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Integrating similarity analysis and ecosystem service value transfer: Results from a tropical coastal wetland in India

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ABSTRACT

Policy demand for ecosystem service values in developing countries results in a growing use of value transfer techniques, even in the absence of primary valuations from highly comparable study sites. Current techniques provide limited guidance on how to quantitatively assess the similarity between study and policy sites and control for the effect thereof on transfer accuracy. This paper proposes a methodology for the estimation of a study-policy site similarity index and explores its application to the Akkulam-Veli wetland in Kerala, India. The use of empirical similarity weights in a meta-analytical transfer yields a narrower prediction interval for the policy site value estimate. Estimating the meta-regression model parameters on a subset of primary valuation studies with greater similarity to the policy site application is found to increase value transfer accuracy. The need for further systematic testing and potential implications of the proposed approach for value transfer practitioners are highlighted.

1. Introduction

The economic valuation of ecosystem services (ES) is broadly accepted as a useful tool to inform development- and conservation-related decisions on the wider societal implications of our collective choices regarding the management of natural resources and the environment. Although various primary valuation techniques are available in the toolbox of environmental economists, environmental managers and decision-makers often rely on secondary ES valuations (i.e., value transfer) as a second-best assessment of ecosystem benefits. Value transfer refers to the procedure of drawing inferences on the unobserved monetary value of ecosystem goods or services in a policy site by borrowing existing valuation estimates from comparable study sites. Though widely used in developed countries, secondary valuation techniques are particularly relevant in the context of developing countries, where the lack of ES valuation expertise and the financial resources necessary for a primary valuation study are often limiting factors (Chaikumbung et al., 2016).

One of the key concerns of the value transfer analyst is the selection of the most appropriate study site, or sites in the case of multi-study site transfer based for instance on meta-regression analysis. The consensus among value transfer practitioners is that the more similar the original data estimates are to the intended policy site application, the more accurate the transfer will be (Rosenberger and Phipps, 2007). Johnston (2007) denotes this consensus as "similarity hypothesis". Several studies have testified to the empirical influence of site similarity on the reliability of value transfer estimates – see Rosenberger (2015) for an overview. The value transfer literature, however, currently lacks a set of standardized, quantitative tools to characterize such similarity (or dissimilarity) and take it into account in the derivation of value estimates for the policy site. Indeed in the context of meta-analytical value transfer, analysts generally aim to be as comprehensive as possible in the selection of studies to be included in the meta-database, since excluding a study is equivalent to applying a zero weight to the information in the study (Bergstrom and Taylor, 2006). While some authors point out the need to perform a systematic similarity analysis when selecting individual studies (van den Bergh et al., 1997), such recommendation is limited to the data collection phase and, in any case, is hardly reflected in the ES value transfer literature where the selection of the most similar study site(s) is generally left to subjective expert judgment. This practice has the potential to introduce a researcher bias in the analysis. Some authors have argued in favor of making "the inevitably subjective nature of benefit transfer more transparent" by acknowledging the explicit role of the analyst's sub-

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jective beliefs in a Bayesian value transfer paradigm (Phaneuf and van Houtven, 2015).

The present paper has two main objectives. First, it aims at defining a study-policy site general similarity index and showing how it can be integrated in a value transfer exercise. We demonstrate how a similarity index can be used to: (1) rank study site estimates based on an objective measure of their similarity to the intended policy site application; and (2) estimate the effect that relying on such similarity criterion has on the empirical transfer estimates obtained with different value transfer techniques. In particular, we assess how restricting the database of primary valuation studies based on the similarity with the policy site may affect the meta-analytical value transfer estimates. Moreover, we explore the use of empirical-similarity-weighted regression (Galbraith and Lieberman, 2013) as a potential alternative to more common meta-regression techniques when value transfer is the intended application of the results.

Second, we investigate the Akkulam-Veli (AV) wetland in Kerala, India as a case-study application for testing the aforementioned value transfer techniques and with the aim to provide a first estimate of the economic benefits provided by this endangered coastal tropical wetland ecosystem. Although wetlands are widely acknowledged as highly productive ecosystems capturing and processing energy to provide food for living organisms and sustain a number of vital ecological functions and economic services (Mitsch et al., 2015), many wetlands worldwide are at risk of degradation and conversion into other land uses because policy makers', planners' and other stakeholders' decisions do not accurately reflect the range of goods and services provided by them and their value to society (de Groot et al., 2006). Especially in tropical wetlands, many of the subsistence uses of wetland resources are not marketed and are thus often ignored in development decisions (Chaikumbung et al., 2016).

In India, only a fairly limited number of wetland ecosystem service valuation studies are available to date (see Table 1 for an overview of valuations in coastal wetlands), in spite of the wealth and diversity of its wetland habitats and the considerable stress they experience from urbanization, industrialization and agricultural intensification (Parikh and Datye, 2003; Bassi et al., 2014). Kerala state on the southwestern coast of India (see Fig. 1) has the largest proportion of land area classified as wetlands amongst all Indian states and displays an extensive network of backwaters, estuaries and lakes (Parikh and Datye, 2003). The AV wetland is located in a densely populated urban area in proximity to Kerala's state capital and largest city Thiruvananthapuram. The AV wetland has historically played an important economic, social and ecological role in the region (Chandran and Gowda, 2014; Indugeetha and Sunil, 2014) and has been the object of extensive investigation by environmental scientists. The AV wetland is currently threatened by severe pollution threats from municipal sources and other economic activities taking place in its drainage basin (Navami and Jaya, 2013; Sheela et al., 2010a, 2012a). Among the identified threats one may include eutrophication (Sajinkumar et al., 2015; Sheela et al., 2010b) and heavy metal enrichment (Sheela et al., 2012b; Swarnalatha et al., 2013a). The introduction of more sustainable environmental management practices in the AV wetland is considered urgent and essential for the conserva-

Table 1
Value estimates of ecosystem goods and services provided by coastal wetlands in India.

State	Site name	Wetland type	Valuation method[a]	Economic value[b]	Reference
Gujarat	All mangroves	Mangrove	VT	i. 953 US$/ha/year for carbon sequestration ii. 1,285 US$/ha for erosion control	Hirwai and Goswami (2007)
Karnataka	Kumpta Taluk	Mangrove	CVM	11,549 US$/ha/year for fish nursery, erosion & pest control	Stone et al. (2008)
Kerala	Ashtamudi estuary	Mangrove	CVM, NFI, RC, TCM	i. 134 US$/ha/year for option value ii. 900 US$/ha/year for commercial fishing iii. 20.4 US$/ha/year for recreation iv. 40.9 US$/ha/year for shrimp nursery	Anoop and Suryaprakash (2008a, 2008b)
Kerala	Ernakulam and Kannur	Mangrove	CVM	148 US$/household/year for conservation	Hema and Devi (2015)
Kerala	Kochin backwater	Lagoon	MP	i. 150 US$/ha/year for agriculture ii. 8,720 US$/ha/year for fishery & aquaculture iii. 141 US$/ha/year for tourism	Thomson (2001)
Kerala	Kol wetland	Brackish marsh	CVM	181 US$/ha for improved management	Binilkumar and Ramanathan (2009)
Kerala	Kol wetland	Brackish marsh	VT	16,077 US$/ha/year of total economic value	Raj and Azeez (2009)
Kerala	Valapattanam, Vellikkeel, Kavvayi	Mangrove	VT	11,123 US$/ha/year of total economic value	Khaleel (2012)
Kerala	Vembanad estuary	Lagoon	NFI	4,495 US$/household/year for prawn fishing	Jeena (2002)
Odisha	Bhitarkanika Conservation Area	Mangrove	MP, RC	i. 13.4 US$/household/year for fuel wood ii. 73.8 US$/household/year for subsistence fishing iii. 28.2 US$/household/year for timber & materials iv. 255 US$/ha for nutrient retention v. 995 US$/ha/year for storm protection	Badola and Hussain (2005); Hussain and Badola (2008, 2010)
Odisha	Chilika lake	Lagoon	CVM, TCM, MP	i. 1,825 US$/ha/year for tourism ii. 601 US$/ha/year for fisheries iii. 671 US$/ha/year for recreation	Kumar (2013)
Odisha	Jagatsinghpur and Kendrapada	Mangrove	ADC	236 US$/ha for protection during 1999 cyclone	Das and Crepin (2013)
Tamil Nadu	Pitchavaram Mangrove Forest	Mangrove	CVM	131 US$/person/year for conservation	Sathya and Sekar (2012)
West Bengal	Sundarban Tiger Reserve	Mangrove	CVM	1.8 US$/person for maintenance & restoration	Ekka and Pandit (2012)

Notes:
[a] VT=value transfer, CVM=contingent valuation method, NFI=net factor income, RP=replacement cost, MP=market prices, TCM=travel cost method, ADC=avoided damage cost;
[b] All values are expressed in US$ (2013, PPP).