katuwal et al. 2010	Conference Proceedings	2009	2
248	Cooper & Burke 2008	Working Paper	2007	9
249	Ringle & Cai 2006	Journal article (Journal of water Resource planning and management)	2004	12
250	Wiwatthanapornchai *et al.* 2014	Journal article (Modern Applied Science)	2013	1
251	Paudel, 2010	Research Report (IUCN)	2010	1
252	Kong *et al*. 2014	Journal article (Sustainability)	2013	4
253	Xiaoyan *et al*. 2010	Research Report (IEEE)	2002	1
254	Qiana and Linfeib 2012	Journal article (Energy Procedia)	2009	1
255	Goldberge 2007	Conference Proceedings	2007	1
256	Janekarnkij 2010	Working Paper	2003	4
257	Greenomics 2004	Research Report	2004	2
258	Akweirho 2009	MSc thesis	2008	1
259	Midora &Anggraeni 2006	Research Report	2004	2
260	Lubis *et al.* 2009	Conference Proceedings	2008	1
261	Subade 2007	Journal article (Marine Policy)	2002	1
262	Kumrai 95	Working Paper	1992	8
263	van Beukering *et al*. 2009	Research Report	2006	2
264	Shahwahid 2001	Research Report (CBD)	2000	1
265	Shahwahid *et al*. 1999	Research Report (EEPSEA)	1998	2
266	YACOB 2002	MSc thesis	2001	3
267	Ferraro 2001	Working Papers	1991	1
268	Tri *et al.* 1998	Journal article (Global Environmental Change)	1994	3
269	Padilla & Janssen 1996	Journal article (Journal Philippine Journal of Development)	1995	13

Study	Author(s)	Type of publication	Year of Survey	No. of Observations
270	O'Toole 2007	Research Report (USAID)	2006	1
271	Neef *et al*. 2009	Journal article (International journal of the Comons)	2008	1
272	Barton & Bergland 2010	Journal article (Environment and Development Economics)	2008	3
273	Zheng & Tu 2009	Conference Proceedings	2005	1
274	Yacob & Shuib 2009	Journal article (Int. Journal of Economics and Management)	2004	7
275	Aghabeygi *et al.* 2011	Journal article (Journal of Agricultural & Biological Science)	2009	2
276	Iied 2006	Research Report	2005	1
277	UNESCO, 2000	Research Report (IUCN)	2000	11
278	Subade & Jugado 2010	Research Report (EEPSEA)	2005	6
279	Alam & Marinova 2010	Conference Proceedings	2001	12
280	Yacob & Shuib 2008	Research Report (UNEPSCS)	2007	2
281	IUCN 2007	Research Report (IUCN)	2002	2
282	Zahabu et al. 2006	Research Report	2001	2
283	Ramachandra *et al.* 2011	Journal article (Journal Environment Science & Engineer)	2009	1
284	Wattage 2002	Research Report	2007	3
285	Kassahun 2009	MSc thesis	2008	3
286	Nde 2011	MSc thesis	2010	21
287	Levchuck 2003	MSc thesis	2002	3
288	IUCN 2007	Research Report (IUCN)	2006	3
289	O'Garra 2009	Journal article (Environ Resource Econ)	2006	3
290	James *et al.* 2008	Working Paper	*2008*	3
291	Shrestha *et al*. 2002	Journal article (Ecological Economics)	1994	9
292	Amiry *et al.* 2009	Journal article (International Journal of Business and Management)	2008	12
293	Mohd *et al*. 1999	Research Report(UNEP/ROAP)	1999	27
294	Israel *et al.* 2012	Journal article (Journal of Sustainable Agriculture)	2009	2
295	GEC 2010	Research Report	2006	5
296	Anoop *et al.* 2008	Conference Proceedings	2007	2
297	DebRoy & Jayaraman 2012	Conference Proceedings	2009	1
298	Tuan & Tinh 2013	Working Paper	2012	2
299	Muraleedharan *et al.* 2009	Research Report (KFRI)	2008	1
300	DebRoy *et al.* 2013	Research Report	2012	1
301	Chand *et al.* 2013	Journal article (Basic Research Journal of Agricultural Science and Review)	2012	1
302	Tantu *et al.* 2012	Journal article (International Journal of Marine Science)	2012	1
303	Subari 2013	Journal article (J. Basic. Appl. Sci. Res)	2011	1
304	Pacal & Bulu 2013	Research Report	2012	8
305	Shuib *et al.* 2011	Conference Proceedings	2011	1
306	Leong, L.F. et al.2005	Research Report	2002	12
307	James 2008	Ph.D. thesis	2005	1
308	Janssen & Padilla 1998	Working Paper	1995	1
309	Fernandez et al. 2005	Journal article (Journal article Science Dilemma)	2005	7
310	Mansilp 2012	Book Chapter	2011	1
311	FDP 2006	Research Report (UNEPSCS)	2006	1
312	Madani *et al.* 2012	Journal article (Int. J. Environ. Res)	2009	1
313	Sinlapajan 2006	MsC. thesis	2005	3
314	Muhamad *et al.* 2012	Research Report	2011	1

Study	Author(s)	Type of publication	Year of	No. of
315	Ali 2007	MSc thesis	2005	1
316	Musamba *et al*. 2012	Journal article (J Hum Ecol)	2011	1
317	Danh 2007	Research Report	2005	6
318	Hargreaves-Allen 2004	Research Report	2002	
319	Passareli 2013	MSc thesis	2012	1
320	Mohamed *et al.* 2012	Journal article (Journal of Applied Sciences)	*2011*	1
321	Mmopelwa & Blignaut 2009	Journal article (SAJEMSNS)	2003	1
322	Dumasile *et al.* 2005	Journal article (The Journal for Trans disciplinary Research in Southern	2004	1
323	Colavito 2001	Research Report (USAID)	1999	1
324	L¨u et al 2012	Journal article (Nat. Hazards Earth Syst. Sci)	2008	12
325	Yoeu & Pabuayon 2011	Journal article (International Journal of Environment and rural	2009	1
326	Jahanifar 2010	Journal article (Middle East journal of scientific research)	2009	1
327	Wasswa *et al.* 2013	Journal article (Academia Journal of Environmental Sciences)	2013	1
328	Ibarra *et al*. 2012	Journal article (Cities)	2011	5
329	Hosking 2011	Conference Proceedings	2008	1
330	Zahabu *et al.* 2003	Research Report	2003	2
331	Kakuru *et al.* 2013	Journal article (The Scientific World Journal)	2012	1
332	Mamat *et al.* 2013	Journal article (African Journal of Environmental Economics and	2004	2
333	Adekola 2007	MSc. Thesis	2006	2
334	Emily *et al.* 2013	Journal article (International Journal of Education and Research)	2011	1
335	Lee et al. 2014	Journal article (Water SA)	2010	1
336	Ahmad 2009	Journal article (Journal of Tropical Forest Science)	2008	1
337	Duangjinda &	Research Report	2011	2
338	Zapata *et al*. 2009	Conference Proceedings	2005	2
339	Fonta *et al.* 2011	Research Report	2004	1
340	Khanal & Paudel 2012	Research Report (IUCN)	2010	1
341	Asadi *et al*. 2013	Journal article (International Bulletin of Water Resources & Development)	2012	1
342	Zhaoyi *et al.* 2012	Journal article (Int. J. Environ. Res. Public Health)	2012	1
343	Ramanathan2008	Conference Proceedings	2007	1
344	Hakim *et al.* 2011	Journal article (Journal of Sustainable Development)	2010	2
345	Abedi *et al*. 2014	Journal article (Int. J. Environ. Res)	2012	1
346	Kevin *et al.* 2006	Journal article (Ecological Economics)	2000	2
347	Angellar *et al.* 2014	Journal article (Journal of Development and agricultural economics)	2012	2
348	The WorldFish Center 2012	Research Report	2011	4
349	Rawi 2012	Ph.D. Thesis	2004	6
350	Mail *et al.* 2012	Research Report	2012	3
351	Chaikumbung 2013	Ph.D. thesis	2012	13
352	El-Bekkay *et al.* 2013	Journal article (African Journal of Environmental Science and Technology)	2010	2
353	Musamba et al 2011	Journal article (Agri Sci)	2010	1
354	TRI *et al.* 1997	Research Report	1994	1
355	Khaleel 2012	Journal article (European Journal of Applied Sciences)	2010	1
356	Jamal *et al*. 1998	Research Report	1997	2
357	Vo & Huynh 2014	Journal article (Appl Water Sci)	2013	6

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358	Gonzales *et al*. 2002	Research Report	2005	1
359	Ahamd2009	Ph.D. thesis	2003	12
360	Baig & Iftikhar 2007	Research Report (IUCN)	2003	7
361	O'Garra, 2007	Research Report (CRISP)	*2006*	19
362	Barnes-Mauthea *et al.* 2013	Journal article (Fisheries Research)	2010	2
363	Richard *et al.* 2010	Journal article (Ocean & Coastal Management)	2006	5
364	Islam & Ikejima 2009	Journal article (Wetlands Ecol Manage)	2004	3
365	University of Dar es Salaam 2006	Research Report	2006	5
366	Tianhonga *et al.* 2011	Journal article (Journal of Sustainable Development)	2010	1
367	Rodriguez, 2009	Ph.D. thesis	1998	39
368	Swanson *et al.* 1999	Journal article (Journal of Environmental science)	1998	4
369	Mezgebo *et al.* 2013	Journal article (Journal of Economics and Sustainable Development)	2011	2
370	Ao *et al.* 2014	Journal article (AISS)	2007	2
371	Fishar 2012	Research Report (CBD)	2011	6
372	Rafiq *et al.* 2014	Journal article (International Journal of Environmental Science and Development)	2010	1
373	Wijayaweera *et al.* 2009	Conference Proceedings	2008	1
374	Widiastuti *et al.* 2012	Journal article (Journal of Indonesia Coral Reefs)	2012	1
375	Tuan & Minh 2013	Conference Proceedings	2010	1
376	Zhao *et al.* 2013	Journal article (Science of the Total Environment)	2008	3
377	Omondi *et al.* 2014	Journal article (International Journal of Science)	2012	2
378	Bongloe 2013	Journal article (International Journal of Innovative Research)	2009	2
379	Chattopadhyay 2008	Research Report	2008	2