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Economics in policy-making **3**

Valuing the environment in economic terms

Unlike mainstream economics (which often disregards the environment's central role in our economy), both environmental and ecological economics argue that economic processes cannot be detached from the natural environment in which they operate.

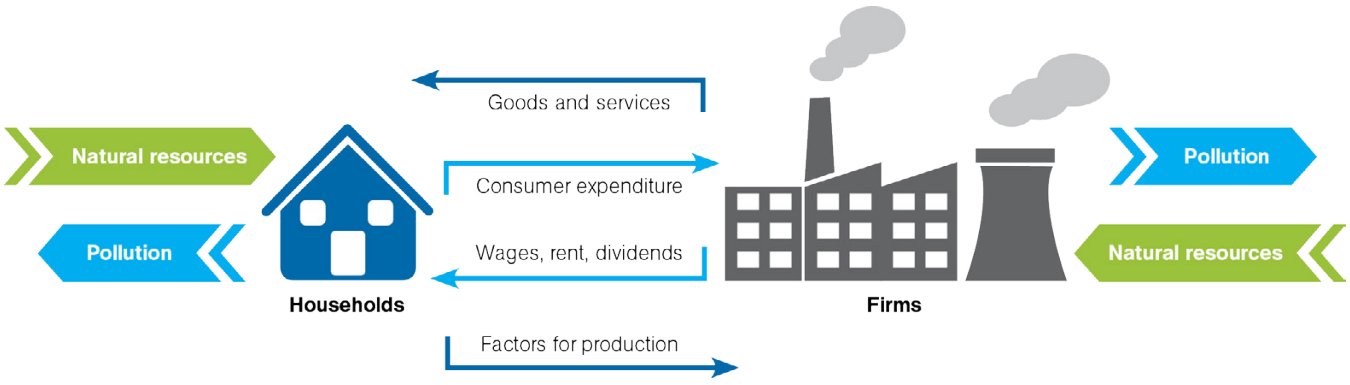
In this briefing, we discuss the different approaches that exist towards valuing nature, and the challenges inherent in doing so.

As shown in the diagram below (Figure 1), the economy cannot operate without a constant flow of matter and energy coming from the natural environment.

For this reason, environmental degradation has a huge economic impact on human societies and productive activities. If, for example, energy flows from the environment were to suddenly stop, then most human economic activity would be impossible. Similarly, if critical natural resources like metals, fossil fuels or water were to vanish, so too would the human economic activities that rely on them.

The central role of the natural environment in economic processes means that nature has an economic value. But unlike other commodities, the value of nature is not reflected, represented or quantified through the price system. For instance, we do not 'pay' for the air we breathe and there is no 'market price' for consuming clean air.

Figure 1: The role of the natural environment in the economy



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Some say this lack of pricing for the natural environment is one of the main causes of environmental degradation. That is, because humans judge natural resources to be free, they have an incentive to over-exploit them.

In the words of the United Nations Environment Program (UNEP):

> *"[…] nature is the source of much value to us every day, and yet it mostly by-passes markets, escapes pricing and defies valuation. This lack of valuation is, we are discovering, an underlying cause for the observed degradation of ecosystems and the loss of biodiversity"*

We can take three points from this: (a) that market prices do not properly reflect the value of nature, thus skewing our consumption and production choices towards an over-exploitation of resources which we do not pay a price for; (b) that market prices only reflect part of the value of the goods we consume and produce; and finally (c) that we need an economy that operates within ecological boundaries without this needing to be linked to the market.

Why value nature in project appraisal and evaluation?

Traditional cost–benefit analysis (CBA) focuses mainly on strict economic returns. If the financial benefits of an action outweigh its costs, then CBA considers it efficient, no matter what its knock-on environmental impacts or 'externalities' are. An infrastructure project that is damaging a nearby river ecosystem, for instance, may still be classed highly efficient – purely because environmental effects like this do not factor in the standard CBA equation. Put simply, the implicit value put on nature is zero.

In contrast, environmental valuation gives environmental impacts a monetary value so that they can be compared like-for-like with financial returns. A project is only judged efficient if the sum of its financial, economic and environmental benefits outweighs its costs in these areas. If its net environmental costs surpass its economic benefits, it does not pass the test.

Two important prerequisites are needed when including environmental impacts in cost-benefit analysis:

1. a precise definition of the value of the natural environment; and,
2. tools and methods to monetise environmental 'assets', 'goods' and 'services'.

What is the economic value of nature?

As shown, nature is of critical importance (and interest) to the economic system.

Some aspects of nature are directly useful for human production and consumption, and have what is known as 'use value'. Clean water and productive soils for agriculture, for instance, are both environmental services with a physical 'use value'.

But there are also aspects of nature that have much less tangible attributes, for example, a 'beautiful' landscape could be thought to have intrinsic aesthetic value. Though this value might not necessarily link to economic production or consumption, it could certainly influence human well-being. Abstract attributes like these are often termed 'non-use values'.

The sum of "use values" and "non-use values" makes up the total economic value ('TEV') of an ecosystem, species or resource.

The figure on the following page illustrates the different components of use and non-use values.

How can we measure the economic value of nature?

Environmental economists have developed various ways of putting a price on environmental services. Their methods fall into two broad categories: (1) revealed preference methods and (2) stated preference methods.

Revealed preference (RP) methods are useful for capturing the use value of nature.

They rely on actual market data and human behaviour to reveal peoples' environmental preferences, and what they will pay to achieve these preferences. RP methods take into account factors such as:

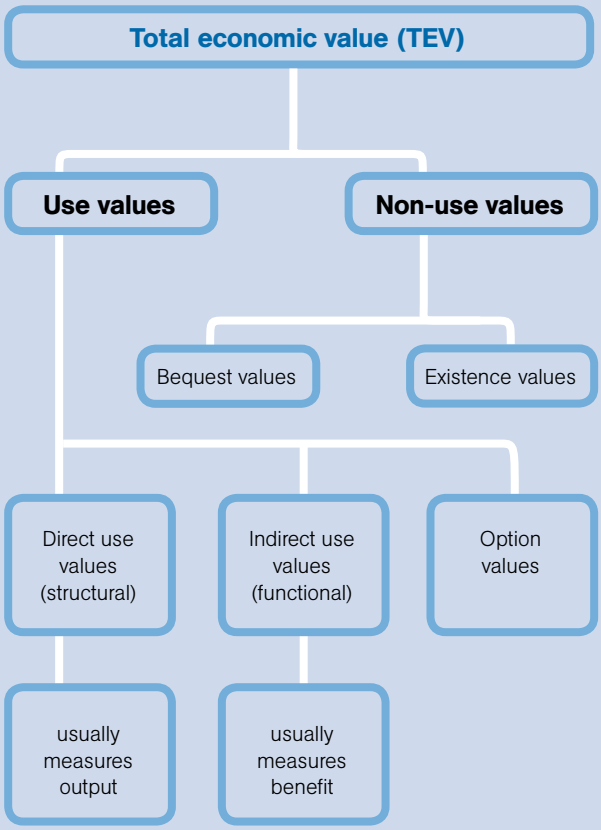
- market prices (such as the cost of visiting a national park);
- averting behaviour (i.e. actions or expenditures that individuals undertake to avoid something);
- hedonic pricing (i.e. the impact of green spaces on real estate price variations); and
- travel costs (for example, the distance people are prepared to travel to get to a certain beach).

Stated preference (SP) methods entail using structured questionnaires to ask people about their environmental preferences.

In principle, SP methods can be applied to a wide range of contexts and are the only way of estimating non-use values (which can be a significant component of overall TEV for some natural resources).

Included in this approach are Willingness To Pay (WTP) and Willingness To Accept (WTA) methods. These are surveys that ask people how much they would be willing to pay, sacrifice or exchange in order to receive a certain good or to avoid something undesired, such as pollution.

In practice, however, most CBA that takes the environment into account uses 'benefit transfer'. This simply involves taking the results of other valuation



Use values:

Direct use values: material benefits provided by an ecosystem that are directly linked to the economic system and for which market values may exist – e.g. recreational sites, timber extraction, landscape amenity, fishing extraction off a coral reef.

Indirect use values: material benefits which are indirectly linked to the economic system and for which market values are more difficult (yet possible) to derive – e.g. ecosystem services such as air purification, carbon sequestration, and waste dispersal.

Option value: the value placed on preserving a resource for future direct or indirect use (e.g. the value of maintaining a river catchment for future irrigation needs or of safeguarding a fish stock)

Non-use values:

Existence or intrinsic values: value from knowing an environmental good exists and is preserved, despite the fact that it may never be used or seen. One example is that of westerners paying to save giant pandas from extinction even without having seen them or deriving any direct benefit from their species' survival.

Bequest value: value derived from knowing that a resource is maintained for future generations

studies (e.g. the value of a mangrove ecosystem in India) and transferring them to the appraisal in question (e.g. for evaluating the value of a mangrove ecosystem in Tanzania). This approach can be problematic if the values are not transposed in a robust manner – usually using econometric techniques (which use maths and statistics to provide empirical evidence).

Is environmental valuation an acceptable methodology?

The practice of putting a price tag on environmental natural resources is not without its limitations. The first of these relates to accuracy: considering the complex, non-linear nature of ecosystems, valuing the worth of their non-marketed goods can be an imprecise exercise. This uncertainty needs to be acknowledged in the analysis.

Critics also question the very notion of monetising natural assets, arguing that changes to nature should not be judged on the same scale as the consumption and production of goods. Can we really weigh up the extinction of species (expressed in dollar values) with consumption gains?

A third criticism of incorporating environmental valuation into CBA warns that doing so may encourage the adoption of a 'weak sustainability' approach (which assumes manufactured capital can replace natural capital) rather than a 'strong sustainability' approach (which views natural capital as irreplaceable). After all, the method does make it possible for market benefits to override environmental losses. This is because it is only the aggregate costs and benefits (be they financial, economic or environmental) of a project that matter. For instance, a project which decreased environmental capital by £50 but raised economic capital by £70 might still go forward in spite of it resulting in an irreversible environmental loss.

Alternatives to environmental valuation

Critics of valuation have proposed some alternatives which include:

1. Using multi-criteria analysis (MCA) techniques (which assess a mixture of monetary and non-monetary benefits) rather than CBA when an intervention has considerable environmental impacts and/or implications. MCA does not require the monetisation of environmental gains or losses. This technique is described in detail in briefing 6.
2. Using a "strong sustainability" criterion when carrying out cost-benefit analysis. By this measure, projects which generate greater overall benefits than costs are only considered 'efficient' if they do not reduce levels of natural capital at all. This follows a precautionary principle approach (a concept which aims to enhance environmental protection by taking preventative decisions, i.e. erring on the side of caution when not all facts are known).

CASE STUDY

The theory and some key economic tools used to value nature have been described. This case study now looks at the Total Economic Value (TEV) framework in practice. The following case studies present examples of valuation techniques and approaches used for marine ecosystem services.

Environmental valuation has begun to play a major role in option appraisal for resource management decision-making. The TEV of a habitat is derived by valuing the benefits we obtain from it (including *direct uses, indirect uses,* and *non-uses).* Economic values include shadow prices, i.e. market prices adjusted for taxes and subsidies, and opportunity costs, i.e. costs measured in terms of their value in their next best alternative use.

The following case studies present the key findings and results from papers produced by Plymouth Marine Lab (Case studies 1 and 2),[1] the Crown Estate (Case study 3),[2] and an example on coral reefs from work by James Spurgeon as well as the WWF (Case study 4).[3]

1 **Beaumont *et al.* (2007)**[4] identified the key ecosystem services provided by the marine environment (Table 1). As you will see, the list includes services covering all aspects of the TEV framework from the briefing (covering both use and non-use values of the marine environment). A full description of each can be found here: www.vliz.be/imisdocs/publications/118829.pdf

2 The paper **Beaumont *et al.* produced in 2008**[5] showed that 'a wide range of goods and services that are essential for the maintenance of the social and economic wellbeing of our society are supported by marine biodiversity'. These goods and services were defined and monetised as you can see in Table 2 on the following page:

3 **The Crown Estates** *Marine Estate Research* publication[6] has assessed all benefits in detail and their findings are set out in Table 3. The study covers food provision, raw materials, energy, space and waterways, well-being (both physical and psychological), and knowledge.

Clearly how these services are defined and valued (and how the monetised values are finally presented) can vary a great deal. This is an emerging approach and (as the briefings have shown) it has its limits. There are some services which are undoubtedly priceless: fresh air to breathe or healthy, productive oceans being two very clear examples. As Mangi[7] puts it: 'It is widely accepted that mankind derives benefits from ecosystem services provided by the marine environment. It is less clear how these benefits can be quantified in order to make objective and responsible environmental management decisions. Providing an economic quantification of these benefits is one approach that can help.'

Table 1

Goods and services provided by marine biodiversity	
Category	**Good or service**
Production services	1 Food provision 2 Raw materials
Regulation services	3 Gas and climate regulation 4 Disturbance prevention (flood and storm protection) 5 Bioremediation of waste
Cultural services	6 Cultural heritage and identity 7 Cognitive benefits 8 Leisure and recreation 9 Feel good or warm glow (non-use benefits)
Option use value	10 Future unknown and speculative benefits
Over-arching support services	11 Resilience and resistance (life support) 12 Biologically mediated habitat 13 Nutrient cycling

Table 2. Overview of goods and services provided by marine biodiversity.[5]

Good/service	Definition	Monetary value, per annum, UK £ 2004 (billion = 10^9)	Method	Remarks
Production services				
Food provision	Plants and animals taken from the marine environment for human consumption	£513 million	Market	Under estimate
Raw materials	The extraction of marine organisms for all purposes, except human consumption	£81.5 million	Market	Under estimate
Regulation services				
Gas and climate regulation	The balance and maintenance of the chemical composition of the atmosphere and oceans by marine living organisms	£0.4-£8.47 billion	Avoidance	Under estimate
Disturbance prevention and alleviation	The dampening of environmental disturbances by biogenic structures	£0.3 billion[c]	Avoidance	Under estimate
Bioremediation of waste	Removal of pollutants through storage, dilution, transformation and burial	Valuation data not available		Valuation data not available
Cultural services				
Cultural heritage and identity	The cultural value associated with the marine environment, e.g. for religion, folk lore, painting cultural and spiritual traditions	Valuation data not available		Valuation data not available
Cognitive values	Cognitive development, including education and research, resulting from marine organisms	£317 million[a]	Market	Over estimate
Leisure and recreation	The refreshment and stimulation of the human body and mind through the perusal and engagement with, living marine organisms in their natural environment	£11.77 billion[a]	Market	Over estimate
Non-use values - bequest and existence	Value which we derive from marine organisms without using them	£0.5-1.1 billion	Contingent valuation	Under estimate
Option use value				
Option use value	Currently unknown potential future uses for the marine environment	Valuation data not available		Valuation data not available
Supporting services				
Nutrient cycling	The storage, cycling and maintenance of availability of nutrients mediated by living marine organism	£800-2320 billion[b]	Replacement	Use with caution
Resilience and resistance	The extent to which ecosystems can absorb recurrent natural and human perturbations and continue to regenerate without slowly degrading or unexpectedly flipping to alternate states (Hughes et al., 2005)	Valuation data not available		Valuation data not available
Biologically mediated habitat	Habitat which is provided by living marine organisms	Valuation data not available		Valuation data not available

Table 3: Selected ecosystem services, possible valuation methods and information sources

Benefits		Example measures	Example baseline values	Spatial allocation
Food	**Fisheries**	Market values - fisheries needs bioeconomic modelling to take account of stock externalities	Direct: £510m turnover in 2007 Upstream: Fleet capacity 213,000 T, 6763 vessels (2007) Downstream: Fish processing - £385m GVA in 2007	Based on a combining VMS data with ICES landings data
	Aquaculture	Market values (NET of the costs of inputs including the fish food below)	Direct: £350m turnover in 2007 Downstream: Fish processing - £105m GVA in 2007	Based on linking market reports for specific species with the distribution of farms and their annual biomass outputs
	Fertiliser/Feed	Market values	Unknown	Unknown
Raw materials	**Cooling water**	Market values in most cases although some values may be hard to source. Replacement costs for cooling water	£150m annually	Based on the distribution of coastal power stations
	Marine aggregates		Direct: £116m turnover in 2008, £54m GVA Downstream: £303m in 2005	Based on the tonnage sourced annually within marine aggregate regions and assumptions surrounding current landed value
	Salt		Direct: £4m turnover in 2008	Based on location of activity and estimated output
	Ornamental materials (shells)		Unknown	Unknown
Energy	**Biofuels**	Market values	In development	In development
	Oil and Gas		Direct: £25,000m GVA in 2007 Upstream supply chain: £43bn GVA in 2008 Downstream: e.g. petrochemicals £50bn turnover 2008	Based on the location of and annual outputs from each oil and gas well
	Renewable energy		£43m GVA 2007	Based on the location and capacity of renewable energy projects
Space and waterways	**Property**	Market value from rental	£102 million from licence and rental in 2007	
	Maritime transport	Replacement costs	Direct: £4,700m GVA in 2007	
	Space for activities/ structures		Pipelines - unknown Telecom cables - £1,459m GVA from international telephone calls Naval defence - £468m GVA	Based on the location and capacity of cables/pipelines. Military defence unknown due to classified information
Physical wellbeing	**Medicines**	Market values	Future seaweed harvesting for alginates	In development
	Natural hazard protection	Avoidance methods	£358m investment in coastal defence structures in 2007	
	Avoidance of contamination	Avoidance methods		
	Avoidance of pollution	Avoidance methods		
Psychological/ Social wellbeing	**Tourism**	Expenditure and/or participation rates	£4.8 billion in 2005	Based on the location of major seaside resorts
	Recreation/Sport		£1,289 GVA in 2007	Based on location of beaches etc., mapped sailing routes
	Nature watching		No recent data	
	Aquariums	Turnover from the sale or marine pets	Unknown	
	Spiritual/cultural wellbeing	Hedonic values or Stated preference methods	Unknown	
	Aesthetic benefits		Unknown	
Knowledge	**Research**	Investment	Cognitive values are suggested of £453m	Based on the location of research trips
	Education	Investment		
	Inspiration - art	Market values	Unknown	

4 TEV studies for Coral Reefs are widespread; the summary below (Table 4.) of work by James Spurgeon shows what has been measured for coral reefs.[8,9,10]

Table 4. What has been measured for reefs – the values of coral reefs

Direct use values: Extractive

- Fisheries, aquarium and curio trades
- Pharmaceutical and other industrial uses
- Construction

Direct use values: Non-extractive

- Tourism
- Research
- Education
- Social value (e.g. heritage)

Indirect use values

- Biological support Coastal zone extensions
- Physical protection from storms and sea-level rise
- Global life support
- Social services

Non-use values

- Existence values
- Options values
- Intrinsic values

Given these types of values and examples, what are coral reefs worth in economic terms?

Coral reefs provide immense yet still underestimated value to society. Benefits include food, recreation, education, health, coastal protection, support for other ecosystems and species and enjoyment from social, spiritual, and cultural aspects and well as income generation and livelihood support. The most authoritative and credible estimate of the global value of coral reefs was produced by Cesar et al (2003) for WWF,[11] who estimated net benefits of nearly US$ 30 billion per year to the global economy using a 3 per cent discount rate and a 50-year timeframe (again, note the difference to the UK MCZ timeframe), the corresponding global asset value of coral reefs is thus nearly US$ 800 billion.

'Coral reefs are an incredibly valuable ecosystem. Not only are they very important for nature, but they represent a very high value for humankind, supporting millions of people whose lives depend on these natural resources for a source of food and income. Estimates in this report show that coral reefs provide each year nearly US$ 30 billion in net benefits in goods and services to world economies, including, tourism, fisheries and coastal protection' (Table 5).[12]

Without even attempting to measure their intrinsic value, it is clear that coral reefs contribute enormously to food, income, and various other quantifiable benefits, if properly managed.

Table 5: Potential net benefit streams per year and net present value (NPV) of the world's coral reefs (in billion US$)

Good/service	Amount
Fisheries	5.7
Coastal protection	9.0
Tourism/recreation	9.6
Biodiversity value	5.5
Total	29.8
NPV (50 year; 3%)	**797.4**

Source: Author's own calculations

Endnotes

1 http://www.pml.ac.uk/

2 http://www.thecrownestate.co.uk/

3 Currently of Sustain Value, formerly of ERM.

4 Beaumont et al, 'Identification, definition and quantification of goods and services provided by marine biodiversity: Implications for the ecosystem approach', Marine Pollution Bulletin 54 (2007) 253–265): PML

5 Beaumont et al, Economic valuation for the conservation of marine biodiversity, Marine Pollution Bulletin 56 (2008) 386–396: PML

6 Saunders, J., Tinch, R., and Hull, S. (2010).*Valuing the Marine Estate and UK Seas: An Ecosystem Services Framework*. London: HMSO, The Crown Estate.

7 Environmetrics, (Mangi, 2011) Valuing the regulatory services provided by marine ecosystems

8 Spurgeon, J. (1992) The Economic Valuation of Coral Reefs. *Marine Pollution Bulletin* [2] and [3]

9 Spurgeon, J. (2002) *Valuation of Coral Reefs: the next 10 years*. WorldFish Centre: Economic Valuation and Policy for Sustainable management of Coral Reefs.

10 Spurgeon, J. (2006) *Time for a third generation economics-based approach to Coral Management*. Coral Reef Conservation, ZSL. London.

11 http://pdf.wri.org/cesardegradationreport100203.pdf

12 WWF (no date) *The Economics of Worldwide Coral Reef Degradation*. Retrievable from: assets.panda.org/downloads/cesardegradationreport100203.pdf

Further reading and useful resources

- UK National Ecosystem Assessment (NEA): http://uknea.unep-wcmc.org/
- The Economics of Ecosystems and Biodiversity (TEEB): http://www.teebweb.org/ecological-and-economic-foundations-report/
- Environmental Valuation Reference Inventory (EVRI): http://www.environment.nsw.gov.au/publications/evri.htm

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