METHOD PROFILE

Cost-based methods

Estimates the amount of money that we save due to the availability of ecosystem services.

In a nutshell

Cost-based methods look at the costs, losses and expenditures that are saved due to the availability of ecosystem services. They are commonly used to value regulating and supporting services, especially the protective functions of ecosystems (for example erosion control, flood attenuation or storm protection).

Three valuation techniques are commonly included in this category of methods:

- *Replacement cost* techniques: What are the costs of replacing an ecosystem service with artificial or human-made technologies or infrastructure?
- *Mitigative expenditures* techniques: What are the costs of dealing with the effects of the loss of an ecosystem service?
- *Damage costs avoided* techniques: What are the costs that occur when the loss of an ecosystem service results in damage to property or production?

Cost-based methods are for the most part relatively simple to apply, and values can often be calculated based on existing secondary data. The main weakness is that they do not strictly measure people's utility or preferences. It is therefore often difficult to be certain when making assumptions and predictions about how people would actually respond to the loss of ecosystem services, what physical damages would occur, or whether the response measures would adequately remediate, mitigate or compensate for lost ecosystem functions.

1. What information does the method provide?

Ecosystem services are assessed and quantified by calculating the avoided (monetary and/or non-monetary) costs, losses and expenditures, which result from their conservation.

2. Which ecosystem services can be assessed?

Cost-based methods are most commonly applied to regulating and supporting ecosystem services, but may also be applied to provisioning services. They lend themselves particularly well to the protective functions of ecosystems (for example erosion control, flood attenuation or storm protection). Cost-based methods would not normally be considered appropriate for valuing cultural services.

3. How, when and where can the method be applied?

Scope and level of detail:

- Cost-based methods generate rough "back of the envelope" estimates. They can also be used as part of more in-depth assessments, which calculate the value of specific ecosystem services, for particular beneficiaries.
- While more in-depth applications would usually be expected to yield monetary estimates of value, rapid assessments might quantify ecosystem values in non-monetary terms (e.g. size of affected human population, volume of gains or losses in production or consumption, or types of cost that are impacted).

Spatial scale:

- Cost-based methods can be applied at different scales.
- In most cases, the larger the spatial scale the more complex the calculations and data requirements will be.
- It may be particularly challenging to determine the spatial "boundaries" of analysis and impacts: the area and population affected by changes in the quantity or quality of the supply of a particular ecosystem service in a specific site.

Potential purpose of application:

- Cost-based methods may yield monetary or non-monetary estimates of expenditures, costs and losses for any kind of decision support framework (e.g. CBA, CEA, MCA).
- Because they indicate the savings associated with ecosystem conservation (or, conversely the costs associated with ecosystem degradation and loss), cost-based methods are often used to help to "make the case" for conservation budgets, investments or other contributions, to weigh up the cost-effectiveness or impact of different development options or projects, and to provide guidance on appropriate levels of environmental damage liabilities and compensation.
- Cost-based methods provide particularly useful information for the individuals, households and companies potentially affected by the loss of ecosystem services. It is also useful for planners, policy-makers and decision-makers operating in sectors that benefit from the protective functions associated with ecosystems.

4. How does the method work?

Basic steps in applying the method

There are 3-4 main steps involved in collecting and analysing the data required to value ecosystem goods and services using cost-based methods:

Replacement cost	*Mitigative/avertive expenditures*	*Damage costs avoided*
1. Ascertain the benefits associated with a given ecosystem service, how it is used and by whom, and the magnitude and extent of such benefits;	1. Locate the area and population which would be affected by the loss of an ecosystem service, and determine a cut-off point beyond which the effect will not be analysed;	1. Identify the protective services of the ecosystem e and determine the on- and offsite damages that would occur as a result of the loss of this protection;
2. Identify the most likely alternative source of product, infrastructure or technology that could provide an equivalent level of benefits to an equivalent population;	2. Identify the negative effects or hazards that would arise from the loss of the ecosystem service;	2. Locate the infrastructure, human population or production that could be affected by the loss of the ecosystem service,;
3. Calculate the costs of introducing, distributing, or installing and operating the replacement product, infrastructure or technology.	3. Obtain information on the measures taken to mitigate or avert the negative effects of the loss of the ecosystem service;	3. Obtain information on the likelihood and frequency of damaging events, occurring under different scenarios of ecosystem loss, as well as the spread of their impacts and the magnitude of damage caused;
	4. Calculate the cost of the mitigation or avertive expenditures.	4. Calculate the costs of these damages and ascribe the

contribution of the ecosystem service towards minimising or avoiding them.

Data requirements

- Cost-based methods usually require both socio-economic (on the affected population and the likely effects of responses to changes in ecosystem services) and biophysical (on the magnitude and extent of benefits/impacts associated with a given ecosystem status or integrity) data.
- Data required for replacement cost techniques include:
  - the users of the ecosystem service;
  - the magnitude of the benefits provided by the ecosystem service;
  - information of the product, infrastructure or technology that could provide an equivalent level of benefits; and
  - the costs of introducing, distributing, installing and operating the alternative product, infrastructure or technology.
- Data required for mitigative/avertive expenditure techniques include:
  - the negative impacts and hazards that would arise from the loss of an ecosystem service,
  - the affected population and area,
  - the measures taken to mitigate or avert the negative effects of the loss of the ecosystem service, and
  - the cost of these responses and measures.
- Data required for damage costs avoided techniques include:
  - degree of protection provided by the ecosystem,
  - the on- and offsite damages that would occur as a result of loss of this protection,
  - the infrastructure, output or human population that would be affected by this damage,
  - the likelihood and frequency of damaging events occurring under different scenarios of ecosystem change,
  - the spread of impacts and the magnitude of damage caused,
  - the cost of damages, and
  - the contribution of the ecosystem service towards minimising or avoiding damages.
- Data collection for replacement cost and mitigative/avertive expenditure techniques is relatively straightforward. In most cases, required information can be obtained from secondary sources such as expert consultation, professional estimates, historical records, existing literature and studies, supplemented if required with direct observation.
- Data collection for damage costs avoided techniques is rather complex. It requires detailed data and modelling for predicting the likelihood of extreme events and the associated impacts under different scenarios.

Stakeholder engagement requirements

- Stakeholder involvement is not essential when applying cost-based methods. In many cases they can be carried out purely as a desk study. Stakeholder involvement is however highly desirable in order to verify the data and assumptions that are used, and to serve as a reality check. This is especially the case when ascertaining likely human responses to changes in the supply or quality of ecosystem services.

Consideration of distributional issues

- Some level of consideration of distributional issues is usually embedded in cost-based methods. This is because they seek to identify which groups and sectors incur costs, losses or expenditures as a result of changes in the supply or quality of ecosystem services, and value the magnitude of these impacts.

Spatial representation of data/results

- Although spatial representation of data/results is not an explicit part of cost-based methods, the values generated are often fed into spatial planning.
- Cost-based methods lend themselves well to being used for the spatial representation of data/results, because they usually involve locating the area and population which would be affected by changes in the supply or quality of a given ecosystem service.

Level of development / technical maturity/ standards

- Cost-based methods have been in common usage by environmental economists for the last two decades or more, are widely accepted, and have been extensively applied across many different sectors and countries.

5. What resources are required for applying the method?

Time requirement:

- Its application usually requires one month or less. However, it depends on the availability of data and the degree of detail required.

Costs:

- Its application is usually low cost. However, it depends on the availability of data and the degree of detail required.

Type and level of expertise/skills needed:

- Cost based techniques are often applied by non-experts to generate rapid "back of the envelope" estimates of the possible costs, losses and expenditures (or savings) associated with ecosystem changes.
- Cost based methods do not demand high level of skills and experience. However, more detailed applications benefit from some level of expertise and training in ecosystem services valuation.

Manpower/human resources required for application:

- Cost-based methods can be carried out by one person. However, their ideal application would include the involvement of an economist and an expert on the biophysical processes (e.g. an ecologist, biologist, hydrologist, civil engineer, etc.).

6. What are the strengths and challenges?

Strengths	**Challenges**
• Can be easily used as part of rapid assessments (to generate “quick and dirty” indications of values), as well as for more detailed analyses. • Are relatively simply to apply and	• Cost-based methods do not measure people’s preferences, utility or benefits: they value avoided costs, losses and expenditures. • Regarding replacement cost methods, it is usually impossible to find perfect replacements or

analyse. • Do not usually require lengthy or complex primary data collection. • Provide value estimates (of costs, losses and expenditures avoided as a result of ecosystem conservation, or incurred as a result of ecosystem degradation) which can be easily communicated, and tend to resonate with decision-makers.	substitutes for an ecosystem service. • Regarding mitigative/avertive expenditures method, the selected response measures when an ecosystem service is lost, do not always provide an equivalent level of benefits. It is also questionable whether such expenditures are worth making. • Regarding damage costs avoided methods, the estimates of damages avoided remain hypothetical, and thus may not be accurate. They are based on predictions usually calculated under considerable uncertainty. • Without evidence that the population would respond or react in a particular way to the effects of ecosystem service loss, it is not possible to ascertain whether the value estimates yielded via methods are in fact realistic.

7. Case study example

Case Study	**Using replacement costs to value wastewater treatment services in Uganda** Replacement cost techniques were used to value the wastewater treatment services provided by Nakivubo Swamp, Uganda. Covering an area of some 5.5 km^2 and a catchment of over 40 km^2, the wetland runs from the central industrial district of Kampala, Uganda's capital city, passing through dense residential settlements before entering Lake Victoria at Murchison Bay. The study looked at the cost of replacing wetland wastewater processing with artificial technologies. Replacement costs included two components: connecting Nakivubo channel to an upgraded sewage treatment plant which could process additional wastewater loads, and constructing elevated pit latrines to process sewage from nearby slum settlements. The study found that the infrastructure required to achieve a similar level of wastewater treatment to that provided by the wetland, would cost up to US$2 million a year. portals.iucn.org/library/efiles/edocs/1999-047.pdf www.teebweb.org/wp-content/uploads/2013/01/Protected-wetland-for-securing-wastewater-treatment-Uganda.pdf Emerton, L., Iyango, L., Luwum, P., and A. Malinga, 1999, The Economic Value of Nakivubo Urban Wetland, Uganda, IUCN –The World Conservation Union, Eastern Africa Regional Office, Nairobi. Lucy Emerton, Environment Management Group lucy@environment-group.org

8. Further guidance

Websites	For an accessible online basic overview of all valuation methods see:

	www.ecosystemvaluation.org/ For databases of value estimates, see: • International Union for Conservation of Nature (IUCN) & World Wide Fund for Nature (WWF). Biodiversity valuation library. biodiversityeconomics.org/valuation • National Oceanic and Atmospheric Administration (NOAA) & Sea Grant. Coastal environmental economics extension network. www.mdsg.umd.edu/programs/extension/valuation/ • Conservation International (CI). Conservation value map. www.consvalmap.org/ • Dennis M. King & Marisa Mazzotta. Ecosystem Valuation. www.ecosystemvaluation.org/ • New South Wales Department of Environment and Climate Change. Envalue. www.environment.nsw.gov.au/envalue/ • The Cost-Benefit Group. Environmental valuation and cost benefit website. www.costbenefitanalysis.org/ envirovaluation.org/ • Environment Canada. Environmental Valuation Reference Inventory. www.evri.ca/ • UK Department of Environment, Food and Rural Affairs. Environmental Valuation Source List for the UK. www.defra.gov.uk/environment/economics/evslist/ • Nature Valuation and Financing Network. Nature Valuation and Financing Casebase. www.eyes4earth.org/casebase/ • Lincoln University. New Zealand Non Market Valuation Database. http://learn.lincoln.ac.nz/markval/ • Beijier Institute. ValueBaseSWE. www.beijer.kva.se/valuebase.htm
Documentation	A number of general manuals, guidelines and textbooks focus on environmental valuation techniques. These include the following among others: • TEEB Ecological and Economic Foundations Report, Ch 5 focused on "The economic of valuing ecosystem services and biodiversity". www.teebweb.org/our-publications/teeb-study-reports/ecological-and-economic-foundations/ • Eftec. 2006. Valuing our Natural Environment. Report NR0103 for Defra. Defra, UK. www.defra.gov.uk/wildlife-countryside/natres/pdf/nr0103-full.pdf • Pagiola, S., von Ritter, K. and Bishop, J. 2004. How much is an Ecosystem Worth? Assessing the Economic Value of Conservation. The International Bank for Reconstruction and Development/The World Bank, Washington, DC. • Georgiou, S., Whittington, D., Pearce, D., and Moran, D. 2006. Economic Values and the Environment in the Developing World. Cheltenham: Edward Elgar.

- Christie, M., Fazey, I., Cooper, R., Hyde, T., Deri, A., Hughes, L., Bush, G., Brander, L., Nahman, A., de Lange, W. and Reyers, B. 2008. An Evaluation of Economic and Non-economic Techniques for Assessing the Importance of Biodiversity to People in Developing Countries. Report CR 0391 to Defra. Defra, UK
- The Economics of Ecosystems and Biodiversity (TEEB) presents the foundations of valuation of ecosystem services in a series of lectures that can be accessed online at: environment.yale.edu/TEEB

A number of tookits and guidelines provide information targeted at specific biomes or sectors, such as:

- Barbier, E. B., Acreman, M. and D. Knowler. 1997. Economic Valuation of Wetlands: A Guide for Policy Makers and Planners. Ramsar Convention Bureau, Gland. www.ramsar.org/lib/lib_valuation_e.pdf
- CBD. 2007. An Exploration of Tools and Methodologies for Valuation of Biodiversity and Biodiversity Resources and Functions. CBD Technical Series Number 28, Convention on Biological Diversity, Montreal. www.cbd.int/doc/publications/cbd-ts-28.pdf
- Emerton, L. and G. Howard. 2008. A Toolkit for the Economic Analysis of Invasive Species. Global Invasive Species Programme, Nairobi. www.gisp.org/publications/toolkit/Economictoolkit.pdf
- Emerton, L., and E. Bos. 2004. VALUE: Counting Ecosystems as Water Infrastructure. IUCN — The World Conservation Union, Gland. data.iucn.org/dbtw-wpd/edocs/2004-046.pdf
- DEFRA. 2007. An introductory Guide to Valuing Ecosystem Services. UK Department for Environment, Food & Rural Affairs, London. ec.europa.eu/environment/nature/biodiversity/economics/pdf/valuing_ecosystems.pdf
- OECD. 2002. Handbook of Biodiversity Valuation: A Guide for Policy Makers. Organisation for Economic Co-operation & Development, Paris. www.iwlearn.net/abt_iwlearn/events/ouagadougou/readingfiles/oecd-handbook-biodiversity-valuation.pdf
- Pabon-Zamora, L. Bezaury, J., Leon, F., Gill, L., Stolton, S., Grover, A., Mitchell S. and N. Dudley. 2008. Valuing Nature: Assessing Protected Area Benefits. A Quick Guide for Protected Area Practitioners. The Nature Conservancy (TNC) and Convention on Biological Diversity, Washington DC. conserveonline.org/workspaces/patools/documents/valuing-nature
- Phillips, A., ed. 1998. Economic Values of Protected Areas: Guidelines for Protected Area Managers. IUCN - The World Conservation Union, Gland and Cambridge. cmsdata.iucn.org/downloads/pag_002.pdf
- UNEP-WCMC. 2011. Marine and coastal ecosystem services: Valuation methods and their application. Biodiversity Series No. 33, United Nations Environment Programme-World Conservation Monitoring Centre, Cambridge. www.unep.org/dewa/Portals/67/pdf/Marine_and_Coastal_Ecosystem.pdf

	• van Beukering, P., Brander, L., Tompkins, E. And E. McKenzie. 2007. Valuing the Environment in Small Islands: An Environmental Economics Toolkit. Joint Nature Conservation Committee, London. jncc.defra.gov.uk/pdf/pub07_environmental%20toolkit7-9.pdf • WBCSD. 2011. Gude to Corporate Ecosystem Vauation: A Framework for Improving Corporate Decision-Making. World Business Council for Sustainable Development, Geneva. www.wbcsd.org/work-program/ecosystems/cev.aspx Textbooks on valuation including all valuation methods include: • Tietenberg, T. and Lewis, L. 2012. Environmental & Natural Resources Economics (9th Edition). Pearson Education, New Jersey. • Hanley, N., J. Shogren, and B. White. 2007. Environmental Economics in Theory and Practice, Palgrave, London. • Garrod, G., Willis, K.G. 1999. Economic Valuation of the environment. Edward Elgar, Cheltenham. • Freeman, A.A. 1993. The Measurement of Environmental and Resource Values. Resources for the Future Press, Baltimore. • Pearce, D.W., Turner, R.K. 1990. Economics of Natural Resources and the Environment. John Hopkins University Press, Baltimore, USA.

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Annex – Further case studies on cost-based methods:

Agroecosystems	Soil nitrogen	Africa	Mekuria. W., Veldkamp, E., Tilahun, M. and R. Olschewski. 2011. Economic valuation of land restoration: the case of exclosures established on communal grazing lands in Tigray, Ethiopia. Land Degradation & Development 22: 334-344.
Coastal wetlands	Flood control & wastewater treatment	Asia	Emerton, L., and B. Kekulandala. 2002. Assessment of the Economic Value of Muthurajawela Wetland. IUCN — The World Conservation Union, Sri Lanka Country Office and Regional Environmental Economics Programme Asia, Colombo.
Coastal wetlands	Prevention of coastal erosion	Asia	De Mel, M. and C. Weerathunge. 2011. Valuation of Ecosystem Services of the Maha Oya, Environmental Foundation, Colombo.
Forest	Waterflow regulation Grazing and fodder	Africa	Kipkoech, A., Mogaka, H., Cheboiywo, J. and D. Kimaro. 2011. The Total Economic Value of Maasai Mau, Transmara and Eastern Mau Forest Blocks of the Mau Forest, Kenya. Environmental Research and Policy Analysis (K), Nairobi.
Forest	Watershed protection	Europe	Getzner, M. 2009. Economic and cultural values related to Protected Areas Part A: Valuation of Ecosystem Services in Tatra (PL) and Slovensky Raj (SK) national parks. WWF World Wide Funds for Nature Danube Carpathian Programme (DCP), Vienna
Forest	Erosion control	Europe	Ceroni, M. 2007. Ecosystem services and the local economy in Maramures Mountains Natural Park, Romania. Report submitted to United Nations Development Programme (UNDP), Bucharest
Forests	Water conservation, nutrient cycling, pollution regulation, pest control	Asia	Xue, D. and C. Tisdell. 2001. Valuing ecological functions of biodiversity in Changbasin Mountain Biosphere Reserve in Northeast China. Biodiversity and Conservation 10: 467-481.
Forests	Flood prevention, erosion control	Asia	Van Beukering, P., Grogan, K., Jansfort, S. and D. Seager. 2009. An Economic Valuation of Aceh's forests: the road towards sustainable development. Report No. R-09/14, Institute for Environmental Studies (IVM), Amsterdam.
Freshwater wetlands	Water quality amelioration	Africa	Turpie, J., Day, E., Ross-Gillespie, V. And A. Louw. 2010. Estimation of the Water Quality Amelioration Value of Wetlands A Case Study of the Western Cape, South Africa. Environment for Development Discussion Paper 10-15, Environmental Economics Unit, University of Göteborg and Resources for the Future, Washington DC.

Freshwater wetlands	Flood control	Africa	Turpie, J., Smith, B., Emerton, L. and J. Barnes. 1999. Economic Value of the Zambezi Basin Wetlands. University of Cape Town and IUCN Regional Office Southern Africa, Harare.
Freshwater wetlands	Urban wastewater treatment	Africa	Emerton, L., Iyango, L., Luwum, P., and A. Malinga, 1999, The Economic Value of Nakivubo Urban Wetland, Uganda, IUCN - The World Conservation Union, Eastern Africa Regional Office, Nairobi.
Freshwater wetlands	Water purification services	Africa	Wasswa, H., Mugagga, F. And V. Kakembo. 2013. Economic Implications of Wetland Conversion to Local People's Livelihoods: The Case of Kampala- Mukono Corridor (KMC) Wetlands in Uganda. Academia Journal of Environmental Sciences 1(4): 66-77.
Freshwater wetlands	Flood control & wastewater treatment	Asia	Gerrard, P., 2004, Integrating Wetland Ecosystem Values into Urban Planning: The Case of That Luang Marsh, Vientiane, Lao PDR, IUCN – The World Conservation Union Asia Regional Environmental Economics Programme and WWF Lao Country Office, Vientiane
Freshwater wetlands	Pollution control	Asia	Pornpinatepong, K. 2010. Pollution Control and Sustainable Fisheries Management in Songkhla Lake, Thailand. EEPSEA Research Report No. 2010-RR5, Environment and Economics Program for South East Asia, International Development Research Centre, Ottawa.
Freshwater wetlands	Nitrogen abatement	Europe	Gren, I., 1995, 'The value of investing in wetlands for nitrogen abatement', European Review of Agricultural Economics 22: 157-172.
Freshwater wetlands	Nutrient removal in flood plains	Europe	Meyerhoff, J. And A. Dehnhardt. 2004. The European Water Framework Directive and Economic Valuation of Wetlands: The Restoration of Floodplains along the River Elbe. Working Paper on Management in Environmental Planning 11/2004, Institute for Landscapearchitecture and Environmental Planning, Technical University of Berlin.
Freshwater wetlands	Water quality improvement	Latin America & Caribbean	Ibarra, A., Zambrano, L., Valiente, E. and A. Ramos-Bueno. 2013. Enhancing the potential value of environmental services in urban wetlands: An agro-ecosystem approach. Cities 31: 438-443.
Marine and coastal	Shoreline protection	Africa	UNEP. 2011. Economic Analysis of Mangrove Forests: A case study in Gazi Bay, Kenya. United Nations Environment Programme (UNEP), Nairobi.
Marine and coastal	Protection against storms and tidal surges	Asia	Das, S. 2009. Can Mangroves Minimize Property Loss during Big Storms? An Analysis of House Damage due to the Super Cyclone in Orissa. SANDEE Working Paper No. 42-09, South Asian Network for Development and Environmental Economics (SANDEE), Kathmandu.
Marine and	Protection	Asia	Mahmud, S. and E. Barbier. 2010. Are Private Defensive

coastal	against storms and tidal surges		Expenditures against Storm Damages Affected by Public Programs and Natural Barriers? Evidence from the Coastal Areas of Bangladesh. SANDEE Working Paper No. 54-10, South Asian Network for Development and Environmental Economics (SANDEE), Kathmandu.
Marine and coastal	Protection against coastal erosion	Asia	Cesar, H. 1996. Economic Analysis of Indonesian Coral Reefs. Environment Department Work in Progress, World Bank, Washington DC.
Marine and coastal	Protection against storms and tidal surges	Asia	Badola, R. and S. Hussain. 2005. Valuing ecosystem functions: an empirical study on the storm protection function of Bhitarkanika mangrove ecosystem, India. Environmental Conservation 32(1): 85-92.
Marine and coastal	Fisheries productivity	Europe	Sundberg, S. 2004. Replacement costs as economic values of environmental change: A review and an application to Swedish sea trout habitats. Beijer International Institute of Ecological Economics, Stockholm.
Marine and coastal	Shoreline protection	Latin America & Caribbean	Burke, L., Greenhalgh, S., Prager, D. and E. Cooper. 2008. Coastal Capital – Economic Valuation of Coral Reefs in Tobago and St. Lucia. World Resources Institute, Washington DC.
Marine and coastal	Oil pollution damages	North America	Boyd, J. 2010. Lost Ecosystem Goods and Services as a Measure of Marine Oil Pollution Damages. RFF DP 10-31, Resources for the Future, Washington DC.