

Nicholas Institute for Environmental Policy Solutions
Working Paper
NI WP 14-06
July 2014

Mangrove Ecosystem Services Valuation: State of the Literature

Tibor Vegh
Megan Jungwiwattanaporn
Linwood Pendleton
Brian Murray

Nicholas Institute for Environmental Policy Solutions, Duke University

Acknowledgments

Support for this report was provided by the Linden Trust for Conservation.

How to cite this report

TIBOR VEGH, MEGAN JUNGWIWATTANAPORN, LINWOOD PENDLETON, AND BRIAN MURRAY. 2014. *Mangrove Ecosystem Services Valuation: State of the Literature*. NI WP 14-06. Durham, NC: Duke University.



Contents

INTRODUCTION	3
METHODS.....	3
RESULTS	4
CONCLUSIONS AND RECOMMENDATIONS.....	8
REFERENCES	9
PAPERS ANALYZED	10

INTRODUCTION

To guide their decision making, marine and coastal managers are increasingly using monetary value estimates of marine ecosystem services (Börger et al. 2014). These estimates reflect various economic valuation methods. Some rely on market values of ecosystem service outputs and substitutes, and some rely on non-market approaches (Barbier et al. 2011).

A growing body of literature provides estimates of ecosystem service values derived from mangroves. If this literature is to be useful in decision making, it must have a solid foundation of value estimates. This paper identifies gaps in data and knowledge regarding mangrove ecosystem service valuations and recommends ways that future research could advance understanding of mangrove ecology, ecosystem services valuation, and conservation.

METHODS

To identify gaps in knowledge and data on mangrove ecosystem service valuations, this analysis considers studies of mangrove ecosystem services values in the Marine Ecosystem Services Partnership (MESP) database.¹ These 72 mangrove valuation studies included peer-reviewed journal articles, institutional reports, and academic theses.

This analysis reports the studies' methodology, valued ecosystem services, assessed region, and inclusion of valuation estimates; it does not track each study's total number of reported values. Mangrove valuation methods are characterized as market-based valuation, stated preference, revealed preference, methods, or synthesis of existing literature. These methods, listed in Table 1, were used in at least one study reviewed herein, and they include both economic valuation and other methods.

Two recent meta-analyses of mangrove value estimates were consulted to gauge the completeness of the MESP library. Salem and Mercer (2012) reviewed 44 mangrove valuation studies; Brander et al. (2012), 41 studies. These meta-analyses may have considered studies in the MESP database and deemed them unusable for their purpose. Although the MESP database contains many of the studies in the meta-analyses, not all studies in these analyses could be located. Some studies do not exist in digital form or are otherwise inaccessible.

¹ <http://marineecosystems-services.org/explore>.

Table 1. Categories of Valuation Methods.

Category	Method	Description of Method
Market-based valuation (MV)	Market value	Estimates economic values of ecosystem products or services that are bought and sold in commercial markets (e.g., fish, timber, crops)
	Change in productivity (CP), net factor income (NFI)	Estimates economic values of ecosystem products or services that contribute to the production of commercially marketed goods (e.g., fish nursery function)
	Avoided cost (AC), avoided damages (AD), substitute price (SP), replacement cost (RC)	Estimates economic values on the basis of costs of avoided damages resulting from lost ecosystem services, costs of replacing ecosystem services, or costs of providing substitute services (e.g., storm protection)
Non-market valuation - stated preference (NMV-SP)	Contingent valuation (CV)	Estimates economic values of virtually any ecosystem or environmental service by asking people to directly state their willingness to pay for it given a hypothetical scenario; proper methods include real budget constraints to better replicate actual economic decisions; most widely used method for estimating non-use, or "passive use" values
	Choice modeling (CM)	Estimates economic values of ecosystem or environmental services by asking people to make tradeoffs among them; willingness to pay is inferred from tradeoffs that include cost as an attribute
Non-market valuation - Revealed preference (NMV-RP)	Travel cost (TC)	Estimates values associated with ecosystems or sites used for recreation through willingness to pay to travel to visit the sites
Synthesis of existing studies (SES)	Meta-analysis (MA)	Combines results of multiple studies to infer potentially robust estimates and identify patterns, often using statistical methods
	Citation (CIT)	Directly cites the results of another study
	Benefit transfer (BT)	Estimates economic values by transferring existing benefit estimates from studies of another location or issue
	Ecosystem value coefficient (EVC)	Derives ecosystem service values by multiplying the area of land use types by value coefficients, which are based on global averages (Costanza et al. 1997)

RESULTS

The geographic coverage of mangroves and the geographic representation of the studies are asymmetrical. For instance, Africa is home to 22% of the world's mangroves, yet only 7% of mangrove valuation studies focus on this part of the world (Table 2). African mangroves exist in both West Africa (i.e., the coast from Guinea down to Nigeria and Cameroon) and East Africa (i.e., Kenya, Tanzania, and Mozambique). The MESP could locate only five studies for the entire continent, and all were on the east coast; none of these studies valued mangrove resources in West Africa. The Americas are home to 30% of the world's mangrove areas but make up only 20% of the valuation literature. The Caribbean and the eastern coast of South America are home to dense stands of mangrove forests. None of the studies the MESP found were for Caribbean islands.

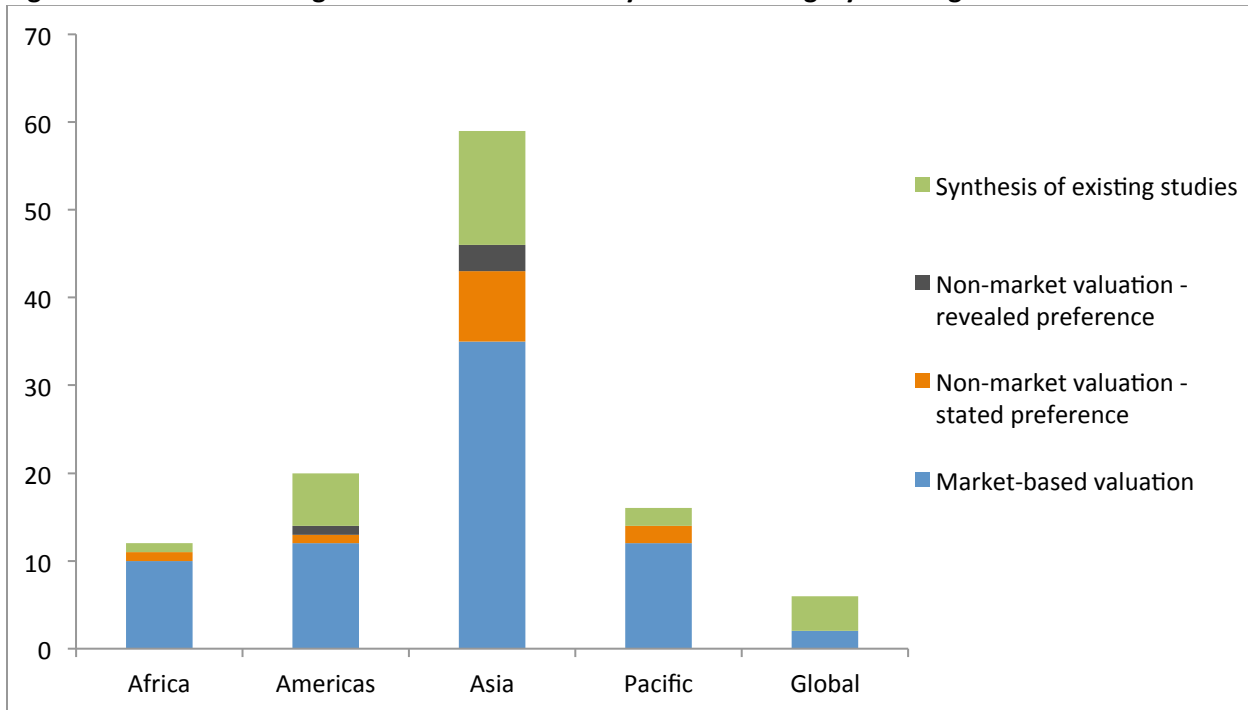
Table 2. Comparison of Mangrove Coverage to Presence in Valuation Literature.

	Percent of World's Mangroves	Percent of Studies
Africa	22%	7%
Americas	30%	19%
Asia	38%	63%
Pacific	10%	10%

Note: Percentages are calculated from the average of mangrove coverage values presented in the following *Sources:* Saenger et al. (1983), Fisher and Spalding (1993), Spalding et al. (1997), Giri et al. (2011), and Hutchison et al. (2013).

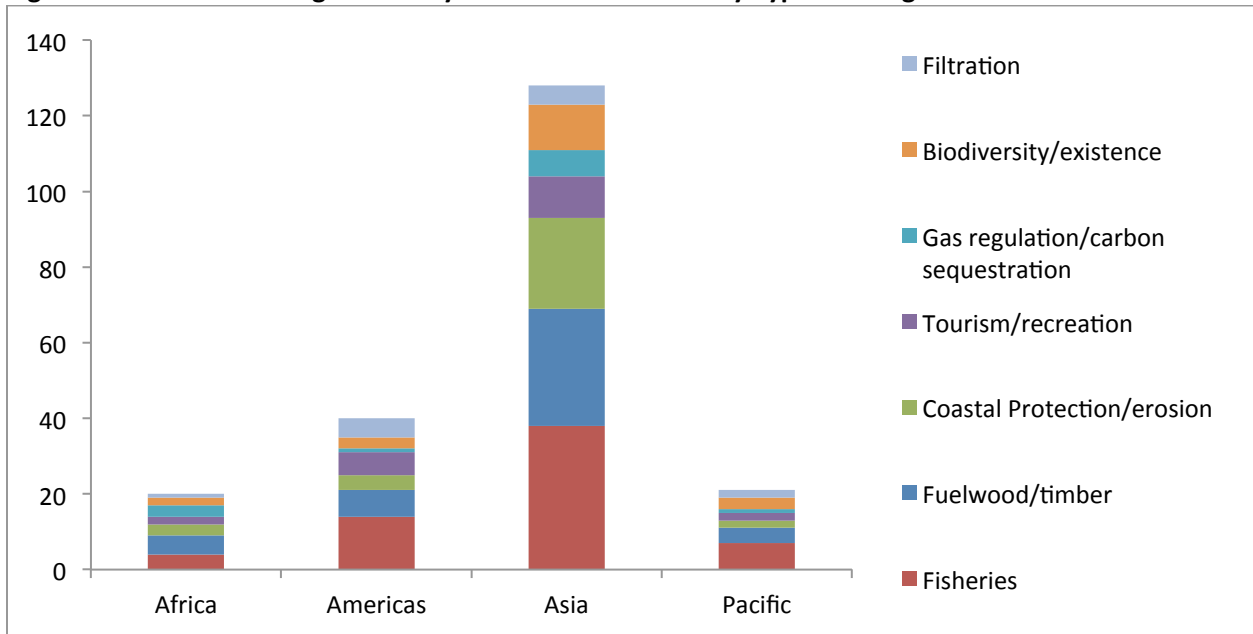
Pendleton et al. (2007) argue that a literature that includes valuation estimates from different methods may yield results that are more robust than a literature with valuation estimates from a single method. The most common methods for valuing mangrove ecosystem services are market-based methods, followed by syntheses of existing studies, and stated preference methods (Figure 1). Stated preference methods were applied more frequently in Asia and the Pacific than in other regions. Studies using non-market valuation revealed preference methods are lacking in Africa and the Pacific region, and these methods have not been used to estimate global mangrove ecosystem service values.

Figure 1. Number of Mangrove Valuation Studies by Method Category and Region.



Across all regions, a wide variety of ecosystem services produced by mangroves have been valued. Studies of the fisheries value of mangroves tend to be most common (Figure 2).

Figure 2. Number of Mangrove Ecosystem Services Values by Type and Region.



Mangrove ecosystem service valuation increased around the turn of the 21st century, but with one notable exception, it has decreased since 2010. The sharp increase in 2013 can perhaps be attributed to the emerging international attention to coastal “blue carbon” (Pendleton et al. 2012; Siikamäki et al. 2013). No pattern in the types of methods applied over time is discernable. Although the number of valuations has generally increased (figures 4 and 5), the proportion of studies focusing on fisheries and fuel wood have decreased.

Figure 3. Mangrove Valuation Categories by Year.

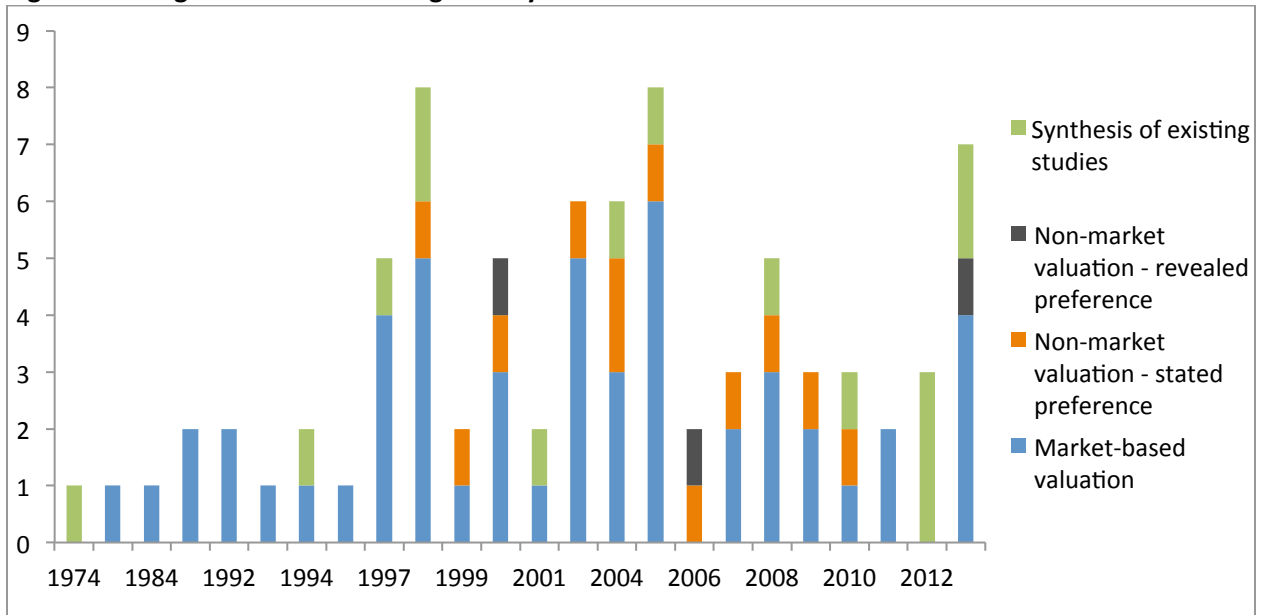


Figure 4. Number of Mangrove Ecosystem Services Values by Year.

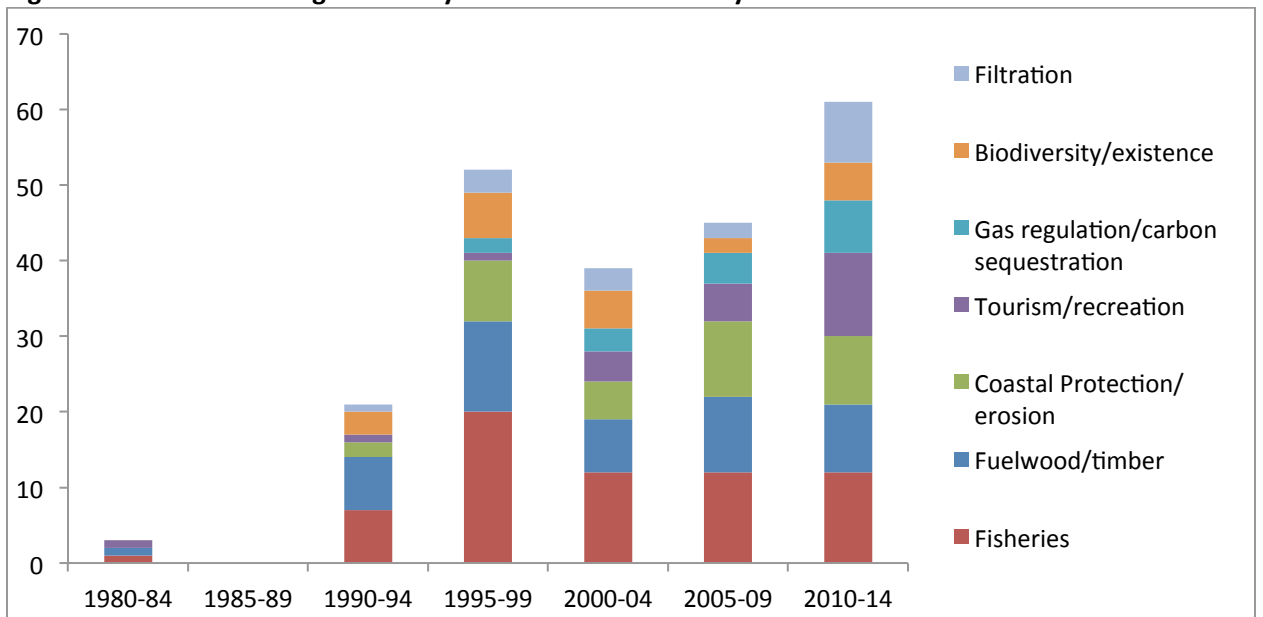
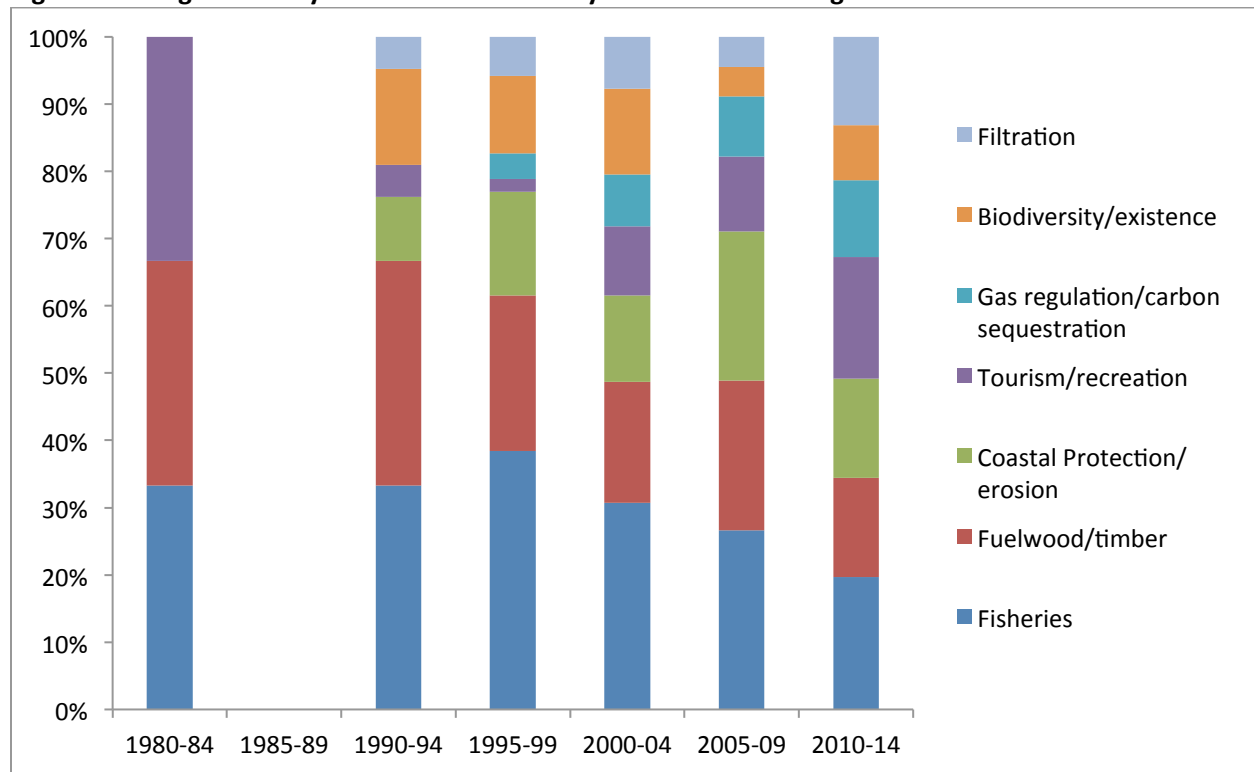


Figure 5. Mangrove Ecosystem Service Values by Year as a Percentage.



CONCLUSIONS AND RECOMMENDATIONS

The importance of mangroves and the ecosystem services they provide is increasingly recognized. But additional research is needed if mangroves are to be managed in a way that fully recognizes their economic contribution in different settings throughout the world. To date, mangrove valuations have primarily focused on Asia, particularly southeast Asia; they are underrepresented for Africa, the Americas, and the Pacific. These valuations reflect marketed and non-marketed services. Most prevalent by far are studies of the value of fisheries, followed by fuelwood and coastal protection. Since 2010, carbon sequestration and greenhouse gas regulation have emerged as services of interest, perhaps due to growing emphasis on “blue carbon” from coastal and marine ecosystems.

In the recent literature on mangroves ecosystem services values, fisheries and wood harvesting values dominate, as do market-based measures. Because market values and other revealed preference measures are often preferred to stated preferences, the focus on market-based measures, in and of itself, is not necessarily of concern. But if it represents a bias toward estimation of the easiest-to-value services, it indicates a research shortcoming.

Valuation assessments can help advance conservation by informing decision makers of the full value of threatened habitats. With respect to mangroves, this analysis points to the following research agenda:

- **Increase valuation studies in western and eastern Africa, the Caribbean, and South America.** The critical knowledge gap in these areas could lead to the undervaluing of mangroves in development and conservation decisions. Filling this gap will require increased awareness and resolve from local communities, resource managers, and economists as well as funding for new research.

- **Give attention to a wide diversity of types of mangrove ecosystem services.** Since the early 2000s, the focus has shifted from fisheries and forestry services to other services, notably, carbon sequestration. But studies of some services, especially biodiversity, are few, particularly in the Americas, Africa, and the Pacific, where the importance of shoreline protection is likely to be locally important.
- **Provide more and better estimates for mangrove ecosystem services for regional and national natural capital accounting.** Without a better global distribution of mangrove valuation studies, estimates of the natural capital value of mangrove stocks cannot be estimated accurately and precisely for many places.

REFERENCES

- Barbier, E.B., S.D. Hacker, C. Kennedy, E.W. Koch, A.C. Stier, and B.R. Silliman. 2011. “The Value of Estuarine and Coastal Ecosystem Services.” *Ecological Monographs* 81(2): 169–193.
- Börger, T., N.J. Beaumont, L. Pendleton, K.J. Boyle, P. Cooper, S. Fletcher, T. Haab, M. Hanemann, T.L. Hooper, S.S. Hussain, R. Portela, M. Stithou, J. Stockill, T. Taylor, and M.C. Austen. 2014. “Incorporating Ecosystem Services in Marine Planning: The Role of Valuation.” *Marine Policy* 46: 161–170.
- Brander, L.M., A.J. Wagtedonk, S.S. Hussain, A. McVittie, P.H. Verburg, R.S. de Groot, and S. van der Ploeg. 2012. “Ecosystem Service Values for Mangroves in Southeast Asia: A Meta-Analysis and Value Transfer Application.” *Ecosystem Services* 1(1): 62–69.
- Costanza, R., R. d’Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O’Neill, J. Paruelo, R.G. Raskin, P. Sutton, and M. van den Belt. 1997. “The Value of the World’s Ecosystem Services and Natural Capital.” *Nature* 387: 253–260.
- Fisher, P., and M.D. Spalding. 1993. “Protected Areas with Mangrove Habitat.” Draft report, World Conservation Centre, Cambridge, UK.
- Giri, C., E. Ochieng, L.L. Tieszen, Z. Zhu, A. Singh, T. Loveland, J. Masek, and N. Duke. 2011. Status and Distribution of Mangrove Forests of the World Using Earth Observation Satellite Data. *Global Ecology and Biogeography* 20(1): 154–159.
- Hutchison, J., A. Manica, R. Swetnam, A. Balmford, and M. Spalding. 2013. Predicting Global Patterns in Mangrove Forest Biomass. *Conservation Letters* 7(3): 233–240.
- Murray, B.C. 2012. “Economics: Mangroves’ Hidden Value.” *Nature Climate Change* 2(11): 773–774.
- Pendleton, L., D.C. Donato, B.C. Murray, S. Crooks, W.A. Jenkins, S. Sifleet, C. Craft, J.W. Fourqurean, J.B. Kauffmann, N. Marba, P. Megonigal, E. Pidgeon, D. Herr, D. Gordon, and A. Baldera. 2012. “Estimating Global ‘Blue carbon’ Emissions from Conversion and Degradation of Vegetated Coastal Ecosystems.” *PLoS ONE* 7(9): e43542.
- Pendleton, L., P. Atiyah, and A. Moorthy. 2007. “Is the Non-Market Literature Adequate to Support Coastal and Marine Management?” *Ocean and Coastal Management* 50(5–6): 363–378.
- Saenger, P., E.J. Hegerl, and J.D.S. Davie. 1983. Global Status of Mangrove Ecosystems. IUCN-CE-no.003, International Union for the Conservation of Nature.

Salem, M.E., and D.E. Mercer. 2012. "The Economic Value of Mangroves: A Meta-Analysis." *Sustainability* 4: 359–383.

Siikamäki, J., J.N. Sanchirico, S. Jardine, D. McLaughlin, and D. Morris. 2013. "Blue Carbon: Coastal Ecosystems, Their Carbon Storage, and Potential for Reducing Emissions." *Environment: Science and Policy for Sustainable Development* 55(6): 14–29.

Spalding, M.D., F. Blasco, and C.D. Field, eds. 1997. *World Mangrove Atlas*. Okinawa, Japan: The International Society for Mangrove Ecosystems.

PAPERS ANALYZED

Ahmad, N. 1984. "Some Aspects of Economic Resources of Sundarban Mangrove Forest of Bangladesh." In *Proceedings of the Asian Symposium on Mangrove Environment Research and Management*.

Ahmad, S. 2009. "Recreational Values of Mangrove Forest in Larut Matang, Perak." *Journal of Tropical Forest Science* 21(2): 81–87.

Asian Development Bank and International Union for Conservation of Nature. 2003. "An Economic Evaluation of Mangrove Ecosystem and Different Fishing Techniques in the Vanthavilluwa Divisional in Puttalam District of Sri Lanka." Regional Technical Assistance for Coastal and Marine Resources Management and Poverty Reduction in South Asia (ADB RETA 5974).

Badola, R., and S.A. Hussain. 2005. "Valuing Ecosystem Functions: An Empirical Study on the Storm Protection Function of Bhitarkanika Mangrove Ecosystem, India." *Environmental Conservation* 32(1): 85–92.

Bann, C. 1997. *The Economic Valuation of Mangroves: A Manual for Researchers*. Ottawa: International Development Research Centre. <http://web.idrc.ca/uploads/user-S/10305674900acf30c.html>.

Bann, C. 1997. "An Economic Analysis of Alternative Mangrove Management Strategies in Koh Kong Province, Cambodia." http://www.juniata.edu/projects/it110/ms/References/362_Island%20Ecosystems/Mangrove%20productivity%20and%20zonation/11_Econ%20analysis%20mangrove%20management%20Cambodia.pdf.

Bann, C. 1999. "A Contingent Valuation of the Mangroves of Benut, Johor State, Malaysia." Report to the Johor State Forestry Department, Malaysia. http://www.unepscs.org/Economic_Valuation_Training_Materials/06%20Readings%20on%20Economic%20Valuation%20of%20Coastal%20Habitats/14-Contingent-Valuation-Mangroves-Johor-Malaysia.pdf.

Barbier, E.B. 2000. "Valuing the Environment as Input: Review of Applications to Mangrove-Fishery Linkages." *Ecological Economics* 35(1): 47–61.

Barbier, E.B. 2007. "Valuing Ecosystem Services as Productive Inputs." *Economic Policy* 22(49): 177–229.

Barbier, E.B., E.W. Koch, B.R. Silliman, S.D. Hacker, E. Wolanski, J. Primavera, E.F. Granek, S. Polasky, S. Aswani, L.A. Cramer, D.M. Stoms, C.J. Kennedy, D. Bael, C.V. Kappel, G.M.E. Perillo, and D.J. Reed. 2008. "Coastal Ecosystem-Based Management with Nonlinear Ecological Functions and Values." *Science* 319(5861): 321–323.

Barbier, E.B., and I. Strand. 1998. "Valuing Mangrove-Fishery Linkages: A Case Study of Campeche, Mexico." *Environmental and Resource Economics* 12(2): 151–166.

- Barbier, E.B., I. Strand, and S. Sathirathai. 2002. "Do Open-Access Conditions Affect the Valuation of an Externality? Estimating the Welfare Effects of Mangrove-Fishery Linkages in Thailand." *Environmental and Resource Economics* 21(4): 343–367.
- Bennett, E.L., and C.J. Reynolds. 1993. "The Value of a Mangrove Area in Sarawak." *Biodiversity and Conservation* 2(4): 359–375.
- Blackwell, B.D. 2006. "The Economic Value of Australia's Natural Coastal Assets: Some Preliminary Findings." Australian and New Zealand Society for Ecological Economics Conference Proceedings, Ecological Economics in Action, December 11–13, 2005, Massey University, Palmerston North, New Zealand. http://www.anzsee.org/anzsee2005papers/Blackwell_Economic_value_of_Aust_coast.pdf.
- Brander, L.M., A.J. Wagtedonk, S.S. Hussain, A. McVittie, P.H. Verburg, R.S. de Groot, and S. van der Ploeg. 2012. "Ecosystem Service Values for Mangroves in Southeast Asia: A Meta-Analysis and Value Transfer Application." *Ecosystem Services* 1(1): 62–69.
- Burbridge, P.R. 1982. "Management of Mangrove Exploitation in Indonesia." *Applied Geography* 2(1): 39–54.
- Cabrera, M.A., J.C. Seijo, J. Euan, and E. Pérez. 1998. "Economic Values of Ecological Services from a Mangrove Ecosystem." *Intercoast Net* 32: 1–2.
- Camacho-Valdez, V., A. Ruiz-Luna, A. Ghermandi, and P.A.L.D. Nunes. 2013. "Valuation of Ecosystem Services Provided by Coastal Wetlands in Northwest Mexico." *Ocean and Coastal Management* 78: 1–11.
- Cooper, E., L. Burke, and N. Bood. 2008. *Coastal Capital: Economic Contribution of Coral Reefs and Mangroves to Belize*. Washington, DC: World Resources Institute.
- Das, S., and A. Crepin. 2013. "Mangroves Can Provide Protection Against Wind Damage during Storms." *Estuarine, Coastal and Shelf Science* 134: 98–107.
- Dehghani, M., P. Farshchi, A. Danekar, M. Karami, and A. Aleshikh. 2010. "Recreation Value of Hara Biosphere Reserve Using Willingness-to-Pay Method." *International Journal of Environmental Research* 4(2): 271–280.
- Do, T.N., and J. Bennett. 2005. "An Economic Valuation of Wetlands in Vietnam's Mekong Delta: A Case Study of Direct Use Values in Camau Province." Occasional Paper No. 8. Australian National University. https://digitalcollections.anu.edu.au/bitstream/1885/43111/2/emd_op8.pdf.
- Emerton, L., ed. 2005. "Values and Rewards: Counting and Capturing Ecosystem Water Services for Sustainable Development. IUCN – The World Conservation Union, Ecosystems and Livelihoods Group Asia. http://cmsdata.iucn.org/downloads/2005_047.pdf.
- Emerton L., R. Seilava, and H. Pearith. 2002. "Bokor, Kirirom, Kep and Ream National Parks, Cambodia: Case Studies of Economic and Development Linkages." Field Study Report, Review of Protected Areas and their Role in the Socio-Economic Development of the Four Countries of the Lower Mekong Region, International Centre for Environmental Management, Brisbane and IUCN - The World Conservation Union Regional Environmental Economics Programme, Karachi.
- Gammage, S. 1997. "Estimating the Returns to Mangrove Conversion: Sustainable Management or Short-Term Gain?" Discussion Paper DP 97-02. Environmental Economics Programme, London.

- Glaser M., and K. Diele. 2004. "Asymmetric Outcomes: Assessing Central Aspects of the Biological, Economic and Social Sustainability of a Mangrove Crab Fishery, *Ucides cordatus* (Ocypodidae), in North Brazil." *Ecological Economics* 49(3): 361–373.
- Gunawardena, M., and J.S. Rowan. 2005. "Economic Valuation of a Mangrove Ecosystem Threatened by Shrimp Aquaculture in Sri Lanka." *Environmental Management* 36(4): 535–550.
- Hussain, S.A., and R. Badola. 2010. "Valuing Mangrove Benefits: Contribution of Mangrove Forests to Local Livelihoods in Bhitarkanika Conservation Area, East Coast of India." *Wetlands Ecology and Management* 18(3): 321–331.
- Hussain, S.A., and R. Badola. 2008. "Valuing Mangrove Ecosystem Services: Linking Nutrient Retention Function of Mangrove Forests to Enhanced Agroecosystem Production." *Wetlands Ecology and Management* 16(6): 441–450.
- Iqbal, M. 2006. "Economic Valuation of Protected Area of Marine National Park in Weh Island (in Indonesian)." In *Today's World: Their Values and Benefits for the Welfare of the Planet*, edited by Lisa Janishevski. Montreal, Quebec, Canada: Secretariat of Convention on Biological Diversity.
- Islam, M., and K. Ikejima. 2010. "Gear Type, Species Composition and Economic Value of Fisheries in the Mangroves of Pak Phanang, Thailand." *Wetlands Ecological Management* 18: 27–36.
- Janssen, R., and J. Padilla. 1996. "Valuation and Evaluation of Management Alternatives for the Pagbilao Mangrove Forest." CREED Working Paper Series No. 9.
- Janssen, R., and J. Padilla. 1999. "Preservation or Conversion? Valuation and Evaluation of a Mangrove Forest in the Philippines." *Environmental and Resource Economics* 14: 297–331.
- Kairo, J., C. Wanjiru, and J. Ochiewo. 2009. "Net Pay: Economic Analysis of a Replanted Mangrove Plantation in Kenya." *Journal of Sustainable Forestry* 28 (3–5): 395–414.
- Kuenzer, C., and V.Q. Tuan. 2013. "Assessing the Ecosystem Services Value of Can Gio Mangrove Biosphere Reserve: Combining Earth-Observation- and Household-Survey-Based analyses." *Applied Geography* 45: 167–184.
- Lal, P. 1990. "Conservation or Conversion of Mangroves in Fiji." East-West Centre Occasional Papers 11.
- Mendoza-Gonzalez, G., M.L. Martinez, D. Lithgow, O. Perez-Maqueo, and P. Simonin. 2012. "Land Use Change and Its Effects on the Value of Ecosystem Services along the Coast of the Gulf of Mexico." *Ecological Economics* 82: 23–32.
- Milon, J.W., and D. Scrogin. 2006. "Latent Preferences and Valuation of Wetland Ecosystem Restoration." *Ecological Economics* 56: 162–175.
- Morton, R.M. 1990. "Community Structure, Density and Standing Crop of Fishes in a Subtropical Australian Mangrove Area." *Marine Biology* 105:385–394.
- Naylor, R., and M Drew. 1998. Valuing mangrove resources in Kosrae, Micronesia. *Environment and Development Economics* 3(4): 471–490.
- Nickerson, D. 1999. "Trade-Offs of Mangrove Area Development in the Philippines." *Ecological Economics* 28: 279–298.

- Othman, J., J. Bennett, and B. Russell. 2004. "Environmental Values and Resource Management Options: A Choice Modelling Experience in Malaysia." *Environment and Development Economics* 9: 803–824.
- Pabon-Zamora, L., A. Fauzi, A. Halim, J. Bezaury-Creel, E. Vega-Lopez, F. Leon, L. Gil, and V. Cartaya. 2008. "Protected Areas and Human Well-being: Experiences from Indonesia, Mexico, Peru and Venezuela." In *Today's World: Their Values and Benefits for the Welfare of the Planet*, edited by Lisa Janishevski. Montreal, Quebec, Canada: Secretariat of Convention on Biological Diversity.
- Padilla, J. 2008. "Analysis of Coastal and Marine Resources: A Contribution to the Philippines Country Environmental Analysis." World Bank, Washington, DC.
- Pascal, N., and M. Bulu. 2013. "Economic Valuation of Mangrove Ecosystem Services in Vanuatu: Case Study of Crab Bay (Malekula Is.) and Eratap (Efate Is.)." Technical Report for Project Mescal, Mangrove EcoSystems for Climate Change Adaptation & Livelihoods.
- Pascal, N., J.-M. Laurent, E. Burgos, J. Carrasco, A. Seibt, V. Caviedes, and A. Alegria. 2013. Valoración de los servicios ecosistémicos del Parque Nacional Jeannette Kawas. United Nations Environment Programme.
- Pendleton, L., D.C. Donato, B.C. Murray, S. Crooks, W.A. Jenkins, S. Sifleet, C. Craft, J.W. Fourqurean, J.B. Kauffmann, N. Marba, P. Magonigal, E. Pidgeon, D. Herr, D. Gordon, and A. Baldera. 2012. "Estimating Global 'Blue Carbon' Emissions from Conversion and Degradation of Vegetated Coastal Ecosystems." *PLoS ONE* 7(9): e43542.
- Premachandra, W., and S. Mardle. 2008. "Total Economic Value of Wetland Conservation in Sri Lanka Identifying Use and Non-Use Values." *Wetlands Ecological Management* 16: 359–369. doi: 10.1007/s11273-007-9073-3.
- Ronnback, P. 1999. "The Ecological Basis for Economic Value of Seafood Production Supported by Mangrove Ecosystems." *Ecological Economics* 29: 235–252.
- Ruitenbeek, J. 1994. "Modelling Economy-Ecology Linkages in Mangroves: Economic Evidence for Promoting Conservation in Bintuni Bay, Indonesia." *Ecological Economics* 10(3): 233–247.
- Ruitenbeek, J. 1992. "Mangrove Management: An Economic Analysis of Management Options with a Focus on Bintuni Bay, Irian Jaya." EMDI Environmental Reports 8. Environmental Management Development in Indonesia and Dalhousie University, Canada.
- Salem, M., and D. Mercer. 2012. "The Economic Value of Mangroves: A Meta-Analysis." *Sustainability* 4: 359–383.
- Samonte-Tan, G., A. White, M. Tercero, J. Diviva, E. Tabara, and C. Caballes. 2007. "Economic Valuation of Coastal and Marine Resources: Bohol Marine Triangle, Philippines." *Coastal Management* 35: 319–338.
- Sanjurjo, E., K. Cadena, and I. Erbstoesser. 2005. "Valoración económica de los vínculos entre manglar y pesquerías." In *Memorias del Segundo Congreso Iberoamericano de Desarrollo y Medio Ambiente*. Puebla, Mexico: Congreso Iberoamericano de Desarrollo y Medio Ambiente.
- Sathirathai, S. 1997. "Economic Valuation of Mangroves and the Roles of Local Communities in the Conservation of the Resources: Case Study of Surat Thani, South of Thailand." Economy and Environment Program for Southeast Asia.

- Sathirathai, S., and E. Barbier. 2001. "Valuing Mangrove Conservation in Southern Thailand." *Contemporary Economic Policy* 19(2): 109–122.
- Siikamäki, J., J. Sanchirico, S. Jardine, D. McLaughlin, and D. Morris. 2013. "Blue Carbon: Coastal Ecosystems, Their Carbon Storage, and Potential for Reducing Emissions." *Environment: Science and Policy for Sustainable Development* 55(6): 14–29.
- Souza, F., and C. Silva. 2011. "Ecological and Economic Valuation of the Potengi Estuary Mangrove Wetlands (NE, Brazil) Using Ancillary Spatial Data." *Journal of Coastal Conservation* 15: 195–206.
- Spaninks, F., and P. van Beukering. 1997. "Economic Valuation of Mangrove Ecosystems: Potential and Limitations." CREED Working Paper 14. Environmental Economics Programme, IIED and Institute for Environmental Studies, Vrije Universiteit.
- Spurgeon, J. 2002. Socio-Economic Assessment and Economic Valuation of Egypt's Mangroves: Rehabilitation, Conservation and Sustainable Utilization of Mangroves in Egypt. FAO Consultancy Report: TCP/EGY/0168, Jacobs GIBB Ltd.
- Spurgeon, J., T. Roxburgh, S. O'Gorman, R. Lindley, D. Ramsey, and N. Polunin. 2004. *Economic Valuation of Coral Reefs and Adjacent Habitats in American Samoa*. JacobsGIBB Ltd.
- Stone, K., M. Bhat, R. Bhatta, and A. Mathews. 2008. "Factors Influencing Community Participation in Mangroves Restoration: A Contingent Valuation Analysis." *Ocean & Coastal Management* 51: 476–484.
- Talbot, F., and C. Wilkinson. 2001. *Coral Reefs, Mangroves and Seagrasses: A Sourcebook for Managers*. Australian Institute of Marine Sciences, Townsville.
- Tianhong, L., L. Wenkai, and Q. Zhenghan. 2010. "Variations in Ecosystem Service Value in Response to Land Use Changes in Shenzhen." *Ecological Economics* 69:1427–1435.
- Tri, N. 2000. "Valuation of the Mangrove Ecosystem in Can Gio Mangrove Biosphere Reserve, Vietnam." UNESCO, Vietnam MAB National Committee.
- Tri, N., N. Adger, M. Kelly, S. Granich, and N. Ninh. 2000. "The Role of Natural Resource Management in Mitigating Climate Impacts: Mangrove Restoration in Vietnam." CSERGE Working Paper GEC 96-06. Centre for Social and Economic Research on the Global Environment.
- Tri, N., W. Adger, and P. Kelly. 1998. "Natural Resource Management in Mitigating Climate Impacts: The Example of Mangrove Restoration in Vietnam." *Global Environmental Change* 8(1): 49–61.
- Turner, R., J. Paavola, P. Cooper, S. Farber, V. Jessamy, and S. Georgiou. 2003. "Valuing Nature: Lessons Learned and Future Research Directions." *Ecological Economics* 46: 493–510.
- Turpie, J. 2000. "The Use and Value of Natural Resources of the Rufiji Floodplain and Delta, Tanzania." Rufiji Environmental Management Project.
- Turpie, J., B. Smith, L. Emerton, and J. Barnes. 1999. "Economic Value of the Zambezi Basin Wetlands." IUCN, Zambezi Basin Wetlands Conservation and Resource Utilisation Project.
- Uddin, M., E. van Steveninck, M. Stuij, and M. Shah. 2013. "Economic Valuation of Provisioning and Cultural Services of a Protected Mangrove Ecosystem: A Case Study on Sundarbans Reserve Forest, Bangladesh." *Ecosystem Services* 5: e88–e93.

UNEP (United Nations Environment Programme). 2011. *Economic Analysis of Mangrove Forests: A Case Study in Gazi Bay, Kenya*. New York: UNEP.

Walters, B., P. Ronnback, J. Kovacs, B. Crona, S. Hussain, R. Badola, J. Primavera, E. Barbier, and F. Dahdouh-Guebas. 2008. "Ethnobiology, Socio-Economics and Management of Mangrove Forests: A Review." *Aquatic Botany* 89(2): 220–236.

Walton, M., G. Samonte-Tan, J. Primavera, G. Edwards-Jones, and L. Le Vay. 2006. "Are Mangroves Worth Replanting? The Direct Economic Benefits of a Community-Based Reforestation Project." *Environmental Conservation* 33(4): 335–343.