Deltares

Valuing ecosystem services

A literature review

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Keywords
Valuation, Ecosystem Services, Valuation Techniques, Cost-Benefit Analysis, decision-making

Summary
Het in geld waarderen van ecosysteemdiensten kan helpen letterlijk en figuurlijk beter rekening te houden met deze diensten. In de praktijk is dit echter niet eenvoudig, en de huidige methoden zijn deels omstreden. Daarom vindt er veel onderzoek plaats op dit gebied. Onderstaand een overzicht van de huidige wetenschappelijke 'state of the art', en de standpunten van relevante organisaties in binnen- en buitenland. De conclusie is dat de ecosysteemdiensten benadering een goed kader biedt voor het in beeld brengen van alle mogelijke effecten. Het waarderen van deze effecten kan bijdragen aan communicatieve doeleinden en besluitvorming. Voor het laatste doeleinde moeten economische waarderingsmethoden gebruikt worden die in sommige gevallen omstreden zijn, daarom moeten de voorwaarden hiervoor per project onderzocht worden. Daarnaast wordt geconcludeerd dat economische waardering/haalbaarheid niet de enige basis mag zijn voor besluitvorming. Andere waarden (ecologisch, cultureel) en richtlijnen (juridische haalbaarheid) vanuit verschillende disciplines moeten een bijdrage leveren om tot weloverwogen besluit te komen.

De systematiek van ecosysteemdiensten is een manier om systematische effecten op natuur en milieu in kaart te brengen. Om te beoordelen hoe groot die effecten zijn en deze af te wegen tegen andere effecten, is het aantrekkelijk om alle effecten in geld uit te drukken, zodat er geen appels met peren vergeleken worden. Eerst kijken we welke soorten waarde er aan natuur en milieu zitten, daarna welke methoden ontwikkeld zijn om deze waarden te meten in euro's. Voor- en nadelen van de verschillende methoden komen aan bod, evenals de discussiepunten. Tot slot worden de standpunten van de belangrijkste organisaties in binnen- en buitenland besproken.

Het in geld uitdrukken van ecosysteemdiensten (natuur en milieu) kan gebruikt worden in Maatschappelijke Kosten Baten Analyses (MKBA's), maar helpt ook om mensen bewust te maken van de het nut van natuur en milieu. Daarbij gaat het om financiële waarde, zoals hout uit een bos dat verkocht kan worden, maar ook om het bredere begrip economische waarde dat normaal niet in geld uitgedrukt wordt. Denk daarbij bijvoorbeeld aan schoon water, mooi landschap, genetische bronnen, en preventie van klimaatverandering. Tenslotte is ook vaak sprake van 'intrinsieke waarde': daarmee wordt bedoeld de waarde die planten en dieren in en voor zichzelf hebben. Per definitie kan de mens daar geen rekening mee houden. Wel kunnen we waarde toekennen aan ecosystemen en het leven van individuele dieren of planten.

Totale economische waarde wordt verdeeld in gebruikswaarde en niet-gebruikswaarde. Ook als een mens een ecosysteem niet actief gebruikt, kan hij er waarde aan hechten:
- 'bestaanswaarde': het kan waardevol zijn te weten dat er een rijke natuur bestaat, ook al doe je er verder niets mee,
- 'vererving swaarde' ('bequest value'): men wil graag een intacte natuur aan de volgende generaties nalaten, en
- 'optiewaarde': het heeft waarde om later nog een keuze te hebben

- Gebruikswaarden zijn:
- directe gebruikswaarden, zoals hout en vis,
- indirecte gebruikswaarden, zoals bescherming tegen klimaatverandering of overstroming, en ook esthetische waarde.

De theorie van het waarderen van ecosysteemdiensten gaat uit van de volgende voorwaarden van de neoklassieke welvaartseconomie, waar in de praktijk doorgaans nauwelijks aan wordt voldaan:

1. Er bestaan markten voor alle goederen en diensten
2. Alle markten kennen volledige concurrentie
   a. Homogene producten
   b. Veel kopers en aanbieders
   c. Vrije toegang tot de markten
   d. Volledige informatie
3. Private eigendomsrechten zijn toegewezen in alle (natuurlijke) hulpbronnen en goederen
4. Er bestaan geen externe effecten (effecten van handelstransacties op anderen dan de handelspartners)
5. alle nuts- en productiefuncties zijn regelmatig en normaal
6. iedereen streeft naar maximaal nut
7. volledige informatie

Als aan deze voorwaarden is voldaan zorgt het marktmechanisme voor een optimaal welvaartniveau en optimale allocatie van middelen. Hoewel aan deze voorwaarden in de praktijk nooit voldaan wordt, is deze theorie het beste wat we hebben.

Directe methoden meten zowel de gebruiks- als de niet-gebruikswaarden, en zijn gebaseerd op hypothetische markten. Belangrijkst nadeel is dat hypothetische markten mogelijk niet de echte waardering weergeven, zodat de uitkomsten omstreden kunnen zijn. Indirecte methoden meten alleen de gebruikswaarden, en zijn gebaseerd op echte markten. Belangrijkst nadeel is dat niet direct gemeten wordt wat men wil meten, maar een afgeleide ervan zodat er een fout en onzekerheid in de resultaten zit.

1. Directe methoden: Contingent Valuation Method (CVM) (enquêtes naar betalingsbereidheid)

Principe van de CVM is dat men een representatieve steekproef van de bevolking vraagt hoeveel men bereid is te betalen voor de te waarderen verandering van een ecosysteemdienst. Hierbij is het belangrijk de enquête zeer zorgvuldig vorm te geven, en bijvoorbeeld het milieugoed heel goed te omschrijven. Hoewel de CVM theoretisch gezien de ideale waarderingsmethode is, zijn er een aantal potentiële bronnen van fouten. De CVM is vooral in de VS een van de meest gebruikte methoden.

2. Directe methoden: Choice Experiments (CE)
Lijkt op de CVM, maar bij een keuze onderzoek wordt de respondent gevraagd te kiezen tussen een aantal alternatieven met verschillende hoeveelheden of kwaliteiten van het onderzochte milieugoed, gecombineerd met verschillende prijzen. Uit de antwoorden is met behulp van statistiek af te leiden wat de betalingsbereidheid is. Deze methode heeft ook de meeste voor- en nadelen van de CVM.

3. Indirecte methoden: Marktprijsmethode
Hierbij wordt de prijs van ecosysteemdiensten die op een markt verhandeld worden gebruikt als maat voor de maatschappelijke waarde van de dienst. Een voorbeeld is toegangskaartjes voor recreatie in een bepaald natuurgebied. Uiteraard worden niet-gebruikswaarden niet gemeten, omdat de betalingsbereidheid van mensen die geen kaartje kopen onbekend blijft. Voor de meeste ecosysteemdiensten is geen markt, en dan is deze methode dus uitgesloten.

4. Indirecte methoden: Afwendingsgedrag methode
Deze methode probeert het milieugoed in kwestie te waarderen door te kijken naar hoeveel mensen betalen om een bepaald milieuprobleem te vermijden of af te wenden. Een voorbeeld is uitgaven voor drinkwaterfilters: men vindt schoon water kennelijk tenminste waard wat men daarvoor uitgeeft.

5. Indirecte methoden: Reiskostenmethode
Om een natuurgebied te waarden (althans de ecosysteemdiensten recreatie en natuurbeleving) kan men de uitgaven voor reiskosten en geïnvesteerde tijd als benadering nemen.

6. Indirecte methoden: Hedonistische prijzenmethode (HPM) (‘hedonic pricing’)
De hedonistische prijzenmethode gaat uit van de veronderstelling dat natuur- en/of milieukwaliteit een van de factoren is die de waarde van een marktgoed bepalen. Door op verschillende locaties te kijken naar de natuurkwaliteit en de prijzen van het marktgoed, kan de betalingsbereidheid voor natuurkwaliteit worden afgeleid. Meestal wordt bij deze methode gebruik gemaakt van de prijzen van huizen, soms van de hoogte van lonen. Zo kunnen huizen in de omgeving van een natuurgebied een andere prijs hebben dan vergelijkbare huizen zonder de nabijheid van een natuurgebied. Het verschil in prijs is een natuurbaat. Om milieurisico's op de werkvloer te waarderen wordt gekeken naar het verschil in lonen, waarbij wordt verondersteld dat banen waarbij werknemers een hoger (milieu-)risico lopen, hogere lonen krijgen. De methode kan geen andere ecosysteemfuncties, zoals regulatie- en productiefuncties, waarderen.

Waardering met kengetallen
Als een goede waarderingsstudie te duur is of te veel tijd kost, kan men ervoor kiezen om resultaten uit andere vergelijkbare studies te gebruiken (kengetallen, 'benefit transfer'). Men kan de waarde direct overnemen als de ecosysteemdiensten voldoende op elkaar lijken. Als ze te verschillend zijn kan men proberen te onderzoeken hoe de waarde afhangt van de karakteristieken van de ecosysteemdienst – men maakt dan een batenfunctie. Vervolgens kan men de waarde berekenen door de karakteristieken in deze functie in te vullen. Benefit transfer kan beter zijn dan niets, maar introduceert extra fouten en onzekerheden bovenop de fouten die al in de originele waardering zaten.

De belangrijkste kritiek op waarderen van ecosysteemdiensten is (1) dat het zinloos is omdat we afhankelijk zijn van ecosystemen en ze niet kunnen inruilen voor geld, en (2) dat het niet mogelijk is om voldoende nauwkeurige cijfers voor de waarde te produceren. Ten eerste kun je de bedragen gebruiken in (maatschappelijke) kosten-batenanalyses om veranderingen in ecosysteemdiensten op gelijke voet en objectief te kunnen vergelijken met andere kosten en baten van een voorgesteld project. Ten tweede zijn de cijfers te gebruiken bij marktconforme milieu-beleidsinstrumenten. Je kunt er bijvoorbeeld de hoogte van een heffing op baseren, ofwel Payment for Ecosystem Service. Ten derde kunnen de cijfers gebruikt worden bij berekening van het Duurzaam Nationaal Inkomen, een alternatief voor het Bruto Nationaal Product. Ten vierde kunnen de cijfers nuttig zijn bij communicatie met en tussen belanghebbenden ('stakeholders'): het is immers duidelijker te spreken over concrete waarden. Het is immers ook duidelijker te zeggen hoe lang een weg (ongeveer) is in kilometers, dan alleen te zeggen dat hij 'lang' of 'kort' is.

Het Centraal Plan Bureau (CPB) vindt dat gemonetariseerde waarden van ecosysteemdiensten niet thuishoren in een MKBA. Zij vinden het monetariseren van natuureffecten en ecosysteemdiensten een abstrahering van de werkelijkheid, die cruciale waarden (andere dan economische) verbergt. Daarnaast zijn de waarderingsmethodes niet ver genoeg uitgekristalliseerd en ontstaat er vaak een hoop discussie rondom de uiteindelijke waardes, een kosten baten analyse moet niet het strijdtoneel zijn van dit soort discussies. In plaats daarvan raden zij aan om natuur effecten zo objectief mogelijk te kwantificeren en apart te presenteren.

In het supplement bij de OEI-richtlijn Waardering van natuur, water en bodem in MKBA's wordt gesteld dat alle effecten die gemonetariseerd kunnen worden, gemonetariseerd moeten worden. Kan dat niet dan moeten de effecten worden gekwantificeerd, of op zijn minst kwalitatief beschreven worden.

Het ministerie van LNV staat positief tegen over waardering van ecosysteemdiensten.

Wat het buitenland betreft, is vooral de VS opvallend. In de VS is waardering van milieueffecten uitgevonden, en sinds 1981 is een MKBA een verplichte voorwaarde voor invoering van alle nieuw beleid en nieuwe projecten. Daarbij worden ook de milieueffecten veelal gemonetariseerd.

De IUCN (International Union for the Conservation of Nature) staat ook positief tegenover waardering van natuur en milieu, en hebben veel ervaring op dit gebied.

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Het WRI (World Resources Institute) staat zeer positief tegen over waardering: het instituut vindt monetariseren een essentieel deel van het volwaardig rekening houden met ecosysteemdiensten.

Bij zorgvuldige toepassing door experts, kan waardering een belangrijk hulpmiddel zijn om beter rekening te houden met ecosysteemdiensten. Een bedrag in euro's of dollars spreekt in het algemeen meer aan dan een PM-post of tekstuele omschrijving. Daardoor helpt waardering om letterlijk en figuurlijk beter rekening te houden met natuur en milieu. De enquêtes naar betalingsbereidheid zijn theoretisch het meest geschikt en internationaal veel gebruikt, maar in Nederland bestaat nog veel scepsis. Indirecte methoden zoals Reiskostenmethode en Hedonische methode zijn theoretisch niet correct, maar worden in het algemeen iets makkelijker geaccepteerd doordat ze empirische getallen gebruiken in plaats van hypothetische.

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	dec. 2009	Rianne van Duinen				Lucas Janssen	

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Contents

1 Introduction

1.1 Background

This study is part of the project 'Sustainable Use of Ecosystem Services' (Duurzaam gebruik van Ecosysteemdiensten DUED). One of the questions from the knowledge arena ('kennisarena') concerned several issues related to ecosystem services. In consultation with the Dutch Ministry of Housing, Spatial Planning and the Environment Deltares decided to focus their strategic research within theme 11.1 subsoil, water and space on the ecosystem service concept. DUED is part of Deltares' strategic research (SO) within this theme. The first goal of the DUED-project is to clarify the contribution of the ecosystem services approach to already existing 'sustainable approaches' and to identify the opportunities of this approach for Deltares. The second goal is to prove the practical usefulness of this concept. One activity under the second goal is to perform a literature scan of the theory and application of ecosystem service valuation. This will be addressed in this report.

From an economic point of view ecosystem services can be defined as the benefits that households, communities and economies obtain from ecosystems (Ranganathan et al., 2008) (Millennium Ecosystem Assessment, 2005) (Boyd and Banzhaf, 2007). This definition has gained popularity in literature since it conveys the idea that ecosystems are valuable; services are based on human needs, uses and preferences (Boyd and Banzhaf, 2007). Although ecosystem services provide benefits to society, they are used in a non-sustainable way so that their quantity and quality is reduced (MA, 2005). Economic, social, cultural, scientific, and technological drivers impose pressures on ecosystems, for example deforestation, climate change and water pollution. Given these pressures, maintaining, developing and investing in ecosystems so that people can benefit from it in a sustainable way is a complex task faced by decision-makers. The 'ecosystem services' approach is a method that facilitates in assessing risks and opportunities of a specific choice (investment, policy etc.). Valuing ecosystem services **can** be part of this approach, see **Error! Reference source not found.**

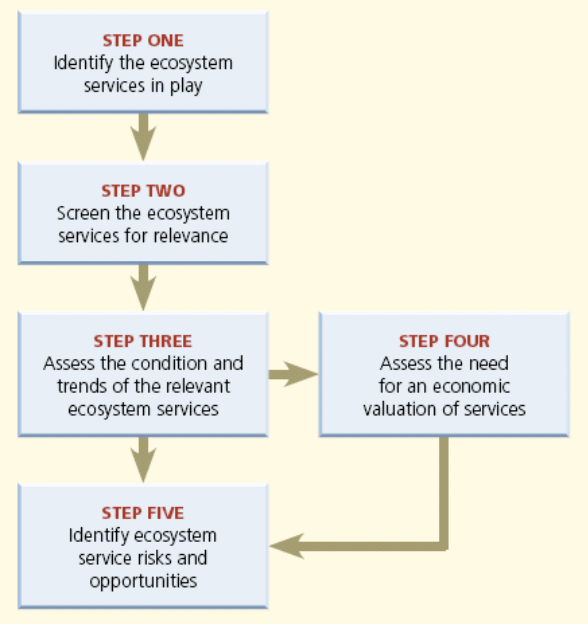


Figure 1.1 Steps in assessing risks and opportunities related to ecosystem services (Ranganathan et al., 2008)

1.2 Objectives

The first goal of this document is to give insight in the concept and methods of ecosystem service valuation as well as the pros and cons of this approach. The second goal is to scan the attitude of national and international institutes towards ecosystem service valuation.

1.3 Document Outline

Chapter 2 gives an overview of the concepts commonly used in economic valuation and gives some background in the theory behind economic valuation. Chapter 3 discusses the valuation techniques including its strengths and weaknesses. Chapter 4 shows the main topics for debate on economic valuation. Then, chapter 5 discusses the main applications of ecosystem services valuation. Chapter 6 gives an overview of the national and international vision economic valuation of environmental goods and services. Finally, the last chapter draws conclusions.

2 Economic valuation of ecosystem services: concepts

This chapter explains the basic concepts underlying ecosystem services valuation. The first section puts forward three reasons to value ecosystem services. The second paragraph discusses three potential values of ecosystems. In recent literature, several classifications of ecosystem services are used; section 2.3 explains which classification is most appropriate for economic analysis. In section 2.4, the concept total economic value is explained. Finally, section 2.5 gives some brief conclusions.

2.1 Why valuing ecosystem services?

Figure 1.1 describes the steps that should be taken to assess the risks and opportunities for ecosystem services. One can question himself why valuation should be part of this process. **Three reasons** from literature are that valuing ecosystem services:

- Supports decision-making
- Raises awareness
- Creates support

The first reason is to **support decision-making** (Perman, 2003). Economic and financial analysis enables informed decision-making on investments and policy measures regarding land use, infrastructure etc. Cost-benefit analysis is often used as a decision support tool to analyze the efficiency of alternative investment options or policy measures. In order to base investment decisions or policy measures on economic ground, all the effects should be considered including environmental effects. This requires economic valuation of ecosystem services. Leaving economic valuation out of the analysis will estimate its opportunity costs at zero, indicating that ecosystem services are ignored in decision-making (Barbier, 2007). Attaching an economic value to ecosystem service can also function as a base for establishing victim compensation due to environmental damages and setting user charges, fees and taxes. For a further discussion of economic valuation and policy-making, see chapter 6.

Two other reasons to value ecosystem services are **raising awareness** and **creating support**, both communication goals. Attaching a value to ecosystem services make people aware of the importance of it. Valuing the benefits illustrates the environmental contribution to well-being and the dependency of society on ecosystems. Policy makers can also use the value to substantiate policy measures or investments. Valuing ecosystem services can increase the acceptation of taxation, command and control measures and payment schemes.

2.2 Value definitions

According to Farber (2002), value is the contribution of an action or object to user-specified goals, objectives or conditions. Valuation is expressing a value to this action, object or condition. For the case of ecosystem services, **three types of values** can be distinguished: ecological (intrinsic), financial and economic value, see Figure 2.1 (de Groot et al., 2002) (Ruijgrok et al., 2004).

Intrinsic value, is based on ecological sustainability, which can be determined by parameters such as complexity, diversity, and rarity which is often expressed in a score. The intrinsic value has nothing to do with human wealth, but with the well-being of animals and plants.

Financial value is the concrete income. The financial value of the ecosystem service recreation is, for example, equal to the turnover of a restaurant in a wildlife area
Economic value is broader than financial value; it considers well-being. This does not only consist of expenditures and turnover, but also of other non-priced benefits such as the enjoyment of a beautiful view; it considers both the material and immaterial benefits. The economic value is more than the financial value, but it does not cover the intrinsic value (Ruijgrok et al., 2004). Economic values are useful to consider when making economic choices: choices that involve tradeoffs in allocating resources.

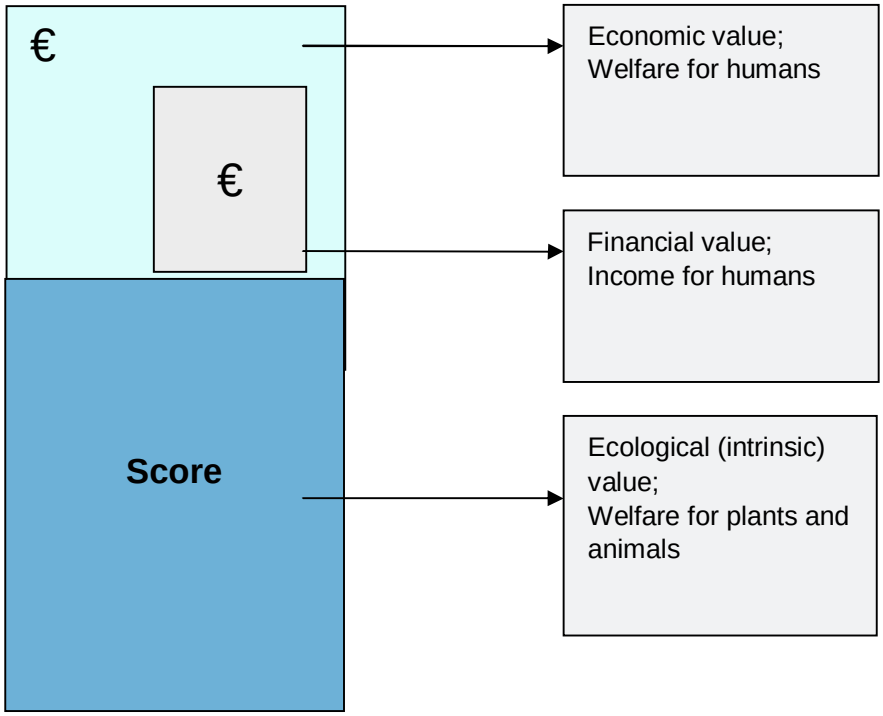


Figure 2.1 Three types of ecosystem values (Ruijgrok et al., 2004). The ecological or intrinsic value considers the welfare for plants and animals, this is often expressed in a score. The financial value is the concrete income related to ecosystem services. Economic value is broader than financial value; it considers human well-being including material and immaterial goods and services.

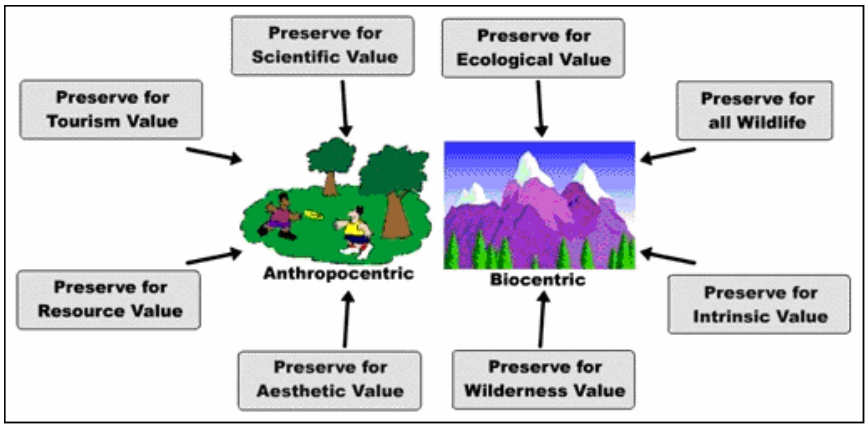
Considering ecosystem services a distinction between **subjective values** and **objective values** needs to be made. Subjective values imply there is a subject who values, objective values are given independent of anyone's preferences, see box 1. Considering ecosystem services, the subjective value covers both financial and economic value. The objective value is equal to the intrinsic value. Welfare economics is anthropogenic, therefore all values are subjective values based on individual preferences; objective values are not considered in welfare economics and therefore left out of economic analysis (Ansink et al., 2008).

Economic valuation of ecosystem services is an anthropocentric approach. In this report we acknowledge that next to subjective values, objective values should be considered. Therefore, economic valuation in for example cost-benefit analysis should be *one of the inputs* for the decision-making process. Decisions should not be made on this information only.

Box 1 Objective vs. Subjective values and Ecocentrism vs. Anthropocentrism

Ecocentrism (also called biocentrism) and Anthropocentrism are two visions on the nature-human-relationship.

Anthropocentrism places humans at the centre of the world. The value of ecosystems is measured by the utility that people derive from it. A tree cannot think for itself and is considered beautiful or has utility when a human considers it as being so. This is an example of a subjective value, a subject (human) attaches value to something.



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.Ecocentrism considers humans as a part of the ecosystem, the interest of humans do not dominate the interests of the ecosystem. In this case, a tree has some intrinsic qualities that are appreciated by humans. These intrinsic qualities are objective values.

2.3 Ecosystem services categorization and economic implications

Ecosystems provide **benefits** to people in the form of goods and services. Think for example about the production of food and fuel. Goods are the physical elements consumed by people; services are the processes that produce or support the production of ecosystems and the processes that sustain human life. The provisioning of ecosystem goods and services is one of the four categories defined by the Millennium Ecosystem Assessment, see Figure 2.1 (MEA, 2005). The other services are regulating services, cultural services and supporting services. Regulating services are the regulating processes and characteristics of the ecosystem itself that indirectly affects the economic system by the provisioning of goods and services e.g. water flows and climate regulation. Cultural services are the immaterial benefits, for example a place to recreate, esthetic perception, and information systems. Supporting services are the services necessary to provide any other ecosystem service, for example the provisioning of (natural) habitat, biomass production and soil productivity.

Figure 2.2 Four categories of ecosystem services, according to the Millennium Ecosystem Assessment. These categories all influence certain aspects of human well-being in a more or less extend

Ecosystem services determine human well-being and on the other side, human well-being has influence on the quality and quantity of ecosystem services. Ruijgrok et al., 2004 shows the interaction between the socio-economic system and the ecosystem and distinguishes different categories of ecosystem services based on their role in the interaction between ecosystem and socio-economic system, Figure 2.3. The provisioning function causes a flow of goods, services and information from ecosystem to socio-economic system. People can directly derive welfare from using (or not using) these goods and services. Supporting services are the counterpart of the provisioning services; it concerns a flow from the economic system to the ecosystem. People put for example houses, infrastructure and waste in the ecosystem. Regulation services represent the flows within an ecosystem, for example nutrient cycling. These services affect well-being indirectly by the provisioning of goods and services.

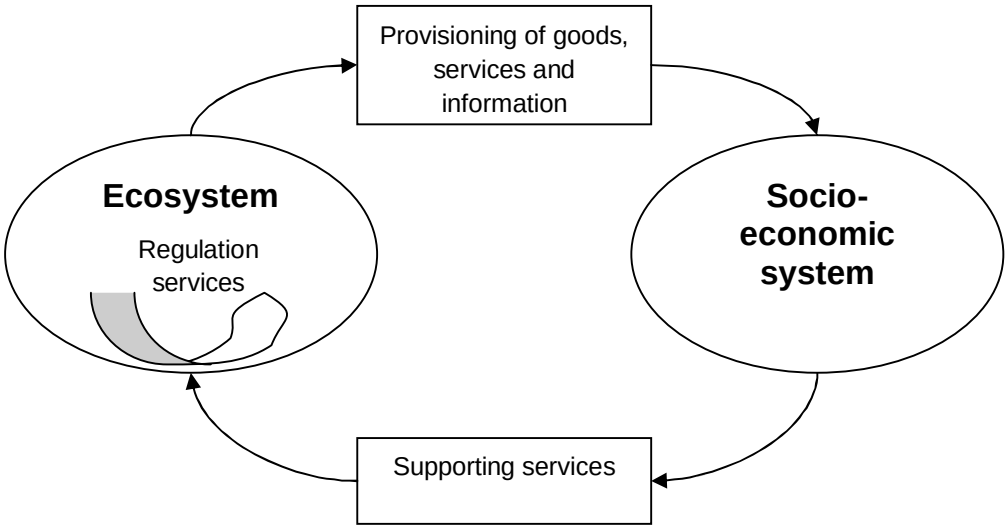


Figure 2.3 Ecosystem services and the economic system (Ruijgrok et al., 2004). This classification is based on the role of the ecosystem service in the relation between ecosystem and socio-economic system.

Comparing the classification of MEA and Ruijgrok et al., 2004 some differences can be observed:

- The provisioning services of Ruijgrok et al., 2004 includes cultural services as distinguished by MEA, 2005
- The regulation services of Ruijgrok et al., 2004 include both regulating and supporting services defined by MEA, 2005
- Supporting services as defined by Ruijgrok et al., are not considered in the MEA, 2005

This raises the question which categorization is appropriate from an economic point of view?

This question can be answered using the approach explained by Ansink et al., 2008. Besides the distinction between objective and subjective values, a distinction between **end-values** and **instrumental values** needs to be made. End-values refer to objects that we value in it self, regardless of whether it gives someone utility. Instrumental values refer to objects that are not necessarily valued themselves but provide other objects that have end-values. Ecosystems can have both values *if* society also values the ecosystem itself. Based on this distinction **two approaches** have developed in ecosystem valuation. One approach employs the valuation of the **functions** of ecosystems (instrumental value). Functions can be defined as the capacity to provide benefits to society (natural capital). From **Error! Reference source not found.**4, it follows that their components, structure and processes characterize ecosystems. Given the structure, the components can interact with each other. The functions or capacity of ecosystems depends on these components, structure and processes. A function may result in the supply of ecosystem services to society. An example: The function 'the capacity to catch fish' depends on ecological components, structure and processes such as water quality, the reproduction of fish, the growth of plants and algae and the oxygen content of the water. The capacity is variable over time and actual and future potential supplies should be valued. The ecosystem function available for society can be interpreted as natural capital.

The second approach focuses on the valuation of **goods and services** of ecosystems (end-values). Ansink et al., (2008), describes the relation between ecosystems, functions, services and values see Figure 2.4. The ecosystem function 'the capacity to catch fish' as mentioned above may result in the service to catch fish. The amount of fish caught from the ecosystem depends on demand and extraction costs.

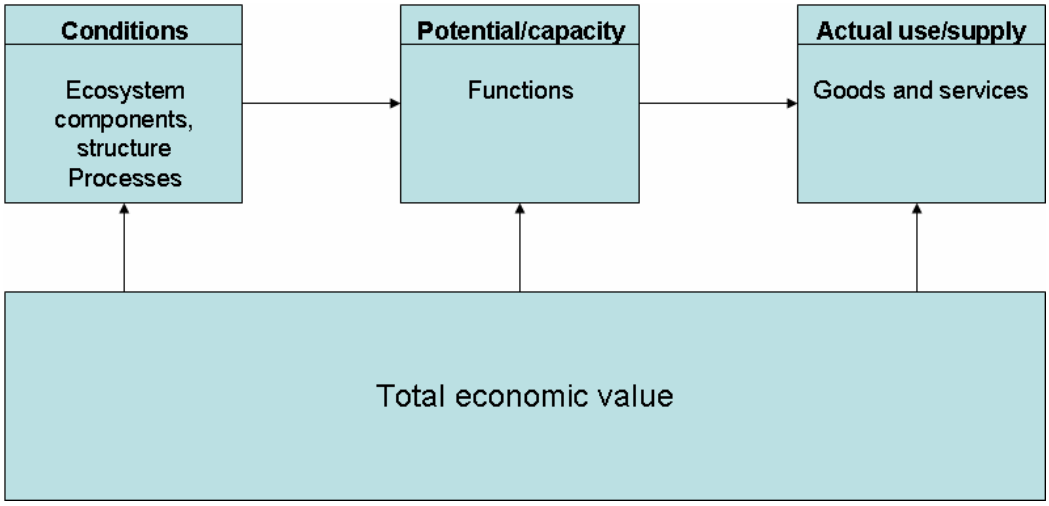


Figure 2.4 Ecosystem functions, services and values (Ansink et al., 2008). This categorization is the same as the categorization of Ruijgrok et al., (2004(. and is preferred from an economic point of view since it prevents from 'double counting'

The distinction between valuing functions and valuing goods and services is crucial from an economic point of view. The values for ecosystem structure, function and goods and services cannot be easily summed up, there is a risk of overlapping or overlooking values if these types are mixed. From literature, it becomes clear that the valuation of ecosystem functions and ecosystem goods and services both give the same values, but that the ecosystem service approach is practically preferable (Ansink et al., 2008).

Comparing this conclusion with the classification of MEA and Ruijgrok, (2004); the last one is preferred since it follows the structure that avoids 'double counting' in contrary to the classification of the MEA, (2005).

2.4 Categorization of total economic value

Continuing from the conclusion of the previous paragraph that total economic value can be derived from either ecosystem functions or actual use, this paragraph explains more abut the components of total economic value.

Total economic value can be divided into two classes of benefits: **use value and non-use value**. These two classes can be split up further. Use value covers direct use value, indirect use value and option value. Non-use value covers bequest value and existence value. Definitions and examples of the different benefit classes are shown in Figure 2.5. Use value arises from the actual or planned use of the goods and services provided by ecosystems. Direct use values are goods that can be directly consumed e.g. food, medicines, industrial products, fuel and building materials. Indirect use values are life support services for example protection of water and climate regulation.

Non-use values capture the elements that are not related to current, future or potential use. Option value is the willingness to pay to guarantee the availability for future use. Bequest value is the willingness to pay to make sure that certain goods and services will be preserved for future generation. Existence value is the value attached to an ecosystem service without making any use from it.

In literature, there is no agreement on a standard categorization or uniform terminology of total economic value (Turner et al., 1998) (Dziegielewska et al., 2009) (Perman et al., 2003) (Farber et al., 2002) (Barbier, 2007) (Perrot-Maître, 2005). Mainly, literature does not agree on whether option value is a use values or non-use values; therefore, they are marked with striped arrows in Figure 2.5. However, for **practical** reasons the categorization between use and non-use values is sufficient, since valuation techniques operate on this level (Perman et al., 2003).

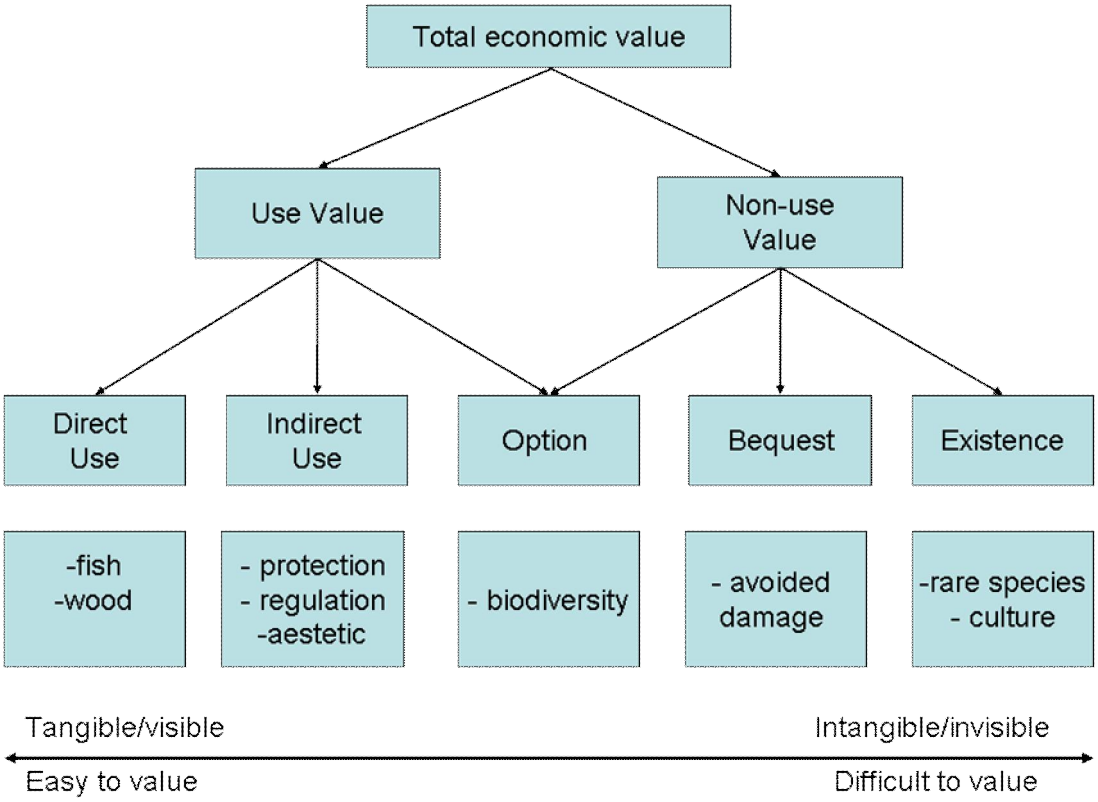


Figure 2.5 Categorization of total economic value (van Beukering, 2008)

2.5 Conclusions

This chapter gave an overview of the definitions and classifications of concepts crucial for economic valuation of ecosystem services. Valuation of ecosystem services is desired for supporting decision-making and communication goals such as raising awareness and creating support. Economic value considers the well-being of humans; this is an anthropocentric approach leaving the intrinsic value out of consideration. In literature many classifications of ecosystem services have appeared; from an economic point of view the classification that distinguishes between supporting services, regulating services and provisioning services (as explained by Ruijgrok et al., (2005) and Ansink, (2008)) is preferred since it prevents from overestimating the economic value due to 'double counting'. Total economic value can be divided in many sub-categories, for which a lot of disagreement exists in literature. From a practical point of view, the distinction between use value and non-use value is sufficient, because valuation techniques operate on this level.

3 Economic valuation theory

After discussing the basic concepts of ecosystem service valuation, this chapter answers the question what is the theoretic correct measurement of total economic value. Economic valuation theory is based on the principles of neoclassical welfare economics; these are discussed in section 3.1. In section 3.2, the theoretic measure for total economic value is further explained. Finally section 3.3 draws some brief conclusions.

3.1 Principles of neoclassical welfare economics

Valuation theory is based on the assumption of neoclassical welfare economics (Perman et al., 2003). The assumptions are that:

1. markets exist for all goods and services
2. all markets are perfectly competitive
   a. Homogenous products
   b. Many buyers and sellers
   c. Free entry and exit
   d. Perfect information
3. private property rights are fully assigned in all resources and commodities
4. no externalities exist
5. all goods and services are private goods
6. all utility and production functions are 'well behaved'
7. all agents are maximizers
8. there is perfect information

Neo-classical welfare economics uses the price of a commodity in a perfect competitive market as an indicator for its value. The price is determined by the market mechanism that pushes demand and supplies into an equilibrium in which supply and demand equal each other. This is further explained below.

Under the assumption of perfect competition, the market mechanism forms the basis for resource allocation. On a market, demand and supply meet each other. The interaction between buyers and suppliers make sure that the quantities demanded and supplied equal each other. When the price increases buyers will demand less and sellers will increase supplies. When the price decrease buyers will increase demand and supplier will decrease supplies. This process, which is called the market mechanism, continues until demand and supply equal each other. The price and quantity at this point are called the equilibrium price and equilibrium quantity. Figure 3.1 shows this process. Demand elasticity is the relation betweens the percentage change in demand and the percentage change in price. Demand is called elastic when a relatively small price change causes a big change in demand. Demand is called inelastic when a relatively large price change has no effect on the demanded quantity.

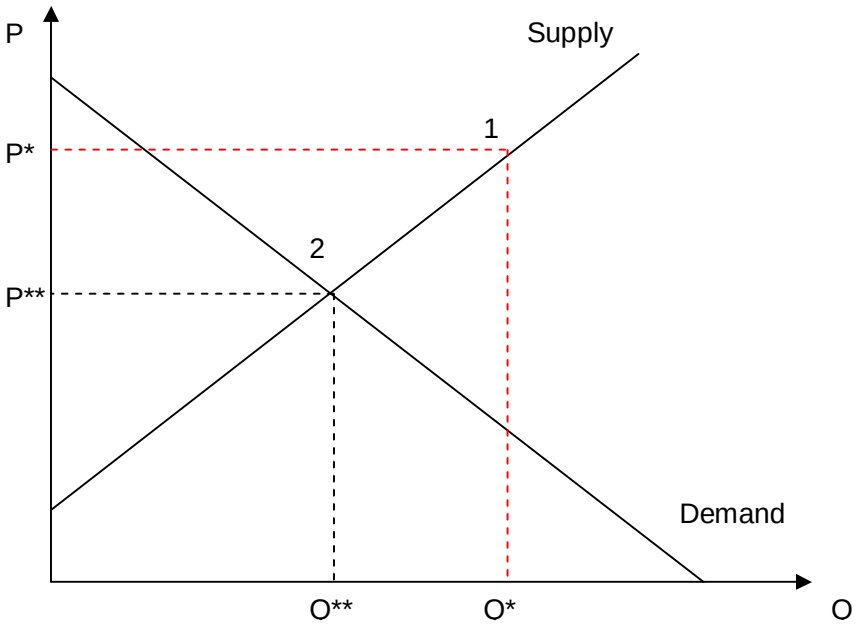


Figure 3.1 The market mechanism. On a market supply and demand meet each other. The vertical axis represents the price; the horizontal axis represents the quantity. Supply has a positive slope; the higher the price the more is supplied. Demand has a negative slope, the higher the price the less will be demanded. First, consider situation 1: price is high, supply is high, demand is low. The result is that the market is out of equilibrium, consumers are not prepared to pay this price. At this point, the market mechanism starts to operate. Suppliers will decrease the price and then consumers will start to increase demand up to the point where supply and demand equal each other. Market equilibrium is reached in situation 2

3.2 Estimation of total economic value

Economic value expresses the degree to which a good or service satisfies individual **preferences**. By explaining economic value we will continue with explaining supply, demand and the market mechanism that were also discussed in the precious section. We will start with explaining the total economic value in a market for 'normal goods', see Figure 3.1**Error! Reference source not found.**. Normal goods have a positive income elasticity of demand, this means that demand increases when income increases and demand falls when income falls given that prices remain constant. The demand curve reflects the marginal willingness to pay curve. The area under the demand curve is the total willingness to pay. The supply curve reflects the availability of the good that is dependent on production and stocks. Due to interaction between supply and demand, what is also called the market mechanism, market equilibrium appears in which supply and demand equal each other. The **total value** of a good is equal to the sum of **consumer surplus** (CS) and **producer surplus** (PS). Consumer surplus results from the fact that consumers are willing to pay more for the good than they actually pay. This is equal to the area under the demand curve and above the equilibrium price. The producer surplus is caused by the fact that producers sell their products for a higher price than they would be willing to sell it. This is equal to the area above the supply curve and under the equilibrium price, Figure 3.2.

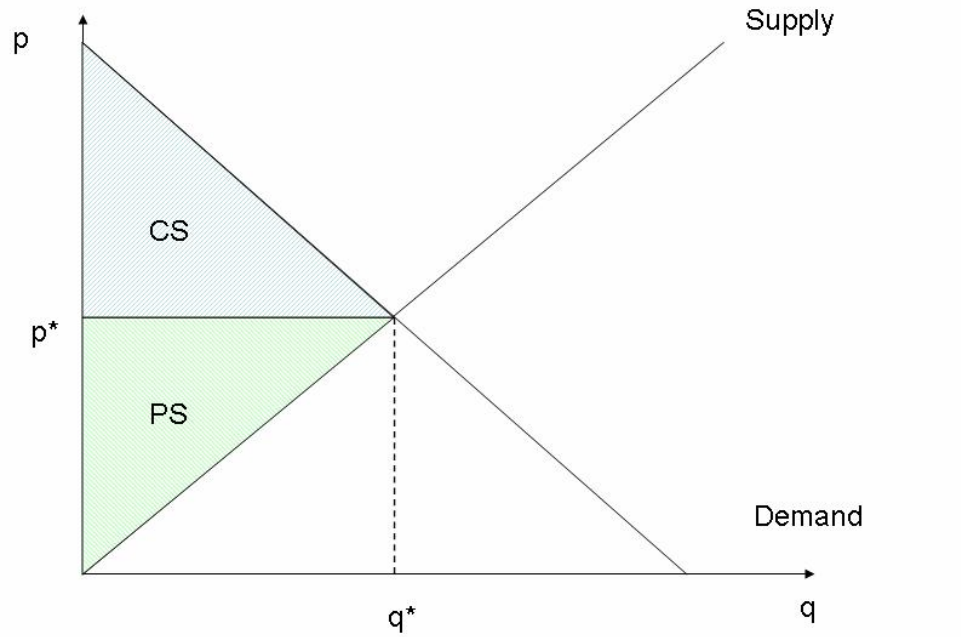


Figure 3.2 Total economic value. Under the assumption of a perfect competitive market, total economic value is equal to the consumer surplus plus producer surplus. Consumer surplus is equal to the area under the demand curve and above the equilibrium price. Consumer surplus results from the fact that consumers pay less than they would be willing to pay. Producer surplus is equal to the area above the supply curve and under the equilibrium price. Producer surplus results from the fact that producers sell their products for a higher price than they would be willing to sell it.

Consumer surplus as a measurement of utility change is valid under some very **restrictive assumptions** such as constant marginal utility of income. Marginal utility of income is the incremental change in utility due to a unit increase in income. As a general rule the marginal income of utility declines when income increases. A constant marginal utility of income implies that the utility stays constant when income increases.

An alternative to estimate total economic value including income effects, is estimating the equivalent variation or the compensating variation. These are two monetary measures of utility change associated with a **price change**. The compensating variation is the change in income that would compensate for the price change. The equivalent variation is the change in income that would be equivalent to the proposed price change. Nevertheless, the estimation of consumer surplus will not be very much wrong; the size of the error depends on the size of the income effect associated with a price fall.

For ecosystem services we are not so interested in price changes, but in **quantity** and **quality** changes. The correct measure for quantity and quality changes is the compensating surplus or the equivalent surplus; it is possible to estimate these values using direct valuation methods such as Contingent Valuation and Choice Modeling. From literature it became clear that unlike for price changes, it is **not possible** to use consumer surplus estimates as an approximation for welfare changes. Although there is little known about the magnitude of the error or whether it is positive or negative, the estimation of consumer surplus as an approximation for quality and quantity changes is widely used by economist using indirect valuation methods such as the Travel Cost Approach and Hedonic Pricing. Box 2 shows some of the characteristics of the supply and demand curve for ecosystem services.

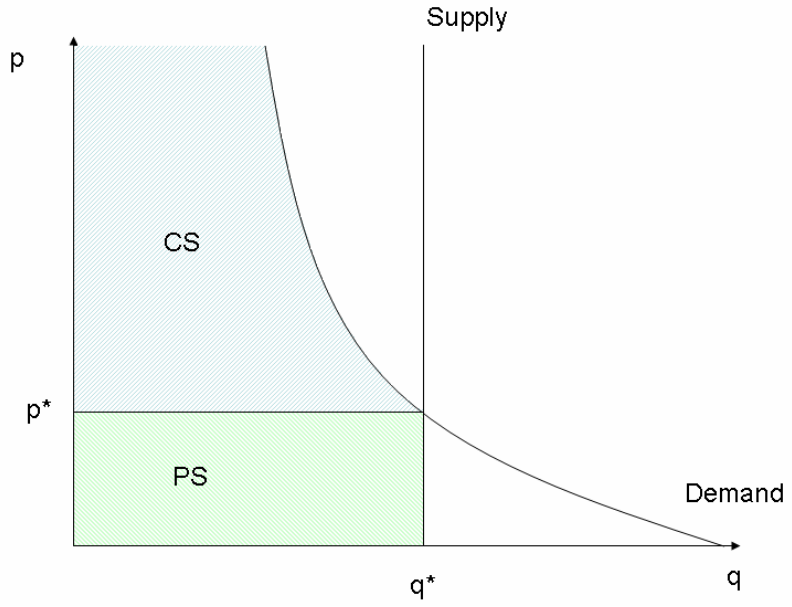
Considering ecosystem services some of the neoclassical welfare assumptions do not hold. Many ecosystem services are exposed to **market failure**, they often

- are public goods
- are exposed to externalities
- do not have well defined property rights.

Some of the ecosystem services are **public goods** and cannot be allocated properly by the market mechanism. Private goods are the opposite of public goods, and these two types of goods can be described as the polar cases of a spectrum. There are two characteristics that make it possible to distinguish between public and private goods; these are excludability and rivalry (sometimes referred to as divisibility). Excludability is the possibility to exclude someone from consumption. Rivalry refers to whether someone's consumption is at the expense of someone else.

Box 2 Characteristics of the supply and demand curve for ecosystem services

For ecosystems, the demand curve is not expected to be linear. Take for example the ecosystem services related to tropical rainforest. As long as the tropical rainforest is abundant, we use it for important and less important economic activities. When the resource becomes scarcer, the less important economic activities will be given up firstly and will lose a relatively low marginal value. However, when the tropical rainforest reduces or degrades further, more important uses have to be given up. In addition, ecosystems have certain thresholds, when these are passed, we expect a more rapid increase in marginal values. As shown by the figure the consumer surplus becomes nearly infinite. The supply curve is price inelastic, the supply of ecosystem services related to tropical rainforest are insensitive for price and marginal value.



Pure private goods are excludible and rivalrous, these are normal goods. Let's consider the ecosystem service timber. For a given amount of timber available, any increase in consumption by someone must be at the expense of others; and anyone can be excluded from consumption. A pure public good is for example fresh air, nobody can be excluded from it and the use by someone is not on the expense of another. Many other ecosystem services lay in between these two extremes, see Table 3.1.

Table 3.1 Characteristics of private and public goods (Perman et al., 2005)

	Excludable	Non-excludable
Rivalrous	Pure private goods	Open-access resource
Non-rivalrous	Congestible resource	Pure public good

Open-access resources is one of them, this good is non-excludable and rivalrous. A good example is the ocean fisheries that lie outside territorial waters. All boats are free to enter the water, but the fish caught by someone cannot be caught by the other. The other good in the spectrum between private and public goods is the congestible resource. This good is excludable and non-rivalrous. This can be for example a visit to a wilderness area. Not all visitors can enter at the same time, but if one person consumes its services like recreation, solitude and wildlife experiences, other visitors can experience these services on the same level. All of the goods except private goods can lead to free riding, overexploitation or degradation.

Externalities are also a type of market failure. Externalities are unintended effects on third parties (the agents that are not directly involved in the market transaction). The externality can be caused by production or consumption and can be negative or positive. An example of a negative externality caused by production is the discharge of contaminated water to the water system by chemical factories. This negative externality can have impacts on the provision of ecosystem services, for example recreation. These negative externalities should be taken into account in the market mechanism, if this is not done the market will 'over-supply' the negative externality.

The **absence of property rights** can also be a cause for market failure. There are not always private property rights in flow resources such as solar radiation and renewable resources such as the ocean fishery. This is also true for services such as a beautiful view. When private property rights are absent, uncontrolled exploitation may appear also known as the free rider problem. Moreover, because these private property rights do not exist, markets do not exist for all goods and services. Where markets and well-defined property rights do not exist, the market cannot allocate goods and services efficiently.

When markets fail in allocating resources efficiently, **government intervention** is required. The government has several instruments to correct market failure like command and control, institutional instruments and market-based instruments. Command and control instruments operate by imposing obligations or restrictions on firms and individuals, e.g. input restrictions, technology controls, output quotas etc. These can be applied in all stages of the production process. Institutional instruments are for example the facilitation of bargaining; it is argued that interaction between two parties could generate efficient outcomes and could internalize externalities. Another example is the specification of liability, the codification of liability by environmental damage. Market-based instruments work by creating incentives for firms and individuals to voluntary change their behavior, e.g. prices, taxes, subsidies, creating markets. A market-based instrument that is well known through the application to ecosystem services is PES, payments for ecosystem services.

3.3 Conclusions

In a perfect competitive market consumer, surplus and producer surplus are a correct indicator for total economic value. However, strong assumptions such as a constant marginal utility of income make the compensating variation or equivalent variation a more suited measure. These indicators correct for income changes, although the effect of income is not expected to be of great influence on the results. Consumer surplus, producer surplus, contingent variation and compensating variation estimate total economic value based on price changes. Ecosystem services mostly don't have well-established prices and are characterized by changes in quality and quantity (instead of price changes). In this case the theoretical correct measures are the compensating surplus and equivalent surplus; it is only possible to estimate these measures using stated preference methods. Although consumer surplus is not suited as a correct measure for total economic value, economists often use them.

4 Valuation techniques

As described in section 2.2 total economic value can be divided in use value and non-use value. Figure 4.1 shows the valuation techniques related to use and non-use values. The direct valuation method, also called stated preference method, is able to estimate both use and non-use value, these are discussed in section 4.1. Direct valuation methods are able to measure **use and non-use value** based on **hypothetical** markets. The advantage of direct valuation methods compared to indirect valuation methods is that the former is able to estimate both use and non-use value, while the latter can only estimate use value. The main drawback is that direct valuation methods analyze hypothetical situations, whereas indirect valuation methods use data on observed behavior. Direct valuation is also referred to as stated preference; two often used methods are Contingent Valuation and Choice Experiments. The indirect valuation methods, also called revealed preferences method is able to estimate only use value, these techniques are discussed in section 4.2. Indirect valuation methods are able to estimate **only use values** and are based on **conventional and surrogate markets**. They are also called revealed preference methods, because the results are based on actual behavior of people. From literature, it becomes clear that this involves some errors. However, indirect methods are often used (Perman, 2003). The most frequently used methods are discussed in this section: Market Price Method, Averting Behavior, Travel Cost Approach and Hedonic Pricing. Section 4.3 discusses the concept of benefit transfer.

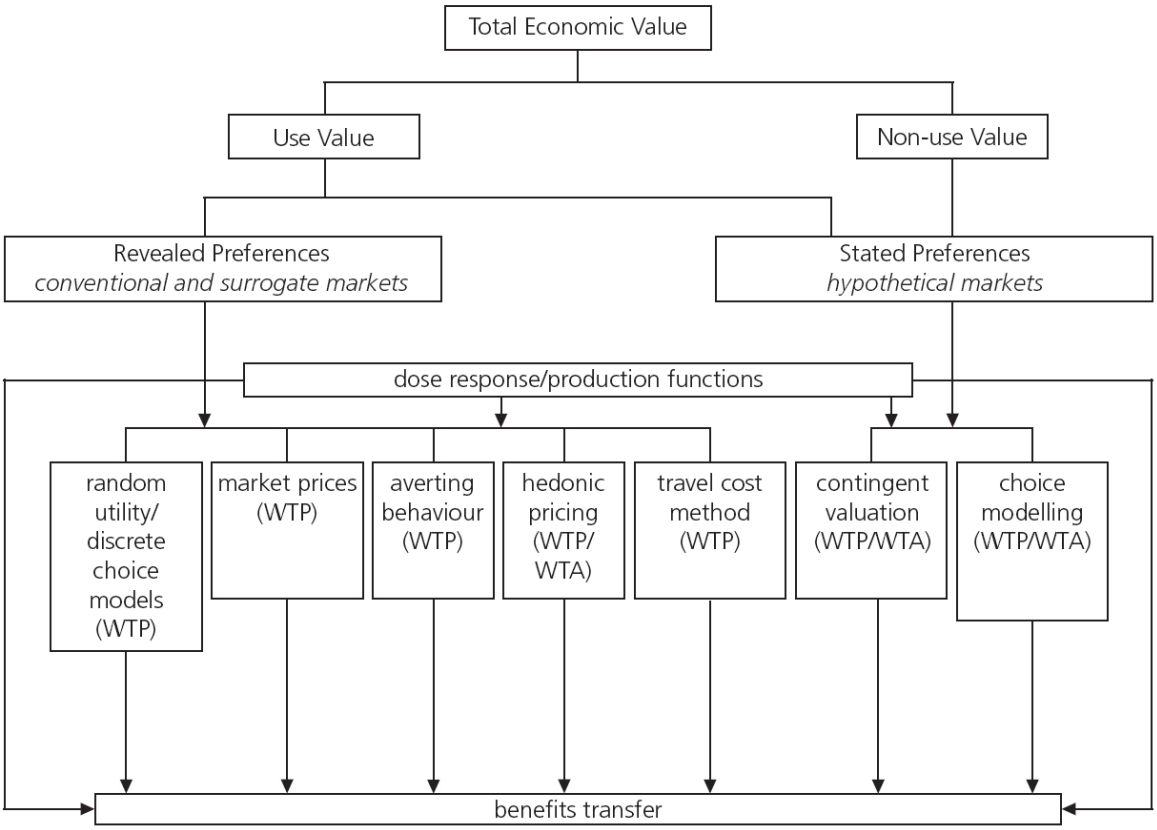


Figure 4.1 Overview of valuation methods, (DEFRA, 2007)

4.1 Direct valuation methods

Contingent valuation method (CVM)	
Concept	The Contingent Valuation Method (CVM) is a non-market based valuation technique that involves asking a sample of the relevant population questions about their willingness to pay. Contingent means that the valuation is contingent on the hypothetical scenario put to respondents.
Estimation	The survey method is used to ask people to their willingness to pay for a specific ecosystem service or a change in quality or quantity.
Strengths	• It is possible to estimate total economic value, as well as use values, non-use value, existence value, option value etc. separately. • CVM answers directly refer to the theoretical correct monetary measure of utility changes, these estimates are not difficult to process and analyze. • It is flexible in that it can be used to estimate the economic value of virtually everything. • The method has been widely used so that the method has been improved, the main strengths and weaknesses are known and a broad range of applications is available.
Weaknesses	• The 'embedding effect'. The embedding effect is the name given to the tendency of willingness to pay responses to be highly similar across different surveys even where theory suggests to the responses be very different. The respondents are insensitive to the scope of the environmental services, e.g. respondents have similar willingness to pay for cleaning up one or five lakes. This effect arises from the fact that the survey respondents do not have individual preferences for the public good in question and that respondents fail to take into account their budget constraints (Diamond and Hausman, 1994). • CVM assumes that people have perfect knowledge about the good and market so that the results from the contingent market reflect the preferences in the real market. The results from asking people hypothetical questions about a hypothetical market might be different from observing peoples actual behavior resulting in a difference between the stated value and the real value. This is also called the hypothetical bias (Murphey et al., 2005). Some underlying causes: – People answer another question than the one the survey intended to ask. People might express their feeling about conserving the environment while they might think that the ecosystem service in itself is unimportant. – People make connections between ecosystem services. E.g., Better water quality can indicate more fish. This is also called the amenity misspecification bias, people have other ecosystem services in mind than the one mentioned in the questionnaire. – People feel the scenario can become true. E.g. they state they have a low willingness to pay due to the believe they have to pay.

	• The charging method has influence on the stated willingness to pay. E.g. people that are against taxation will state a low willingness to pay while they would be prepared to pay more under another charging method • A strategic bias occurs when people feel their answer influences decision-making. • Due to the problems mentioned above, CVM is one of the most controversial valuation methods. Many economists and policy makers doubt the validity of the estimates and are not willing to spend any money on these kinds of studies.

Choice Experiments (CE)	
Concept	Choice experiments (CE) are also called Contingent Choice Methods and Conjunct Analysis. The principle of this method is the same as for CVM, so respondents are confronted with a hypothetical good and a hypothetical market. But instead of asking directly their willingness to pay, the respondent is asked to make a stated preference between one group of attributes and ecosystem services at a given price or cost and a second group of attributes and ecosystem services at a given price and cost.
Strengths	• CE are very well suited to valuate complete actions (improving the whole ecosystem) as well as single ecosystem services. Therefore, they can be very useful for decision-making. • For the respondent it might be easier to think in terms of tradeoffs instead of attaching a value as in the CVM method.
Weaknesses	• Due to hypothetical biases values are overestimated, literature disagrees whether the hypothetical bias is more present in CVM or CE (Murphey et al., 2005) Some important survey-factors that influence the overestimation in choice experiments are (Boyle and Özdemir, 2009): ▪ The place of the monetary value in the list of attributes can affect the decision. ▪ The number of comparisons is crucial: too many comparisons can cause confusion and frustration, too few comparisons forces to make choices people normally don't make. ▪ The inclusion/exclusion of a status quo alternative. • The choice can be made on ground of other reasons than preferences. This is often difficult to analyze and process in statistical analysis.

4.2 Indirect valuation methods

Market price method	
Concept	The Market Price Method estimates the value of ecosystem services that are sold through markets.
Estimation	This method estimates the value by calculating consumer and producer surplus.
Strengths	• This method uses observed data from existing markets. • The method uses standard, accepted economic theory.
Weaknesses	• For most ecosystem services there exist no markets, so this it is limited applicable. • There might be market imperfections causing that prices don't reflect the true scarcity of the good. • Prices are not constant over time.

Averting behavior method	
Concept	The Averting Behavior method is based on the concept that people try to protect themselves from environmental risks. This concerns expenditures on measures also called 'defensive expenditures'.
Estimation	The value estimates are distracted from the expenditures that people make to reduce environmental risk.
Strengths	• Cost data is most of the time already available.
Weaknesses	• Limited to cases where households spend money to avoid environmental risks. • Discussion on the definition of defensive expenditures.
When use this method?	This method can be used only when individual households make additional expenditures to protect themselves against environmental risks.
Example	The investment in water filters to clean drinking water.

Travel cost approach	
Concept	The Travel Cost Method is based on the assumption that people visit recreational sites so often that their marginal benefits are equal to the marginal costs. The marginal benefit consists of preference for recreation and a revealed preference for nature. The marginal cost consists of travel costs and time costs. In this approach, the travel costs are regarded as a revealed preference for recreation and nature.
Estimation	The estimation is based on travel costs.
Strengths	• Estimation is based on actual behavior. • Results are straightforward and easy to interpret.
Weaknesses	• Only applicable to value ecosystem services in an recreational context • Method uses a lot of simplifying assumption. • Direct neighbors are not included in the research.
When to use this method?	Only applicable to nature and recreation areas that are frequently visited by people that comes from far.
Example	Travel costs related to visiting the Oostvaarderplassen.

Hedonic pricing	
Concept	The Hedonic Pricing Method is based on the idea that market goods are often traded at prices in which amenities are internalized. So people do not only value the good, but also some of its characteristics or services that it provides. It is often used to value environmental quality and ecosystem services using housing prices. Houses are a composite good because characteristics such as distance to work, availability of sport facilities and green areas partly determine the housing price. The housing market shows the buyers preferences on housing and localization. The main principle is that systematic variations in the price can be explained by an environmental characteristic of the house.
Estimation	This method measures the willingness to pay of people for ecosystem services in their direct environment, derived from increased housing prices.
Strengths	• Estimation is based on actual behavior. • Reliable data. • Results are straightforward and easy to interpret.
Weaknesses	• The assumption of perfect information: buyers observe all the characteristics of the house. • The assumption that buyers can buy exactly what they want, that means the combination of characteristics they desire. • It is only possible to asses the marginal variations in the characteristics of the house. • Results depend on model specification. • The scope of ecosystem services that can be analyzed is restricted to those connected to housing prices. (However, also other goods can be considers e.g. cars.
When to use this method	This method is only applicable to the quality of ecosystem services in the direct living environment.
Example	Decrease in house prices around Schiphol due to nuisance of airplanes.

4.3 Benefits transfer

Benefit transfer is a procedure for taking value estimates from one site and apply it to another. Normal valuation studies are mostly time consuming and expensive. Benefits transfer can provide a solution to these problems. Two approaches can be used to make a benefits transfer. In the first approach a detailed description of the site under investigation is made, the next step is to make a selection of past valuation studies of which the site has the same characteristics. Based on these studies the value is determined. The second approach uses a benefit function. The benefit function relates the benefits to the site-specific characteristics. This function can be estimated on the basis of one or several studies. The benefit transfer takes place by measuring the site-specific characteristics of the new studies and to calculate the value by inserting these site specific characteristics in the benefit function.

Box 3: Site-specific characteristics of ecosystem services values

Ecosystem services are context and ecosystem specic. De Groot et al., (2003) gives in his article an overview of the range of monetary values per ecosystem service based on a literature review. It becomes clear the the range is extremely large, therefore values for ecosystem services cannot be used for benefit transfer without any consideration of the site specific elements. The table below gives two interesting examples.

Ecosystem function	Range of monetary values US dollars / ha
Waste water treatment	58-6696
Recreation and tourism	2-6000

The ecosystem function waste treatment varies between 58 and 6696 US dollars per hectares. This range can be explained by many characteristics such as demography, water resource use and current health and sanitation standards. For recreation and tourism, it was found that the benefits were highest in coral reefs.

The most problems concerning benefits transfer arise from the fact that no studies can be found with exactly the same characteristics. Valuation of ecosystem services is context specific and ecosystem specific, see box 3. Furthermore, the valuation is guided by the problem perception of the beneficiaries, see box 4. Different individuals, groups or societies can have different value perceptions of the same ecosystem service. Also, the initial condition and state of the ecosystem is important, the reference base determines the value people attach to it (Plummer, 2009).

Box 4: Problem perception and valuation: willingness to pay to protect the seal population in the Waddensea

The seal population in the Netherlands is under pressure because of global warming and gas drilling in the Waddensea. Policy-makers and economist wanted to know how much worth the seal is, therefore they performed a study asking 2000 households about their willingness to pay to reduce the pressure on the seal population distinguishing between different causes. The results showed that the respondents were willing to pay 15 Euro to protect the seal population from climate change and that they were willing to pay 30 Euro to protect them from gas drilling. Clearly, there is not one value for the presence of seals. The difference in willingness to pay can be explained by the fact that people are willing to pay less for threats that are caused by the whole society such as global warming, than for assignable threats such as gas drilling.

5 Criticism on economic valuation of the environment

The general critique on economic valuation of the environment and ecosystem services can be summarized in the next statement: 'due to the specific characteristics of living systems, it is **inappropriate** and **inaccurate** to represent their economic worth through monetary valuation' (Farrell, 2005). The critics on economic valuation of the environment can be divided into two categories that include the critics on the:

1. Concept of economic valuation of the environment → environmental valuation is inappropriate (section 4.1).
2. Methodology and estimation → environmental valuation is inaccurate (section 4.2).

5.1 The concept of economic valuation of the environment

The critics on the concept of economic valuation of the environment are mainly based on **moral questions**; economists do often not consider these critics. However, many people feel that in policy-making the moral discussion should dominate the economic discussion.

5.1.1 Dependence on ecosystems

Economic value tells us something about the competitive price or exchange value that is a measure of scarcity and not dependence (Sagoff, 2008). This thought is based on the idea that ecosystem and biosphere processes would endure without humans, but human life cannot endure without these processes. Without ecosystems, that purify the air and water, that regulate the climate and that recycle nutrients and wastes, life would not be possible. The dependency on ecosystem services makes its value infinite and therefore priceless.

5.1.2 The existence of rights

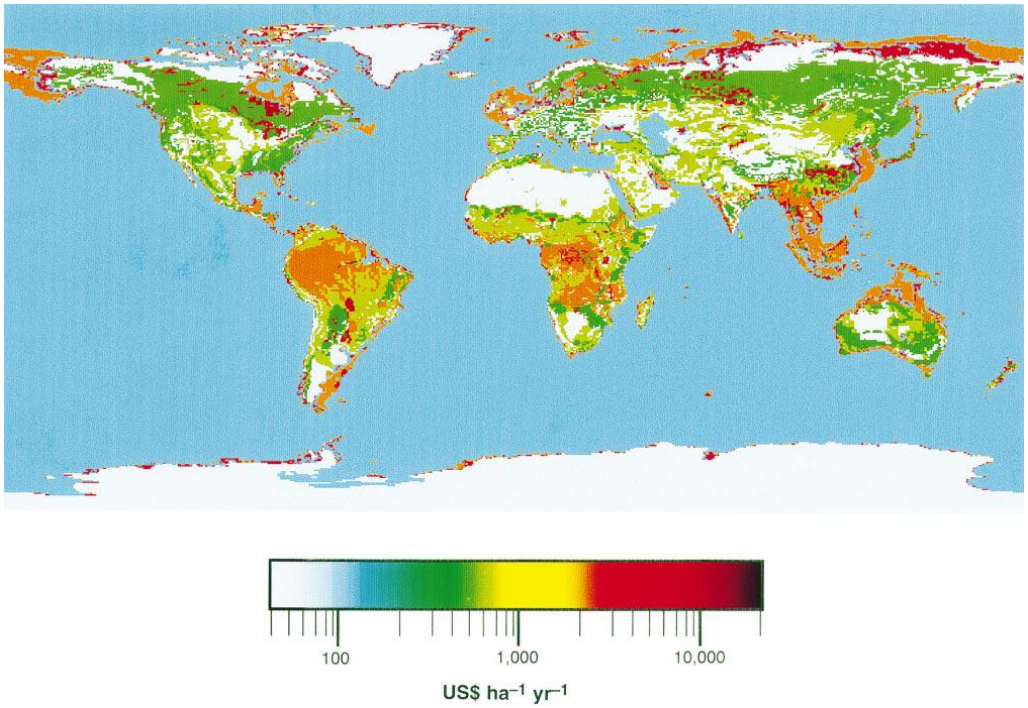
The existence of rights for future generations, human rights, animal rights and even biodiversity rights can constrain policies based on maximizing welfare or can even constitute a policy choice itself. This is based on the idea that: there are things wrong to do, no matter the consequences. In other words: even though some environmental project or policies will give welfare gains, they will not be carried out because they conflict with rights. Hampicke, 1999 considers fairness and respect for freedom for future generations; the rights of future generations. The main point is that future generations' preferences should be involved in valuing ecosystem services. However, trade and communication with future generations are impossible. Therefore, biodiversity and ecosystem services should not be monetized and traded. Instead, its conservation becomes a strict limiting condition to economic activity.

5.1.3 The position of economic values

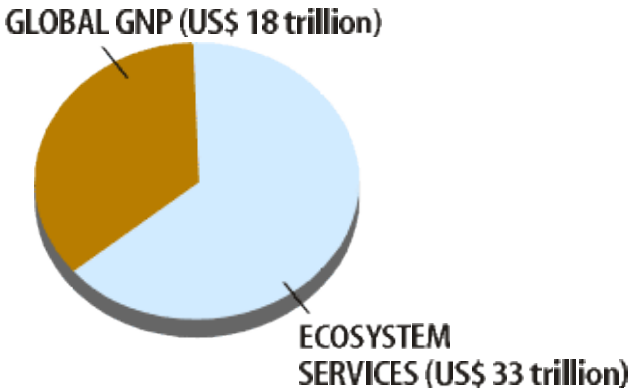
Ludwig, (2000) argues that economic values are of tertiary importance; social and personal values are of a higher order. The higher order involves integrity and dignity and is combined with religious, ethical and social values. People often make choices based on these aspects without considering any economic value.

Box 5: valuing the global ecosystem services

Although there is a lot of criticism on the total valuation of ecosystem services based on the non-substitutable character of most of the services, there have been some attempts to estimate the total value of the world's ecosystem services. The figure below shows the results of a study by Constanza et al., (1997).



Critics from economists were not because they consider valuation of ecosystem services unimportant or impossible. It was rather criticism on the study's scientific validity and policy value. Furthermore, the publishing journal was criticized for the decision not to print follow-up (van den Bergh en Withhagen, 2001).



http://www.wri.org/publication/content/8381

Although the harsh criticism, the valuation results are used by main institutes such as the World Resource Institute. They argue that the total value of the world's ecosystem services is needed so that policy decisions can be made on the bases of these numbers. They recognize that the total value of the world's natural capital would be infinite, but any number is better than no number.

5.2 Theory and methodology of environmental valuation

This category distinguishes critique on the economic assumptions and on the methodologies that are used to estimate the economic value of ecosystem services.

5.2.1 Willingness to pay

Value is not only expressed in willingness to pay. People contribute for example to organizations because they recognize the duty to protect the aesthetic, moral, historical and religious value of particular places (Sagoff, 2008). Gowdy, (1997) also draws the conclusion that exchange values only capture a small part of the total value. One important argument in his article is that individual preferences cannot be fully captured in the value of market exchange because people can make contradicting choices considering their role as individual or citizen. As example, the author uses a study he did among students. In a survey he described the situation of a natural park for which a ski resort was planned. He asked the students whether they want to visit the area if it remained a wilderness, most answered no. He also asked whether they wanted to visit the ski resort, most of them answered yes. Finally, he asked whether the project should be developed if they had the choice. Most of them refused. This view is supported by psychological research that found that in many choice situations people base their preferences on the time and context of the choice opportunity and not on historical price information (Shabman and Stephenson, 2000).

5.2.2 Substitutability and complementarity

Hampicke, (1999) states that the two characteristics that *can* make monetization of ecosystem services inapplicable are unsubstitutability and complementarity. He argues that priced goods and services can be substituted, e.g. a computer is worth 1500€ this price can also be expressed in a bundle of alternative goods. Something that cannot be substituted can have no price and therefore cannot be monetized, e.g. sunlight. It is impossible to estimate the fundamental functions of nature as a whole, see box 5. The unsubstitutable characteristic of ecosystem services makes it mandatory for authorities to exercise force, marginal valuation of indivisible services based on voluntary exchange are beside the point. By putting a price on the environment, we regard nature as a resource to exploit rather than a heritage and an endowment to maintain and protect.

Complementarity of ecosystem services can cause double counting, since one service can possess parts of the value of the other service. Many other authors (Sagoff, 2005) (Gowdy, 1997) recognize these characteristics. Furthermore, he argues that monetary valuation takes place under incomplete information; it takes place in a specific situation depending on expectations and available information. It is impossible to express the ‘true value’ considering every possible purpose, every possible human being in every instant of time. Goods and services that are priced lowly by monetary standards does not imply that the good or service is low of value or worthless. E.g. if shipwrecked a boat would be of high value because it can save one’s life while it was sold for a fraction of the price the person is prepared to pay for it. Therefore, monetary valuation is restricted

5.3 Conclusion

In literature, there are many moral, theoretical and methodological objections against economic valuation. Although these points are true, economist argue economic valuation gives important information for policy-making. It should be kept in mind that:

- Cost-benefit analysis is one of the evaluation tools which is frequently used in policy-making, ignoring economic valuation would cause environmental aspects not being considered in this type of analysis;
- Environmental valuation should focus on marginal changes and not on total valuation;
- Economic values should not be the only input for policy-making, other values (like ecological values) should also be considered.

6 Ecosystem service valuation and policy making

There are different ways ecosystem valuation can be integrated in decision-making (Pearce and Seccombe-Hett, 2000):

- Cost-Benefit Analysis of projects and policies (section 3.1)
- Environmental market-based policy instruments (section 3.2)
- National Accounting (section 3.3)
- As a participatory exercise and communication tool.

6.1 Cost-benefit analysis of projects and policies

Government policies, programs and projects have a major influence on society. It is necessary to evaluate if these actions are *justified* by determining whether government intervention is needed and whether the proposed solution is the best available option. This evaluation should include all environmental impacts. The valuation of ecosystem services is a means of taking into account all environmental impacts and is therefore suitable to apply to the evaluation of any type of intervention. The most common used procedure for policy selection is cost-benefit analysis. Valuing ecosystem services makes it possible to **incorporate environmental impacts** into this analysis in a systematic way, so that the environmental effects can be compared and weighed up against other costs and benefits, see Figure 6.1(van Beukering, 2008).

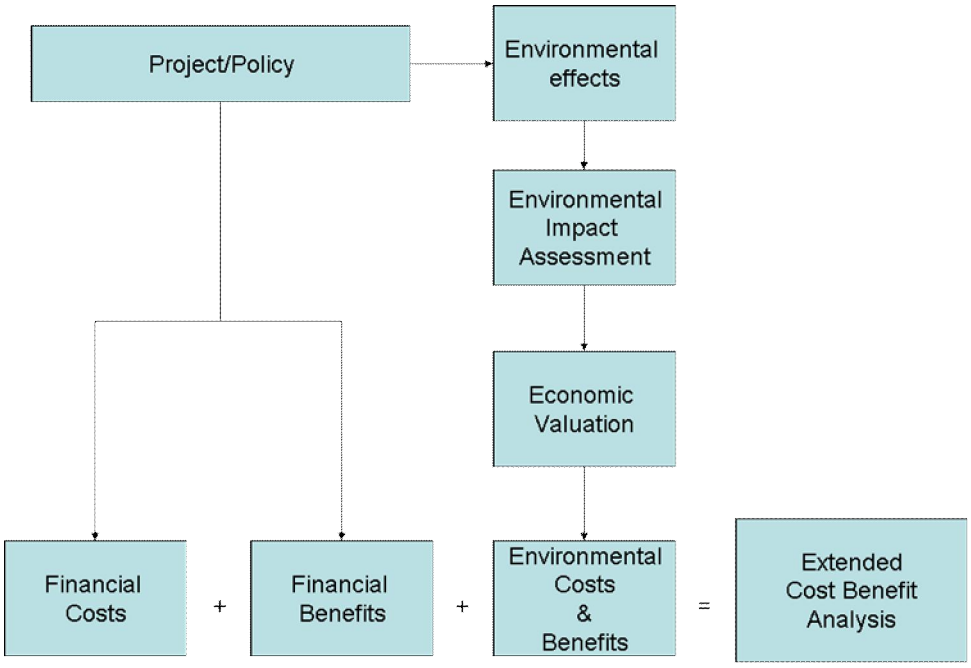


Figure 6.1 Incorporating environmental and social effects in costs benefit analysis

Other decision-making procedures that take into account environmental impacts are: Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA), Life-Cycle Analysis (LCA), Risk Assessment, Cost-Effectiveness Analysis and Multi-Criteria analysis (MCA). These methods have different objectives and decision rules. There are some complementarities between CBA and these methods. The output from EIA's and SEA's are useful input for cost-benefit analysis. In the MCA method, a mix of monetary values, quantified data and qualitative criteria can be compared. Valuating ecosystem services is mainly useful for CBA.

A restriction on the use of economic valuation for decision-making follows directly from section 6.1. **Error! Reference source not found.** That gives an overview of the critique from a moral and methodological point of view. 'Because monetary valuation is never suitable for articulating ecosystem values, the practice explicitly undermines its own purpose, by creating the illusion of taking the environment into account while failing to provide the required data' (Farrell, 2005). This point of view is often shared with decision makers, who doubt the reliability of benefits estimation. Besides that, theory and methods applied to benefit estimation evolve rapidly. Therefore, it is difficult for policy makers to keep up with the latest developments and to assess the work that is completed for them. Furthermore, Pearce and Seccombe-Hett, (2000) argue that economic valuation removes part of discretion in decision-making. This has focused the attention on establishing an acceptable procedure for decision-making rather than focusing on the right numbers. Section 7 describes the point of view of several institutes within the Netherlands and from abroad that are familiar with regard to the concept of ecosystem services.

6.2 Design of market-based policy instruments

There exist many policy instruments to deal with the forms of **market failure** that were described in section 2, Figure 6.2. Two factors that can be used to distinguish these instruments are market-based vs. non market-based and direct vs. indirect instruments. Market-based policy instruments are based on economic incentives and are also called incentive-based instruments. The valuation of ecosystem services forms the basis for market-based policy incentives because it help to determine charges and prices, it cal also be useful to evaluate the efficiency of non market-based and market based policy instruments. Among these market-based instruments, 'payments for ecosystem services' are relatively new and specifically applied to ecosystem services. According to Wunder, (2005) PES is a voluntary, conditional agreement of well-defined ecosystem services between one buyer and one seller. PES is also referred to as markets for ecosystem services, compensation for ecosystem services and rewards for ecosystem services. All definitions imply the same approach; different names are used because they raise different interpretation that can be criticized. Although PES is implemented in many initiatives around the world, for example in Costa Rica, Mexico and China they don't always show to be successful. This is because the design and implementation of payments schemes are not straightforward. Potential solutions for the design and implementation of PES schemes are discussed in Jack et al., (2008) and Wunder, (2005).

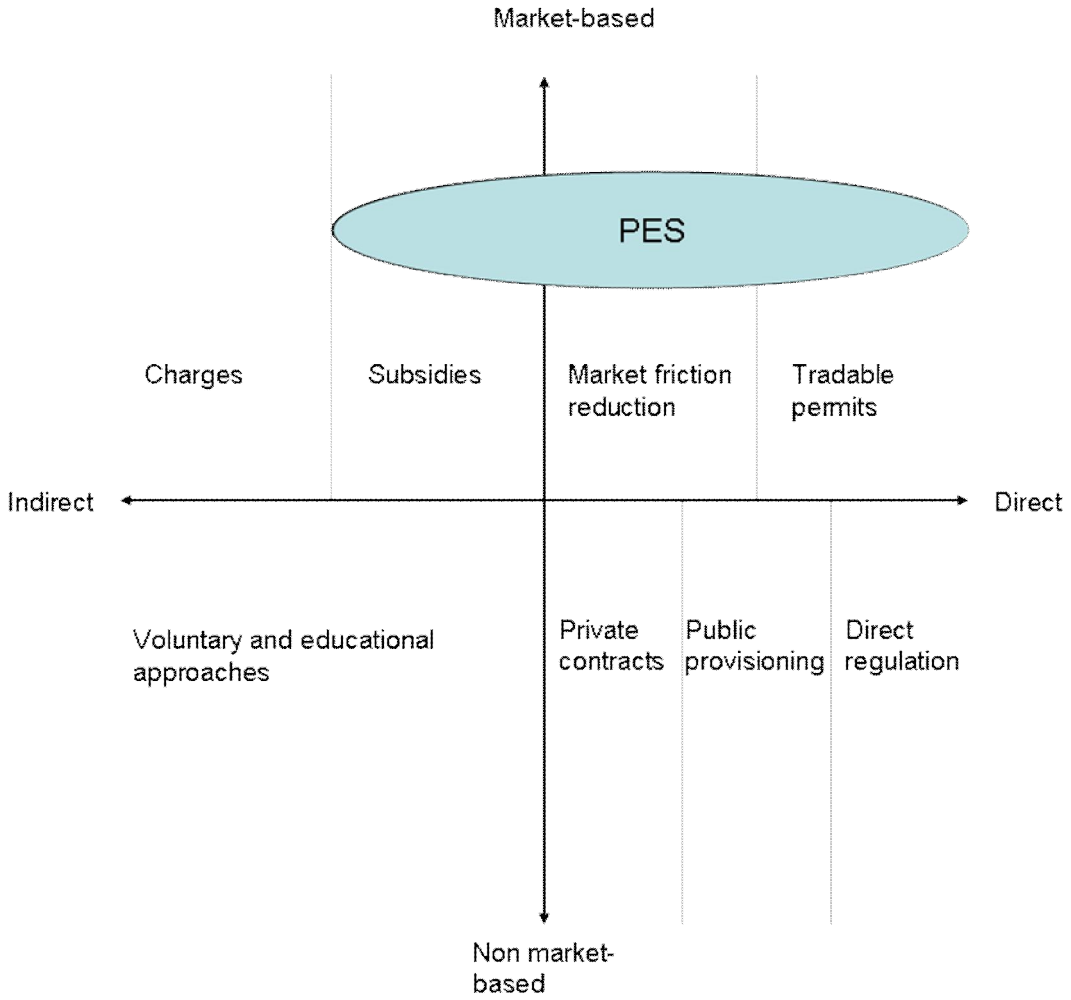


Figure 6.2 Classification of environmental policy instruments (based on Jack et al., 2008 and Wunder, 2005)

6.3 National accounting

A common indicator for national well-being and economic growth is **Gross Domestic Product** (GDP). Other used indicators are Net National Income, Net Savings and Net Domestic products. GDP is calculated as the sum of consumption, investments, government expenditures, exports and imports. In 1972, these economic indicators were criticized due to the fact that these indicators do not account for environmental quality and natural resource stocks. This shifted the focus to expand the economic indicators with environmental indicators as a measure for national well-being and economic growth, this is also known as 'green accounting'. Depending on the chosen approach, the environmental indicators can be monetized and aggregated or they can provide additional physical information on the environment separately. Figure 6.3 shows the approaches to 'green accounting' as classified by O'Conner et al., (2001) these approaches are often combined and built upon each other.

Expanded national accounts contain directly monetary and physical information on the environment; the only difference with satellite accounts is that the latter are kept separately from the conventional national accounts. Adjusted national accounts directly integrate monetized environmental components into the national accounting system. The advantage of monetary valuation is that aggregation with other indicators is possible; the advantage of physical information is that they provide detailed information on the environment. The problems of monetization in 'green accounting' are uncertainty of the environmental problem, data and values.

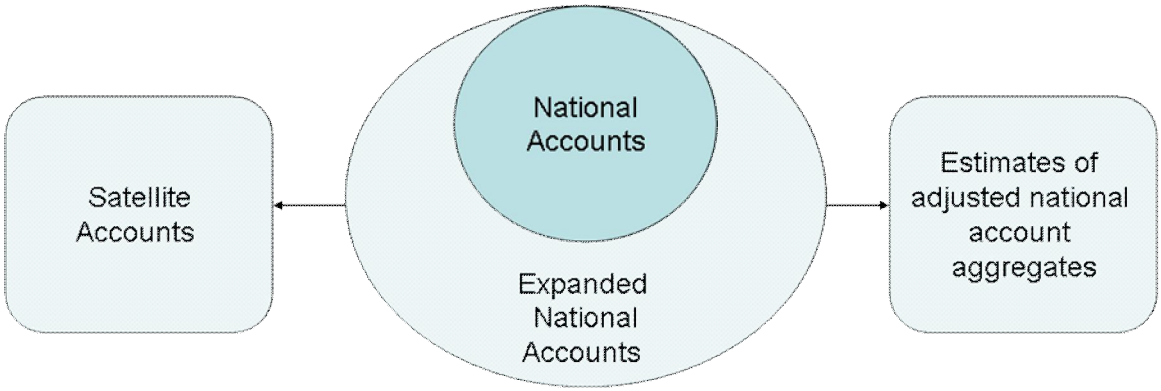


Figure 6.3 Approaches to 'green accounting' (O'Connor et al., 2001)

6.4 Participation and communication

The ecosystem services approach can be performed using a participatory approach. This can be helpful in identifying the ecosystem services that needs to be taken into account. Stakeholders that live in the area that is subject of the case study can have site-specific information, that otherwise would not be included in the study. Furthermore, the participative approach can be helpful to create support for the ecosystem services that are identified, but also for the selected ones that will be valued and the results of the monetization. Indirect valuation methods, such as contingent valuation include questionnaires directly posed to society. This can support the acceptability of the outcomes of valuation studies.

Environmental valuation studies can also function as a communication tool. Attaching a value to ecosystem services makes people aware of the importance of it. Although the outcomes of the total value of the worlds' ecosystems from Constanza, (1997) were heavily criticized, the outcome makes people aware of importance of ecosystems.

7 (Inter)national visions on ecosystem service valuation

Whether the valuation of ecosystem services is ethical and whether it should be included in cost-benefit analysis and formal decision-making are two debated subjects. This chapter gives an overview of the opinion on ecosystem service valuation of different institutes in the Netherlands (section 7.1) and abroad (section 7.2).

7.1 The Netherlands

The valuation of nature and ecosystem services has never played a significant role in Dutch cost-benefit analysis and policy processes. In the Netherlands, the environmental effects description (Milieueffectrapportage MER) is the only institutionalized evaluation method. The next sections give an overview of the attitude towards environmental valuation of the Netherlands Bureau for Economic Policy analysis, the Ministry of Transport, Public Works and Water Management and the Ministry of Economic Affairs and the Ministry of Agriculture, Environmental and Food Safety.

7.1.1 Netherlands Bureau for Economics Policy Analysis

The Netherlands Bureau for Economic Policy Analysis, in Dutch Centraal Planbureau (CPB), is an independent research institute that makes economic analyses for policy-making in the Netherlands. They perform many second opinions on cost benefit analyses. According to this institute, the problem in environmental cost benefit analysis is that not all consequences of a project can be estimated in the same dimension. For example, the effects on nature, landscape, environment and ecosystem services are difficult to express in euros. The CPB states that the monetization of nature and ecosystem services is an **abstraction** of reality that makes the analysis technical more easily. However, the interpretation of these values is difficult since it **hides crucial values**. Cost-benefit analysis for policy decision-making should not be the area where the discussion on economic valuation should take place. Therefore, they suggest not to include monetary values in the cost-benefit analysis. Instead, they suggest constructing a multiple cost-benefit analysis in which in a clear and informative way the effects that appear outside the traditional markets can be analyzed (Stolwijk, 2004).

7.1.2 Ministry of Transport, Public Works and Water Management and Ministry of Economic affairs

These two ministries set up a procedure for evaluating the effects of infrastructural projects in a cost-benefit analysis. This procedure is captured in a document named ‘de OEI-Leidraad’. In 2004 a supplement to this document was published called ‘the valuation of Nature, Water and Soil in Social Cost-benefit Analysis’ (Ruijgrok et al., 2004). According to this document all effects that **can** be monetized, **should** be monetized in CBA. In the case non-priced effects on nature or ecosystem services cannot be monetized, they should be mentioned explicitly in quantitative or qualitative way. There are two reasons why the effects on ecosystem services sometimes cannot be monetized. In some cases the physical effects can be quantified, but cannot be translated into welfare effects due to a lack of ratio’s available from benefits transfer. This can be solved by performing an empiric valuation study or by describing the physical effect only. In other cases the physical effects cannot be quantified, the only thing that remains is to make a qualitative description of the effect.

7.1.3 Ministry of Agriculture, Environment and Food Safety

In the publication: Nature and Landscape estimated on the right value: what is the economic value of nature and landscape, the Ministry of Agriculture Environment and Food Safety gives his vision on environmental valuation. Their statement is that space in the Netherlands is scarce and that, therefore, a good assessment should be made of the functions that possibly could fill in the open space. To make this assessment successful the monetized value of nature and landscape should be considered. This is a difficult job, but the economic discipline is more and more capable to monetize pleasure and perception. The valuation of environmental effects becomes more and more part of the evaluation techniques, and this should expand even further in the future (Ministry of Agriculture, Environment and Food Safety, 2006).

7.1.4 Netherlands Environmental Assessment Agency (PBL)

PBL is the national institute for strategic policy analysis in the field of environment, nature and spatial planning. In their latest report: 'Environmental effects in cost-benefit analysis of projects for integrated spatial planning' they argue against the monetization of environmental effects. They give several reasons why monetized environmental effects should not be used in cost benefit analysis:

- Monetizing environmental effects is time-consuming and expensive. A CVM analysis involves conducting many questionnaires, which is often expensive
- There is little support among scientists and policy-makers for the CVM method and the use of benefit transfer
- It is unclear how many households attach a value to a specific ecosystem service, distance plays an important role
- The end-value does not capture any information about the willingness to pay in relation to specific characteristics of the service
- Therefore, it is hard to compare the results of CBA for several regions with each other.

Instead of using monetized environmental effects in cost-benefit analysis, the PBL suggest to use the so-called Environmental Value Indicator. This is an already known and international acknowledged indicator based on variety of species. This indicator is adjusted to represent also the rarity of species and ecosystems. The goal of the indicator is to aggregate quality changes within and between ecosystems. This indicator because is a univocal measure for quality within an ecosystem and between ecosystems, see box 6 for further explanation on how the indicator works. Advantages of using it is that it covers the international rarity of species and ecosystems, the indicator is a standardized objective method that can be used as within CBA but also to compare multiple CBA's. See box 6 for a comparison between environmental effects using the Environmental Value Indicator and monetization.

Box 6: Calculating the Environmental Value indicator (Sijtsma et al., 2009)

The indicator includes two dimensions: the change in nature acreage and the change in natural quality. The change in acreage can simply be calculated using information on ha. For calculating quality changes, two steeps need to be taken. First, the quality of a particular ecosystem should be determined in a univocal way. Second, the qualities of different ecosystems should be weighed.

For the first step, the local Nature Value Indicator is used; for each ecosystem it will be indicated which characteristic species should occur when the ecosystem is intact. The species choice is focused on 'target species' (doelsoorten), these are species that are selected on the bases of their (inter)national significance or decline. The 'target species' are recorded in the Dutch Handboek Natuurdoeltypen. The amount of 'target species' that occur on a location is the measure for the quality of the ecosystem. The quality is reflected as a percentage of the ideally amount occurring 'target species' in that ecosystem; this is the NI^L-value. This value can be aggregated to NI^L-score by multiplying the value by the acreage, see table below.

Ecosystem	NI^L-value	Areaal ha	NI^L-score
Forest	83%	50	41.50
Heathland	67%	25	16.75
Meadow	53%	100	53.00
Total		175	111.25

The NI^L-score only accounts for quality changes within an ecosystem and not among different ecosystems. Therefore, the NI^L-score should be multiplied with a weighing factor that reflects the variety of species and the degree of threat. In this way, the importance of having different ecosystems can be distinguished. The table below shows the Nature type related to a weighing factor.

Natuurtype	Onderliggende natuurdoeltypen[b]	Weegfactor
Kwelder	Kwelder	2,4
Droge schraalgraslanden	Kalkgrasland, Droog schraalgrasland en duingraslanden	1,9
Natte schraalgraslanden	Nat schraalgrasland, Dotterbloemgraslanden	1,8
Moeras	Moeras, Natte strooiselruigte	1,6
Voedselrijke natuurgraslanden en soortenrijke reservaatakkers (incl. soortenrijke weidevogels graslanden)	Bloemrijke graslanden, (reservaat) Akkers, Binnendijks ziltgrasland	1,4
Voedselarme venen en vochtige heide	Natte heide, Natte duinheide, (Trilvenen), (Moerasheide)	1,2
Vochtige bossen	Bos van voedselrijk vochtige gronden, Bos van bron en beek, Haagbeukenbossen, Zomen van het rivierengebied, (Ooibos), (Laagveenbos), (Hoogveenbos)	1,1
Strand en stuivend duin[c]	Strand en stuivend duin	1,1
Droge heide	Droge heide, Droge duinheide, (Zandverstuiving)	1,0
Droge bossen	Bossen van arme zandgronden, Eiken-beukenbos van lemige zandgronden	1,0
Hakhout	Hakhout en middenbos, (Stinsebos)	0,7
Agrarische akkers	Agrarische akkers[d]	0,4
Agrarisch graslanden	Agrarische graslanden[d]	0,4
Stenig terrein	Stenig terrein, Daken, Ruimte in gebouwen, (Sterk verstoord terrein)[d]	0,2
Naaldbos met productie	Naaldbos met uitheemse soorten[d]	0,1

[a] Natuurtypen zijn zoveel mogelijk gedefinieerd op basis van verwachte nieuwe aangescherpte natuurdoeltypologie (zie LNV, 2008).
[b] Namen verwijzen naar Handboek natuurdoeltypen (Bal et al., 2002). Tussen haakjes de natuurdoeltypen waarvoor de weegfactor van toepassing is, maar die niet gebruikt is voor de berekening van de weergegeven weegfactor.
[c] Het natuurtype 'open duin', zoals dat in kwaliteitsborging wordt onderscheiden, is onderverdeeld bij andere natuurtypen aan de hand van verschijningsvorm. 'Strand en stuivend duin' is als enige onderdeel van 'open duin' niet toebedeeld aan een ander natuurtype.
[d] Cultuurtypen zoals genoemd in Bal et al. (2002).

The Netherlands Environmental Agency advices to perform more research to the exact magnitude of the weighing factors. Using these weighing factors a specie weighed nature value indicator appears, also called the NI^{sg}-score. This score does not only value local intact ecosystems above local incomplete ecosystems, but also values intact ecosystems with threatened species above intact ecosystems without threatened species. In the example below, the nature value increases due to replacing 25 ha meadow by 25 ha of heathland.

Ecosystem	NI^{L}	Acreage ha.	Weiging factor	NI^{sg}-score
Forest	83%	50	0.7	29
Heathland	67%	25	1	16.8
Meadows	53%	100	0.4	21.2
Total		175		67
Forest	83%	50	0.7	29
Heathland	67%	50	1	33.5
Meadow	53%	75	0.4	15.9
Total		175		78.45

In Cost-Benefit analysis the NI^{sg}-score can be presented besides the balance of costs and benefits, this could look like the table below:

Projectalternatief	*NCW baten-kostensaldo (milj.€)*	*Biodiversiteit*
Gevarieerd	-16,4	+180
Natuurlijk	-26,9	+450
Aangepast	-14,4	+180

Although the use of the NI^{sg}-score seems to be promising, there are some disadvantages of this approach:

- Because the NI^{sg}-score is not monetized, it remains difficult to compare it with balance of costs and benefits. Reflecting on the table above one can question himself whether the increase in biodiversity of 270 NI^{sg}-score is worth 10,5 million Euro.
- The NI^{sg}-score does not always represent individual preferences. The results between CVM and the NI^{sg}-score can be contradicting. For example when people do not distinguish two alternatives on a marginal increase in biodiversity.
- Besides environmental values, the NI^{sg}-score does not give a solution for estimating other 'soft' benefits that are outside the environmental scope. Consider for example values related to landscape or cultural-history.

7.2 The United States

In the United States environmental valuation has a long history and is, in contrary to the Netherlands, included in policy evaluation. CBA is a **compulsory** part of decision-making, only the regulations that have a positive cost-benefit ratio will be accepted. Box 5 gives an overview of some important dates in the history of American cost-benefit analysis and environmental valuation.

Box 5 Some important dates in the history of American cost-benefit analysis and environmental valuation

1902	River and Harbor act. First recorded CBA of an investment project for shipping
1960	CBA becomes standard methodology for evaluating government investments
1972	Clean Water Act. In the late 70's the Water Resource Council set up the Principles and Standards for Planning Water and Related Land Recourses. The first documents in which the definition non-priced market goods was used. The travel cost method and contingent valuation method were declared as being legitimate estimation techniques
1980	Introduction of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). In the beginning, environmental valuation was not included because it was said to be unreliable. This led to resistance from many stakeholders. Finally, it was brought to court; the verdict was that the non-market valuation methods should not be discriminated. Following on the sentence the Minister of Foreign Affairs adjusted the rules.
1981	President Reagan signed the Executive Order 12291 that requires CBA for all policy evaluation. Since then CBA has been applied on a broad scale, including the environmental costs and benefits.
1990	Further realization of the CERCLA regulation

There are many institutes in the US that have a guideline giving instructions on how to perform cost-benefit analysis including environmental costs and benefits. These are:

- U.S. Army Corps of Engineers, largest administrator of nature and recreation areas
- U.S. Bureau of Reclamation focuses on the construction and maintenance of waterways, dams, hydropower and irrigation.
- U.S. Natural Resources Conservation Service, focuses on the protection of soil, water and other natural resources
- Tennessee Valley Authority, main electricity supplier
- U.S. Forest Service; focuses on the protection of national forests and meadows
- U.S. Environmental Protection Agency (see box 6)
- National Oceanographic and Atmospheric Administration.

The guidelines are **scientifically** founded, partly because they are designed by well-known scientist in the field of environmental economics but also because the guidelines overlap the scientific guidelines for environmental valuation. The applicability and validity of the revealed preference method is not discussed. De development of non-market-based valuation methods improved the methodology and made them more legitimate for the use of policy evaluation (Bos, 2003).

Box 6 The guidelines of the U.S. Evironmental Protection Agency (EPA)

After President Reagon signed the Executive order 12291 that requires perfoming CBA for all policy evaluations, the EPA was more concerned with nature and environmental valuation than other institues in the US. This guideline describes the valuation methods and the type of effects that need to be valued and evaluated. The effects that follow from environmental improvements due to regulations have to be explored. This also involves the external effects. EPA distinguishes four methods to value environmental effects: the direct cost method, travel cost method, hedonic valuation method and contingent valuation method. Because inaccurate data on costs and benefits that cannot be monetized, the results are often not unambiguous. In the case many non-priced benefits cannot be monetized or when law specifies specific goals, a cost effectiveness analyses may be used to evaluate.

7.3 Some other international institutes

7.3.1 International Union for Conservation of Nature (IUCN)

The IUCN states that the monetary value of ecosystem services is enormous. These values are often not taken into account in decision-making. Nearly all ecosystem services have an economic component and society is dependent on these goods and services. Therefore, we should be investing in nature and biodiversity to drive sustainable and social growth. The IUCN works together with governments to ensure that decision-making is taking into account the value of ecosystem services. The challenge in internalizing costs and benefits within the ecosystem is to avoid attaching the benefits in one ecosystem or subsystem while exporting the costs to another one. The IUCN has developed a guideline for decision-makers that also describes the place and role of the valuation of ecosystem services in the decision-making process (IUCN, 1996). Besides that, it gives an overview of several case studies. They have a lot of experience on using the ecosystem service approach also in relation with the valuation of ecosystem services and payments for ecosystem services.

7.3.2 World Resource Institute (WRI) and Worldbank

The World Resource Institute is a research institute with the mission to move human society to live in ways that protect Earth's environment and its capacity to provide for the needs and aspirations of current and future generations. They perform many studies including economic valuation, for example on the valuation of coral reefs in Belize. The Worldbank finds valuation of environmental impacts an essential element in incorporating the benefits and costs into the analysis of alternatives. In this way, a decision can made based on the benefits that are provided to society. Recent development has made it possible to monetize more non-priced effects. The monetization can help by setting up a scheme for 'Payments for Environmental Services'.

7.4 Conclusions

In the Netherlands there seems to be a lot of discussion on whether or not to use monetized effects for policy-making. The Ministries are positive, while the Netherlands Bureau for Economic Analysis is critical. The new report of the Netherlands Environmental Agency develops a new method that tries to integrate both economic and ecological principles in one indicator. However, still questions are raised on how to interpret and use this indicator. International Institutes have accepted monetization of environmental effects for the use of policy-making.

Conclusion and Discussion

In literature, there is no consensus on the definition of total economic value of ecosystem services, this causes confusion and discussion about the research methodology and results. Most important is to make a distinction between use values and non-use values, because this is the practical level considered in most valuation studies. To avoid this confusion and discussion it is necessary to determine a position before carrying out an economic valuation study. It is important to formulate an approach towards valuation; how are concepts such as economic value, total value subjective vs. objective value and instrumental vs. end-value defined? Furthermore, it should be clarified what is valued: ecosystem goods, services, functions, natural capital or a combination of them?

Economic theory provides two measures to estimate the change in economic value for quantity and quality changes of ecosystem services: the compensating and equivalent surplus. Direct valuation methods are capable, when properly used, to estimate the change in total economic value. Direct valuation methods use hypothetical markets to estimate use and non-use value. Contingent Valuation and Choice Experiments are often used in practice. Although direct valuation methods estimate total value using the right theoretical measure, they are controversial because they use questionnaires that involve many biases. In the survey-designing phase, this should be kept in mind.

Unlike for price changes, it is not possible to use consumer surplus as an approximation for welfare changes of quality and quantity changes in ecosystem services. Nevertheless, indirect valuation is based on this concept and is widely used by many economists. The magnitude and sign of the error are not known; therefore, one should be careful when interpreting and using indirect valuation methods. Indirect valuation methods use conventional and surrogate markets to estimate use value. Hedonic Pricing, Averting Behavior and the Travel Cost approach are examples. Strength of the indirect valuation method is that they use observed behavior as input. Disadvantages are that they use consumer surplus which is not the theoretical right measure and that they only estimate use value.

Besides the methodological flaws concerned with ecosystem service valuation, there is some controversy about valuing ecosystem services, this stems from ethics. The notion that human life is dependent on ecosystems, that human rights are more important than welfare and that other values like religious and ethical ones are of a higher order cause resistance against the use of environmental valuation for decision-making. Valuation of ecosystem services can be used for many purposes such as cost-benefit analysis, the design of market-based instruments, green accounting and communication and participation goals. In the Netherlands, it is not yet compulsory to include monetized environmental effects in cost-benefit analysis, but the support is growing and more and more studies include environmental values. Abroad it is widely accepted that environmental valuation forms a part of cost-benefit analysis; in the United States, it is even enforced by law. Thinking these critics over it should be kept in mind that decision-making should be partly based on welfare effects. Economic effects should never be the only basis, instead economic considerations should be one of the criteria for policy and project appraisal. Cultural, religious and distribution effects also have to be considered. Anyway, decisions have to be made and leaving the economic perspective out of this process would be a shortcoming.

Recommendations

Position of Deltares

Consider cost-benefit analysis (including environmental effects) as part of the input for policy-making

Economic evaluation is *one of many approaches* to answer questions related to policy-making. Economy gives an answer to the question how resources should be allocated efficiently, including natural resources. This point of view may contradict with other approaches, like ecological ones. Deltares, as an independent research institute, should give all relevant points of view to a problem. It is up to policy-makers how they weigh and prioritize the different outcomes.

Monetize environmental effects when possible

Two reasons:

- In many cost-benefit analyses, environmental effects are scored qualitatively. One of the advantages of cost-benefit analysis is to aggregate all effects to one parameter, so that effects within and among projects can be compared; a qualitative approach complicates the comparison. However, it should be kept in mind that it is not always possible to monetize the environmental effects. For example, when the quantitative ecological effects cannot be determined. In that case, it is better to describe the environmental effects qualitatively.
- When not including/monetizing environmental effects in the economic analysis of a project causes the environmental effect to be left out of the economic analysis; indicating that we do not value the environment at all.

When interpreting environmental value; think in terms of marginal changes and not in terms of total value

The unsubstitutable character of ecosystem services causes this. Expressing a total value to ecosystem services, raises the feeling that ecosystem services can be traded on transaction markets. This is of course not the case for many ecosystem services; therefore, it is beside the point to attach total values. Instead, we are interested in changes; the central question should be how much we gain or lose when the environment changes.

Further research

Deltares is not an economic research institute and with the limited capacity in the field of this discipline, it is not likely that they will perform fundamental economic research in the near future. From this point of view it is more interesting to look at the different approaches that are newly available, such as the NI^{sg}-score developed by the Netherlands Environmental Agency. Possible research questions could be:

- Is it possible to give an economic interpretation to the NI^{sg}-score? (e.g. 1 point is 10 euro)
- What are the advantages and disadvantages of using the NI^{sg}-score?
- How are other institutes dealing with this indicator?

Besides this new technique, it is also interesting for Deltares to build up a little but more of experience with regard to environmental valuation studies and the ecosystem approach. It would be interesting to find a case study in which environmental valuation will be part of the analysis.

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