Economic Valuation of Wetlands: Case Studies

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Abstract

Economic valuation is recognized as an important tool to incorporate the value of nature into decision making on wetlands, but its application in the policy process is still a challenge. Valuation can be applied at different scale levels (from local to global) and a range of different methods is available. In this paper, four examples of valuation studies at different scales are reviewed: a global study estimating the value of the world's wetlands using the benefit transfer method; a study of the Kala Oya River Basin in Sri Lanka using a cost-benefit analysis of four management scenarios; a study of Randers Fjord in Denmark using a contingent valuation study to estimate the value of water quality improvement; a study of Nakivubo wetland in Uganda using market value and the replacement cost

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method; and a study of shrimp farming in Thailand which uses the production function and expected damage function approaches. These cases demonstrate that estimation of indirect use and of non-use values is more challenging than estimating direct use values, both in terms of the availabe valuation methods and in terms of uncertainty around the outcomes. However, the indirect use values are usually much higher than the direct use values, which emphasizes the need for governments to incorporate estimates of these values in their decision making processes to avoid the loss of the ecosystem services represented by these high values.

Keywords

Economic valuation of wetlands · Decision-making · Ecosystem services · Trade-off analysis

Introduction

Economic valuation is now recognized as an important tool to incorporate the value of nature into decision making and to prevent the further loss of biodiversity and natural resources in the world (Costanza et al. 1997, 2014; de Groot et al. 2006; Russi et al. 2013). However, valuation of ecosystem services has limitations, and the application of economic valuation in the policy process at different governance levels (river basins, countries, wetland sites) is still a challenge. Values by definition are instrumental, anthropocentric, individual-based, subjective, context dependent, marginal, and state dependent (TEEB 2010). There is an ongoing debate about the concept of valuation and the utilitarian approach to valuation of ecosystem services as opposed to the ethics around the intrinsic value of ecosystems (Tallis and Lubchenco 2014). Also, governments and nongovernment organizations involved in decision making about wetlands face challenges when applying valuation methods for different ecosystem services. Because of gaps in the literature on the values of wetlands, the existing data should be seen as indicative, and further research and capacity building are needed to support the application of economic valuation in wetland policy and management (TEEB 2010).

The selection of the valuation method depends on a range of factors. Each wetland site has its own biophysical characteristics and its own group of stakeholders, making each valuation case unique. Valuation methods differ in the degree of necessary resources, require different levels of stakeholder involvement, and provide different kinds of information. Methods thus have advantages and disadvantages, and adopting a valuation method implicitly means adopting a certain model of how humans and nature interact (TEEB 2010). To give an idea of the application of different methods, in this overview we present some examples of economic valuation case studies at different scale levels (global, at wetland site level) and with different objectives (e.g., for management decision making).

Economic Valuation of the World's Wetlands

A number of valuation studies attempted to estimate the value of the world's ecosystems on a global scale. These studies use the "value transfer" approach (Schuyt and Brander 2004; Brander et al. 2006; Costanza et al. 2014), in which statistical relationships (using regression analysis) between wetland characteristics (such as wetland type, income per capita, population density, and wetland size) and the economic value of the wetland are estimated for known wetlands. The data for these relationships are obtained from individual wetland valuation studies. Then, these relationships are applied to a much larger number of wetlands (for which the characteristics are known), assuming that the same relationship with economic value exists. This form of value transfer is called "function transfer" and uses the characteristics of the wetlands to obtain a more accurate estimate of value. "Direct value transfer" simply applies the value per hectare of a study wetland to another wetland, without considering characteristics such as wetland type, population, etc. A study to estimate the value of the world's wetlands used a regression analysis of 89 wetlands with the resulting value function being applied to 3,800 wetlands around the world (with a total surface area of 63 million hectares) to obtain a global economic value of 3.4 billion US$/year. The highest benefits were found in Asia with an economic value of 1.8 billion US$/year (Brander and Schuyt 2010).

A first estimate of the value of the world's ecosystems was published by Costanza et al. (1997). They estimated the total value of the world's ecosystems at 45,900 million US$/year (converted to 2007 dollars), of which wetlands, coastal ecosystems, and lakes and rivers (all within the Ramsar definition of wetlands) represented 26,300 billion US$/year. In a recent paper, they updated their earlier estimates and arrived at 56,600 million US$/year for the same wetland categories (Costanza et al. 2014). This increase was mostly caused by better recent estimates of the value of ecosystem functions compared to 15–20 years ago. Applying the current value estimates to both the 1997 and 2011 ecosystem areas, the loss of ecosystem services from all biomes in the world due to land use change was estimated between 4.3 and 20.2 trillion US$ per year.

A common critique in connection with benefit transfer at this large scale is that the wetlands to which the regression equations are applied are often different in terms of size, the functions and services provided, and the socioeconomic characteristics. Transferring estimated values from one study to another and aggregating them at larger scales creates inaccuracies. As an illustration, the per ha value from the two studies cited above were US$ 54 and 7,536 (assuming 1997 dollars), showing the large differences that can occur when aggregating numbers from widely varying wetland types. Some of this can be avoided by using more sophisticated value transfer methods that take into account wetland characteristics and expert opinion. The most recent models use spatially explicit information and even include dynamic function modeling to increase the precision of the estimates. The main objective of these large-scale estimates of economic value is a reframing of nature as natural capital, one of the important assets contributing to human well-being (next to built capital, human capital, and social capital) and to raise awareness of the importance of incorporating the value of nature in decision making (Costanza et al. 2014).

Wetland Site Valuation Case Studies

Kala Oya River Basin, Sri Lanka

The Kala Oya River Basin in Sri Lanka covers an area of about 2,870 km^2 and expands over three provinces and four districts. The basin includes different types of ecosystems and different forms of land use. The river basin is characterized by serious ecosystem degradation and has known several conflicts between resource users (Vidanage et al. 2005; Emerton et al. 2005). Part of this system consists of human-made wetlands for water storage that are locally known as “water tanks.” These tanks store water for rice production but also provide fish, lotus flowers, and roots that contribute to household incomes. The tanks also contribute to maintaining water quality in wells and are a source of drinking water and fodder for livestock. Unsustainable land use and an increased demand for water in the catchment have led to a reduced inflow of water into these water tanks and an increase in sedimentation. Until now, tank management consisted of mechanically raising the spillway of the sedimented tanks in order to rapidly restore their capacity for water storage. Although in the short term this was the least expensive and required the least effort, in the long term this method is not the most cost effective. Raising spillways does not reduce tank sedimentation and wetland degradation – it merely postpones it and does nothing to address its cause. A valuation study was done to come up with a better, cost-effective management strategy for the future.

The valuation study consisted of two parts. Direct use values of the wetland (provisioning ecosystem services: resources that could be bought or sold such as water, crops, and fish) were estimated according to their market prices based on a participatory rural appraisal (PRA) and focus group discussions (FGD) to understand what the tanks were used for. Indirect use values (regulating ecosystem services: ground water and subsurface water recharge, sediment and nutrient retention, and biodiversity) were valued qualitatively using a plus/minus system that was applied to four future management scenarios. The natural capital of the system (the ability of the tanks to provide ecosystem services in the long term) was also assessed qualitatively. Results showed that the tanks yielded an average value of US$ 425 per household per year in terms of water and aquatic resource use or almost US$ 3,000 per hectare of inundated area. A cost-benefit analysis of the four scenarios showed that net benefit of the most expensive scenario was the highest. This scenario also scored highest on the ecosystem services and natural capital indicators (see Table 1).

Scenario 4 was selected because in the long run this scenario would prove the most beneficial to the community. The findings of the Kala Oya study underline the importance of looking at livelihoods and environmental values when land use and water allocation decisions are made. Before the valuation took place, there was a

Table 1 Comparison of four future management scenarios for wetlands (water tanks) in the Kala Oya River Basin, Sri Lanka. Net present value (NPV) was estimated using participatory methods. Indirect use values were estimated using qualitative methods (Adapted by permission from Emerton 2005, © 2005 IUCN)

Future management scenario	Direct use values (NPVin US$ per tank)	Indirect use values	Natural capital
1. Do nothing. Here, sedimentation loads remain the same or increase, and tank wetlands continue to deteriorate	0	−7	↓↓
2. Raise the spill. Here, the water body will grow, and additional land will be flooded, but sedimentation loads remain the same or increase	23,800	−4	↓
3. Raise the spillway and rehabilitate the area around the tank. Here, the water body will grow, additional land will be flooded, and future sedimentation loads will be reduced, thus prolonging the lifespan of the wetlands	28,800	6	↑
4. Remove the silt and rehabilitate the tank reservation. Here, original tank capacity and seasonality is restored, and future sedimentation loads will be reduced, thus prolonging the lifespan of the wetlands and restoring their ecosystem goods and services	57,900	7	↑↑

lack of ownership feeling by the community, who placed the responsibility for upkeep of the tanks with the (local) authorities. The valuation made the community realize that their tanks not only support their agricultural activities but also fishing, collecting lotus flowers, weaving mats, water for livestock, etc. There is now a general acknowledgement of the value of the tanks. Further improvement would be a mechanism to ensure community participation in regular maintenance of the tanks as well as more thorough maintenance and repair by the (local) authorities.

An Initial Economic Evaluation of Water Quality Improvements in the Randers Fjord, Denmark

Randers Fjord is a 27 km long shallow estuary in the County of Arhus on the east of Jutland, Denmark. The Fjord is located in the Gudenå catchment which has an area of 3,260 km^2. Land use in the catchment is dominated by agriculture (64% of land use), but there are also industrial activities and urban areas with associated wastewater discharge. Randers Fjord is used for tourism and recreational activities like sports fishing, water sports, swimming, and camping. Wastewater discharges and agricultural runoff have led to a tenfold increase in nitrogen and phosphorus loading compared with natural levels in the Randers Fjord. Increased microalgal growth and sedimentation of organic matter caused decreased light penetration and a marked decrease of submerged aquatic vegetation (eelgrass beds).

An economic analysis of the implementation of European water quality legislation (the EU Water Framework Directive) was done to weigh the costs and benefits of reduced eutrophication of Randers Fjord (Atkins and Burdon 2006). A contingent valuation study collected data on the public's preferences for water quality improvements by reducing the level of eutrophication. The data were collected by a postal survey, in which a hypothetical 10-year action plan was presented which would improve water quality and clarity. It was explained that to implement the plan, an increase in local taxes would be required, and respondents were asked if they were willing to pay a tax for this purpose and if so, how much they would be willing to contribute per month. After a pilot survey, the main questionnaire was sent to 1,510 individuals and 15% of them responded. Respondents were diverse in terms of personal characteristics (63% males, 68% in the 30–60 year age group, and from a wide range of income groups). Their uses of the fjord were mostly recreational (recreational hunting/fishing 11%; walking, jogging, and running 12%; bird/wildlife watching 9%; enjoying the views and the sounds of the water 22%). Only 43% of the respondents knew about eutrophication before the survey, and 36% had seen the effects of eutrophication in the fjord themselves. Results indicated that 70% of the respondents "definitely or probably" supported the proposed action plan that would return the Fjord to its pre-1915/1916 (pristine) conditions. Average maximum willingness-to-pay was €12.02 per month over the suggested 10-year period of the action plan. At the Arhus County level, this implies potential total benefits in the region of €5.5 million per month over the 10-year period. These survey findings indicate that the residents of Arhus County value reduced eutrophication in the Randers Fjord. Further statistical analysis of the survey evidence will provide greater insight into the preferences for such water quality improvements.

Nakivubo Swamp, Kampala, Uganda

Almost one sixth of the capital city of Uganda, Kampala, is covered by wetlands. Of these wetlands, the Nakivubo swamp is the largest one, covering an area of over 5 km^2 with a total catchment area of 40 km^2. It is dominated by papyrus (*Cyperus papyrus*) vegetation but also has cattails (*Typha* sp.), common reeds (*Phragmites* sp.), and *Miscanthidium* grass. Due to its location, Nakivubo swamp functions as a buffer through which most of the city's wastewater passes before being discharged into Lake Victoria. Over the last decade, Uganda has experienced rapid economic as well as population growth. The urban population, which now comprises over 14% of the total population, is increasing with 5% per year. This creates a pressure to convert Kampala's wetlands for residential and industrial development, with the argument that the "undeveloped" wetland is not worth much compared to industrial and residential areas. A valuation study was therefore done to estimate the economic value of the wetlands' wastewater purification and nutrient retention functions (Emerton et al. 1999).

The direct use values (wetland resources or provisioning ecosystem services) of Nakivubo swamp consisted mainly of agriculture, papyrus production, brick

Table 2 Economic valuation of Nakivubo wetland, Uganda. All values are in thousands of US Dollars converted from Uganda Shillings (using 1998 exchange rate) (Adapted by permission from Emerton et al. 1999)

Economic benefits	Current value ('000 USD/year)	Value per unit area ('000 USD/ha/year)
Wetland resources		
Crop cultivation[a]	88.8	0.90
Papyrus harvesting	14.0	0.92–3.46
Brick making	25.8	2.02
Fish farming	4.9	0.26–1.51
Total direct values	133.6	–
Wetland services		
Water treatment and purification[b]	1006–1866	2.44–4.06
Total indirect values	1006–1866	
Total wetland value	1140–2000	

[a]Excluding dryland cultivation value (71.9)
[b]Excluding reticulation (upkeep water network-small channels) costs (282.3)

making, and fish production of which agriculture provides over two-thirds of the economic value. By comparing the production value of irrigated crops (through the wetland) to rainfed crops as well as the additional savings on the purchase of fertilizer as would be necessary for areas outside of the wetland basin, the direct use value of the wetland can be calculated. For the indirect use values (or regulating ecosystem services) of the wetland, two valuation methods were used: valuing the avoided cost of replacing natural wetland functions with human-made alternatives; and valuing of foregone expenditures on mitigating or offsetting the effects of wetland loss. These methods estimate the costs of having to supply equivalent wastewater purification and nutrient retention services by other means and of moving the water intake for drinking water production, both in case Nakivubo wetland would no longer be there. The replacement costs included connecting Nakivubo channel to a sewage treatment plant which could absorb the wastewater load as well as the construction of elevated pit latrines to prevent sewage from low-cost settlements to enter the wetland. To compensate the effects of reduced water quality due to wetland loss would require the inflow from Kampala's water supply to be moved to a different location away from where the wastewater flows into Inner Murchison Bay. The National Water and Sewerage Corporation (NWSC) had already calculated the cost for these works for earlier projects which were never implemented. The cost of building pit latrines was obtained from a part of Kampala with similar circumstances.

Results showed that the wastewater purification and nutrient retention services of Nakivubo swamp had an economic value of between US$ 1 million per year (using the replacement cost method) and $1.75 million per year (using the mitigative expenditures methods) (Table 2). Even taking account of the costs of managing the wetland to simultaneously optimize its waste treatment potential and maintain its ecological integrity (some US$ 235,000) resulted in a significant net benefit. The high economic value of Nakivubo wetland for nutrient retention and wastewater purification provides a strong argument for protecting the wetland from further draining and development. In fact, the wetland saves the NWSC a large amount of money each year as it is less expensive to maintain the wetland than to build and maintain human-made infrastructural works.

Although Nakivubo wetland already greatly improves the water quality of water entering Inner Murchison Bay, its wastewater treatment capacity is not even fully utilized. Currently the two outlets which carry most of the wastewater and between 75% and 85% of the nutrients only pass through a limited area of the wetland and the wastewater is only retained for 0.5–2 days at most (COWI/VKI 1998). To optimize wastewater treatment as well as ecological integrity of the wetland, channels would need to be dug and maintained for optimal dispersion of the wastewater across the whole wetland area. This option would be low cost and easier to maintain than a more costly option of constructing artificial wastewater treatment facilities which require higher level of maintenance and operation.

Shrimp Farming in Mangroves in the Coastal Areas of Southern Thailand

Between 1961 and 1996, Thailand lost over 2,050 km^2 of mangrove forests, equivalent to about 56% of the total pre-1961 coverage. Over half of this loss was due to conversion mainly for shrimp farming and other coastal developments. Mangrove loss has called attention to two main ecosystem services provided by mangrove ecosystems: their function as a nursery and breeding habitat for fisheries and their role as natural “storm barriers” for periodical coastal storms, tsunamis, and typhoons. Additionally, many coastal communities rely directly on the mangroves for a variety of products such as fuel wood, timber, raw materials, honey, resins, crabs, and shellfish.

The production function approach and the expected damage function approach were used to value nursery and breeding habitat for fisheries and the storm protection services of the mangroves. These values were then compared to the value provided by shrimp farming, both before and after subsidies are taken into account. The benefits of mangroves in Southern Thailand were estimated at about 10,821 US$/ha for coastal protection against storms, 987 US$/ha for fish nurseries, and 584 US$/ha for collected wood and non-timber forest products (all in net present value terms; Barbier 2007; Fig. 1).

In contrast, the benefits of commercial shrimp farming were estimated at 9,632 US$/ha with government subsidies contributing the equivalent of 8,412 US$/ha (Fig. 1). Hence shrimp production without subsidies created benefits of only 1,120 US$/ha which was dwarfed by the monetary value of the ecosystem services provided by intact mangroves (Hanley and Barbier 2009). While the benefits of mangroves are provided continuously, shrimp production declines after 5 years, and shrimp farms are abandoned when turning unproductive. The costs of restoring

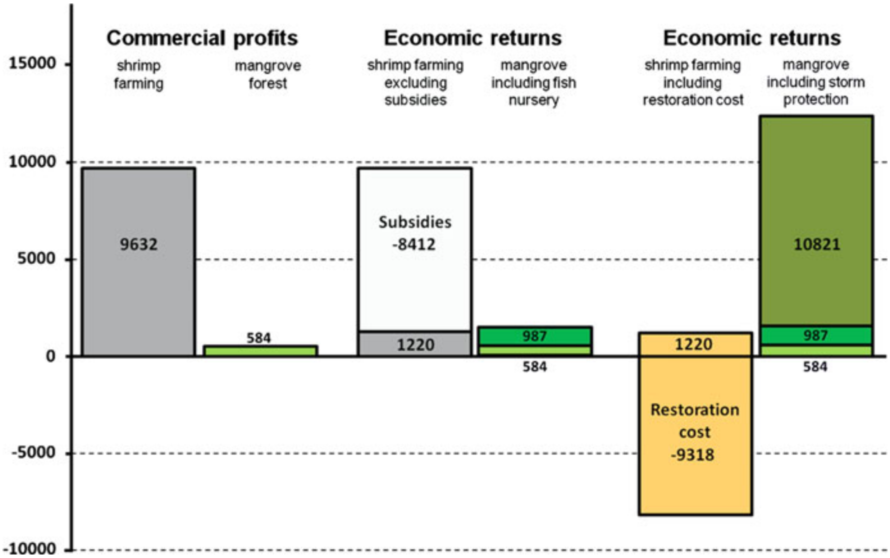

Fig. 1 Benefits of intact mangroves and shrimp farms in southern Thailand with and without subsidies. All values are net present value in US$/ha/year (Figure adapted from Russi et al. (2013) and based on Barbier (2007) and Hanley and Barbier (2009); used with permission)

mangroves are 9,318 US$/ha beyond the private profits from shrimp and have to be borne by the public.

Wise use of wetlands, including the conservation and restoration of the wetlands' hydrological functions, is essential in maintaining services such as storm protection and nursery and breeding. In many cases, natural ecosystems can provide ecosystem services at a lower price than hard engineering approaches. According to these value estimates, the main economic benefit with the highest value provided by the mangrove is protection against storms (Russi et al. 2013).

Conclusion and Future Challenges

Based on the cases studies presented, it becomes clear that estimation of the indirect use values and nonuse values (equivalent roughly to the regulating, cultural, and habitat ecosystem services of the Millennium Ecosystem Assessment and the TEEB studies) is much more challenging than estimation of the direct use values (provisioning services). Goods produced by wetlands (often food or other materials) are traded on markets using market prices that can serve as a basis for monetary valuation. For the regulating and cultural ecosystem services, more indirect methods for estimation are used, and the range of uncertainty around these values is much higher (see, e.g., Table 2) or the estimation can only be done in a qualitative way (Table 1). Despite these challenges of quantitative estimation, inclusion of regulating and cultural services in a valuation exercise can still be very useful as valuation of different options allows preference ranking, trade-off analysis, and decision making.

Another observation is that in most valuation studies, the value of the regulating services is much higher than the value of the provisioning services. For example, Table 2 shows that the water treatment functions of Nakivubo wetland were valued an order magnitude higher than the food production. Figure 1 demonstrates the same phenomenon when comparing the values of shrimp production with the value of the storm protection function f mangroves. Similar results can be observed in many other valuation studies (see, e.g., Stuip et al. 2002). This implies that protection and sustainable management of wetland ecosystems and their functions is economically much more viable for governments than conversion of wetlands for food production (and probably also for other commercial uses). Very often, decision makers are not aware of the enormous economic value they lose when permission for wetland conversion is granted. These losses are generally not borne by the proponents of the "development", but by the general public who suffer the consequences of water quality degradation or the loss of their livelihoods options. In many cases, it may be possible to have "the best of both worlds" by using wetlands responsibly and wisely, developing food production and other activities in such a way that the ecosystem functions are preserved. More research into such "wise use technologies" is needed.

Future challenges also include further research into valuation methods, especially for the indirect use and nonuse values. Hydrological and ecological modeling will increasingly help in estimating quantitatively the water, nutrient, soil, and plant processes that are the basis for many wetland functions related to water storage, flood protection, and water quality regulation. These material processes can then be valued using avoided cost or replacement cost methods. Contingent valuation methods will also be developed further. While monetary valuation is not strictly needed for determining trade-offs between different wetland benefits, it will be particularly useful for applying certain market-based policy approaches such as payment for environmental services (PES) or mitigation banking. Most of all, wetland valuation will help to increase awareness of the importance of wetlands as natural capital that is needed for human development and needs to be protected. Global-scale studies will mainly help to achieve that awareness, where the valuation studies on more local scales (river basin or wetland site scale) can play an important role in actual decision making about use and management.

References

Atkins JP, Burdon D. An initial economic evaluation of water quality improvements in the Randers Fjord, Denmark. Mar Pollut Bull. 2006;53:195–204.

Barbier EB. Valuing ecosystem services as productive inputs. Econ Policy. 2007;22(49):177–229.

Brander L, Schuyt K. The economic value of the world's wetlands. Case study, the economics of ecosystems and biodiversity (TEEB); 2010. Available at: www.TEEBweb.org

Brander LM, Florax RJGM, Vermaat JE. The empirics of wetland valuation: a comprehensive summary and a meta-analysis of the literature. Environ Res Econ. 2006;33:223–50. https://doi.org/10.1007/s10640-005-3104-4.

Costanza R, d'Arge R, de Groot R, Farberk S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neill RV, Paruelo J, Raskin RG, Suttonkk P, van den Belt M. The value of the world's ecosystem services and natural capital. Nature. 1997;387:253–60.

Costanza R, de Groot R, Sutton P, van der Ploeg S, Anderson SJ, Kubiszewski I, Farmer S, Turner RK. Changes in the global value of ecosystem services. Glob Environ Chang. 2014;26:152–8.

COWI/VKI. Kampala water quality monitoring programme: Murchison Bay water quality project. Report prepared for Ministry of Natural Resources National Water and Sewerage Corporation, Kampala; 1998.

de Groot RS, Stuip MAM, Finlayson CM, Davidson N. Valuing wetlands: guidance for valuing the benefits derived from wetland ecosystem services, Ramsar technical report No. 3/CBD technical series no. 27. Gland/Montreal: Ramsar Convention Secretariat/Secretariat of the Convention on Biological Diversity; 2006.

Emerton L, editor. Values and rewards: counting and capturing ecosystem water services for sustainable development. IUCN Water, Nature and Economics Technical Paper No. 1. Sri Lanka: IUCN – The World Conservation Union, Ecosystems and Livelihoods Group Asia; 2005.

Emerton L, IIyango L, Luwum P, Malinga A. The present economic value of Nakivubo Urban Wetland, Uganda. IUCN—The World Conservation Union, Eastern Africa Regional Office, Nairobi and National Wetlands Programme, Wetlands Inspectorate Division, Ministry of Water, Land and Environment, Kampala, Uganda; 1999.

Hanley N, Barbier EB. Valuing ecosystem services, in pricing nature: cost-benefit analysis and environmental policy. London: Edward Elgar; 2009.

Russi D, ten Brink P, Farmer A, Badura T, Coates D, Förster J, Kumar R, Davidson N. The economics of ecosystems and biodiversity for water and wetlands. London: IEEP; 2013.

Schuyt K, Brander L. The economic value of the world's wetlands. Gland/Amsterdam: IUCN and Free University; 2004. Available at: www.iucn.org.

Stuip MAM, Baker CJ, Oosterberg W. The socio-economics of wetlands. Wageningen/Lelystad: Wetlands International/RIZA; 2002.

Tallis H, Lubchenco J. A call for inclusive conservation. Nature. 2014;515:27–8.

TEEB. The economics of ecosystems and biodiversity: mainstreaming the economics of nature: a synthesis of the approach, conclusions and recommendations of TEEB; 2010. Available at: www.teebweb.org

Vidanage S, Perera S, Kallesoe M. The value of traditional water schemes: small tanks in the Kala Oya Basin, Sri Lanka. IUCN Water, Nature and Economics Technical Paper No. 6. Colombo: IUCN—The World Conservation Union, Ecosystems and Livelihoods Group Asia; 2005.