MIDS Working Paper No. 242

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July 2023

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Published by
Madras Institute of Development Studies
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Chennai 600020 India
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pub@mids.ac.in | www.mids.ac.in

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L. Venkatachalam

Abstract

Wetlands act as an important *natural capital* and supply highly valuable ecosystem services that are utilised for innumerable consumption and production activities in an economy. However, most of their ecosystem services are non-marketed in nature and therefore, their benefits are not getting reflected anywhere in the system. As a result, the economic importance of wetlands is undermined in the public policy domain, subjecting these natural assets to severe *depletion* and *degradation*. To internalise various negative externalities that harm wetlands, it is necessary to obtain information on the economic values of ecosystem services utilised and their losses thereof in order to determine if the allocation of scarce resources for improvements in wetlands produces positive net benefits to the society. Across the globe, many economic valuation studies have been carried out to monetise the non-marketable ecosystem services of wetlands, and the results of these studies are used for creating awareness among stakeholders as well as for evidence-based policymaking in the area of wetland management. In this study, we critically review some of the important valuation studies to assess the current status, highlight the issues involved in generating such values and propose measures to strengthen wetland valuation practices in the future.

Introduction

The United Nations Organisation (UNO) declared 2021–2030 as a *Decade of Ecosystem Restoration* to encourage governments to initiate massive efforts to restore and protect the environment across the globe[1]. The third UN Environment Assembly passed a key and comprehensive resolution to protect 'water-related' ecosystems and subsequently developed a Framework for Freshwater Ecosystem Management[2] to help governments manage freshwater ecological systems[3]. Of all water-related ecosystems, wetlands act as the most productive ecosystem (Ghermandi *et al.*, 2008), but they are prone to major anthropogenic threats or *negative externalities* such as pollution, encroachment, environmentally harmful tourism and over-exploitation (Bassi *et al.*, 2014). The Wetlands (Conservation and Management) Rules 2017, formulated by the Ministry of Environment, Forest and Climate Change (MoEFCC), prescribes various measures to be adopted by state governments to improve the wetlands across India. These measures include preparing 'brief documents', determining their 'wise use', protecting their ecological characteristics, preparing a list of activities for regulation and permission, and developing an Integrated Management Plan (IMP). The Ramsar Strategic Plan 2009–2015 states that a key driving force for the continued deterioration and loss of wetlands is the scarcity of information on the economic value of wetland ecosystem services (WESs); therefore, 'to ensure the wise use of wetlands, it is important to know the values, both costs and benefits, of wetland resources related to the services provided' (Whiteoak & Binney, 2016, p. 1).

Most WESs are 'non-marketed' in nature (Costanza *et al.*, 1997), and therefore, their true opportunity cost is not reflected in the prevailing market prices. Since they are extracted mostly in informal settings – especially in developing countries – the values of the existing WESs

1 https://www.iucn.org/theme/nature-based-solutions/initiatives/decade-ecosystem-restoration.

2 https://www.unep.org/news-and-stories/story/wetlands-and-biodiversity-theme-world-wetlands-day-2020

3 https://www.unep.org/resources/publication/framework-freshwater-ecosystem-management?_ga=2.90012828.665537988.1624694456-1775488713.1624694456

extracted as well as their loss due to over-extraction are not adequately captured by any formal institutions in the economy (e.g.: System of National Accounts). The lack of relevant information on the benefits and costs associated with the changes in WESs, usually derived from individuals' preferences in the case of market goods and services, leads to 'policy failure' in the area of wetland protection and management. Addressing such a failure requires accessing adequate information about the social benefits and social costs resulting from changes in the non-market WESs at different points in time. As the United Nations World Water Development Report 2021 states recognising, quantifying and expressing the values of water and incorporating such values into decision-making are important in achieving sustainable and equitable water management (United Nations, 2021). Information on the economic value is a *necessary condition* for decision-making regarding wetland management. In the absence of such information, we need to deploy scientifically established economic valuation methods to produce *valid* and *reliable* information for making evidence-based policy decisions. In this study, we review some important wetland valuation studies to assess the current status of the economic valuation of WESs, the issues involved in calculating such values and how to strengthen future efforts on economic valuation so that governments can formulate evidence-based policies for an efficient, equitable and sustainable management of wetlands.

Wetland Ecosystem Services

Wetlands, as a non-reproducible natural capital (Barbier, 2011a), supply varieties of highly valuable WESs, which find application in numerous consumption and production activities in the economy. Nature and human well-being are inextricably interlinked to each other, and 'ESs represent an instrumental value of nature as a means to enhance human well-being' (Schroter *et al.*, 2021, p. 290). WESs are various goods and services originating from water bodies such as marsh, swamp, bog and fen (Mitsch & Gosselink, 2015), which, both directly and indirectly, contribute to human well-being (MEA, 2005). They are classified into

a) *provisioning services* (food, drinking water, irrigation water, etc.), b) *regulating services* (flood regulation, groundwater regulation, carbon sequestration, etc.), c) *cultural services* (recreation, spiritual, aesthetic, etc.) and d) *supporting services* (soil formation, biodiversity support, etc.) (TEEB, 2010)[4]. WESs are spatially heterogeneous in nature (Dronova, 2017). The value of WESs may significantly differ across space and time; a small increase (reduction) in their size and quality can have a larger positive (negative) impact, as well as a non-linear impact (Koch *et al.*, 2009), on the well-being of the users; the loss of well-being caused by a small reduction in WESs is much larger than the welfare gain brought about by a similar level of improvement in WESs[5]. When some of unique WESs are lost, they are lost forever (Chavas, 2000), causing irreversible environmental damage and welfare loss to human beings. Depletion and degradation of wetlands due to overuse, which are rapidly taking place across the globe, diminish the quantity and quality of WESs. For example, 35% of wetlands across the globe were lost between 1970 and 2015 (Gardner & Finlayson, 2018), which has profound implications on human well-being. Thus, wetlands as *natural capital* needs to be used 'wisely' (Ramsar Convention Secretariat, 2010) so as to make the flow of income—the WESs—more sustainable. However, what is the value of WESs and how such value changes due to changes in the natural capital need to be systematically and scientifically assessed.

Economic Valuation of WESs: Current Status

Economic value is expressed in terms of individuals'/households' willingness to pay (WTP) or willingness to accept (WTA) compensation for a small change in a good or service under consideration. For a normal market good, the market price reflects WTP and WTA values. For non-market ecosystem services, however, these values are invisible (or hidden

4 The supporting services provide fundamental support to the first three services. Since supporting services enhance the other three services, they are not subjected to the economic valuation due to potential double counting problem.

5 The disparity in the marginal gains and losses arises due to income effect, endowment effect, substitution effect and transaction costs (Venkatachalam, 2004).

in the economic system). The economic valuation exercise makes them visible and objective by measuring them in monetary terms—either by using the variants of the 'revealed preference method' or by using the 'stated preference method' (Champ *et al*., 2017). Therefore, non-market valuation is a process by which a monetary value, reflecting an individuals'/households' marginal WTP/WTA value, is assigned for a small change in a non-market ecosystem good/service preferred by the concerned individual/household.

Economic valuation, however, is a difficult, controversial and highly challenging task (see Barbier, 2011b) because the value calculated should capture the 'true value' of the non-market goods or services being valued. Theoretically, the true value is either the Hicksian 'compensating variation' or 'equivalent variation' (Chipman & Moore, 1980). In reality, the true value equals the market price of that good/service in case it were bought and sold in a competitive market. Since we do not have prices from fully developed markets for most of the non-market goods and services, the second best alternative, namely estimating their monetary values through direct/indirect market price methods (or revealed preference methods), becomes a challenging task. Similarly, economic values estimated through the *stated preference methods* are potentially affected by various *biases* and *errors* if the preferences are not elicited scientifically (Venkatachalam, 2004). Although eliciting *valid* and *reliable* results has been made possible by the tremendous progress in the CV method through extensive empirical research, the transaction cost involved in that process is still substantial, especially in developing countries where the behaviour of the respondents is governed by complex institutions. Economic valuation is also controversial because many critics argue that the valuation exercise tries to put the ecosystem services merely into a 'price jacket', which otherwise are invaluable and incommensurable and cannot be measured in a single monetary unit. In the following section, we will critically review a limited number of empirical studies dealing with economic valuation of WESs so that we could stock-take the progress made in valuing WESs, analyse some of the pertinent issues involved in non-market valuation of WESs, and suggest a way forward.

Empirical Studies

Let us start with some of the global level valuation studies. Costanza *et al*. (1997) pioneered in empirically estimating the economic value of 17 ecosystem services delivered by 16 biomes (including wetlands) using the *benefit transfer method (BTM)*[6]. The estimated annual global value (1997 value) of these services ranges between US$16 trillion and US$54 trillion, with the average value being US$33 trillion. Wetland goods and services contributed US$14.9 trillion per year (minimum), which is equivalent to 45% of the total value of the then global ecosystem services. This implies that the largest contribution to total global ecosystem values comes from the wetlands. Although this is a pioneering study, environmental economists criticised it for not being theoretically and methodologically sound (e.g.: Bockstael *et al*., 2000). Later on, Costanza *et al*. (2014) updated the original values based on additional information on the improved biome area as well as on comprehensive estimates of unit values (per hectare values). The revised global ecosystem values for the year 2011 was $145 trillion/yr. (assuming only unit values have changed) and $125 trillion/yr. (assuming change in both unit value and change in the area of wetlands) – both estimated in 2007 $US values. This value was three times greater than the original value, despite a considerable amount of loss of WESs (US$4.3–20.2 trillion/yr.) during the period from 1997 to 2011. It should be noted that the loss of WESs that increased significantly over a period of time poses a challenge to sustainable human well-being. The results from the aforementioned studies highlight that the ecosystem services are more important in enhancing human well-being than the conventional economic factors (Costanza *et al*., 2017).

Brander and Schuyt (2010) attempted to assess the economic value of global wetlands using the *BTM* and obtained relevant information from 89 of 197 suitable wetland valuation studies. From the selected wetland studies, 246 separate observations of wetland values were extracted based on several variables such as wetland type, income per capita, population density and wetland size. The values were adjusted for price

6 A method used to transfer already estimated values through a process called, meta-analysis (Woodward & Wui, 2001)

differentials in different countries using 'purchasing power parity' (PPP), an indicator used to allow for variability in the prices of commodities in a basket of commodities consumed in different regions. Wetlands were also divided into five types: mangroves, unvegetated sediment, salt/brackish marsh, freshwater marsh and freshwater woodland. Next, a regression analysis was used to obtain the wetland value function, which was used to predict the value of wetlands of policy interest with similar characteristics. Finally, the values were transferred to 3,800 wetland sites, covering 63 million hectares around the world, to calculate the global economic value of wetland benefits. The results revealed that the 'total economic value' (TEV) of 63 million hectares of wetland worked out to be US$3.4 billion per year. It was also found that, with a high population density accompanied by a high demand for wetland goods and services, the wetlands in Asia were found to produce the highest economic value at US$1.8 billion per year. Latin American wetlands generate the lowest economic value because of low population density. Similarly, sediment wetlands produce the highest values (US$374 per ha per year), followed by freshwater wooded wetlands (US$206 per ha per year) (Brander & Schuyt, 2010). Surprisingly, wetland values appear to be relatively much smaller than those in the previous studies (e.g. Costanza *et al.*, 2014), which highlights the challenge in calculating the 'true value'. Yet, the results suggest that the economic valuation of wetlands can help policymakers around the world to recognise wetlands as an important *natural capital* and make a collective effort toward sustainable management of global wetlands.

In a similar attempt, de Groot *et al.* (2012) estimated the global ecosystem values of 10 major biomes[7], including the values of wetland ecosystems, using the *BTM*. They screened over 320 publications, covering over 300 individual case studies conducted across the globe. Of 1,350 value estimates extracted from these case studies, 665 values found to have the required level of information were used for quantifying the global economic values of the selected biomes. As far as wetlands are

7 The biomes are: Open oceans, coral reefs, coastal systems, coastal wetlands, inland wetlands, lakes, tropical forests, temperate forests, woodlands, and grasslands.

concerned, the selected studies provided value data points for inland wetlands (25%), coastal wetlands (mangroves) (21%), tropical forests (14%) and coral reefs (14%). The geographic distribution of the valuation data had a balanced distribution over all the continents: 28% from Asia, 26% from Africa, 14% from Europe, 12% from Latin America and the Caribbean, 12% from North America and 8% from Oceania. For each biome, 22 WESs were considered for economic valuation. While coastal wetlands deliver 193,845 int.US$/year per hectare, inland wetlands generate benefits worth 25,682 int.US$/year per hectare. The issue is that this study considered only 22 WESs, whereas in a developing country like India, some wetlands are found to supply more than 31 services (Venkatachalam, 2022). The values of such locally important WESs are not getting reflected in the global values, and as a result, the values are considered underestimated as far as the developing countries are concerned.

Davidson *et al.* (2019) recalculated wetland values estimated by Costanza *et al.* (2014) using more wetland class areas and WESs of forested wetlands. The recalculated values of wetlands amounted to int.US$47.4 trillion per year (approximately int.US$3 trillion less than the value from Costanza *et al.*, 2014) at 2011 prices, which is 43.5% of the global values (int.US$109.1 trillion per year) originating from all-natural biomes. Of int.US$47.4 trillion, natural coastal wetlands (occupying 15% of the area of all-natural wetlands) delivered values worth int.US$20.4 per year, which is 43.1% of the global economic value of all-natural and coastal natural wetlands. Of all the values from coastal wetlands, coral reefs contributed 49% (i.e. int.US$10 trillion per year). Inland natural wetlands delivered benefits worth of int.US$27.0 trillion per year at 2011 values, and the largest contributions (53%) were from vegetated non-forested wetlands (non-forested peatlands and marshes and swamps), accounting for int.US$14.5 trillion per year. On the other hand, benefits worth of int.US$7.1 trillion per year (i.e., 27% of inland wetland value) were from forested wetlands. Lakes and rivers contributed int.US$5.5 trillion per year (20% of inland wetland value). While the largest contributions were from the wetlands in Asia (33.7% of the regional total), North America (22.3%) and Oceania (18.4%), the largest value for 'inland wetlands' was from the wetlands in North America, Asia and Europe. Davidson *et al*. estimated the value of annual loss of ecosystem services equivalent to int.US$47.8 million, with the largest loss due to forested peatlands. The relative values of wetlands from different regions will have to be interpreted with caution because the conditions of the wetlands, especially in developing countries, are poor and therefore, the values will be low. Estimating the maximum potential values that can be obtained when the wetlands are fully restored can not only increase the total contribution but also change the relative contributions of regional wetlands significantly.

Most of the studies mentioned in this section applied a macroeconomic valuation approach that broadly utilises the *BTM*. Previous studies have provided different results and indicated that there are issues with the macroeconomic valuation methods. In the following section, we will review the studies from developing countries to understand the issues involved in estimating the ecosystem values in a completely different context where the social, economic, institutional, political and ecological factors play a complex role in explaining such values.

Economic Valuation in the Developing Country Context

The Buriganga River acts as a lifeline of Dhaka city but became polluted due to continuous dumping of domestic and industrial wastes and encroachment of riverbanks. Alam (2005) implemented a CV study with a hypothetical clean-up program called the Buriganga River Clean-up Programme (BRCP), which was proposed to be implemented for a 10-year period. The study area was restricted to Dhaka city (i.e. 360 sq. km based on the demarcation of the Dhaka City Corporation), and it was stratified into two constituents, namely, Buriganga River Area (BRA), which is adjacent to the river, and Outside Buriganga Area (OBA). A *payment card* elicitation format and an 'increase in water bill' as a *payment vehicle* were used in the survey design; nearly 400 households (from a total of 6,43,016 households) in the city were interviewed in 2001. The results of the CV study suggest that 25.5% of the sample households were willing to contribute cash equivalent to Tk 51.91 (US$2.73) per household for the BRCP, and 32.75% of them were willing to contribute 'time' for the BRCP by providing their services in terms of physical labour, participating in campaigns and public awareness-building programs, organising meetings and rallies, contributing towards technical and non-technical office work and providing consultancy services. It should be noted that the households willing to contribute labour for the restoration programme were higher than the households willing to contribute cash. It was found that the annual per capita income of Bangladesh in 2001 was only US$387, and 55% of the residents in Dhaka city were living below the poverty line. Yet, they were willing to pay for improving the environmental quality of the river by rendering their labour services. The study did not disclose the measures adopted to minimise *biases* and *errors*, which are usually encountered in CV studies. Despite this issue, the study clearly shows two aspects in a developing country context: a) in a poor country, people are willing to pay for restoration programmes but more in terms of labour, which is relatively abundant, and b) the CV scenario employed should take into account the site-specific socio-economic, cultural and political factors for arriving at useful results.

Barbier (2007) used a micro-valuation tool, such as the *production function approach*, to value the habitat service of mangroves (supporting fisheries in terms of spawning grounds and nurseries for fry) in Thailand. Based on the data on changes in the mangrove area and fish caught over some time, the 'net present value' (NPV) of the loss of fish due to reduction in mangroves turned out to be between US$1.5 and US$2.0 million (lower deforestation) and between US$0.28 and US$0.37 million (higher deforestation). The marginal value of the habitat service provided by a hectare of mangrove for fish and shellfish production was US$135.44 per hectare per year (when the demand was not much responsive to price changes), but only US$3.98 per hectare per year when the demand was highly responsive to price changes (1993 dollars) (see also Barbier, 2013). While this valuation study demonstrates that an environmentally benign land use policy with regard to mangroves would bring significant social benefits to society, it also highlights the challenges of economic valuation arising from the complex ecological and economic relationships as well as the uncertainties arising from irreversibility, etc.

Korsgaard and Schou (2010) critically evaluated 27 valuation studies conducted in developing countries dealing with the *direct use values*, *indirect use values* and TEV of aquatic ecosystems. They found that the TEV of aquatic ecosystem services was in the range from US$30 to US$3,000/ha/year or US$10 to US$230/capita/year. The values were found to be scattered due to the valuation method used, the context of the study and the type of ecosystem valued. The authors identified four main premises for the valuation of aquatic ecosystem services, namely, acknowledging the assumptions of marginality and substitutability; using the TEV framework that includes both *use* and *non-use values*; defining spatial (geographical extent of the services and location of the beneficiaries), socio-economic (different value of WESs to different groups of people) and temporal scale (change in the WESs and their values over a period); and appropriately dealing with *uncertainty* (e.g. the non-linear impact of WESs). These premises are important for strengthening valuation studies in developing countries. The authors concluded that although economic valuation methods have some disadvantages, their wise use helps in raising awareness about the roles and values of ecosystem services for decision-making and enhanced human well-being.

Another empirical study related to coastal wetlands by Tan *et al.* (2018) demonstrated that the economic valuation of environmental improvements could help policymakers design socially efficient coastal wetland restoration strategies. With a focus on mangrove area, biodiversity and water quality, the study demonstrates how wetland restoration attributes, payment and individual characteristics influence the public support for coastal wetland restoration in the Ximen Island Special Marine Protected Area, China. The study employed the Choice Experiment (CE), and 201 randomly selected respondents in wetland regions were interviewed, which generated 1608 observations. Although most of the respondents expressed positive and significant economic values from wetland restoration, younger and better-educated respondents were more likely to provide support for the restoration. Moreover, regression results revealed that the size of the mangrove area was the most important attribute that needed to be considered in the restoration strategy design as it was highly valued by the respondents. The economic values derived for modest, moderate and ambitious restoration measures were ¥302.30 (US$43.5), ¥434.25 (US$62.5) and ¥551.29 (US$79.4) per respondent, respectively. The values could be used by policymakers to calculate the costs and benefits of the coastal wetland restoration projects or to calculate how much payment is needed for financing the restoration projects. The values are useful in determining level of subsidy in case the costs exceed the benefits of restoration.

Lamsal *et al*. (2015) studied the socio-economic factors determining the participation of the local community in the conservation of the Ghodaghodi wetland in Nepal, as well as the value of ecosystem benefits that they derive from it. The study utilised a primary survey among 217 households in the wetland region and found that approximately 37% of indigenous households and 23% of migrant households received income of between NPR 5,000 (US$71) and NPR 10,000 (US$142) from the wetland. The rest 4% of indigenous households and 2% of migrants received an income between NPR 10,000 (US$142) and NPR 15,000 (US$214), respectively. On average, a sample household received annual benefits worth NPR 4,379 (US$63), which is equivalent to 12.4% of the households' gross annual income. It should be noted that the current income derived from the wetlands may be low due to poor quality of the wetland. When the wetlands are restored, the income may increase considerably, which the study has not highlighted.

Baral *et al*. (2016) studied the Jagadishpur Reservoir, a Ramsar site in Nepal, to estimate its TEV. The study prioritised six values that include two *direct use values* (i.e. wetland goods consumption – fish, edible foods/fruits, tortoise and tourism) and three *indirect use values* (i.e. carbon sequestration, water supply and biodiversity conservation), and the *option value* (i.e. conservation of the reservoir for future use). The study employed various market price and survey-based valuation techniques separately for *direct, indirect and non-use values* to estimate the TEV of the reservoir. The study found that fish was the main good consumed from the wetland, contributing to more than 95% of the total value of the wetland goods. The CVM results revealed that in addition to cash, the respondents were willingness to contribute in terms of labour, which is an interesting finding in a developing country context. The study concluded by stating that out of the TEV, *non-use values* contribute more than half of the total value of the reservoir followed by *direct* and *indirect use values*. This implies that the local community gives high importance to the future use of wetlands, thereby laying more emphasis on adequate restoration and sustainable management.

In the Indian context, Verma (2001) made a pioneering attempt to estimate multiple ecosystem values of an urban wetland—the Bhoj wetland in Bhopal, Madhya Pradesh. The primary benefits estimated include drinking water, fish production, recreation (boating), water purification and enhanced property values, in addition to secondary benefits such as income and employment from wetland-based economic activities. Using various revealed and stated preference methods, the author calculated the total benefits of the Bhoj wetland at Rs. 177.3 (US$3.95) million per annum. Although this is a pioneering wetland valuation study in the Indian context, the values estimated suffer from the *double-counting* problem as both primary and secondary benefits have been valued together. To avoid this issue, the valuation exercise should mainly focus on the value of the primary benefit (fish) and not the secondary benefit (employment) whose value (e.g. in terms of wage) is already captured in the economic system.

The Chilika wetland in Odisha is one of the largest coastal wetlands in India. Kumar and Patnaik (2012) focused on monetising some of the important *use values* (using the market price method) and *non-use values* (using CVM) of the Chilika wetland. The market value of fish caught and the benefit generated in the ancillary industry that used fisheries as input were Rs. 768.82 (US$14.4) million and Rs. 215 (US$4.02) million per annum, respectively. The results of the travel cost method (TCM) revealed that domestic and international tourists enjoyed recreational benefits worth Rs. 2,336 (US$43.71) million per annum. The navigation value provided by the wetland was calculated based on the revenue occurring to the Chilika Development Authority, which is equivalent to Rs. 0.72 (US$0.014) million per annum. The aggregate 'use value' was Rs. 3,320.54 (US$63.00) million per annum. The aquatic vegetation harvested by the local communities was equivalent to 58,000 MT, and its economic value was Rs. 34.7 (US$0.65) million per annum. The aggregate *non-use values* from all the beneficiary households, estimated through CVM, amounted to Rs. 858.78 (US$16.07) million. The values clearly demonstrate how the coastal wetlands act as an important source of livelihood and address poverty as well as act as *natural capital* in enhancing regional sustainable development. However, this study also suffers from *double-counting* problem due to combining the primary and the secondary benefits, in addition to the problem of potential *biases* and *errors* in the CV estimates, which altogether would have adversely affected the final results.

The Pallikaranai marshland in the Chennai Metropolitan Area (CMA) has been under tremendous pressure from severe *negative externalities* such as encroachment and pollution. In 2011, the government of Tamil Nadu proposed to restore the marshland with an investment of Rs. 157.5 (US$2.90) million. Venkatachalam and Jayanthi (2016) quantified the ecosystem benefits enhanced by the proposed restoration measures. The results from a well-designed CVM conducted among 733 randomly selected households revealed that each household in the CMA would gain a restoration benefit worth Rs. 2,096.59 (US$39.00) annually during a five-year period starting from 2011. This translates into a total restoration benefit of Rs. 2,340.00 (US$36.50) million per annum (2015 prices). The expected benefits are significantly higher than the cost of restoring the marshland, which implies that restoration of the marshland can significantly enhance the welfare of the city population on a long-term basis.

When a wetland is converted into a protected area, what is the trade-off to its ecosystem services? How the economic valuation highlights such a trade-off? The Ousteri wetland, jointly managed by the Tamil Nadu and Puducherry governments, was fully converted into a bird sanctuary in 2014, which resulted in preventing traditional stakeholders in 10 neighbouring villages from continuously using various WESs from the wetland. In the context of such trade-off, Venkatachalam and Zareena (2016) could identify only a limited number of ecosystem services, such as recreational service, groundwater irrigation and biodiversity, for valuation. The recreational benefits estimated by using the TCM amounted to Rs. 5.72 (US$0.09) million per annum; the agricultural benefits, estimated by using the *net income method*, amounted to Rs. 11.5 (US$0.2) million per year. The estimated value of groundwater used for irrigation was Rs. 2,69,652.00 (US$4,243.14) per year. The economic value of biodiversity conservation, elicited by using a well-administered CVM, was Rs. 2.44 (US$0.04) million per year. The TEV of ecosystem services was Rs. 19.67 (US$0.31) million per year (in 2015 prices), and the *net present value* of the benefits (with the discount rate being 6) was Rs. 83.00 (US$1.30) million for a five-year period. The value was meagre because the conservation measures restricted the traditional users from accessing many WESs, resulting in huge welfare loss. An important policy conclusion from the study is that involving people in conservation measures and allowing them to utilise various WESs would significantly enhance future ecosystem benefits and economic welfare.

When the wetlands are embedded in another biome, what kind of complexity do we face in valuation? Verma *et al*. (2019) calculated the ecosystem values of India's tiger reserves that imbed the wetlands as a sub-category. Twenty-seven ecosystem services, including some of the WESs, from 10 tiger reserves were considered for valuation. The study utilised the 'Value+' approach by estimating the economic values in monetary units, wherever possible, and accounting for other ecosystem services (for which monetary valuation is not possible) only in terms of non-monetary indicators. The monetary values were estimated within the TEV framework by using various economic valuation approaches, including *BTM*. The value of ecosystem services of the 10 tiger reserves ranges from Rs. 50,949.10 (US$723.61) million to Rs. 1,62,021.10 (US$2,301.11) million per annum. Of the total annual benefits from all ten tiger reserves (ranging between Rs. 42,303.10 (US$600.81) million and Rs. 1,34,193.7 (US$6,906.00) million), the direct benefits were in the range of Rs. 89.70 (US$1.30) million to Rs. 1,018.70 (US$14.50) million, and the indirect benefits were in the range of Rs. 42,213.40 (US$600.00) million to Rs. 1,33,175.00 (US$1,891.42) million per annum. However, the benefits of the wetlands within the tiger reserves were embedded in the total values estimated but were not separately identified. This shows that when biomes are embedded, the values of the individual biomes can be quantified only jointly. The study has some limitations. The *substitution effect* (namely, WESs from one tiger reserve becoming substitutes for another reserve) has not been considered in the value estimation, and therefore, the values are overestimated. Adopting the 'marginal approach' is important in economic valuation, but the study adopted a 'total value approach', which is problematic. From an economic view point, the values of the existing reserves do not matter much, but it is the marginal changes in the reserves that do matter for decision-making. Similarly, *double-counting* is another problem with the study since its values of the *primary benefits* and the *secondary benefits* were estimated jointly. Similar to Ousteri Lake, the 'protected areas' are restricted for human use, and therefore, the values reported in the present study may be overestimated as all the 27 WESs considered for valuation might not have found any human use. Despite all these problems, the study highlights the importance of measuring the ecosystem values within a 'Value +' framework including both *tangible* and *intangible benefits* as well as the need for protecting the tiger reserves for managing the embedded wetlands and promoting human well-being.

Table 1: Summary of results of the economic valuation studies on WESs.

Author(s)	Ecosystem services valued	Valuation method	Monetary values of WESs
Costanza *et al.* (1997)	17 ESs (including WESs) delivered by 16 biomes at the global level	Benefit transfer method (BTM)	Annual global value was US$14.9 trillion (1997 prices)
Verma (2001)	WESs of the Bhoj wetland in India	Revealed and state preference methods	US$3.95 million per annum
Alam (2005)	Ecosystem services from river restoration in Bangladesh	Contingent valuation method (CVM)	Average WTP cash is US$2.73 per household
Barbier (2007)	Mangrove ecosystem services in Thailand	Production function approach	The value ranges between US$135.44/ha/year (with more demand) and US$3.98 per hectare per year (with less demand)
Brander and Schuyt (2010)	WESs of 63 million hectares of wetlands	Benefit transfer method (BTM)	US$3.4 billion per annum
Korsgaard and Schou (2010)	Aquatic ecosystem services in developing countries	Benefit transfer method (BTM)	Per hectare value ranges between US$30 and US$3,000 per year
de Groot *et al.* (2012)	22 types of WESs	Benefit transfer method (BTM)	Per hectare value ranges between 193,845 int.US$/year and 25,682 int. US$/year

Author(s)	**Ecosystem services valued**	**Valuation method**	**Monetary values of WESs**
Kumar and Patnaik (2012)	Limited WESs of Chilika wetland, India	Market price methods and contingent valuation method	Total economic value is equivalent to US$79.00 million per annum (2012 prices)
Costanza *et al.* (2014)	Updated the values estimated in Costanza *et al.* (1997)	Benefit Transfer Method (BTM)	Annual global value was estimated to be US$50.7 trillion (2011 prices)
Lamsal *et al.* (2015)	WESs from Ghodaghodi wetland in Nepal	Market price method through primary survey	Annual value is US$63 per household
Venkatachalam and Jayanthi (2016)	Restoration value of Pallikaranai marshland	Contingent valuation method (CVM)	Total restoration value is US$36.50 million per annum
Venkatachalam and Zareena (2016)	WESs of the Ousteri wetland, India	Revealed and stated preference methods	Total economic value stood at US$0.31 million per year (in 2015 prices). Too small a value because of the governments restricted access to most of the WESs
Tan *et al.* (2018)	WESs of Ximen Island Special Marine Protected Area, China	Choice experiment (CE)	Values for modest to ambitious restoration levels range from US$43.5 to US$79.4 per person

Author(s)	Ecosystem services valued	Valuation method	Monetary values of WESs
Davidson *et al.* (2019)	Re-estimated the values of Costanza *et al.* (2014)	Benefit transfer method (BTM)	Re-estimated global values stand at int. US$47.4 trillion per year
Verma *et al.* (2019)	Total economic value of ecosystem services (including WESs) from 10 tiger reserves in India	Market price method and benefit transfer method (BTM)	Value of ecosystem services of all the 10 tiger reserves is estimated to be US$723.61 million to US$2,301.11 million per annum

Discussion and Conclusion

The review of limited empirical studies focusing on wetland valuation provides many important lessons. As Schroter *et al*. (2014) argued, the ES concept that links ecosystem benefits to human well-being concentrates more on the 'anthropocentric value', rather than the 'intrinsic value'. This is getting reflected in almost all the empirical studies we reviewed. The assumption behind these studies is that the monetary value expressed in terms of individual preferences does accommodate the *intrinsic value* as well, and therefore, the anthropocentric approach is sufficient to support the conservation and sustainable use of the environment. Another criticism is that the process of assessments involving monetary valuation tries to put a price on everything, making it unethical. However, the monetary valuation provides useful additional information in decision-making processes, and researchers are also using other techniques (e.g. *multi-criteria analysis* and *Value+ approach*) that take into account other non-monetary values. As economic value is only a *necessary* condition and not a *sufficient* condition for wetland management, along with monetary valuation, more biophysical and socio-cultural value indicators of WESs should also be developed to improve the management decisions (Schroter *et al*., 2014).

Wetlands generate varieties of material and non-material ecosystem services. However, the economic valuation practitioners at present focus mainly on material services. As Small *et al.* (2017) argued, significant efforts must be taken to include non-material services in the existing ES framework because the inclusion of these values will increase our understanding of human–nature interaction as well as enhance sustainable management of wetlands. There is a need to disaggregate beneficiaries of WESs using a place-based context to reflect how societies across the globe are composed of different communities, groups and individuals with diverse competing needs at different phases of life and how each individual or group prioritise different aspects of the ecosystem services that reflect trade-offs among the services. It should be noted that when the ecosystem services with non-material characteristics are concerned, they should be classified as '+' services (non-monetisable) in the 'Value+ approach' (see Verma *et al.*, 2019) which is developed to capture both monetary and non-monetary values that would assist decision-making.

One of the areas that pose major challenge is estimating the value of wetland-based biodiversity. Nunes and Bergh (2001) argued that prior to economic valuation, adequate knowledge on the biodiversity values in terms of instrumental vs. intrinsic values, monetary vs. biological indicators, direct vs. indirect values, biodiversity vs. biological resources, the value of levels vs. changes of biodiversity, local vs. global diversity, genetic vs. other life organisation levels, holistic vs. reductionist approaches and expert vs. general public assessments is essential. These distinctions are important for making the valuation process more useful and for avoiding certain pertinent issues – e.g. *double-counting* – encountered during monetary valuation.

Many empirical studies we reviewed have categorically demonstrated that wetlands, among all the biomes, supply highly valuable WESs, enhancing human well-being. However, these values are considered underestimated since many important WESs, such as carbon sequestration and biodiversity protection, were not fully monetised and included in the estimated values. Similarly, most of the studies have either not quantified the *non-use values* or have not clearly distinguished these values in the valuation process. If the *non-use values* are also included as part of the valuation exercise, then the marginal increase in the value calculated will become significant. Similarly, the studies also have not captured the change in the future values of wetlands. For instance, the temporal values arising from the arrival of new bird species, the creation of recreational benefits and mitigation of sea-level rise can shift the current values significantly, but they are not adequately represented in the valuation studies.

Another issue with most of the valuation studies is that the trade-offs between different ecosystem services are not properly taken into account in the process of valuation. For example, some of the wetlands have been declared as 'protected areas' or 'sanctuaries' for enhancing biodiversity, which is a highly valuable WES. However, such measures deny the traditional users of their access to various other WESs that they utilised before such conservation efforts have been initiated. Similarly, many multipurpose wetlands in India are now converted for a single use—e.g. for diverting drinking water under the National Water Policy 2002 directive—and such a measure deprives the access to the traditionally used WESs such as irrigation and fishing. The review clearly demonstrates that providing people with access to WESs and appropriately regulating their use can increase the benefits manifold. Another issue that has not been addressed adequately in the current valuation literature is the valuation of *disservices* (such as invasive species) (Lyytimaki, 2014). The current valuation practices do not usually make a clear demarcation between the ecosystem *services* and *disservices*; rather, they put all of them in one basket without clearly identifying the positive and negative values associated with the respective values. Similarly, the studies have mainly focused on the benefits and not much on damage; as a result, the values of the benefits estimated are overestimated. In the future, studies should consider estimating both the benefits and costs associated with the changes in ecosystem services, separately.

Many of the studies using *BTM* assume that wetlands generate all types of WESs as would a typical wetland, and therefore, they estimate all the values by assigning maximum values to these wetlands. In reality, many wetlands that suffer from various negative externalities supply only a limited number of services. Similarly, the services delivered are assumed to be of high quality, and therefore, they assign a maximum value to these services. However, many services are of poor quality due to depletion and degradation of the wetland, a scenario widely seen in developing countries. As a result, the values estimated using the *BTM* are considered inflated. Similarly, some of the ecosystem benefits that are locally important (e.g. cow dung and fuelwood) are not included in the *BTM*, leading to underestimation. Similarly, individual wetlands are unique and can generate a variety of ecosystem services that are diverse in nature. *BTM*-based studies have not adequately captured the uniqueness and the diversity of many ecosystem services of the wetlands; rather, these studies utilised a 'standard global value' to estimate the benefits of all the wetlands uniformly; as a result, the 'per hectare value' estimated for all different types of wetlands are mostly constant, undermining the uniqueness and the diversity of the wetlands. This argument is supported by studies focusing on individual wetlands and using micro-valuation techniques, which have reported a wide range of values across the WESs and across the wetlands. Another related issue is that some of the WESs not used by human beings may not be subjected for monetary valuation, which is 'anthropocentric' in nature; these services in principle should be excluded from the valuation to avoid potential overestimation. Prior to valuation, a scientific understanding of the complex ecological and hydrological aspects of the wetlands should be the prerequisite for initiating monetary valuation exercise so that economic values adequately reflect the interdisciplinary aspects of wetland ecosystems.

The CVM is a widely used method for wetland valuation, especially in developing countries. An important issue is that wetland-based WESs play a significant role in the lives of poor households in rural areas; however, these households assign a lower WTP value due to income constraints and other institutional issues. This provides a misleading picture of the role of wetland WESs in explaining the welfare gained from them. To address this issue, the CV method should be combined with revealed preference methods; the results should be interpreted properly by taking into account the prevailing socio, economic, cultural, political and institutional context in which the values were elicited. Therefore, relevant qualitative data in sufficient quantity should be supplemented with quantitative data used in monetary valuation. Another issue is that the developing country CV practitioners undermine *validity* and *reliability* issues encountered in the CV results, which may lead to wrong policy decisions. To address these issues, CV practitioners should strictly follow the standard CV guidelines (Venkatachalam, 2004) and should accept a higher transaction cost (arising from, e.g. more time spent on testing the biases in the field) of conducting the survey to elicit the true value. In order to overcome these issues, more valuation studies should be initiated in a systematic and scientific manner for individual wetlands.

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Madras Institute of Development Studies (MIDS) was founded in 1971 by Malcolm S. Adiseshiah. It studies development problems of India, with a special focus on Tamil Nadu. Since 1977, MIDS is a national institute funded jointly by the Indian Council of Social Science Research and the Government of Tamil Nadu.

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