basque ecodesign center

THE COMPANY AND ECOSYSTEMIC SERVICES

How to incorporate biodiversity in corporate decisions

EUSKO JAURLARITZA GOBIERNO VASCO

CIE Automotive EROSKI euskaltel FAGOR

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design and layout

dualxj comunicación&diseño

photography

Irekia. Basque Government
Mikel Arrazola

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PRESENTATION

The Basque Ecodesign Centre driving Corporate Ecosystemic Services

Society is increasingly more concerned about the environment and the sustainability of the planet. Companies have begun to embrace that concern not only as a need, but also as an opportunity to position themselves and stand out from among their competitors. They are aware that incorporating environmental and resource efficiency criteria in their products is reflected in the profit and loss account.

It is obvious that team work, joining forces and establishing cooperation spaces that multiply the individual achievements are essential to progress on that path. Therefore, the values of trust, transparency and respect that generate a favourable climate for dialogue, cooperation and learning must be embraced and fostered.

The Basque Ecodesign Center, which started out with eight of the most important Basque companies, is a highly appropriate instrument to implement this joint work model, by bringing on board the stakeholders that form part of the supply chain of the partner companies.

During this exercise, we will embrace the ecodesign concept in the main sectors through business associations including clusters.

This document seeks to drive the participation of new companies in the planned actions as part of this programme, specifically regarding the procurement of corporate supplies and services.

Javier Agirre Orcajo
General Manager
Ihobe, Publicly-owned Environmental Management Company
Ministry of the Environment and Territorial Policy
Basque Government

“Biodiversity includes services that involve undisputed and often essential benefits and opportunities for business activities, and for development and social wellbeing”.

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1. WHAT ARE ECOSYSTEMIC SERVICES?

Ecosystemic goods and services are indirect or direct contributions that eco-systems make to human wellbeing and its activities. These contributions can be resources or processes and provide benefits that can be divided into three types: ecological, socio-cultural and economic. It should be noted that different values can be attributed to a specific benefit. For example, fishing provides us with food and also a cultural identity (fishermen) and economic income.

It is noteworthy that a specific resource can generate several specific services. For example, fishing provides us with food and also a cultural identity (fishermen), and leisure and entertainment. In the same way, there are individuals and companies that often benefit from ecosystemic services without noticing them or appreciating their value.

As has already been stated, the benefits generated by the ecosystemic goods and services are classified into three categories:

1. Ecological

The ecological importance of the ecosystems is to be found in the causal relationship existing between their members; for example, the value of a certain species of tree to control erosion or the value of another species for the survival, in turn, of others or even those of the whole ecosystem.

2. Socio-cultural

Biodiversity and ecosystems are a crucial source of intangible wellbeing due to their impact on the mind and health of people and by their symbolic, spiritual and historical values.

- It should be stressed the company not only benefits from Ecosystemic Services, but often depends on them and can use them more efficiently.
- Ecosystemic services are indirect or direct contributions of ecosystems to human wellbeing.
- An ecosystem provides different services.
- Each service usually contributes various benefits (ecological, economic or socio-cultural) and they may or may not be perceived depending on the user.

3. Economic

Economic benefits account for a considerable part of them and are the prevailing ones for companies. These consist of assets that can be marketed directly or indirectly (raw materials or others) and of processes that support or underpin business activities. The latter include fauna and flora or landscape attractions for tourism, regular water supply for business activities, processes to prevent recontamination and preventing erosion. In the same way, socio-cultural benefits and values help to transmit a commodity corporate image of its social perception.

Biodiversity, i.e., the variability of living beings and their interactions, goes far beyond the sum of the species, and includes services that lead to **undisputed** and often essential **benefits and opportunities for businesses**, and for social wellbeing and development. **The company is intrinsically linked to biodiversity and ecosystemic services**, to their use, and this can be an **opportunity** rather than a legislative straightjacket. **It is foreseeable that the valuation of the ecosystems, of their services, will be progressively incorporated in the public support policies and in legislation**.

2. THE COMPANY AND ECOSYSTEMIC SERVICES INTERACTION

All companies interact and have some direct or indirect dependency on biodiversity and ecosystemic services, even though the relations vary depending on the different sectors, and even within each sector and activity. These relations depend on the location of the company, the source of its raw materials, how its supply chains operate, the production technology used and transport to the points where its customers are located.

These links can be grouped into **impacts and dependencies** on biodiversity and the ESs. Companies that quantify the impacts that they cause, along with the degree and characteristics of their dependency on biodiversity and the ecosystemic services, may better manage and administer their use, compensation and restoration policies and actions to guarantee the viability and sustainability of the business or the economic efficiency in managing that resource.

Table 2 summaries the results of three studies that have calculated the magnitude of the biodiversity risks of activities in different business sectors. The impacts and dependency on biodiversity, and therefore the ESs, are set out. This table does not contemplate all the sectors, but rather uses a classification where the business activities are grouped into large blocks. The scale of the impact and the degree of dependency on biodiversity are indicated for each sector.

An example of the impact and dependency on the ecosystemic services is the one arising from the peripheral management of a reservoir. In many cases, it is more profitable to cover the forest canopy of the basin so that the water stored is purified prior to arriving to the drinking glass, as well as to minimise the accumulation of suspended matter that may clog up the water. Thus, the maintenance and appropriate management of the forest canopy of the reservoir, which may even involve purchasing the felling rights, results in savings and lower key purifying and drainage costs to recover the storage capacity. Other benefits can also be obtained from the forests or they can be managed to preserve the biodiversity as part of the biodiversity policy of the company.

- Companies depend on, and impact, the biodiversity and therefore depend on the ecosystemic services and affect them.
- It is very important to identify the impacts, dependencies and opportunities of the business activity on the biodiversity, and to thus be able to perform an appropriate management of the ecosystemic services used.

Table 3 sets out some opportunities for different sectors to benefit from biodiversity.

SECTOR	IMPACTS	DEPENDENCY
Paper and pulp	**Potentially high:** Water use, Land transformation, reducing soil fertility, felling.	**High**: Water, soil, pest control, yield levels, need for raw materials.
Livestock	**Potentially high:** Transformation of the land for feed and pasturing, use of water.	**High:** Access to appropriate feed and drinking water.
Oil and gas	**Potentially high:** The reserves are located in increasingly more sensitive place and require sound management practices to ensure operating licences.	**Moderate:** The level depends on the location (e.g. in the case of a refinery on marshland, if the marsh is destroyed, the protection against the water and storm surges will be limited).
Mining and metallurgy	**Potentially high:** (see oil and gas)	**Moderate:** Water (see oil and gas)
Food	**Potentially high:** Transformation of the land for feed and grazing, using of water overfishing, etc.	**High:** Water, soil, pollinating insects, pest control, raw materials (e.g. Fish).
Beverages	**Potentially high:** Transformation of the land for feed and pasturing, use of water.	**High:** Water, some raw materials (e.g. agave, barley).
Financial Services	**Indirect impacts:** Exposed to high risk if involved in financial activities that destroy the biodiversity.	**Low:** In general, the financial system does not penalise the poor administration of the biodiversity and the ecosystemic services.
Pharmaceutics and biotechnology	**Low:** Relatively low impact on biodiversity by means of the extraction of natural natural resources.	**Moderate:** The supply of natural ingredients is rare nowadays, even though there continues to exist concern for bioprospecting and the use of living beings.
Retailers in general	Indirect through the supply chains.	**Moderate:** The retailers can often change product and therefore the risk of exposure in cost terms of the product and of safety of the supply is relatively low.
Leisure and hotels	**Moderate:** Impact due to the construction, use of raw materials and provision of food, the potential impact of mass tourism can be harmful, air transport releases emissions that also impact biodiversity.	**Moderate:** Some tourist items are dependent on continuing access to clean water, pleasant settings, landscapes, leisure resources, etc.
Construction and construction materials	**High:** Climate change (cement), sources of raw materials (e.g. timber and development of roads/urban areas).	**Moderate:** Some dependency on timber and network adaptation, potential for developing opportunities by means of using natural infrastructures.
Electricity	**High:** Water provision can disrupt supplies of water to biodiversity, the water purifying releases greenhouse gas emissions, transformation of the habitat in the case of hydroelectric energy.	**High:** In particular the provision of water.

Table 2: Impacts and dependency on biodiversity by sectors.

SECTOR	COMMERCIAL ADVANTAGE	EXAMPLE
Agriculture	Higher profits due to the sale of products produced using methods that respect biodiversity and therefore offer a value added.	Product certification or labelling such as "Eusko Label", "Fair Trade" or "Organic Product".
Biodiversity (consultancy, audits)	Conserving biodiversity fosters an increase in turnover, due to the increase of the policy area.	The work volume of this sector increase with a greater presence of the environmental legislation (EIA, Plans of Action, audits, etc.).
Cosmetics	By means of the responsible supply of ingredients: - Attracting consumers. - Safety in the supply chain raw materials	Cosmetics certified with the label of "Organic product" or "fair trade". Own projects of the companies to protect endangered plants.
Extractive industries (oil, gas, quarries, mining)	Better corporate image.	Restoring quarries or degraded areas.
Finances	Increasing earnings, reducing costs, due to investments in biodiversity and ecosystemic services. Improved corporate image.	A financial institution invests in environmental projects in return for the users to receive notifications electronically.
Fishing	Higher profits due to the sale of biodiversity-friendly products, and therefore offer a value added.	Fish certification using the "Marine Stewardship Council (MSC)". Supermarkets such as Aldi or Lidl ask their suppliers to provide certified fish of frozen products. McDonalds Europe also offers certified fish.
Forestry	Guarantee the entrance of products on the European market. Increased competitiveness. Adaptation to the consumers' requirements.	Certification of paper and timber as "PEFC", "FSC", "RA". The goal of IKEA is for all the timber used in its products are from forests with responsible management certificate.
Textile	Better corporate image. Gain of the consumers.	Products labelled as "organic/eco cotton".
Drugs	More secure supply chain.	Raw materials certificate. Good farming and harvesting practices.
Retailers and small stores	Sustainable supply thanks to good harvesting practices of the suppliers. Improving customer the consumers thanks to certified suppliers.	Carrying out sustainable extraction reeds, the basketry will ensure the supply of their product (ditto mushrooms and fungi). In the case of asparagus, their certification will improve loyalty.
Tourism	Better economic returns by means of respecting the biodiversity and the ESs.	Certification of hotels, tours or eco-educational activities. Possibility of experiencing tourism year round in the Pyrenees.
All	Possibility for economic benefits by means of the ES markets and biodiversity (carbon, water, biodiversity) regulated or voluntary.	Sale of carbon credits of the Carbon Market (Kyoto).

Table 3: Opportunities for some sectors to benefit from biodiversity.

3. VALUATION OF ECOSYSTEMIC SERVICES IN THE INTERNATIONAL FRAMEWORK

Increasingly more benefits and opportunities are obtained from appraising the goods and services of the ecosystems as a tool for making decisions and analysing alternatives. This appraisal is only one way to show the relationship existing between nature and human wellbeing. It should be noted that the environmental valuation only captures a part of the different and many aspects of this relationship. In fact, some services of the ecosystems cannot be adequately expressed in monetary terms.

The economic valuation process for the ecosystemic services of a zone consists of assigning a monetary value, while taking into account that the aim is to analyse the benefits of products that are, in their majority, non-market ones. The monetary valuation approach that is generally applied is known as **the total economic value (TEV)** approach (see Table). Different methodologies are used to calculate the TEV and which range from the use of real prices linked to trading services of the ecosystems (mainly supply), to the valuation of economic activities that are more or less directly related to the service (as is the case of the tourist market and recreational services) or, for example, to the assessment of hypothetical markets created by calculating the estimated potential demand by means of surveys that directly or indirectly determine the willingness to pay for the service or to be compensated for its loss. However, all of them are based on a sound technical base and are implemented in current economic and business practice.

Even though multiple ecosystemic services valuation studies and initiatives have been implemented, two international projects, **"The Economics of Ecosystems and Biodiversity"** (TEEB), and the Millennium Ecosystem Assessment (MA), are benchmarks when addressing the classification and definition and valuation of the ecosystemic services.

The total economic value and the value types

The Total Economic Value consists of estimating all the economic flows that an ecosystem generates by means of the different ecosystemic goods and services that it provides. Within this economic approach, the goods and services of the ecosystems are classified according to how they are used. Before defining the different types of values that we can identify when valuing an environmental commodity or service, we must be aware that the value of an ecosystem must take into account two differentiated aspects [1]:

- **OUTPUT VALUES**: the aggregated value of the benefits provided by the services of the ecosystems in a determined state (that is related to the Total Economic Value that is explained below).
- **INSURANCE VALUES**: the capacity of the system to maintain those values when faced with variability and disturbances.

The Total Economic Value (TEV) concept is related to the output values and is defined as the sum of the values of all the flows that the natural capital generates both now and in the future-appropriately discounted [1]. Those flows are measured using marginal changes and vary between the individuals according to different factors such as the degree of knowledge or the perception of its importance. In order to avoid double accounting, we must focus on the end product (end benefits or output values, such as the control of water flows by cloud tropical forests).

As can be seen in Figure 1, the TEV incorporates different values that include the no-use and use value. The use value can be divided between current value and option value, while philanthropic values (legacy or altruistic) and existence values are identified in the no-use value. Each of those values is defined below.

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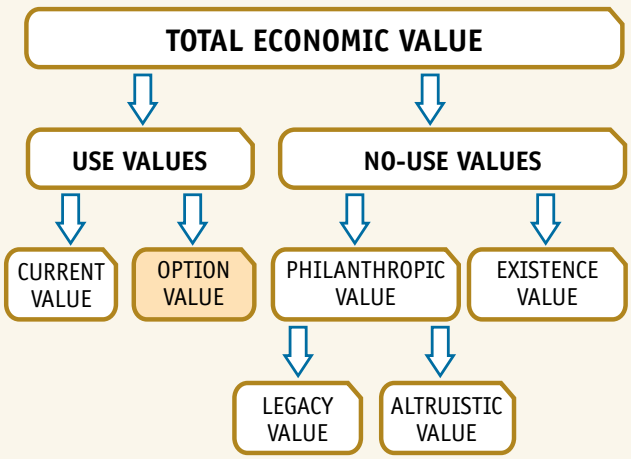


Figure 1: Total economic value.

- **DIRECT USE VALUE**: The direct use value is assigned to goods that can be produced, extracted, consumed or enjoyed from the environment, both directly and indirectly. For example, in the case of a forest, its direct use value can come from the timber, from the non-wood products (fruit, mushrooms, etc.), from hunting, etc. Those values are consumptive direct values as they involve consumption of the commodity or service by the individual. On the other hand, there are other non-consumptive values, such as tourism or enjoying walks in the forest.
- **INDIRECT USE VALUE:** The indirect use value (or functional use value), arises from the services that the environment provides. For examples, wetlands, apart from providing values arising from a direct use (fishing, recreational activities), generate benefits using other functions such as controlling flash floods and flooding of the rivers, collecting and filtering nutrients, supply aquifers or protecting the biodiversity.

  Measuring the indirect use value is often more complex than measuring the direct use value. In the majority of cases, there is no market for those services and, therefore, their value is established using valuation techniques developed for it.
- **OPTION VALUE:** The option value consists of valuing the possibility of a future use (non- or consumptive) of a certain ecosystemic commodity or service. It should be noted there is no consensus regarding the exact place where it has to be placed (along with use, no-use values or between both). That is why the dotted line is usually included. Some experts consider that the option value has to form part of the use values, as it is a value to ensure the indirect or direct use of the commodity. Others interpret it as a no-use component, as the option value is not related with any current use of the commodity. Some even argue that the option value must be considered as a value category separately in addition to the no-use and use values, as it would allow both values, both its future use and the no-use benefits, to be established. Another type of value and related to the option value is the quasi-option, framing the TEV in conditions of uncertainty, and indicating the possibility that even though something seems to be unimportant now, the information subsequently received can help us to subsequently value it. For example, the option value consists of having the option in the future of using and consuming some resources or services, even though that use is uncertain (use of medicines from a plant in a tropical forest). Therefore, this value is an additional value to any other utility from its current consumption; in other words, the conserved plant has the value of the actual consumption of the medicine made from it and that from a future consumption due to its conservation. The option value would today be zero if we guarantee the availability of this resource (plant) in the future and our preferences were also the same with relation to that resource. Therefore, if we are not sure that we are able to enjoy that resource or whether we will keep our current preferences, we should want to pay a premium to keep that possibility in the future (as an insurance), that is the option value. While the quasi-option value is the value provided by protecting the biodiversity, due to the simple fact that a medicinal value can be found in the future for some of the conserved species (new technologies, discoveries, etc.). In other words, it is the expected usefulness for not taking irreversible decisions and thus being able to maintain future use options in the light of the technological advances and the progress of knowledge.
- **NO-USE VALUES:** The no-use value reflects the benefits that the ecosystemic services or biodiversity provide without implying an indirect or direct use. The existence value is the value that people give to the knowledge of the existence of an environmental good or service even though they do not plan to ever use it, or the altruism and legacy values, related with the value allocated to conserving a commodity to be used by future generations (inter-generational) or by other people (intra-generational). For example, society gives a value to the existence of species in danger of extinction, although the majority of people have never seen them and will probably never see them. If an iconic species such as the Iberian lynx were to disappear, many people would have a strong feeling of loss that can be quantified.

These two studies assess the work, gather information and put forward a unified and coherent methodological framework to value the ecosystemic goods and services. The provision of goods or services should be first established in physical terms and thus provide ecological grounds for the economic valuation in order for the services of the ecosystems to be correctly valued. Once that has been established, the valuation exercise would be carried out.

- The valuation of the ecosystemic services takes shape as it is perceived and as it is taken on board that the benefits and services of the ecosystems are those that guarantee the sustainable growth and development of the modern society model.

"The Economics of Ecosystems and Biodiversity" (TEEB)

It is a global study on the economics of biodiversity loss, and it was launched by Germany and the European Commission in response to a proposal by the G8+5 Environment ministers (Potsdam, Germany 2007). Thus, TEEB set up a broad team of scientists and experts from over 40 countries in order to synthesize current knowledge on environmental services from different perspectives, assessing them and valuing them, and also with the aim of analysing the viable and committed political options against the degradation of the ecosystems and their resources. TEEB can be considered a ground-breaking benchmark in economic valuation of ecosystemic services.

In 2008, TEEB released an interim report (TEEB Interim Report) where it set out the grounds that compiled evidence and research into the TEEB goal, and identified **a framework to assess the elements of the biodiversity/ecosystems**. Subsequently, in a second phase, TEEB published different reports, aimed more specifically at different targets.

TEEB focuses on the concept of assessing ecosystems as an accredited and practical tool in business decision making. Furthermore, as has already been pointed out, performing an economic valuation helps to perceive the trade-offs more clearly when comparing costs and benefits and taking the biodiversity risks into account.

Millennium Ecosystem Assessment (MA)

It is an interdisciplinary scientific programme under the United Nations to assess the capacity of the planet's ecosystems to maintain the wellbeing of its inhabitants.

Although major advances had been made in ecological sciences during the 1980s and 1990s, these new findings appeared to be poorly reflected in economic assessments of the natural recourses and their use. Recognizing these shortcomings, a panel of 40 leading scientists prepared a draft international assessment of the ecosystems: "Protecting our Planet, Securing our Future: Linkages Among Global Environmental Issues and Human Needs". The specific proposal for the Millennium Ecosystem Assessment (MA) arose during a brainstorming meeting held at the World Resources Institute (WRI) on 17 May 1998 to discuss plans for the biennial World Resources Report published by the WRI, UNEP, World Bank and UNDP. The meeting concluded with a proposal to undertake a set of activities to create a new international assessment process. The four partners (WRI, UNEP, World Bank and UNDP) approved that proposal and the explanatory phase began that same month.

The MA started in Spain in 2009 and the results of the biophysics dimension assessment were unveiled in 2012. This biophysics assessment of Spain's ecosystems involved 60 social scientists and bio-physicists.

4. WHICH ARE THE ECOSYSTEMIC SERVICES?

When classifying and defining ecosystemic services, the benchmark international projects (Costanza et al., 1997, De Groot et al., 2002, MA, 2005a, Daily et al., 2009) propose very similar and comparable classifications. Table 4 sets out the classification followed here which is the one developed in **"The Economics of Ecosystems and Biodiversity"** (TEEB report). The TEEB report groups the ES into four categories: provisioning, regulating, habitat and cultural services. This approach is very functional, is widely accepted and is also very similar and easily equated to the classification of the other major ES initiative, the Millennium Ecosystem Assessment (MA).

PROVISIONING SERVICES
Food
Fresh water
Raw materials
Genetic resources
Biochemical and medicinal resouces
Ornamental resources
REGULATING SERVICES
Air quality
Climate regulating
Moderation of extreme events
Regulating the water cycle
Water purification
Erosion prevention
Soil fertility
Pollination
Biological control
HABITAT SERVICES
Maintaining life cycles of migratory species
Maintenance of genetic diversity
SUPPORTING AND CULTURAL SERVICES
Aesthetic appreciation
Tourist and recreational activities Inspiration for culture, art and design Religious and spiritual appreciation
Information for cognitive development (environmental education)

Table 4: Classification of ecosystemic services.

Each of these services is described below as per the classification and order set out in the table.

4.1. Provisioning services

Provisioning services are **ecosystem services** that **generate a resource or material that is used** directly or indirectly by society. Those resources or materials can be biotic (from living beings) or abiotic.

Food

The food provisioning services consists of generating goods that are used in human food. The most obvious cases are the production of wheat, fruit, meat or others in managed agricultural environments. It also includes the production of meat, milk and cheese in grazing zones, fishing in water ecosystems, hunting in forests, dry fruit, mushrooms, to name just a few. All those cases are thus included in this category where food is the purpose of using the resource. However, when the use of the resources is distinctly recreational (angling, hunting for sport, etc.), it is usually valued as a cultural service.

Fresh water

It consists of the availability of fresh water that an ecosystem offers. This resource is typically from lakes, rivers and aquifers. Vegetation, and particularly forests, has a significant influence on the quantity and speed of water available in an ecosystem. Apart from the physical presence of fresh water, this service can appear in more subtle ways, as wooded environments, for example, have high evapotranspiration than pastureland and crops, providing greater atmospheric humidity and hydration, and, therefore, more probabilities for cloud formation with the ensuing rainfall and snow. This resource is used in industry, agriculture and domestic applications. For example, the availability of fresh water allows land to be irrigated in order to obtain better crops, or to cool certain production processes. This service also provides us with water for our consumption and hygiene.

Raw materials

The provision of raw materials consists of generating elements that are directly used by industry or transformed to generate consumer goods; they include: fuels, timber, cotton, cellulose, minerals, fodder, sugars, oils, etc. These materials can be generated in ecosystems managed for that purpose (such as timber for construction or biomass, harvests for biofuel, fibres for roofs) or be a product that is used from non-managed ecosystems or for other uses (such as using wood for domestic heating or collecting reeds and other fibres for basket-making and other traditional uses that may have a high economic importance locally).

Genetic resources

The provision of genetic resources consists of the generation and availability of genetic materials from the ecosystems. A commodity example of this service are the wild varieties of crops and the local breeds and varieties of plants and domestic animals, that increase the production and reduce the vulnerability to diseases and epidemics and to climate variation. On the other hand, genetic resources are also important to ensure certain medicinal purpose and provide the base for biotechnological research. Thus, the wild and local varieties are a large source of genetic information that may be used to improve the yields of the undertakings.

Biochemical and medicinal resources

This service consists of using substances generated by plants or animals for medicinal purposes. It includes both cosmetic and productive purposes; for example, chamomile, linden, aniseed, chicory, etc. among plants, and the anti-toxins or hormones among those of animal origin, are well-known products. Historically, the use of flora and fauna for medicinal purposes played a crucial role in all cultures. Nowadays, and even though traditional western medicine is essentially based on chemistry, the use of this resource directly, particularly from plants, continues to be usual practice in aesthetic, hygienic and health treatment. Furthermore, a great deal of modern pharmacological development is based on researching the therapeutic application of substances produced naturally by plants or animals, mainly in tropical regions. The potential value of those resources is undeniable, even though they are still not being exploited in some cases. On the other hand, the potential of some biochemical stances has been studied in recent years to manufacture new oils, plastics, fabrics, etc; one example of which, is corn or potato starch to produce plastic bags.

Ornamental resources

This service refers to the generation in the ecosystems of elements that are used for essentially aesthetical purposes: feathers, shells and other items for decorative purposes, coral and pearls for jewellery, seeds and woods for bead making, souvenirs for tourism, selling plants and pets, etc. By way of example, it should be noted that the aquarium fish business turns over more than two billion euros a year, and that approximately 10% of the fish come directly from the environment. Wild flowers such as edelweiss, plants such as thistles or mistletoe and the different decorations made using shells in coastal areas are examples of this service in our milieu, which locally can be important for the economy.

4.2. Regulating services

The regulating services category includes those that intervene or regulate ecological processes that are important for the development of life and economic activities. Those services are responsible for some processes that, as they are carried out artifically, require a considerable economic investment, also generate greater yield from some activities or can reduce vulnerability to atypical or extreme occurrences.

Air quality

This service occurs when an ecosystem helps to maintain or recover the quality of the air. Generally, the bio-geochemical cycles that occur in the ecosystem help to maintain a balance in the concentrations of the different chemical elements and dust particles present in the atmosphere. These particles include some that in high concentrations can cause respiratory problems, along with frequent and known pollutants such as carbon dioxide and monoxide, sulphur dioxide, nitrogen oxides, methane, ozone, etc., which worsen the air quality that we breathe. Thus, the regulation of the oxygen and of the nitrogen, carbon and sulphur cycles play a key role in the provision of this service. In urban areas, for example, this service is of particular importance as parks or other urban wooded areas considerably reduce air pollution.

Climate regulating

The climate regulating service consists of absorbing greenhouse gases with the ensuing regulating of the planet's climate. Carbon dioxide, CO_2, is the main greenhouse gas and it is absorbed by vegetation, soil and large areas of water. Vegetation, by means of photosynthesis, is the main means of extracting carbon dioxide from the atmosphere. Soil also stores a significant amount of carbon in the form of organic matter, roots and sediments (calcium carbonate), which can attain very high values and exceed those of the vegetation on the soil. Furthermore, other greenhouse gases, such as methane and nitrous oxide are also regulated by the microbial fauna of the soil. Marine ecosystems likewise contribute to carbon sequestration as it is directly absorbed by the water and assimilated by phytoplankton, corals and fish; part is also transformed into sedimentary rocks.

Moderation of extreme events

Some ecosystems have the capacity to moderate or mitigate the destructive effects of certain natural phenomena (storms, fires, floods, droughts, landslides...). For example, keeping strips of vegetation protects crops from strong winds and keep the soil fertile. Vegetation plays a key role in avoiding landslides. Another example is fire-resistant shrubs that therefore help to minimise the consequences of fires, in the same way that some forests and wetlands do. Furthermore, several ecosystems modulate the hydrological cycles by regulating and mitigating the impact of torrential rain and flooding, and also of droughts. The latter is extremely important for economic activities that depend on a stable supply of fresh water.

Regulating the water cycle

It consists of regulating the water flows as they go through an ecosystem, which depends on the drainage and retention capacity of the substrate, along with the presence of vegetation and of its water-retaining capacity. Regulating the flow reduce the surface runoff and modulates water availability in such a way that the impact of flood due to heavy rain is mitigated (see previous point) and the water is available for a longer period of time. The same conditions that increase the water filtering reduce the surface runoff. Those conditions are the ones that shape the differences in availability of the resource overtime. This is the case of sandy land, which helps to reduce the surface runoff and a rapid evacuation of the water of that ecosystem. On the other hand, ecosystems, such as forests and some wetlands can slow down the flow of running water, by modulating and regulating water availability after it has been raining.

Water purification

This service refers to the capacity of some ecosystems to purify the water, improving its quality and reducing the amount of sediments and microorganisms in it. Vegetation, microbes and soil eliminate, in different ways, inorganic and organic pollutants from the surface flows. The underground water going through the soil purifies it, by physically retaining the sediments, adhering pollutants, reducing the speed of the water and thus increasing filtration, biochemically transforming the nutrients and facilitating the absorption of water and nutrients from the roots of the plants. In turn, plants, animals and microorganisms grow in wetlands, particularly shallower water ones. Thanks to certain physical processes, they are capable of eliminating large amounts of organic matter, solids, nitrogen, phosphorous and even toxic chemical products. The oceans also provide this same service, thus contributing to the purification of the majority of the water present on the planet.

Erosion prevention

This service refers to the capacity of some ecosystems to minimise erosion. Plant cover is a key factor to avoid or reduce soil erosion. The destruction or modification of the vegetation pays the penalty of leaving the soil vulnerable to the effects of wind or rain leading to soil loss and the resulting silting up of reservoirs, changing the physical-chemical characteristics of the water courses or landslides. Soil loss due to erosions processes is one of the main environmental problems in Spain and which also results in loss of soil fertility. This service is closely related to the soil's potential to supply food. It is therefore an aspect of great importance.

Soil fertility

The provision of soil fertility consists of the contribution of the ecosystem to facilitate productive land. The soil formation process depends on the nature of its materials, biological processes, topography and climate. The progressive accumulation of organic matter is one characteristic in the evolution of the majority of soils and depends on the activity of microbes, plants and associated organisms. The food production quality and capacity of the land is determined by the nutrient cycle that occurs in all ecosystems. Therefore, the destruction of modification of any of them influences these variables. Furthermore, some ecosystems are capable of regenerating the fertility of degraded soils.

Pollination

The pollination service is linked to the dissemination of pollen and other organelles related to the plant reproduction that ecosystems facilitate or boost. Ecosystems foster the pollination of crops offering shelter, breeding areas, alternative food, etc. to pollinating species: bees, birds, bats, moths, flies and many other insects. Thanks to the pollination, the yield and the efficiency of the crops increase. In some agricultural holdings and systems, pollination is actively managed by establishing vectors such as the bees. The loss of biodiversity in the farming systems, mainly due to more intensive farming, negatively affects the upkeep of the natural pollinating systems and consequently the farming production.

Biological control

Many pests and diseases are regulated in the ecosystems using the species that make them up; for example, parasite predatory insects, insect-eating birds (woodpeckers, blue tits, great tits, nuthatches, treecreepers, redstarts, etc.), rodent predators, etc. Classic examples of biological control are the parate predatory insects such as fly larvae (**Syrphus spp.**) or ladybird larva (**Coccinella septem-punctata**) that eat aphids (**Aphididae**). The natural control of pests and diseases occurs in all ecosystems, with the ones where there is the greatest intervention or streamlining by man being the most likely to suffer pests or be the focus of diseases.

4.3. Habitat services

This category assesses the capacity of the ecosystems to provide favourable conditions and places for the species to develop their life cycles and to conserve biodiversity. Both the capacity to offer crucial requirements for different phases of the life cycle of the species, including migratory ones, and that of accommodating high levels of genetic and species diversity are considered. The latter is highly important to maintain life and its variety on Earth in the medium and long term. Habitat services underpin all or the majority of the other services (provisioning, regulating and cultural), but they are

different as they depend on specific conditions within the ecosystems. The classification used by the Millennium Ecosystem Assessment calls this ecosystemic service category "support", due to the aforementioned function of supporting the other services.

Maintaining life cycles of migratory species

This service ¡consists of providing environments and physical means with the characteristics required for the migratory species and for the development of some of the parts of their lifecycle. Migratory species such as salmon, dolphins, some birds and insects, etc. can use an ecosystem only during a period of their life; it is therefore necessary to have spaces that provide aspects such as food or shelter. Coastal wetlands or rivers are examples of ecosystems that provide this service. They are essential ecosystems for the reproduction of certain species, and without them the exploitation (for example commercial fishing) in other places would be affected.

Maintaining genetic diversity

This service consists of conserving the genetic diversity of living beings. Genetic diversity, both the intra-specific (between specimens of the same species) and the inter-specific (between those of different species), is dynamic through natural selection, an evolutionary process that models the adaptation of living beings to the different habitats. It should be noted that this service is particularly important for the upkeep genetic bank of the crops and livestock to develop varieties that best adapt to new conditions, are disease resistant, with better yields…

In the case of exclusive species (local biodiversity), an added valuation is provided arising from the unique distribution, generally due to being specific or rare, of those species in the zone, a singularity that forms part of the identity of the inhabitants of a certain geographical area, region, etc. as a value to be showcased to visitors, tourists, etc.

4.4. Cultural services

This heading includes services closely linked to the human values and behaviour, as well as to their political, economic and social patterns; therefore, they also refer to qualities of the ecosystems that are not purely material and to their recreational use by people.

Aesthetic appreciation

It refers to the direct or virtual (by means of books, art, films, television, Internet, etc.) enjoyment of the ecosystems, to the values that they deliver from their very existence from the point of view of their sensory, visual or emotive perception. Nature is fascinating to human beings, evoking in them feelings or states such as tranquillity, awe, happiness, etc., which are positively rated. Embracing the natural environment from urban zones has become so established that this service has become an essential leisure and recreation benchmark. This service is related to the state of the ecosystem and in general, the better conserved it is, the better the service it will provide.

Tourist and recreational activities

The majority of ecosystems enable tourist and recreational activities to be implemented. These have been consolidated, particularly, in the last three decades, increasing the importance of the businesses and services related to them and the tourist sectors. The variety of recreation options offered by the ecosystems is immense. The activities on land include hiking, cycling-tourism routes, horse-riding routes, hunting; caving underground; canonying, rafting, kayaking, angling, sailing, bird watching in rivers and wetlands; and in the sea, diving, snorkelling, angling, etc.

Inspiration for culture, art and design

Providing inspiration for culture, art and design is the contribution by the ecosystems, through their contemplation or use, to generate works of art, design and to establish cultural connotations. Music, painting, sculpture, literature and architecture are just some of the disciplines that have typically embraced nature as a reference to create, describe, praise, set the atmosphere, etc. Thousands of examples can be found in artistic movements where the authors externalise their special sensitivity towards the ecosystems that have marked them, vindicating them through their creations. On the other hand, technologies, and fundamentally those that wish to be governed by sustainability, find good models in the ecosystems and species to design strategies, processes and products that are more economic, efficient and ecological. One example of this is biomimetics, which analyses species and natural processes to improve and design artificial features.

Religious and spiritual appreciation

This service draws on more abstract qualities of nature, such as the relationship between it and faith or other spiritual experiences, or the capacity of some places or ecosystems to inspire reverence in the human being. Many places, species and ecosystems are, even in the developed world, particularly valued due to their relation with the religious values, symbols, traditions and/or beliefs of the societies that inhabit them. This service includes the spiritual experience and enjoyment in all their connotations, from those that assume divine creation to those that have a different perception of the world and its evolution.

Information for cognitive development

It consists of the capacity that ecosystems offer to generate information and increase human knowledge, with the research projects ran in the natural environment or those that have this as a point of reference in some of its rationale or materials. The relevance of the educational activities that are programmed and developed in or about ecosystems is also noteworthy in this regard. Those activities stimulate, raise awareness and provide information, particularly for the child and youth sector of society, about environmental values and problems, regarding the functioning of the ecosystems, the characteristics of their components, the ecological history of the place, etc.

5. HOW CAN I IDENTIFY MY MOST IMPORTANT ECOSYSTEMIC SERVICES?

An initial step to value the services of the ecosystems lies in identifying the present or important services in the place. In other words, once the decision has been made to assess a zone, which ecosystems and services occur there? How can they be identified? In order to help companies decide which services are valued in their respective sectors, the ecosystems in question are explained succinctly and the main services and the most commonly considered of each one are then cited.

5.1. Main ecosystems of the Iberian peninsula

Each ecosystem is described very briefly below in order to facilitate its identification:

Atlantic forest

Ecosystem characterised by rainy and damp climate forests. In the Iberian Peninsula, beech, oak and spruce are the species of trees that predominate in that environment. Their distribution extends along the most northern strip that runs from the Pyrenees to the north of Galicia, even though many examples of this type of forest are to be found in the Iberian system mountain range.

Mediterranean forest

This is the term for woodland with trees with perennial, hard and small leaves, adapted to avoid excessive loss of water as the result of droughts, particularly in summer. Holm oaks made up the main woodland, even though there are other important ones in Iberian areas (for example, cork oak, Spanish juniper and gall oak woods). The Dehesa pastureland, an ecosystem created by clearing the Mediterranean forest (mainly Holm oak) for livestock purposes, is another example of this ecosystem that is particularly typical.

Forestry plantations

This ecosystem refers to the land with forestry species, nearly always trees, grown for restocking or economic purposes, usually by means of planting trees of the same age and same species (monocropping). Examples of this are the poplar plantations on river banks, along with those of Monterey pine, eucalyptus and other species.

Scrubland

Scrubland is characterised for being a plant formation mainly of bushes of many and different species in terms of the size and characteristics; it often also includes ground cover of herbaceous plants. There are natural and other scrubland that are degraded stages of the forest, particularly where felling has taken place. Heaths, gorse, thyme and coastal juniper patches are examples of that scrubland, a plant formation that is very common in nearly all ecological environments.

High mountain grazing

These are pastures that are located at altitude, with a mountain continental climate. They show a high degree of naturalness, due to a lack of human intervention, and are particularly to be found in the Pyrenees, Cantabrian and the Iberian System mountain ranges. Extensive livestock farming is very closely associated to this ecosystem (mountain grazing).

Rocky grounds

They are ecosystems made out of large blocks of rocks resulting from orogenic folding and subsequent erosion. They include scree, canyons, ravines, gorges and defiles. These rocky zones are practically bare with no plants except for lichens and are often chosen by birds to build their nests.

Macaronesian ecosystems

They are local to the Canary Islands. Apart from their insularity, they are characterised by their climate, particularly by the prevailing winds (trade winds) and ocean currents. This ecosystem also include the semi-arid systems, volcanoes and lava flows, beaches and dunes, ravines, heaths, pine forests, laburnum groves and the laurel forest, which is typical of the Canary Islands.

Steppe

This ecosystem is created by the anthropic transformation of the continental Mediterranean forest. It is characterised by the prevalence of short woody species, growing in very poor soils, often with high levels of salinity, which can thrive in a semi-arid Mediterranean climate. On the Iberian peninsula, they are found in the Ebro valley (Monegros, Bardenas), as well as on the vast cereal-growing plains of Andalusia (Hoyas de Guadix and Baza), Extremadura (La Serena and Alcudia), Castilla-La Mancha and on the moorlands of the province of Burgos and of the Central and Iberian mountain ranges.

Agro-systems

It is an ecosystem modified and managed by human beings in order to obtain food, fibres and other biotic materials. In other words, they are sowed surfaces or multi-annual or annual woody or herbaceous plantations that require significant human involvement. This ecosystem includes both traditional agriculture and its new versions (ecological, organic, etc.) and industrial and conventional agriculture.

Marine

These ecosystems include the seas and oceans in their entirety beyond the continental or coastal shelf.

Coastal

This heading includes ecosystems that are located in a transition strip between the areas that come under the marine and continental headings. There is a continental coastal zone influenced by the presence of the sea, and a marine coastal zone that would be partly the space submerged by the waters of the sea and influenced by the proximity to the continent; both are separated by the coastline (contact lines between the land and sea). Deltas are also included here.

Wetlands

The zones of the earth's surface that are temporary or permanently flooded make up this ecosystem. It includes bodies of waters that are lakes, lagoons, pools, etc. and also the coastal wetlands, which are differentiated from the former by the salinity of their water.

Rivers and riverbanks

It is an ecosystem that is always present wherever there is a permanent runoff of water. It includes the riverbed, the alluvial plain on either side, with its strip of riverbank vegetation and the alluvial aquifer.

Underground aquifers

Ecosystem associated to the dynamics of underground water, which limited by impermeable rocks, is accumulated in very fractured or porous geological formations. It is an abundant ecosystem in the Peninsula, as there are 700 bodies of underground water that extend under the subsoil of 70% of the territory.

Urban

This ecosystem is made up of the urbanised environments with high human population densities, in other words, the spaces occupied by medium-sized and large cities that can, furthermore, have traces of nature.

5.2. Most acclaimed services in each ecosystem

Once the ecosystems to be assessed were established, the following tables were produced that help to identify the main or most characteristic services of each ecosystem. **https://maps.gstatic.com/mapfiles/mapcontrols3d7.png**

Table 5 lists the 15 most representative Iberian ecosystems and the 22 ESs referred to in the "Classification of the Ecosystemic Services" section of this document. Table 5 also reflects the relevance of the ESs in each of those ecosystems: thus, number 1 indicates that that service is priority, number 2 that it is secondary and the empty cell indicates that that ecosystem does not provide that service or that its provision is negligible. The main studies in the subjects were reviewed and rounded off with expert criteria in order to prepare the table. It should be noted that the table sets out the services that each ecosystem could provide, even though each assessment case should have its specific reflection or analysis as there may be different uses and geographical nuances regarding that table, that determine whether or not an ecosystemic service is allocated to a specific environment.

Two examples: even though it is possible that high mountain grazing land provides the medicinal resources services, not all the pasture land will do so. The same occurs in the agri-systems: even though the reference table reflects that they provide the waste treatment services (by means of the soil bacteria, sedimentation or adherence processes), this service is not only not offered by this ecosystem where the production involves intensive application of pesticides and chemical fertilizers, but could have quite the opposite effect and pollute the water.

Table 5. Importance of the ecosystemic services in the ecosystems considered (Iberian & Macaroneisan)

ECOSYSTEMIC SERVICES		ECOSYSTEMS														
		Atlantic forest	Mediterranean forest	Forestry plantations	Thicket	High altitude grazing land	Rocky outcrops	Macaronesian Ecosystems	Steppe	Agro-systems	Marine	Coastal	Wetlands	Underground Aquifers	Rivers and riverbanks	Urban
Provisioning	Food	2	2	2	2	2		2	2	1	1	1	2		2	
	Fresh water	2	2	2	2	2		2				2	1	1	1	
	Raw materials	2	2	1	2	2	1	2	2		2	2			2	
	Genetic resources	1	1		1	1	2	1	1	2	1	1	1		1	
	Medicinal resources	2	1	2	1	2	2	1	1		1	2	2	1	2	
	Resources ornamental	2	2	2	2	2	2	2	2		2	2			2	
Regulating	Air quality	1	1	1	1	2		1	2	1	1	2	2		2	
	Climate regulating	1	1	1	2	2		2		2	1	2	1		2	1
	Moderation of extreme events	1	1	1	1			1				2	1	1	1	1
	Regulating the water cycle	1	1	1	1	2		1	2				1	1	1	1
	Waste treatment	2	2	2	2	2		2	2	2	1	2	1		1	
	Prevention of erosion	1	1	1	1	1		1		2		2	2		1	
	Soil fertility	1	1		1	1		1	2	2	2	2	2		2	
	Pollination	2	1		1	2		2	2	2					2	
	Biological control	2	2		2	2	2	2			2	2	2		2	2
Habitat	Maintenance of the lifecycle of migratory species				1						2	1	1		2	
	Conserving the genetic variability	1	1		1	1	1	1	1		1	1	1		1	
Culture	Aesthetic appreciation	1	1	2	2	2	1	1	2	2	1	1	1	2	1	2
	Tourist and recreational activities	1	1	2	2	2	1	1	2	2	1	1	1	2	1	1
	Inspiration for culture, art and design	1	1	2	2	2	1	2	2	1	1	1	2		1	1
	Religious and spiritual appreciation	1	1				1	1			1	1	2		2	1
	Information for cognitive development	1	1	1	2	2	2	1	2	2	1	1	1	2	1	2

Very important (1). Secondary (2). This service is not provided or its provision is typically negligible (empty cell)

Table 6. Percentage of studies selected by the TEEB which considers each ecosystemic service in each biome

ECOSYSTEMIC SERVICES		BIOMES									
		Marine n=10	Coral reefs n=104	Coastal systems n=38	Coastal wetlands n=114	Inland wetlands n=92	Rivers and lakes n=16	Tropical forest n=142	Temperate forest n=47	Undergrowth n=24	Pastureland n=28
Provisioning	Food	20.00	21.15	36.84	10.53	17.39	18.75	16.90	10.64	16.67	10.71
	Fresh water			2.63	2.63	6.52	12.50	2.11	6.38		14.29
	Raw materials	10.00	5.77	13.16	15.79	13.04	6.25	19.01	10.64	33.33	7.14
	Genetic resources		0.96			1.09		2.82	2.13		3.57
	Medicinal resources				1.75	1.09		3.52	4.26		
	Ornamental resources		4.81			1.09				4.17	
Regulating	Air quality				0.88			1.41	2.13	4.17	3.57
	Climate regulating	20.00	0.96		5.26	5.43	6.25	7.04	17.02	8.33	17.86
	Moderation of extreme events		12.50	2.63	11.40	7.61		2.82	2.13		
	Regulating the water cycle					4.35		2.82	4.26		
	Waste treatment		1.92		3.51	9.78	12.50	4.23	8.51	16.67	10.71
	Erosion prevention		0.96		2.63	1.09		7.75	2.13	4.17	7.14
	Soil fertility	10.00		10.53	0.88	5.43	6.25	2.11			3.57
	Pollination					1.09		2.11	2.13		
	Biological control	20.00	1.92	2.63		1.09		0.70	2.13		
Habitat	Maintaining the lifecycles of migratory species			5.26	28.95	2.17		0.70		4.17	
	Maintenance of genetic diversity	10.00	7.69	2.63	4.39	7.61	6.25	9.15	14.89	4.17	10.71
Culture	Aesthetic appreciation		11.54	2.63		2.17				4.17	
	Tourist and recreational activities	10.00	29.81	18.42	11.40	9.78	31.25	14.79	8.51		10.71
	Inspiration for culture, art and design					2.17			2.13		
	Religious and spiritual appreciation										
	Information for cognitive development			2.63							

Table 7. Percentage of monetary valuation studies of ecosystemic services validated by the applicable to the ecosystems considered

ECOSYSTEMIC SERVICES		Marine n=6	Coastal systems n=25	Coastal wetlands n=29	Inland wetlands n=80	Rivers and lakes n=18	Deciduous temperate forest n=4	Conifer / Boreal forest n=13	Undergrowth and scrubland n=17	Pastureland n=9	Crops n=33	Urban n=3
Provisioning	Food	16.67	4	6.90	15.00	11.11		15.38		11.11	18.18	0.00
	Fresh water		4.00	6.90	6.25	16.67	25.00	7.69		33.33	6.06	0.00
	Raw materials		12.00	3.45	13.75	5.56		7.69	35.29	11.11	9.09	0.00
	Genetic resources				1.25							0.00
	Medicinal resources				1.25			7.69	23.53			0.00
	Ornamental resources				1.25							0.00
Regulating	Air quality										6.06	0.00
	Climate regulating	16.67		6.90	6.25	5.56		30.77	5.88		9.09	33.33
	Moderation of extreme events		4.00	20.69	7.50	5.56						0.00
	Regulating the water cycle				5.00							33.33
	Waste treatment			10.34	1	11.11	25.00	7.69	5.88		9.09	0.00
	Erosion prevention				1.25					22.22	6.06	0.00
	Soil fertility	16.67			3.75	5.56					9.09	0.00
	Pollination				1.25		25.00				3.03	0.00
	Biological control	16.67			1.25			7.69			3.03	0.00
Habitat	Maintaining the lifecycles of migratory species		8.00	20.69	1.25							0.00
	Maintenance of genetic diversity	16.67	4.00	3.45	1	5.56	25.00	7.69	17.65	11.11	12.12	0.00
Culture	Aesthetic appreciation				2.50				5.88			0.00
	Tourist and recreational activities	16.67	24.00	20.69	8.75	33.33		7.69	5.88	11.11	9.09	33.33
	Inspiration for culture, art and design				2.50							0.00
	Religious and spiritual appreciation											0.00
	Information for cognitive development		4.00									0.00

Table 8. Percentage of monetary valuation studies of ecosystemic services selected and not selected by the TEEB, applicable to the ecosystems considered

ECOSYSTEMIC SERVICES		Marine n = 24	Coastal systems n = 42	Coastal wetlands n=76	Inland wetlands n=199	Rivers and lakes n=36	Deciduous temperate forest n=34	Conifer / Boreal forest n=20	Undergrowth and scrubland n=17	Pastureland n=22	Crops n=33	Urban n=3
Provisioning	Food	25.00	38.10	13.16	20.60	5.56		1		4.55	18.18	
	Fresh water		2.38	3.95	8.04	33.33	8.82	5.00		13.64	6.06	
	Raw materials	4.17	7.14	7.89	18.09	2.78		5.00	35.29	9.09	9.09	
	Genetic resources			1.32	0.50		2.94					
	Medicinal resources				2.51			5.00	23.53			
	Ornamental resources				0.50							
Regulating	Air quality										6.06	
	Climate regulating	12.50		5.26	5.03	5.56	8.82	45.00	5.88	18.18	9.09	33.33
	Moderation of extreme events	4.17	4.76	18.42	6.53	2.78						
	Regulating the water cycle				2.51					4.55		33.33
	Waste treatment			10.53	9.05	8.33	5.88	5.00	5.88	4.55	9.09	
	Erosion prevention		2.38	1.32	1.01	2.78	5.88			18.18	6.06	
	Soil fertility	12.50	2.38	2.63	2.01	2.78	5.88			4.55	9.09	
	Pollination				0.50		2.94			4.55	3.03	
	Biological control	4.17	7.14		0.50	2.78	2.94	1		4.55	3.03	
Habitat	Maintaining the lifecycles of migratory species		7.14	7.89	1.01							
	Maintenance of genetic diversity	8.33	4.76	5.26	9.55	8.33	20.59	5.00	17.65	4.55	12.12	
Culture	Aesthetic appreciation	4.17			1.51				5.88	4.55		
	Tourist and recreational activities	25.00	16.67	22.37	9.55	25.00	32.35	1	5.88	4.55	9.09	33.33
	Inspiration for culture, art and design		2.38		1.01							
	Religious and spiritual appreciation		2.38									
	Information for cognitive development		2.38				2.94					

A complementary approach consists of determining **which services are those that have been mainly valued in each ecosystem**. The data used to produce Tables 6, 7 and 8, which are set out below, are from the database of the TEEB study that reviewed over 1000 valuation studies (see page with TEEB Box) and contain the number of studies conducted for each service: Table 6 refers to the studies conducted for each biome of the world and Tables 7 and 8 reflect the studies applicable in Spain. The difference between them is that in Table 6 only those studies of the ones validated by the TEEB Report are considered that are of sufficient quality (data of origin, traceability, specifications, etc.). While Table 7 includes all the reports included in the TEEB database, both those that are considered that had sufficient quality and those that did not.

It is important to ascertain that even though the importance of each ecosystemic service in a specific place is not correlated with the study percentage performed for the service, this is informative of its importance and will therefore help to identify the services and their most common application as it tends to assess the services that provide most benefits to man. Therefore, this approach helps to determine which services should be considered in each ecosystem, those that have mainly been valued, even though the fact that a service has not been considered in previous studies does not mean that it is not provided.

6. HOW CAN I ASSESS MY ECOSYSTEMIC SERVICES?

For several decades, different techniques have been developed to calculate the non-market value of environmental assets, some based on market information that are indirectly related to the service (**revealed preference methods**) and others based on simulated markets (**declared preference methods**). Consequently, the measurement methods to be used vary according to what we are measuring. The valuation of all the services in a common metric unit is one of the main advantages TEV, as it avoids the duplicity of using monetary values for some services and non-monetary ones for others. Allocating an economic value to the benefits and services of ecosystems and to biodiversity is useful when assessing the current value of an ecosystem and to decide the convenience of the different management options or to use their resources in either way. Therefore, **there are consolidated practices for companies to proceed to assess the ecosystemic services**.

6.1. Main economic valuation methods

Even though there are multiple methods for the economic valuation, the most commonly used one when performing economic valuations are a handful for them. A review of the bibliography and the most extensive database available (TEEB Database), which has over 1300 values for different **services performed** using different valuation techniques, allows the most common to be determined. Thus, the market price method is the one used to the greatest extent, in 56% of studies, in order to value the provision services. As regards the **regulating services**, benefits transfer is one of the main methods, used in 45% of the studies. Finally, with respect to the **cultural and habitat services**, benefits transfer is also one of the main methods, with this method accounting for 37% and 39% of the total studies, respectively.

As can be seen in Table 8, seven methods account for nearly 90% of the methods used to assess the different services in the studies analyzed. The most frequently used methods and which will be considered in greater detail are:

1. Benefits transfer.
2. Market prices.
3. Cost avoided, replacement cost and substitution cost.
4. Travel cost.
5. Hedonic pricing.
6. Contingent valuation.
7. Election experiments.

What does each method consist of? The above are outlined below. Further details can be found in the relevant section of this guide where they are all explained in detail and references are given for further information.

Benefits transfer

Benefits transfer consists of estimating the economic value of a commodity or service of the ecosystems by transferring the economic value calculated in another zone. It is important to note that an economic value is transferred in space and in time for a similar ecosystemic service or commodity, but in a location whose socio-economic circumstances vary with respect to the original, and it is therefore an approximation. For example, the benefits of angling of a zone in question may be estimated by adapting the angling values obtained in a study performed in another zone with similar characteristics.

Market prices

It is a method that uses the current prices of goods and services sold on international and national markets. The market price method can be used to assess changes both to the quality and to the quantity of a commodity or service. This method uses the standard economic techniques to measure the market commodity benefits based on the amount that amount that people demand at different prices and the quantity that is supplied at different prices.

Cost avoided, replacement cost and substitution cost

Those methods are based on estimating costs and do not provide strict economic value measurements; in other words, they are not based on the intention that individuals take to pay for a product or service. The fundamental idea is to assume that if society or companies incur costs to avoid damages from lost ecosystemic services or to replace the services of the ecosystems, those services must be worth at least what is paid to replace them. Those methods are the most appropriate in cases where the actions and costs to avoid the damage or to replace the services have already been carried out, or there is an undertaking.

- **COST AVOIDED:** method that estimates the value of a certain service of an ecosystem based on estimating the value of the damage that would be incurred if this service is not provided by the ecosystem. For example: the value of the flood control service may be derived from the estimated damage if the flood occurred.
- **REPLACEMENT COST:** this method estimates the value of a certain service of an ecosystem using the cost that would be incurred to recover or establish the service that that commodity was providing by means of restoring the initial conditions of the ecosystem. In other words, once environmental damage has occurred, it is estimated how it could return to the initial state and the cost involved. For example, the value of the erosion control service of a forest may be measured by means of the cost that would be incurred to eliminate or remove the eroded sediment from the area.
- **SUBSTITUTION COST:** the value is estimated in this case of a certain service of an ecosystem by means of the cost of providing substitute services. For example, the value of the service to purify the water of a wetland that has been damaged can be obtained using the cost incurred to provide water to a population, i.e., cost of filtering and chemical treatment of the water.

Travel cost

It consists of estimating the willingness to pay for the environmental benefits in a given place using information about the money and the time that visitors use to reach it. It is one of the most used methods to assess tourist goods and services or scenic resources.

This method is based on the idea that even though the entry price to a space of natural interest is zero, the access cost is generally higher than the amount the visitor incurs to visit it.

Hedonic pricing

It consists of determining the implicit prices of the different characteristics of a property and which determine its value. The underlying idea is that people acquire certain goods on the market that have different characteristics or attributes (one of which can be the environmental quality) which cannot be sold or purchased separately, as there are no markets for them. Therefore, it is about estimating the implicit prices of those attributes or characteristics that mark the difference between the prices of a same asset. In the context of environmental valuation this method aims to identify those environmental attributes or characteristics of an asset that make up its market price. Regression techniques are used to measure the desire to pay for those environmental aspects of the assessed asset and its contribution to the global market value is estimated.

Contingent valuation

This method simulates a market and the demand for a hypothetical change in the provision of the ecosystemic services that are being valued by means of surveys. The questionnaire is used to determine how much people would be willing to pay to increase or improve the provision of this commodity or service, or alternatively, how much they would be willing to accept for its loss or degradation, assuming that that value is related to the value of the service.

Election experiments

In the same way as the contingent valuation method, the election experiments use surveys to simulate a market and the demand for a hypothetical change in the provision of ecosystemtic services that the individuals are rating. However, in this case and unlike the contingent valuation method where the aim is to assess a specific scenario, this method allows different attributes or characteristics of environmental assets to be valued. Therefore, more than one variation in the quality or quantity of an asset is included. Using this questionnaire, the individuals are asked about their preferences regarding different alternatives, including an option where the current status or "status quo" of each of the attributes is considered. As it is focused on the exchange or tradeoff between scenarios with different characteristics, this method is particularly appropriate for social perception and political decision making, where a set of possible actions could result in different impacts on ecosystemic services or natural resources.

6.2. Most used methods by ecosystemic service

An analysis was carried out using the available databases to establish which the most used methods are for each service in order to guide and contrast the choice of methods to assess the Ecosystemic Services selected. Table 8 shows both the percentage relating to the number of studies conducted with each of the above methods with respect to the total studies and the number of individual and global studies (last column) conducted for each service. For example, we can see the benefits transfer method within the provisioning services. The table indicates that 26% of the studies have been conducted using this method. Furthermore, while the **valuation** of raw materials (30 studies) is the service where this method has been used to the greatest extent in absolute terms, the most used in percentage terms is genetic resources (benefits transfer was used in 56% of the studies conducted to assess this service). This information provides guidelines to determine which methods could be used to assess the services that we have selected and/or compared to establish how appropriate the method is.

Table 8. Number of studies and percentage according to the method used in terms of the total number of studies conducted for different types of service

	BT	MP	CA, RC and SC	TC	HP	CV	EE	Studies Total
PROVISIONING								
Food (number of studies*)	43	137	4		1	2		210
Number*/Total studies	20%	65%	2%		0.5%	1%		
Water (number of studies*)	18	9	9					53
Number*/Total studies	34%	17%	17%					
Raw materials (number of studies*)	53	113	1			2		175
Number*/Total studies	30%	65%	1%			1%		
Genetic resources (number of studies*)	7	5						12
Number*/Total studies	58%	42%						
Medicinal resources (number of studies*)	9	10				2		40
Number*/Total studies	23%	25%				5%		
Ornamental resources (number of studies*)		7						8
Number*/Total studies		88%						
Total per method (number of studies*)	130	281	14	0	1	6	0	498
Number*/Total studies	26%	56%	3%	0%	0%	1%	0%	87%
	BT	MP	CA, RC and SC	TC	HP	CV	EE	Studies Total
REGULATING								
Regulating the air quality (number of studies*)	5	1	2					8
Number*/Total studies	63%	13%	25%					
Climate regulating (number of studies*)	46	18	21			2		88
Number*/Total studies	52%	20%	24%			2%		
Moderation of extreme events studies*)	20	3	42			4		70
Number*/Total studies	29%	4%	60%			6%		
Regulating water flows/hydrological systems (number of studies*)	6	1	2					12
Number*/Total studies	50%	8%	17%					
Water purification/detoxing and waste treatmen/ pollution control (number of studies*)	30	3	28			1		65
Number*/Total studies	46%	5%	43%			2%		
Erosion prevention (number of studies*)	11	5	18			1		38
Number*/Total studies	29%	13%	47%			3%		
Conservation / soil fertility (number of studies*)	18	3	9					31
Number*/Total studies	58%	10%	29%					
Pollinating (number of studies*)	5	3						9
Number*/Total studies	56%	33%						
Biological control (number of studies*)	10	3						15
Number*/Total studies	67%	20%						
Total per method (number of studies*)	151	40	122	0	0	8	0	336
Number*/Total studies	45%	12%	36%	0%	0%	2%	0%	96%

	BT	MP	CA, RC and SC	TC	HP	CV	EE	Studies Total
HABITAT								
Biodiversity and "nursery" service (number of studies*)	2	16	2			1	1	33
Number*/Total studies	6%	48%	6%			3%	3%	
Protection of the gene pool/protection of species in danger of extinction (number of studies*)	47	3	2			35		100
Number*/Total studies	47%	3%	2%			35%		
Total per method (number of studies*)	49	18	4	0	0	36	1	133
Number*/Total studies	37%	14%	3%	0%	0%	27%	1%	81%
	BT	**MP**	**CA, RC and SC**	**TC**	**HP**	**CV**	**EE**	**Studies Total**
CULTURAL								
Aesthetics (number of studies*)	2	2			4	4		12
Number*/Total studies	17%	17%			33%	33%		
Tourism and recreation/ecotourism (number of studies*)	67	46		18	1	32		173
Number*/Total studies	39%	27%		10%	1%	18%		
Educational (number of studies*)	3	6		1				12
Number*/Total studies	25%	50%		8%				
Artistic and spiritual inspiration (number of studies*)	4	1				3		8
Number*/Total studies	50%	13%				38%		
Cutural heritage and identity (number of studies*)	9	1				1		11
Number*/Total studies	82%	9%				9%		
Total per method (number of studies*)	85	56	0	19	5	40	0	216
Number*/Total studies	39%	26%	0%	9%	2%	19%	0%	95%

Source: Own production using the studies included in the TEEB (2012): BT= benefits transfer; MP= market prices; CA= costs avoided; TC= travel cost; HP=Hedonic pricing; CV= Contingent valuation; EE= Election experiments.

7. MAIN EVALUATION METHODS STEP BY STEP

7.1. Benefits transfer

What is it?

Benefits transfer consists of estimating the economic value of a commodity or service of the ecosystems by transferring the economic value calculated in another zone. Thus, the value of a commodity calculated in Zone A (where the original valuation study was conducted) is transferred and adapted to the characteristics of Zone B (where the aim is to estimate the value of this commodity or service). It is important to note that an economic value is transferred in space and in time for a similar ecosystemic service or commodity, but in a location whose socio-economic circumstances vary with respect to the original, and it is therefore an approximation. For example, the benefits of angling of a specific zone may be estimated by adapting the angling values obtained in a study performed in another zone with similar characteristics.

In practice, there are different approaches when conducting a benefits transfer exercise. These approaches differ in the degree of complexity when carrying them out, in the data requirements and in the reliability of the results. The main approaches are:

1. **TRANSFER OF AVERAGE UNIT VALUES WITHOUT ADJUSTING:** an average unit value obtained in the original study is selected and is transferred to the specific case.

   ORIGINAL UNIT VALUE (for example, €/individual/year by the use in a recreational area in Catalonia) = **TARGET UNIT VALUE** (for example, €/individual/year for the use of a recreational area in San Sebastián).

2. **ADJUSTED AVERAGE UNIT VALUE TRANSFER:** an average unit value obtained in the original study is selection and transferred to the specific case taking into account the possible differences existing between both cases (for example, different populations, income, currency, etc.).

   ORIGINAL UNIT VALUE (for example, €/individual/year for the use of an urban leisure area in Catalonia) = **ADJUSTMENT FACTOR** (for example, per capita income in San Sebastián /(per capita income in Catalonia) x **TARGET UNIT VALUE** (for example, €/individual/year for the use of a rural leisure area near to San Sebastián).

3. **TRANSFER OF THE VALUE FUNCTION:** the value function calculation is transferred that contains one or more explicative variables observable both in the study and in the application place.

   FACTORS THAT DETERMINE THE VALUE OF THE ORIGINAL COMMODITY OR SERVICE (for example, €/individual/ year use of an urban leisure area in Catalonia is the function of a series of factors, such as size of the surface area, number of nearby leisure areas, population affected, etc.) = **FACTORS THAT DETERMINE THE VALUE OF THE ORIGINAL COMMODITY OR SERVICE** (for example, €/individual/ year use of a rural leisure area near to San Sebastián is the function of a series of factors, such as size of the surface area, number of nearby leisure areas, population affected, etc.).

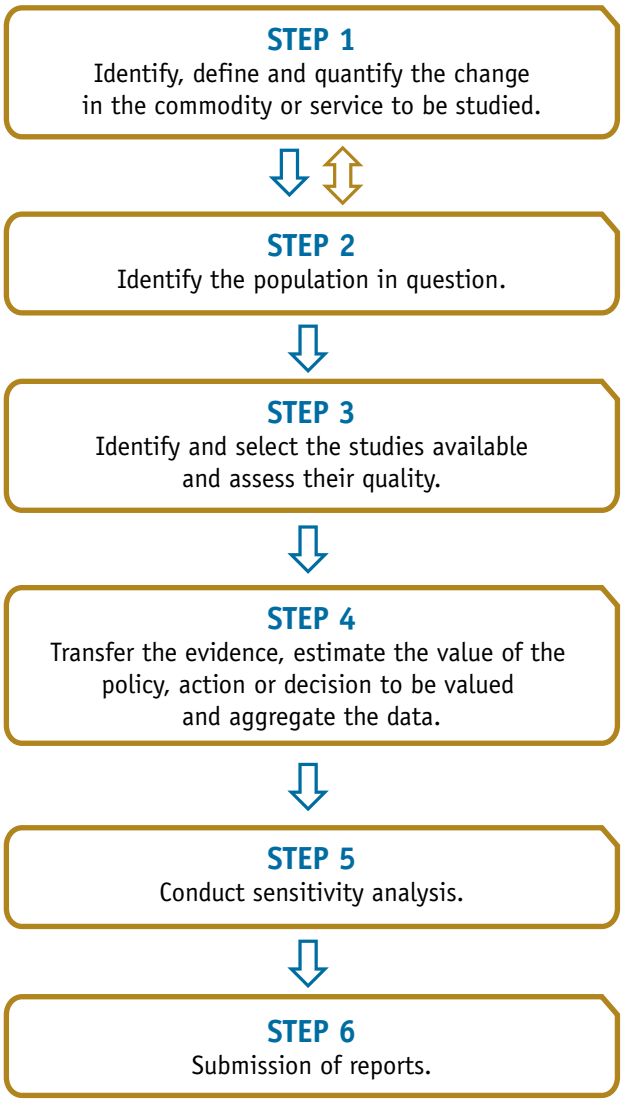
Strengths

- **RAPID:** it enables an initial estimate of the value of the commodity or service to decide whether it is worthwhile to conduct a more in-depth study, above all the transfer of average adjusted values (see ii in the previous section).
- **ECONOMIC:** the benefits transfer is more economic and, usually requires less time, than when carrying out an original study.
- **EASY:** a large amount of data and prior information is not required for some goods and services.
- **IT ENABLES AN ASSESSMENT OF THE QUALITY OF THE RESULTS:** given that the studies used for obtain the data are already done, this enables us to assess their quality and select based on that. To the contrary, if the decision is make to conduct a specific study in the place of application, the quality of the study is unknown beforehand, and only when the study is completed can it be valued, with the risk that the cost and that the results are not good.
- **APPROPRIATE FOR RECREATIONAL VALUES:** recreational values can be easily and rapidly estimated using this method, as it is more likely to find studies with similar recreational experiences and sites.

Weaknesses

- **THE GOODS HAVE TO BE COMPARABLE:** it is often difficult to ensure that the goods and services in Zone A (original zone) and Zone B (target zone) are comparable.
- **THE CONTEXT MUST BE SIMILAR:** the socio-economic context of the areas between which the transfer takes place must also be compatible. The benefits transfer between North and South countries and even between regions with very different realities may provide unreal results.
- **DIFFICULTY TO FIND PREVIOUS STUDIES**: Difficulty to find original studies that are adjusted to the characteristics of the valuation to be conducted, or which are adaptable to it, and even difficulty to access or interpret the results with studies in other languages.
- **DIFFICULTY TO TRANSFER CULTURAL OR INTANGIBLE VALUES:** In the cases where the valued asset is intangible or linked to the cultural values of the community, the transfer is particularly difficult and/or tenuous.
- **LACK OF KNOWLEDGE OF THE TRANSFER ERROR:** The **transfer error, the difference between the value estimated by means of the transfer and the value obtained by means of an "in situ"** specific study may be very high.
- **DEPENDENCY ON THE QUALITY OF THE ORIGINAL STUDY:** The estimates can only be as precise as the results are of the original or primary study that is used as the source for the values that are going to be transferred.

Steps to be followed



The steps to be followed are:

- **STEP 1:** Identify the goods or services that are to be valued and estimate their dimension or quantity importance, or the changes that occur in the commodity or service as the result of the action to be carried out.
- **STEP 2:** Identify the human population affected by the commodity or service in the zone to which we want to transfer the values of the original study. The values of the study will be corrected according to the characteristics of that population.
- **STEP 3:** Identify the existing studies or values that can be used to transfer them to our case study, and decide if the values that exist are transferrable. Some of the considerations that we have to take into account are: appropriately identifying the commodity or the change in the service that has been valued in the original study, the commodity or the change that we want to assess, the target population, etc. Some of the possible questions that can be raised are set out below:

1. Is the commodity or service to be valued comparable with the commodity or service valued in the existing studies? Some factors that determine this are: similarity of place (e.g. fluvial beaches), similarity of the quality (water quality, access facilities, etc.) and similarity of the existence of substitutes (number of nearby fluvial beaches).
2. Are the characteristics of the relevant population comparable between the target zone and the zone where the original study was carried out? If that is not the case, is information available that allows me to make adjustments? The information required depends on the context in which we operate, but it can be related to variables such as the revenue (GDP per capita) or the population density. The following step will explain this in further detail.

In this step, the assessment needs to be carried out of the quality of the studies that will be used to transfer the values. As has been previously mentioned, the better the quality of the original studies is, the more precise and useful the transferred values will be. This requires a professional judgement and prior knowledge of the methodology used in the original study (contingent valuation, opportunity cost, etc.). A guide on the factors that could indicate the quality and validity of the study according to the method used is included later among the resources selected. Some of the factors that should be taken into account (regardless of the method used) are:

- Has the original study undergone an external review? Where was it published? Which method was used? Is this method based on economic theory?
- The economic value estimates often involve some uncertainty. Therefore, the use of statistical resources such as confidence intervals[1] and standard deviations[2] are necessary to present the economic values and estimate the associated uncertainty.
- If the results presented in the original study are values related to the future, it is necessary to know if they are current[3] and which discount rating has been applied.
- In many cases, the values are obtained using survey-based methods that are aimed at estimating the representative values of a population. In this case, the fundamental aspects to be taken into account are target population, type of sampling, size of the sample, etc. It is also necessary to answer another type of questions such as: Were focus groups used? Was a pilot study conducted before applying the survey? Is the non-response ratio known[4], and how is this point controlled?

- **STEP 4:** adjust the existing values to better reflect the values for the site in question, using all the available and relevant information. Complementary data may need to be gathered. For example, use economic (GDP or per capita income), demographic (population density) etc. data to adjust the different target populations affected by the commodity or service being valued. Adjust the values between countries (for example, if a study is in dollars and we want to express it in euros, we should use the exchange rate adjusted by the purchasing power parity, that indicates to us the real purchasing capacity of the salaries in a country).

- **STEP 5:** the analysis must be subject to sensitivity tests. The transfer error should be calculated. The transfer error is defined as the difference percentage between the estimate or value obtained with

[1] **Confidence interval:** pair of numbers between which it is estimated what will be the economic valuation with a certain success probability.

[2] **Standard deviation:** measure that indicates the mean of the distances that have the different data or values regarding their arithmetical mean. It is expressed in the same units as the variable.

[3] **Discounted values:** Result of discounting future quantities of the present quantity, using a certain discount rate. This discount rate reflects the interest rates of the money and the risk element existing in the operation.

[4] **No-response ratio:** [Number of people who do not answer the survey/Total number of people contacted to conduct the survey (adding together of those who answer and who do not answer)] x 100.

the transfer (the transferred willingness to pay WTP_t) and the estimate or valuation performed in the primary site or original study (primary willingness to pay p) WTP, that is:

$$TE = \left(\frac{(WTP_t - WTP_p)}{WTP_p} \right) \times 100$$

The values currently accepted in practice are in the range of 25% -40% [2].

- **STEP 6:** presentation of the results for decision making. Different transfer scenarios with the values resulting from using different studies as reference should be presented. In practice, the assessment does not generally follow a linear progression over the six steps. In particular, it is an iterative process, above all between steps 1 and 2.

Example of transferring adjusted average unit values

Let us take the example of a park with a lake. The park managers are considering creating a beach to improve the leisure opportunities of that park. Prior to making the investment, they need to know what the benefit or value of that improvement is, but there is no large budget to carry out an original study in depth. As the recreational values are relatively easy to transfer, the decision to taken to opt for benefits transfer.

Therefore and once what is to be valued has been defined, the leisure use of a beach at a lake, they will search for existing studies that can be used for that transfer. Suppose that several studies are found, but only one of them is in line with our case in terms of valued services and characteristics: beach at a lake, water quality, amenities, number of beaches located at nearby lakes, etc. Suppose that the characteristics of the populations are similar (in terms of density, they are both urban, etc.) And that the only differences are that the original study is from 2005, that it was conducted in an area of the USA and that the income of the target populations is different. Therefore, and once the quality of the study has been assessed as mentioned in Step 3, the existing values have to be adjusted using all the relevant and available information. Correcting inflation, carrying out the currency exchange (those two changes would be needed if the unadjusted average value transfer is to be carried out) and correcting the different income is required here.

Suppose that the original study reports a value of $10 per visitor in 2005.

In order to correct for inflation and express this value in 2012 USD, the US consumer price index (CPI)[5] can be used and the inflation factor calculated.

INFLATION FACTOR = (index value in the benchmark period - 2012) /
(value in the period of the original study - 2005)

Using the (fictitious) data on the CPI 2005=80 CPI 2012=110 of the United States, the inflation factor is = 110/80 = 1.375.

The 2005 $10 value is multiplied by the inflation factor and a value is obtained of: 2012 $13.75.

[5] It can also be carried out using the purchasing power parity (PPP). The next step is to perform the currency exchange using the rate adjusted by the purchasing power parity, now corrected by the CPI.

The 2012 dollars then need to be converted into 2012 euros. The exchange rate adjusted by the purchasing power parity (PPA)[6] is used. The currency conversions must be performed in the same year, i.e., from 2012 dollars to 2012 euros.

The calculation would be performed as follows:

TARGET VALUE OR WILLINGNESS TO PAY = (Original Value or Willingness to Pay x PPP of target zone in 2012) / (PPP of original study zone in 2012)

Suppose the following data:

Target zone PPP in 2012 = 0.719.

Original study zone PPP (United) in 2012 = 1.000.

In our case, $13.75 x 0.719 / 1.000 = €9.886 of 2012.

Finally, the value must be adjusted to the differences between the visitors of the different areas. Suppose that the visitors to each area are individuals from areas in the proximity of the park. Therefore, the per capital income of those zones (if available) should be established. In this case, the US average per capita income and the Spanish average per capita income (target zone) can be used. The adjustment would be performed as follows:

TARGET VALUE OR WILLINGNESS TO PAY = Correction Factor x Original Value or Willingness to Pay

Suppose that the 2012 per capita income in the USA is € 37,662 and that the Spanish per capita income is € 25,742. Therefore, the correction factor is 2012 Average Per Capita Income in Spain/2012 Average Per Capita Income in the USA = 25,742/37,662 = 0.6835.

Therefore, the Value or Willingness to Pay for the recreational use of the new beach is 0.6835 x € 9.89 = **€ 6.76 per visitor.**

Finally, the number of people who are going to use the beach would have to be estimated. This could be obtained by means of a survey of the visitors of the park, asking them if they would use a beach at the lake and how many times they would use it or using the number of visitors and the seasonality. Suppose that there will be 400 visits per day.

Therefore, the total value would be 400 visits x €6.76 per visitor = € 2,704 per day.

The transfer error then needs to be calculated. As per the equation set out above, the TE = [(€ 6.76 - € 9.89)/€ 9.89] x 100 = -31.64%, which would be within the aforementioned range. The TE is interpreted in absolute terms.

In some cases, it is possible to use certain hypotheses to estimate a margin of error in the estimates. For example, suppose that there is uncertainty as to whether the number of daily visitors to the park will be 400, and it is believed that that could vary between 350 and 400. A higher value and a lower value should then be estimated and this range presented in the final results.

[6] The exchange rate could also be used, even though it would be more appropriate to use the PPP in the previous case.

In our case:

400 visits x €6.76 per visitor = €2,704 per day HIGHER VALUE.

350 visits x €6.76 per visitor = €2,366 per day LOWER VALUE.

Practical example

Hushak, Leroy J. 1998. "Restoration of Saginaw Bay Wetlands," Case Study – Benefits Transfer, Great Lakes Environmental Valuation Project. Chapter 7 en el link: http://www.lakesuperiorstreams.org/stormwater/toolkit/policy/EconomicValueOfProtectingTheGreatLakes.pdf

"Restoration of Saginaw Bay, Michigan, Wetlands"

Case Study

The State of Michigan considered a series of plans to protect and restore the coastal wetlands along the south coast of Saginaw Bay. Therefore, the potential benefits of protecting and restoring the wetlands needed to be estimated. Therefore, a survey was conducted where the people were asked about their support for the restoring of the wetlands, but this survey did not include a valuation question that allowed a monetary value to be assigned. Therefore, the researchers used benefits transfer methods to estimate the value of protecting and restoring the wetlands of the Bay.

Original study

A valuation study for the protection of the wetlands and the proposal to restore the coastal wetlands of Lake Erie in Ohio were used. The researchers assumed that the Ohio estimated values were sufficiently similar to be able to be transferred to Michigan. The original study assessed similar programmes and amounts of wetlands to those proposed in Michigan. However, the coastal residents were not surveyed in this case. Therefore, the transfer of the values of the Ohio study for the Michigan coastal residents required the assumption that the residents of the coast have similar values to those of the residents of others areas of the drainage basin.

Aspects to be taken into account in the transfer

The original study established the value of the restored acre by dividing the total value obtained in the study by the 3,000 acres that were going to be restored. In the target study, the restoration proposal involves different actions, not just restoration. It also includes maintenance and improving the existing wetlands, along with a habitat restoration programme. Therefore, three alternatives are proposed to calculate the value per acre:

1. Divide by the new protected or restored acres: 3,500 in Saginaw and 3,000 in Ohio.
2. Divide by the new protected acres plus the restored acres: 7,500 in both cases.
3. Divide by the total acres of the project: 21,300 in Saginaw and 33,000 in Ohio.

Results

The value estimates of the Michigan wetlands, based on the Ohio study, were between $500 and $9000 per acre for the residents of the drainage basin, and between the $7,200 and the $61,000 per acre for the residents of the State of Michigan.

Resources

1. **Practical guides and application examples:**

- Department for Environment, Food and Rural Affairs (UK). 2009. Valuing Environmental Impacts: Practical Guidelines for the Use of Value Transfer in Policy and Project Appraisal- Value Transfer Guidelines. Practical guide on how to apply the benefits transfer.
  Link: http://archive.defra.gov.uk/environment/policy/natural-environ/using/valuation/documents/vt-guidelines.pdf
- SEPA, (2006): An instrument for assessing the quality of environmental valuation studies. Report, Swedish Environmental Protection Agency, Stockholm. Guide to assess the quality of the existing studies.
  Link: http://www.naturvardsverket.se/Documents/publikationer/620-1252-5.pdf
- Rosenberger, Randall S.; Loomis, John B. 2001. Benefit transfer of outdoor recreation use values: A technical document supporting the Forest Service Strategic Plan (2000 revision). Gen. Tech. Rep. RMRS-GTR-72. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Guide on the different benefits transfer which includes a bibliography of original studies on the recreational use values.
  Link: http://www.fs.fed.us/rm/pubs/rmrs_gtr072.pdf
- For further details of the application method, consult the following guide produced by the Danish Environmental Protection Agency: Danish Environmental Protection Agency (2007) Practical tools for value transfer in Denmark – guidelines and an example.
  Link: http://www2.mst.dk/udgiv/publications/2007/978-87-7052-656-2/pdf/978-87-7052-657-9.pdf

2. **Databases:**

- Environmental Valuation Reference Inventory (EVRI) (UK studies). www.evri.ca
- ENVALUE http://www.environment.nsw.gov.au/envalueapp/: is the main valuation study database of Australia. It covers over 400 studies, a third of which are Australian. It covers nine different environmental assets. It has not been updated since 2001.
- Valuation Study Database for Environmental Change in Sweden (ValueBaseSWE) http://www.beijer.kva.se/valuebase.htm: contains Swedish studies.
- Review of Externality Data (RED) http://www.isis-it.net/red/start_search.asp: contains a list of studies mainly related to environmental costs (from a lifecycle perspective) of the energy and other sectors. It mainly contains value transfer exercises rather than primary valuation studies.
- Benefits Table (BeTa) http://www.isis-it.net/red/start_search.asp: database produced by the environmental division of the European Commission that provides external costs (related to health and the environment) of air pollution.
- Natural Resource Conservation Service (NRCS), US Department of Agriculture, http://www.economics.nrcs.usda.gov/technical/recreate: it is a database and a list of unit values estimated for different recreational activities.
- National Oceanographic and Atmospheric Administration (NOAA) http://coastalsocioeconomics.noaa.gov/core/bibsbt/welcome.html: provides three databases and four lists of marine and coastal resources bibliography.

3. **Bibliography:**

[1] Pascual et al. 2012. *The Economcis of Valuing Ecosystem Services and Biodiversity. In The Economics of Ecosystems and Biodiversity*. Ed Pushpam Kumar. Routledge. Link: http://www.teebweb.org/EcologicalandEconomicFoundationDraftChapters/tabid/29426/Default.aspx.

[2] Ready, R., Navrud, S. 2006. *"International benefit transfer: Methods and validity tests"*, Ecological Economics 60, 429-434.

7.2. Market prices

What is it?

It is a method that uses the current prices of goods and services sold on international and national markets. The market price method can be used to assess changes both to the quality and to the quantity of a commodity or service. This method uses the standard economic techniques to measure the market commodity benefits based on the amount that amount that people demand at different prices and the amount that is supplied at different prices.

Market prices represent the value of a marginal or additional unit of the valued service or good, always assuming that the commodity or service is sold on a perfectly competitive market[7]. In order to apply this method, sufficient data and information are needed to calculate the **producer surplus (PS)** and the **consumer surplus (CS)**. When this is not possible, current market prices can be applied. Applications of each approach are described later.

Strengths

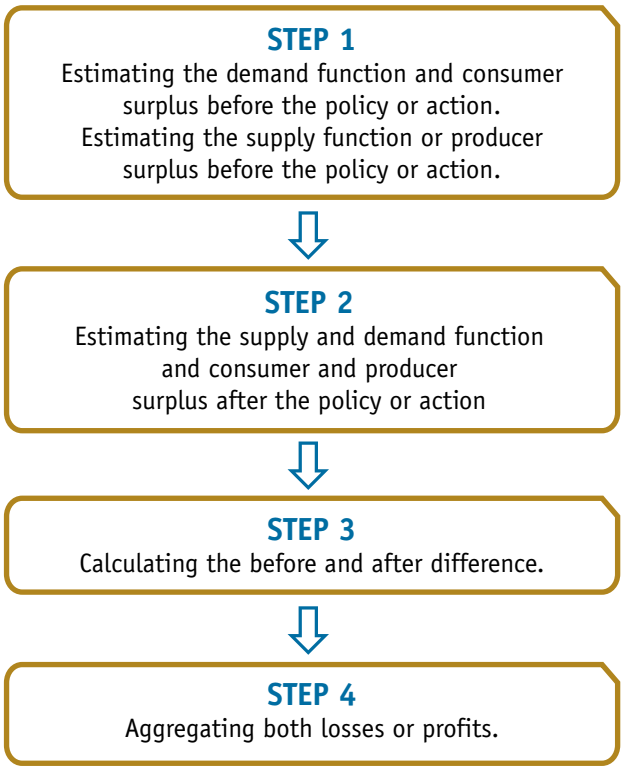
- **RELIABLE:** they faithfully reflect the willingness of people to pay for the goods and services that are traded on a market (for example, fish, timber, firewood, recreation, etc.).
- **VERSATILE:** they can be used to produce financial accounts in order to compare the alternative uses of the different ecosystems and the associated profits and losses.
- **ACCESSIBLE:** the data relating to the prices are relatively easy to obtain on the existing markets.
- **WIDELY ACCEPTED:** the method uses standard and accepted economic techniques.
- **CURRENT**: the method uses data on the current preferences of the consumers.

Weaknesses

- **BIASES:** Due to the existence of imperfections or failures of the market (existence of public assets, negative externalities, property rights, etc.), market prices can be biased and, therefore, may not reflect the accurate economic value of the goods and services for society overall.
- **PRICE SEASONALITY:** The seasonal fluctuations and other effects on the prices must be taken into account when using market prices in economic analysis.
- **UNDERVALUATION**: The market data could be solely available for a limited number of goods and services and could not reflect the value of all the productive uses of the resource.
- **PROBLEMS ASSOCIATED TO SCALE:** They may not be overly appropriate to measure the value of a large scale change that affects the demand or supply of the commodity or service.

[7] **Competitive market:** in economics, depending on the different conditions to be found on a market, different market types (monopoly, oligopoly, perfect competition, etc.) are identified. The competitive market or with low perfect competition conditions meet the following, among other, conditions: availability of full information, the products are uniform, and there are no taxes or subsidies.

Steps to be followed



The steps to be taken are as follows:

- **STEP 1:** the market data are used to calculate the **demand function** and the **consumer surplus (CS)**. The CS is the difference between the maximum amount of money that a consumer would be willing to pay for a certain amount of a commodity or service and what they really pay. The demand function needs to be estimated to calculate the CS. This requires time series data of the amount demanded at different prices, but other information on other factors that may affect demand, such as income or demographic data.

  In the cases involving a market commodity or service, the losses experienced by the producer also need to be estimated. The change in the producer surplus (**PS**) must therefore be calculated. The PS is the difference existing between the prices at which the producers are willing to sell their products and those that they receive in reality. To estimate the PS, information is needed on the variable costs[8] of production and profits from the sales over time.

  The **demand function** is a function that relates the quantity consumed with different characteristics, one of the main ones is the price of a unit of the commodity or service. If the demand function is represented on a graph where the price is shown on the vertical or abscissa axis and the quantity on the horizontal or ordinate axis, the slope is negative, as in the case of normal goods, the consumers look for cheaper substitutes when the prices increase and the rest remain constant.

$Q_d = f(P_b, P_s, R, ...)$ where

[8] They are those costs that vary when the volume of productive units is changed.

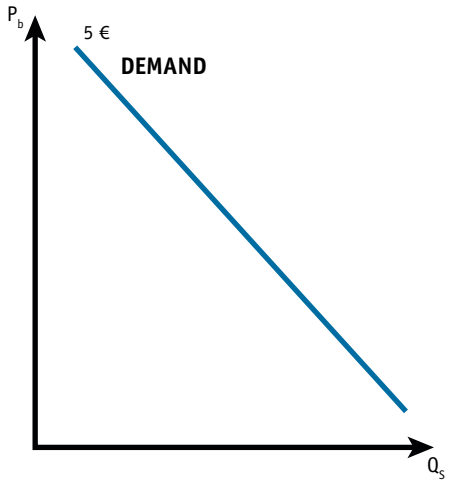


Figure 2: Demand function.

Q_d: is the quantity demanded of the commodity or service in question (for example, oak wood).

P_b: is the price of the commodity or service in question (for example price of the m^3 of oak wood).

P_s: is the price of the substitute good or service (for example, price of the m^3 of pine).

R: is the income of the consumer or individual.

On the other hand, the **supply function** relates the amount of a commodity that the producers are willing to sell at different prices, for a specific period. If the supply function is represented on a graph where the price is shown on the vertical or abscissa axis and the quantity on the horizontal or ordinate axis, the slope is positive, as in the case of normal goods, the producers would sell a larger amount of a commodity as the price per unit of each good increases, and the rest remaining constant.

$Q_s = f(P_b, w, r, \ldots)$ where

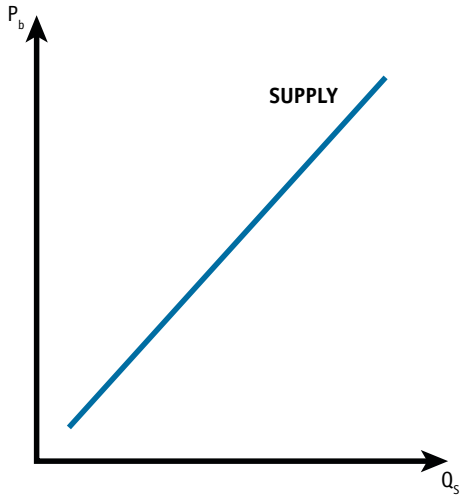


Figure 3: Supply function.

Q_s: is the quantity supplied of the commodity or service in question (for example, oak wood).

P_b: is the price of the commodity or service in question (for example price of the m^3 of oak wood).

w: cost of the work.

r: cost of the capital.

The CS (consumer surplus) is the area that remains between the demand curve of a person for a commodity or service, i.e., their willingness to pay for it, and the line that indicates the price of the commodity (the difference between what a person would be ready to pay and what they really pay for a commodity). It is indicated by the green area in the figure below. When this area is calculated, the measurement units are monetary units, i.e., euros, dollars, etc.

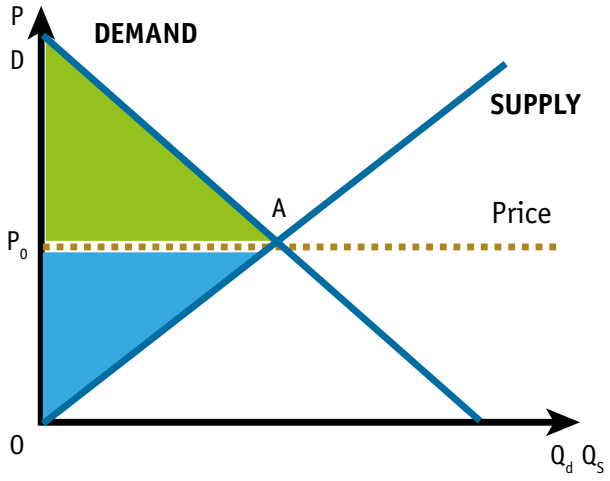


Figure 4: Producer and consumer surplus.

In Figure 4, the demand for the commodity is shown as a straight line with a negative slope, according to its price, the CS at Point A would be given by the areas of the AP_0D triangle.

The **PS** is the area between the price curve or line and the supply curve. It is the difference between what the producer would be willing to accept for each unit produced of a commodity (as a minimum) and what they really receive. In our figure, it would be represented by the blue area, i.e., the PS on Point A would be given by the area of the AP_00 triangle.

- **STEP 2:** estimating the market demand function and the CS **after the action** to be carried out. The PS must likewise be calculated **after the action**. This step estimates how the changes in the commodity or service will affect its price and therefore, the changes that will be involved in both surpluses.

- **STEP 3:** Estimating **the loss or benefit by means of the difference between both surpluses** (prior to the action and after the action). It consists of comparing the consumer and producer surpluses (CS and PS) before and after modifying the service to estimate what its impact is. By analysing the fluctuation in monetary units of the areas described in Figure 4.

- **STEP 4: Aggregating both losses or profits**. This step unifies the variations in both surpluses to obtain an estimate of the total variation in the profits.

In some case, the calculation of the PS and/or of the CS is complicated due to the lack of data that allows a correct supply and demand function to be determined. Some studies only perform the calculation on the demand function and the CS. While other carry out approximations using the variation of the final price and the quantities of the commodity or service before and after the change (See examples 2 and 3). In those cases, the steps to be followed are simplified are reduced to calculating the initial situation or before the change (Step 1), final or after the change (Step 2) and the variation arising from that change (Step 3 and 4).

Market price explanatory example

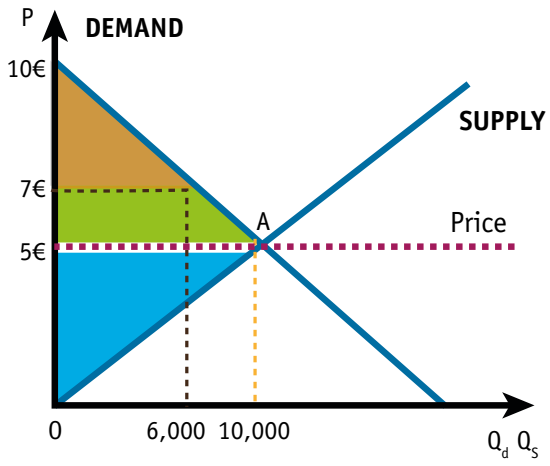
1. **Variation of the CS before and after a policy or action**

The aim is to measure the total economic surplus for the increase in pastureland, which would allow more cattle to be fed than the current number, on common land where different neighbours graze their livestock and subsequently sell it to enter the food chain. This will involve an investment by the manager of the common land, as both the area of pastureland will needed to be increased and the current means of production changed (greater investment in machinery, workforce, maintenance, etc.).

As has already been mentioned, the CS is measured by the maximum amount that the consumers are willing to pay for the commodity (in this case, kilogramme of beef), less what they effectively pay. The PS is likewise measured by means of the difference between the profits obtained by the sale of beef and the variable costs for obtaining that meat. Therefore, the difference must be calculated between the total economic surplus before and after carrying out the actions to increase the pastureland surface area and, therefore, beef production.

The first step uses market data (obtained from the company data, agricultural statistical data, etc.) and the market demand function, which indicates the price at which different quantities of this commodity are sold (the price of a kilogram of beef according to different amounts of beef). Therefore, a linear demand function is assumed where the initial market price is €7 per kilogram of meat and the maximum amount that they would be willing to pay would be €10 per kilogram. At a market price of €7 per kilogram, consumers would purchase 6,000 kilograms of beef, while they would not buy the meat if the price was €10/kg. When that data are shown on a graph, it can be seen which is the CS[9] (red area), which can be calculated.

The total spending a year at a price of 7€/kg comes to 42,000€/year (7€/kg x 6,000 kg/year). However, some individuals would be willing to pay over 7 €/kg and therefore, they receive a net economic profit for buying the meat (consumer surplus). This profit or total CS is (10€/kg-7€/kg)/2 x 6,000 kg/year = 9,000€[10].



[9] In this case, the CS can be calculated as the area of a triangle as the demand function is linear. If that were not the case, other more complex calculations have to be performed.

[10] Note that this expression corresponds to the formula of the area of a triangle: (Base x Height)/2.

The demand function and the consumer surplus after carrying out the action to increase production are then calculated. Suppose that after this increase in production has been achieved, the price of a kilogram of meat drops from €7 to €5 per kilogram, while demand rises to 10,000 kilograms (supposing that the demand function does not vary). In this scenario, the CS increases and corresponds to the area of the green triangle. In monetary terms, the CS is (€10-€5) x 10,000/2 = €25,000.

Therefore, there is a CS increase of €25,000 - €9,000 = €16,000.

On the other hand, the PS before and after the actions must be estimated. In this case, the PS will be the difference between the total of the profits earned with the sale of meat and the total of the variable costs for obtaining this meat. Before increasing production, the producers were paid 1 €/kg for 6,000 kg of meat. Therefore, they earned 6,000 €/year. The variable cost[11] is 0.6€/kg as the pastureland does not give such a high yield per hectare. Therefore, the PS is €6,000 -0.6 €/kg x 6,000 kg = €2,400.

Now, after making the necessary investment, the wholesale price of the producer does not change, 1 €/kg, while the variable cost has fallen, due to improved productivity per hectare. Therefore, the PS is now 10,000 kg x 1€/kg – 0.5€/kg x €10,000= €5,000. The variation of the PS is €5,000-€2,400 = €2,600.

The last step is to estimate the total variation (in this case a profit) that would occur by carrying out the necessary actions. This amount is obtained using the sum of the variation of the PS and the CS, i.e., €2,600+€16,000 = €18,600.

This result could be used to compare the benefit that could involve carrying out actions to expand and improve the quality of the current pastureland. If the cost of these actions is under €18,600, the investment would be profitable in one year.

2. Variation of the prices before and after a policy or action

This approach uses cases where the data on the supply and demand function are not available and there is no possibility to calculate the CS and PS. Suppose that the aim is to improve a forestry undertaking, by changing the tree species from eucalyptus to oak. The former is mainly used to produce paper, while the latter will be used to produce furniture. In the case of a commodity such as timber, the market price method seems to be an appropriate methodology[12].

The current price and production data are as follows:

- Cubic metre price in eucalyptus loading yard for paper pulp: €38-40.
- Production of current cubic metres per year of eucalyptus. 1,000 m^3

[11] The costs of a company can be divided into two main types of costs: fixed costs and variable costs. The **fixed costs** are those that do not depend on the level of activity of the company, but rather are a specific amount, regardless of the turnover. For example, the rent of the offices that a company will have to pay regardless of the turnover of its business. The **variable costs** are those that evolve in parallel with the turnover of the company (if there is no activity, those costs would be zero). For example, the costs.

[12] It is necessary to be aware that within the wooded area, there can be other type of values not considered such as collecting mushrooms, recreational uses, etc. In this example, we are only referring to the value of a cubic metre of a commodity with a direct consumptive use value such as timber.

The prices and production data with the new production are as follows:

- Price of the cubic metre in tabebuia rigida loading yard: €80-90.
- Cubic metres per year production that is expected to be obtained: 900 m^3

The following steps are performed to assess the benefits due to this production change:

1. **SITUATION PRIOR TO THE CHANGE:**
   - lower range: 38 €/m^3 x 1,000 m^3/year = 40,000 €/year.
   - upper range: 40 €/m^3 x 1,000 m^3/year = 40,000 €/year.
2. **SITUATION AFTER THE CHANGE:**
   - lower range: 80 €/m^3 x 900 m^3/year = 72,000 €/year.
   - upper range: 90 €/m^3 x 900 m^3/year = 81,000 €/year.
3. **THE CHANGE OR IMPROVEMENT OF THE CHANGE IN THE TIMBER PRODUCTION IS IN A RANGE PER YEAR:** [38,00-72,000; 40,000-81,000] = [34,000; 41,000].

   In the same way as in the previous case, this figure could be compared with the cost that could result from the change in timber production. If the cost is lower than the range obtained, it would be profitable to carry out the project. It should be considered that the calculation is being simplified in this example, as only one aspect is being considered: the timber commodity and not time needed to in order to achieve the annual production of 900 m^3 of oak or other types of timber, nor the different values of other services in the different uses.

3. Variation of the prices before a policy or action

In the same way as in the previous case, suppose that there are no available data on the demand function and there is also no possibility of calculating the CS and the PS. In this case, the aim is to calculate the implication that improving a recreational area would have by including angling as a recreational activity. There is an artificial lake and the aim is to estimate what would be the benefit of introducing fish. Fishing is a commodity that can be valued using the market price method, as they are traded on a market and the price per kilogramme can be obtained. Suppose that each visitor to the park pays €10 per kilogram of fish. Therefore, by estimating the number of kilograms that could be taken from the lake (that data could be obtained by observing another lake with the same characteristics in terms of surface area, water quality, fish species, climate, etc.), the benefits that could be obtained with the recreational improvement can be estimated. The number of anglers who would visit that lake must also be estimated. Suppose that even though the capacity of the lake would allow 10,000 kg to be caught, the amount of fish that is expected to sell by means of this activity is 5,000 kg. Therefore, the profit that could be obtained is 5,000 kg x 10 €/kg = €50,000.

This figure can help to decide whether or not to make the necessary investment to introduce fish in the artificial lake by comparing it with the costs of the investment and others that could arise from it.

Practical examples

- **Loureiro** *et al.* **(2006)**

Estimated costs and admissible claims linked to the Prestige oil spill. Ecological Economics 59:48-63.

Abstract: This paper estimates the short-term costs arising from the Prestige oil spill in 2004. The authors use market prices to estimate the losses arising from some of the sectors involved, such as the shellfish and fishing sector or the tourist sector.

Link: http://www.sciencedirect.com/science/article/pii/S0921800905004581

- **Barrio** *et al.* **(2007)**

Estimate the short-term economic losses caused by forest fires in Galicia in 2006. Economía Agraria y Recursos Naturales, 7(14): 45-64.

Abstract: This study quantifies part of the immediate or short-term economic losses (excluding the passive use ones) caused by the forest fires in Galicia in 2006. The assessment model is based on the economic estimate of the ecosystemic services lost due to the fires. The losses relating to timber and tourism were estimated using the market prices.

Link: http://ageconsearch.umn.edu/bitstream/7056/2/07140045.pdf

Resources

Some international and national databases:

- Global fishery databaes. FAO.
  Link: http://www.fao.org/fishery/statistics/en
- Different world data (agricultural prices, forestry sector, etc.) FAOSTAT.
  Link: http://faostat3.fao.org/home/index.html%23HOME
- Different European data (agriculture, forestry sector, etc.) EUROSTAT.
  Link: http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database
- Tourism data in Spain. IET.
  Link:http://www.iet.tourspain.es/es-ES/turismobase/Paginas/default.aspx
- Different Spanish statistics (agriculture, fisheries statistics, etc.) INE.
  Link: http://www.ine.es/
- Different Spanish statistics (food, agricultural statistics, etc.) Ministry of Agriculture, Food and the Environment.
  Link: http://www.magrama.gob.es/es/estadistica/temas/default.aspx

7.3. Cost avoided, replacement cost and substitution cost

What are they?

They are methods based on estimating costs. Those methods do not provide strict economic value measurements; in other words, they are not based on the intention that individuals have to pay for a product or service. The fundamental idea is to assume that if people incur costs to avoid damages from lost ecosystemic services, or to replace the services of the ecosystems, those services must be worth at least what people pay to replace them. On the other hand, those methods are the most appropriate in cases where the actions and costs to avoid the damage or to replace the services have already been carried out, or there is an undertaking.

- **COST AVOIDED:** method that estimates the value of a certain service of an ecosystem based on estimating the value of the damage that would be incurred if this service is not provided by the ecosystem. The value of the expenditure on protection, the cost of the actions taken to avoid environmental data or the costs of the goods that would the loss of the services that the resources provide would generate in society as an approach to those benefits.

  For example: the value of the flood control service may be derived from the estimated damage if the flood occurred.

- **REPLACEMENT COST**: this method estimates the value of a certain service of an ecosystem using the cost that would be incurred to recover or establish the service that that commodity was providing by means of restoring the initial conditions of the ecosystem. In other words, once This does not mean restoring the initial state in all cases, but rather determines how that loss arising from the impact or environmental damage can be offset through the implementation of other projects or services that enable those services to be available to people. For example, the value of the erosion control service of a forest may be measured by means of the cost that would be incurred to eliminate or remove the eroded sediment from the area.

- **SUBSTITUTION COST**: the value is estimated in this case of a certain service of an ecosystem by means of the cost of providing substitute services. For example, the value of the purification services of the water of a wetland that has been damaged can be obtained using the cost incurred to provide water to a population, i.e., cost of filtering and chemical treatment of the water.

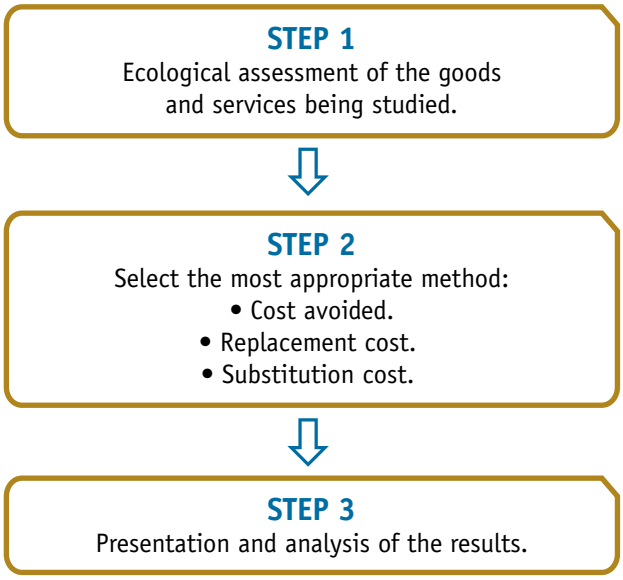
Strengths

- **COMMON:** these methods are very commonly used when the institutions do not have a large budget.
- **ECONOMIC:** they are methods whose application is relatively inexpensive, both in time and in necessary resources.
- **EASE-OF-USE:** compared to other methods that estimate the WTP by society are methods easier to apply, with a need for less resources and data. This is due to it being easier to measure the costs of producing benefits than the benefits themselves, when they are not marketed.
- **INFORMATIVE:** they are methods that can provide an approximate indicator of the economic value (always bearing in mind that they do not estimate that value).

Weaknesses

- **COSTS vs. BENEFITS:** those methods assume that the cost of repairing the damage or substituting the services of the ecosystem is valid measurements of the benefits. However, costs are not in general measure of the profits.
- **INCOMPLETE:** they do not take into social preferences for services of the ecosystems, or the behaviour of the individuals, in the absence of those services.
- **SUBSTITUTION VALUES:** the replacement (and substitution) cost method requires information on the degree of substitution between the natural commodity or service and the market commodity or services. Few ecosystemic goods or services have those indirect or direct substitutes and it is also probable that they offer the same type of benefits as the original. For example, salmon from a fish factory cannot be valued in the same way as wild salmon.
- **UNDERVALUING**, the goods or goods or services that are substituted probably account for only a part of the full range of services provided by the ecosystems. Therefore, the estimates can give a value lower than the real one. On the other hand, much of the damage cannot be perceived completely, either because they would appear in the long run, or because they are not known by people.
- **POSITIVE VALUATION:** if the company has not shown its willingness to pay for the project in a different way (for example, approving the budget to carry out the project), there is no signal that the value of the commodity or service for the population affected is greater than the estimated cost of the project. In other words, the fact that an environmental service does not imply that the general public is willing to pay for the lower cost alternative identified by the simple fact that it provides the same benefit level as that lost service. Without evidence that the public would demand that alternative, those methods are not an appropriate economic estimator of the value of the ecosystemic services.

Steps to be followed



The steps to be taken are as follows:

- **STEP 1:** The first step is to perform an estimate or ecological assessment of the services being studied. For example, suppose that we want to analyse the flood protection services provided by the forests. This assessment should establish the current flood protection level.

- **STEP 2:** This step will depend on the specific method chosen.

  COST AVOIDED METHOD: two approaches can be used in this case. The first consists of using the information obtained in the first step, and calculate what the damage would be if the commodity or service is not provided. In other words, we need information about the potential loss of goods and services that the loss of those environmental services would generate for society (or the population affected) in order to estimate the costs that society would have to face. In the example in question, the question that should be answered is: what damage is there to the property if the flood were to happen? Therefore, the damage to different properties (houses, estates, cars, roads, etc.) could be calculated in the case of the forest not being replanted after, for example, a forest fire. The second of the approaches consists of determining whether society or the population affected have spent money to protect their characteristics. In our example, the question that should be answered is: have any actions been taken to protect these properties from possible flooding? To do so, costs such as insurance, maintenance actions of the forest, containment walls built, etc. could be determined. Those two approaches are very likely not provide the same value, i.e., that the costs of preventing the catastrophe from occurring, are greater than the costs arising from the flooding. Therefore, it is logical for the people to pay for the preventive actions to be carried out.

  RESTOCKING OR REPLACEMENT COST METHOD: this is used to estimate the costs arising from restoring the level of the initially provided commodity or service, prior to the damage occurring. In our example, the cost incurred from returning the flood control to the initial level could be calculated. This would be complicated and an alternative would be to estimate the cost of returning the forest to its initial level (even though we have to be aware that this does not mean a direct estimate of the service being studied). Another alternative would be to estimate the costs of providing that service by artificial mechanism. In this case, it would be complicated and this method would therefore not be useful.

SUBSTITUTION COST METHOD: the costs of providing a substitute of the service in question are estimated. In this case, it could be the cost of making a containment wall or a dyke to protect the nearby properties from possible flooding (construction cost+maintenance cost).

An aspect that must be taken into account is whether people are willing to accept this dyke instead of the restored forest, as, as has been previously indicated, those methods are not an appropriate economic estimator of the value of the ecosystemic services if there is no evidence that the public are demanding that alternative.

- **STEP 3:** Finally, the results would be stated in euros and would be analysed. In our example, the value in euros of the damage avoided to the private property or the value of the substitution services provided to avoid the floods, give an estimate of the benefits of protecting against floods and can give us an idea as to whether it is worthwhile to restore the protection services against flooding of the forests.

Explanatory example

Suppose that we want to value a commercial area being established in woodland. Therefore, one of the costs that we have to take into account when conducting a cost-benefit assessment would be the loss of carbon sequestration of that area (among other costs, but in this example we do not only focus on this aspect). Therefore, we could use the costs avoided method.

In this case, the deterioration of the environmental quality (loss of carbon sequestration) is valued by the cost that would be involved to establish an area that allows the quality level to be maintained (sequestered carbon quantity) before the change. In other words, the reforestation cost avoided must be estimated to produce an equivalent sequestration to the one that the degraded woodland or which is going to be degraded currently sequesters (cost incurred/avoided to maintain the quality level prior to the change). The value that appears in the document of the IFN3 of Castilla y León of 8,50$/t[13], a figure used internationally only for wooded ecosystems (it is therefore an undervalued figure as the non-wooded strata are not considered) is therefore taken as a benchmark).

The tons of carbon that the wooded area sequesters that are going to be eliminate have to be first estimated (suppose 2000 with a mixture of conifers and deciduous trees). If we assume a carbon sequestration capacity in living biomass of 3.17 Mg/ha/year[14], the amount of carbon that we would have to be capable of sequestering and restoring rose to 6,340 tons of carbon in the last year. If we take an average age of the eliminated biomass of 10 years, the sequestrated total increases to 63,400 tons of carbon (10 years x 6,340 tons of carbon/year). With a cost of 6.81 €/t, we find that the costs that would be incurred if we wanted to create a similar area, in terms of sequestrated carbon, would come to €431,754.

[13] €/dollar exchange rate as of 22 June 2012: 0.80 /$. Therefore, 8.5$/t x 0.80 /$= 6.81 /t.

[14] Figure obtained for the set of deciduous and conifers in Galicia by Dans & Molina a (2005).

Practical examples

● Eustorgio Jaén Núñez, Ricardo Shirota: **Economic valuation of the sediment reduction environmental service of the forests of the river basin forests of the Panama Canal**

Abstract: The sedimentation process reduces the depth and capacity of the lakes to store water from the Panama Canal, which means that they need to be periodically dredged which increases the operating costs. This process is accelerated by the loss of woodland cover in the river basin. This study seeks to estimate the economic value associated to the sediment reduction by the forests of the Canal basin, using the dredging cost avoided method. The physical affect of the woodland cover on sediment reduction was estimated using the linear regression of biophysical data of seven micro basins that have sediment production measurements: Chagres, Pequení, Boquerón, Gatún, Trinidad, Cirí Grande and Caño Quebrado. The results show that each hectare of forest in this area reduces 14.32 m^3/year of sediments, which corresponds to an economic value of USD 197.40. The conclusion is that forests contribute significantly to offsetting the sedimentation process of the water storage lakes of the Panama Canal, and that contribution may be valued at USD 39,640,091 per year, for all the forests of the basin.

Link: http://www.fao.org/fileadmin/user_upload/training_material/docs/EJN - VE Bosques Canal de Panamá.pdf

● Elsa Varela-Redondo et al. 2007. **Economic valuation of the pastureland in terms of costs avoided in forest fire prevention work**

Abstract: Forestry workers regularly use motorised cutters to clear forest undergrowth to prevent fires. As an alternative to this system, the use of grazing livestock to reduce the fire hazards in firebreaks is being tested in Andalusia. This study, focused on the woodland of the Sierra de las Nieves mountains (Malaga) seeks to compare the costs associated to grazing in firebreaks to the costs of mechanical clearing that this service avoids, which allows the comparison of both alternatives in financial terms.

The costs of maintaining the firebreaks by using bush cutters have been calculated for each of the 14 environmental units studied by means of applying the rates that EGMASA uses to budget those actions. Grazing is not considered to completely eliminate the need for clearing and it has been estimated that up to 75% of its costs could be avoided. The resulting amounts of between €82.22 and €460.77 ha/year vary according to the characteristics of each unit. The grazing costs have been estimated for those same environmental units, by means of a formula to calculate the payment for the grazing service that has been developed in order to economically compensate the shepherd for the work involved and encourage him to carry out his work. The maximum amount to be paid per surface unit is modulated according to the grazing difficulty in the zone, with a maximum of €69.32 and a minimum of €33.99 ha/year.

The comparison of both costs shows that the maximum amount that could be paid to the shepherd is an average of 23.3% of the costs avoided (ranging between 12.8 and 56.8 per cent). This figure shows that, financially speaking, grazing in firebreaks is a significantly less costly option that clearing using bush cutters, and this saving could be used to expanding, or more frequent maintenance, of the defence structures against forest fires.

Link: http://digital.csic.es/bitstream/10261/42937/1/Varela-Redondo Wildfire.pdf

Resources

1. **Bibliography**

- Dans, F. y Molina, B. (Coord.) (2005). *O monte galego segundo criterios de xestión forestal sostíbel. Diagnóstico*. Ed. Asociación Forestal de Galicia.

7.4. Travel cost

What is it?

It consists of estimating the willingness to pay for the environmental benefits in a given place using data on the money and the time that visitors use to reach it. It is one of the most common methods to assess tourist goods and services or scenic resources. By observing the behaviour of the individuals, the value of the environmental goods without market price can be estimated by calculating the costs incurred to use the commodity or service being studied.

The method involves conducting surveys and estimating the transfer costs from the place of origin of the individuals to the place where the study takes place. Aspects such as the distance travelled, means of transports, conditions for using the transport, etc. are taken into account. Different individuals face different travel costs, and their response (the number of visits that they make to the place) to those variations of the implicit prices are the base to be able to estimate the demand.

This method is based on the idea that even though the entry price to a space of natural interest is zero, the access cost is generally higher than that amount as the visitor incurs costs to visit it. Therefore, it is supposed the nearer the environmental commodity is, the greater the number of visits will be, as the costs are lower. Using this idea, the demand function of that commodity can be calculated, by relating the number of visits (Q_d) with the travel cost (P_b), the consumer surplus and the possible changes of this surplus if there is a change to the situation of the environmental commodity, the opportunity cost of the time lost in the journey and other factors.

The aim is to model the number of visits according to a series of characteristics. There are different approaches to carry out this method[15]:

1. **ZONAL APPROACH OF THE TRAVEL COSTS:** it mainly uses secondary data with some data directly gather from the visitors by means of surveys. The dependent variable is defined as a proportion between the number of visits made by the inhabitants of a certain zone and the population of that same zone in a time period.

   Using this model, the recreational demand is defined as the following function:

$$W_{ih} = f_i\left(P,Q,I\right)$$

   where w_{ih} is the proportion between the visits made to place i from zone h and the population of that zone in a specific time period, while P indicates the average access cost from zone h to place i, Q is the perception that the consumers from zone h have of the quality characteristics of place

[15] There is another approach that is not included due to its degree of the difficulty and it is the random utility approach. Survey and other data, with more complex statistical techniques are used.

i, and I is the average income of zone h. In other words, demand is defined as the proportion of visits from a specific zone and the population of that zone ([for example visits from Bilbao to the Picos de Europa national park in 2012/Total population of Vizcaya in 2012]*100) as per the average access cost (from Bilbao), the average income of the inhabitants (of Bilbao) and the perception of the population (of Bilbao) of the characteristics of the place.

2. **INDIVIDUAL APPROACH OF THE TRAVEL COSTS:** data obtained from direct surveys of the visitors are used. The dependent variable is defined as the number of trips made by each of the visitors in a specific time period. The recreational demand of the individual method of the travel cost is defined as a function that relates the number of visits to the place with the access cost, the income and the perception of the characteristics of the zone by the person:

$$Z_i = f_i(P,Q,I)$$

Where z_i indicates the number of visits made by the persons to place i, P indicates the average access cost, Q is the perception that consumers have of the quality characteristics of the place i, and I is the average income.

CASE EXAMPLE: let us suppose that the aim is to calculate the value of the recreational use of a Natural Park. An individual that decides to spend their holidays there or visit it would incur a series of costs: the opportunity cost or the benefits not obtained when not working during that time, the cost of the time it takes to reach the National Park from their place of origin, the cost of the journey itself (petrol, tolls, accommodation, etc.). This information, along with other characteristics of the traveller (income, age, etc.) and with the visit rate, can be used to infer a demand function for that National Park, and therefore calculate the consumer surplus. This surplus allows us to obtain the recreational use value.

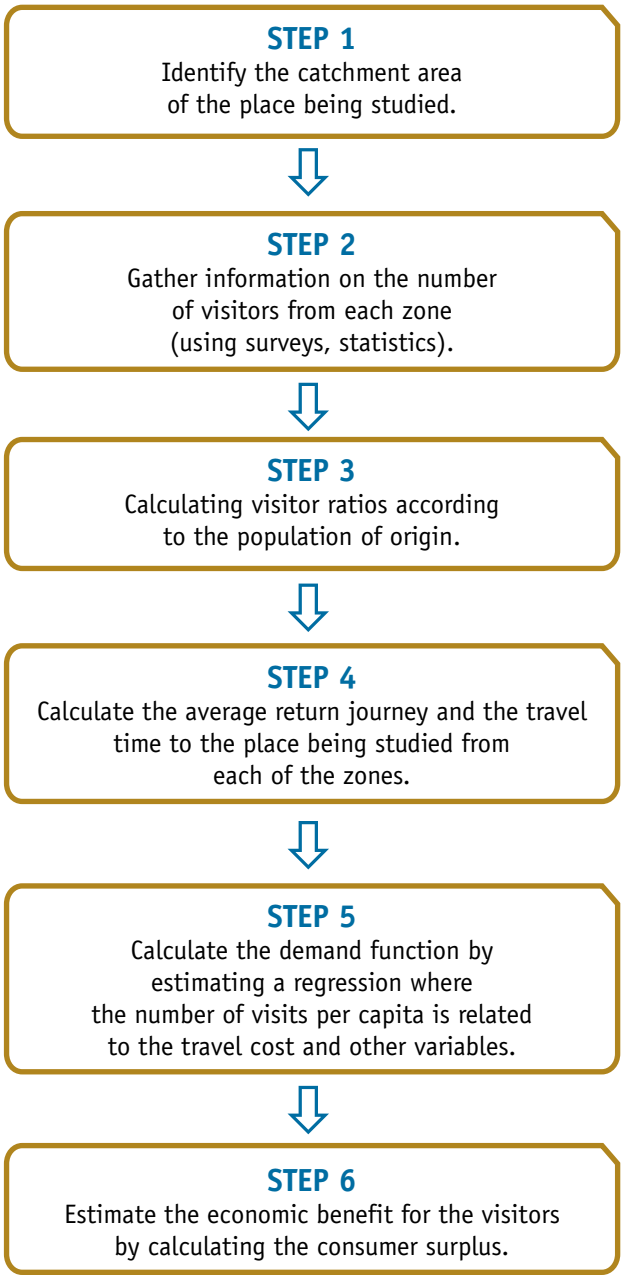
Strengths

- **APPLICATION IN TYPICAL CASES:** It is generally used to estimate the value of recreational places, such as public parks and natural reserves.
- **ECONOMIC**
- **NORMALLY AVAILABLE DATA**
- **THE CURRENT** method is based on the current conduct (what people really do), rather than on what they would be willing to pay or do in a hypothetical willingness to pay situation.

Weaknesses

- **AMOUNT OF INFORMATION NEEDED:** A high data coefficient is needed to apply the method.
- **OVERESTIMATING BIASES:** The valuation requires usually restrictive assumptions about the conduct of the consumer (for example, travelling with different purposes where visiting the place is just one of the objectives, substitute and/or complementary goods such as other nearby goods, etc.).
- **SENSITIVITY:** the results are very sensitive to the statistical methods used to specify the relationships with the demand.
- **ONLY USE VALUES:** unlike the contingent valuation method, this method only allows use values to be calculated.

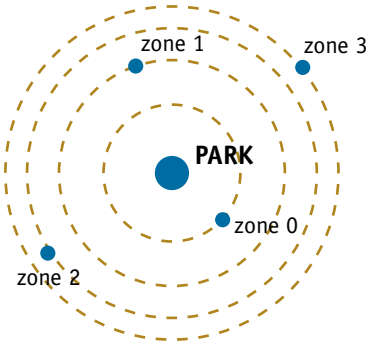
Steps to be followed[16]



[16] We have indicated the steps for a zonal approach of the travel cost.

The steps to be taken are as follows:

- **STEP 1:** First, the different catchment areas of the place being studied must be defined. They can be defined using concentric circles around the zone, or using geographical divisions, such as municipalities or provinces that are situated at similar distances. For example:



- **STEP 2:** The second step is to collect information about the number of visitors to the zone in question in a specific time period (generally) in the last year, according to each of the zones that have been defined in the previous step. This can be carried out using tourist statistics or specific information available about the visitors in the zone in question. Thus, in order to access some natural areas, visitors are asked for information that can include data such as the post code or number of times that they have visited the area in the last year.

- **STEP 3:** The third step is to calculate the ratios or visit rates per population according to each zone defined in step 1. The ratio can be calculated as:

$$\text{Visit rate } (V_{zone}) = \frac{\text{No. of zone A visitors}}{\text{Zone A inhabitants}} \times 100$$

- **STEP 4:** The fourth step involves calculating the average return journey and the travel time to the place being studied from each of the zones. If there is information on the number of overnight stays, that information should also be included. The aim is to use that data to calculate the cost per journey. One example of cost calculating would be as follows: suppose that 4 zones have been defined and data is only available on the average distance travelled and travel time. The zones are defined from zone 0, the closest zone and with a time cost and zero distance, to zone 3 with the greatest cost in both variables. Suppose fixed costs per kilometer (0.30€/km and 0.15€/minute) and per minute[17]. We would now have the following information:

Zone	Total Visits/ Year	Population per zone	% Visits per zone/ Population per zone	Return distance (km)	Outward and Inward time (minutes)	Total cost of distance (0.30€/km)	Total cost time (0.15€/ minute)	Total cost/ Visit
0	40,000	1,000,000	4%	0	0	0	0	0
1	30,000	2,000,000	1.5%	200	120	60€	18€	78€
2	20,000	4,000,000	0.5%	400	240	120€	36€	156€
3	10,000	8,000,000	0.125%	600	360	180€	54€	234€
Further from zone 3	0							
Total Visits	**100,000**							

[17] Those costs could vary according to the zones, for example, the price of a litre of petrol is not the same in all Autonomous Regions.

- **STEP 5:** In this step, a regression is used to estimate the equation that relates the number of visits per capita with the travel cost and other variables, such as income, age, etc.). The aim is estimate a function of the following type:

$$v_{zone} = v\ (\text{Travel cost}_{zone} + \text{income}_{zone}, \text{other variables}_{zone})$$

where vz_{one} = visit rate per zone.

Suppose that only the travel cost per zone is included, and that the resulting model is as follows:

$$v_{zone} = 0.03425 - 0.000162 \times \text{Travel cost}_{zone}$$

Then, and using the results of the obtained regression, the demand function is constructed. The first point of the demand curve is the total number of visitors with a zero access cost (i.e., visitors are not charged for entering the area being studied). This number is 100,000 visits per year in the example. The other points are calculated assuming different costs, i.e., by increasing the travel cost by that amount. Therefore, the Travel Cost variable is replaced in the model by those values and we obtain the following results.

Zone	Travel cost + 40€	% Visits per zone/ Population per zone	Population	Total number visits per zone
0	0+40= 40€	2.8%	1,000,000	27,774
1	78+40=128€	1.4%	2,000,000	27,054
2	156+40=196€	0.3%	4,000,000	10,070
3	234+40=274€	-1.0%	8,000,000	0
			Total number visits	**64,898**

Thus, the second point of the demand curve is obtained for an entrance with a cost of €40, the number is, logically, lower than for a €0 cost and is around 64,898 visitors. In order to calculate the rest of the demand function, the same procedure is followed varying the entrance costs (in this example €80, €130 and €211.55), obtaining the following demand curve points:

Coste entrada	Número total visitas
0€	100,000
40€	64,898
80€	35,400
130€	13,203
211.55€	0

- **STEP 6:** Once the demand curve is obtained, the total economic benefit of the visitors is calculated by working out the consumer surplus by calculating the area under the demand curve. In this case, the number of visits is a linear function of the entry cost:

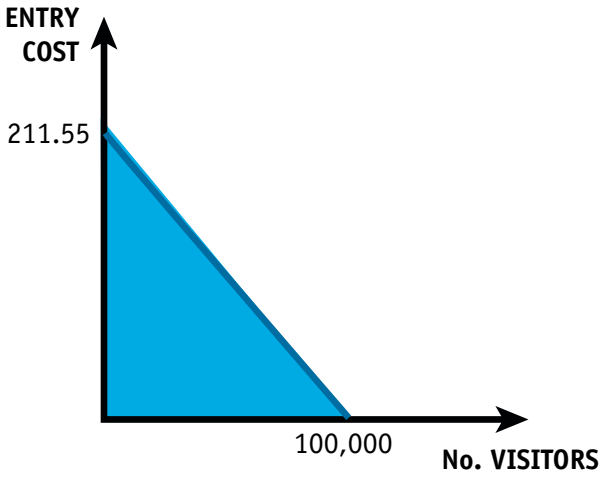
$$\text{Total No. visits} = 100{,}000 - \beta \times \text{CosteTravel Cost}$$

The representation is linear and, therefore, we only have to calculate the area between the demand curve and the horizontal axis. In this case, as it is a triangle, the CS is calculated as the area of a triangle[18], i.e.,

[18] If it is a non-linear function, the CS would be calculated as the integral defined between the maximum and minimum entry cost (if we have expressed the demand function as No. Visitors according to the Entry Cost).

$$\frac{\text{Base x Height}}{2} = \frac{100{,}000 \text{ x } 211.55}{2} = 10{,}577{,}500 \text{ €}$$

i.e., 10.57 €/visitor is the average CS per visitor.



We believe that the aim is to decide whether it is worth investing in improving the park. If the cost of the actions is under 10,577,500 euros per year, the cost will be less than the benefits that the park provides. If it is greater, we could try to analyse other elements of the park, such as no-use values related to the legacy value.

Finally suppose that we want to assess how the improvement in the natural area will affect demand (and therefore the CS). Suppose that the situation was the one described above in 2010, where the average CS was €10.75 per visitor. Now suppose that we want to analyse how a series of improvements in the zone has affected this average CS. We would have to obtain data from 2012 about the visitors of the different zones, costs, etc. and again perform the prior steps, obtaining a new average CS. Suppose that it is now 15 €/visitor. This indicates that the impact of those actions is positive ($CS_{average\ 2012}$-$CS_{average2010}$) and which means an average of €4.43 per visitor. Therefore, it can be seen that one of the main application of the Travel Cost Method is to analyse the changes in the CS to analyse the effects of different actions or eventsS (for example, we could calculate the variation of the CS after a forest fire, obtaining information about how this catastrophe affected the demand of the natural area).

Explanatory example of the zonal travel cost method

The previous section has described in greater detail how to perform an assessment using the travel cost method. A practical example conducted by Riera & Farreras in 2004 to estimate the recreational use loses of the Basque coast as the result of the Prestige accident is set out below. In this case, it is an environmental change. Therefore, two demand functions have to be calculated, one before the change and the other after the change. These two functions are used to calculate the variation in the consumer surplus, in other words, the loss of recreational value as the result of the Prestige pollution.

The number of trips made to the Basque Country was obtained from the statistics available on peninsular national tourism[19]. The first step consisted in defined the set of zones (seven) used to identify

[19] Those costs could vary according to the zones, for example, the price of a litre of petrol is not the same in all Autonomous Regions.

the geographical provenance of the visitors. The criterion used was to group the autonomous regions by zones and supposed that the journey was by car. To establish the cost, two aspects were taken into account. Travel costs (petrol and tolls) + Cost of overnight stay (48 €/night). This information was used to obtain the demand function and an average surplus of 37.07 €/visitor was calculated. The aggregate value for 2003 for the recreational experience on the coasts of the Basque Country came to around 33.95 million euros (37.07 €/visitor x total visitors recorded for 2003).

Once this value had been calculated, the 2003 statistics were analysed and two phenomena were noted: on the one hand, trips to the Basque Country fell with regard to those recorded for 2002 and on the other hand, the geographical provenance of the tourists to the Basque Country in 2003 change with respect to what had been seen in 2002.

These observations were used to estimate the probable demand function if the Prestige accident had not occurred. Therefore, the authors perform different hypotheses obtaining different results in each case. Only the first case is considered here and is based on the assumption that if the accident had not occurred, tourism of the Basque Country in 2003 would have evolved in the same way as was observed in Spain in 2003. In other words, it is supposed that the change in the number of tourists is the consequence of the accident, but not the distribution of the geographical provenance of the visitors.

Taking this into account, a value of the average surplus of 37.07 €/visitor[20] is estimated, even though the number of visitor is lower. An estimate value of the damage of 1,539,640 euros is obtained in this scenario.

Practical examples

- Farré Perdiguer, M. 2003. **The recreational use value of the protected natural spaces. An application of the contingent valuation and the travel cost methods.** Estudios de Economía Aplicada, 21 (2): 297-320.

Abstract: This article presents an application of two of the methodologies developed to measure the benefits arising from the recreational use of the environmental goods in market absence, the travel cost method (TCV) and the contingent valuation method (CVM). The study zone was the "Aigüestortes y Estany de Sant Maunici" National Park, located in the Catalan Pyrenees.

Link: http://dialnet.unirioja.es/servlet/articulo?codigo=652982

- Castro, M. & Albiac, José. 1994. **Economic valuation of environmental assets: application of the travel cost method to the Dehesa del Moncayo natural park.** Work document 94/7.

Link: http://www2.cita-aragon.es/citarea/bitstream/10532/281/1/10532-80_81.pdf

[20] It may be surprising a priori that this value coincides with the average surplus of the visitors calculated above. Yet this is logifcal as the same distribution in the geographical provenance is used both with accident and without accident. The only thing that varies is the number of visitors.

Resources

1. **Databases and statistics:**

- Institute of Tourist Studies. Link: http://www.iet.tourspain.es/es-es/estadisticas/fichadecoyuntura/paginas/default.aspx

2. **Basic bibliography:**

- Riera y Farreras. 2004. *The travel cost method in the valuation of environmental damage. The Basque Country case due to the Prestige accidente*. Ekonomiaz: Revista vasca de economía, 57: 68-85. Link: http://www1.euskadi.net/ekonomiaz/taula1_c.apl?IDPUBL=52 - http://www1.euskadi.net/ekonomiaz/taula1_c.apl?IDPUBL=52

7.5. Hedonic pricing

What is it?

It consists of determining the implicit prices that different characteristics of a property have and which determine its value. The underlying idea is that people acquire certain goods on the market that have different characteristics or attributes (one of which can be the environmental quality) which cannot be sold or purchased separately, as there are no markets for it. Therefore, it is about estimating the implicit prices of those attributes or characteristics that mark the difference between the prices of a same commodity. In the context of environmental valuation this method aims to identify those environmental attributes or characteristics of an asset that make up its market price. Regression techniques are used to measure the desire to pay for those environmental aspects of the assessed asset and its contribution to the global market value is estimated.

By means of an example: let us take a house whose price is determined, among other factors, by the neighbourhood, its size (m^2), its location (close to work, close to school, etc.), its features (type of windows, timber, etc.). The price differential with properties with similar characteristics in other localities, but with a higher degree of pollution, can be a good approach to the willingness to pay due to the difference in air quality.

This method is usually used to estimate the economic benefits or costs associated to the quality of the environment (air pollution, water pollution, noise, landscape, etc.) and with the environmental services related to the beauty views or with the proximity to recreational sites. It therefore seeks to relate those aspects to the price of residential properties. It can also be applied to other types of properties, such as land.

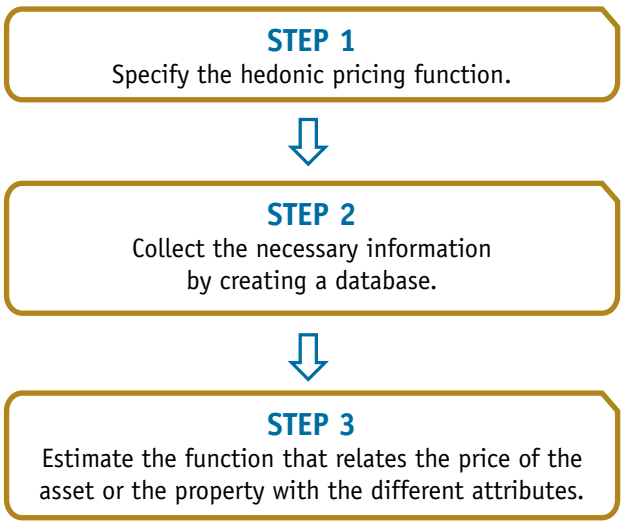
Strengths

- **REAL VALUES:** the values are estimated based on real choices. The property markets are also relatively efficient and they are therefore usually good value indicators.
- **RELIABLE**: the property registries and the prices assigned are usually very reliable.
- **ACCESSIBLE:** the data on property sales and the characteristics of those properties are usually available through different sources.
- **VERSATILE:** it is a method that can consider different relations between the market assets and the quality of the environment.

Weaknesses:

- **LIMITED:** the environmental benefits that can be measured are limited to the relation existing with the price of the asset in question (house, land). It also only reflects the willingness to pay of the people for the difference perceived in the environmental attributes and their direct consequences. Therefore, when people are not aware of the link between the environmental attribute or characteristics and the benefit that they obtain, that value will not be reflected in the prices of the asset.
- **INACCURATE:** the method supposes that people have the opportunity to select the combination of attributes of the asset according to their preferences, taking the limitation of their income into account. However, the market can be affected by other factors, such as taxes, interest rates, etc.
- **COMPLEX:** statistical skills are required to carry out this method. Large amounts of data also need to be handled and processed.
- **SENSITIVITY:** the results depend to a great extent on the specifications of the model.

Steps to be followed



Source: Own preparation.

The steps to be taken are as follows:

- **STEP 1:** The first step consists of collecting information on the aspect being studied and supposes that prices in a specific zone (for example houses) for a specific time period (for example, a year). The necessary information would include:
  - **The selling price and the locations of the asset (houses).**
  - **Characteristics or attributes of the property** that affect the selling price, such as the surface area, number of rooms, bathrooms, quality of the materials, etc.
  - **Characteristics of the neighbourhood** that affect the prices, such as taxes, crime rates, proximity and quality of the schools.
  - **Accessibility characteristics** that affect prices, such as distance to work, to shopping centres, public transport.
  - **Environmental characteristics** that affect the price, such as air quality, noise, smells or proximity to open spaces.

  Therefore, the hedonic pricing function that needs to be obtained would be an expression that relates the prices of the property (housing, land, etc.) with the attributes that have an impact on the wellbeing of the individual. Its expression would be:

  Price = f (Property C.; Neighbourhood C.; Accessibility C.; Environmental C.)

where Property C. represents the characteristics of the property; Neighbourhood C. represents the characteristics of the neighbourhood; Accessibility C., the accessibility to the property characteristics and Environmental C., the environmental characteristics that affect the property.

- **STEP 2:** The information quality and quantity is very important to perform an adequate assessment. The data required refers to all the aforementioned information for a specific period (cross-sectional data). Information of the properties in time (time series) can also be used, even though it is usually less accessible information.

  The variables that we have defined in our hedonic pricing function need to be taken into account to obtain this information. For example, suppose that the aim is to analyse the influence of an open space on the price of the housing unit. Information could be gathered on the quantity and type of open space for each given property in a certain ratio. Maps prepared using the Geographic Information Systems (GIS) usually need to be used to obtain this type of information.

- **STEP 3:** Once the variables that contain the attributes have been identified and the data have been assembled, the function of the price of the property will be estimated. We here have to use econometric techniques.

Following the example of the value of the open spaces, the hedonic pricing function is calculated as follows:

Price = f (Property C.; Neighbourhood C.; Accessibility C.; Environmental C.)

$P = f (x_1, x_2, x_3,..., x_n, Z)$ where:
x_1: size of the plat
x_2: size of the plat
x_3: number of schools nearby
...
Z: number of nearby open spaces

Once the above expression has been estimate, the marginal willingness to pay (MWTP) for the marginal increase of the environmental benefit (marginal reduction of the environmental damage) will be obtained, in the case of the example, the amount of open spaces near to the house. The MWTP

is equal to the partial derivative of the price with respect to the environmental variable, Z[21]. Using the MWTP, the total willingness to pay for the environmental characteristic being assessed will be obtained[22]. From this expression, the MWTP=b is obtained; i.e., the MWTP is constant, it does not depend on the level reached by Z or environmental variable (number of open spaces). If on the contrary once the function is estimated, the following expression is obtained:

P = constant + 2,354.2 No. rooms + 156.2 public transport +
+ 222.0 No. schools + 80.2 No. open spaces

This indicates that the price of the house increases (defined in this case as €/m^2) by €80.52 per square meter if the housing unit has an open space (an open space implies 80.2 more in the price, proportionally increasing according to this number).

Practical examples

● Gracia, A; Pérez y Pérez, L; Sanjuán, A; Barreiro Hurle, J. 2004. **Hedonic assessment of land prices in Zaragoza province. Estudios Agrosociales y Pesqueros,** 202: 51-69

Link: http://www.magrama.gob.es/ministerio/pags/biblioteca/revistas/pdf_reeap/r202_02.pdf

● Arias, Carlos. 2001. **Estimation of the value of the irrigation using the land price. Economía Agraria y Recursos Naturales,** 1(1): 115-123

Abstract: This article calculates the irrigation value in the province of León using land price data desegregated by use and region. The value of the benefits associated to the irrigation can be ascertained by comparing two "equal" plots of land, except for the fact that one of the plots can be irrigated and the other cannot. The difficulty of finding these equal plots of land was solved by using the regression analysis where the effects of the irrigation on the price of the land was assessed after controlling the effects of the characteristics that differentiate the analysed plots. An econometric model is used to calculate the average prices of the land associated to the non-irrigated and irrigated uses. The difference between those prices is a valuation of the irrigation. The results of the research allow irrigation projects to be assessed according to the land surface that can be irrigated.

Link: http://recyt.fecyt.es/index.php/ECAGRN/article/view/14482

● Julio Berbely Pascual Mesa. 2007. **Valuation of the irrigation water using the quasi-hedonic pricing method: application to the River Guadalquivir. Economía Agraria y Recursos Naturales,** 7 (14): 127-144

Abstract: Estimating the value of the water can be performed using different methods, out of which this paper proposes the "quasi-hedonic" pricing method. In this paper, water is considered as an "external" variable that impacts the differential price of land, and whose value is estimated for the Guadalquivir River Basin. The results show capital value of water in the range 2.8 €/m^3 to 4.2 €/m^3 with a more frequent value of 3.46 €/m^3.

Link: http://recyt.fecyt.es/index.php/ECAGRN/article/viewFile/14290/8932

[21] That is: MWIP $= \delta P/\delta Z$.

[22] It should be recalled that depending on the methodology chosen at the time of estimating the hedonic pricing function, the results can vary. Thus, in the case of a linear structure, the function will be: $P = a_1x1 + a_2x_2 + a_3x_3 + \ldots + a_nx_n + bZ$.

7.6. Contingent valuation

What is it?

This method simulates a market and the demand for a hypothetical change in the provision of the ecosystemic services that are being assessed by means of surveying individuals. The questionnaire is used to determine how much people would be willing to pay to increase or improve the provision of this good or service, or alternatively, how much they would be willing to accept for its loss or degradation (TEEB, 2012, Chapter 5).

Strengths

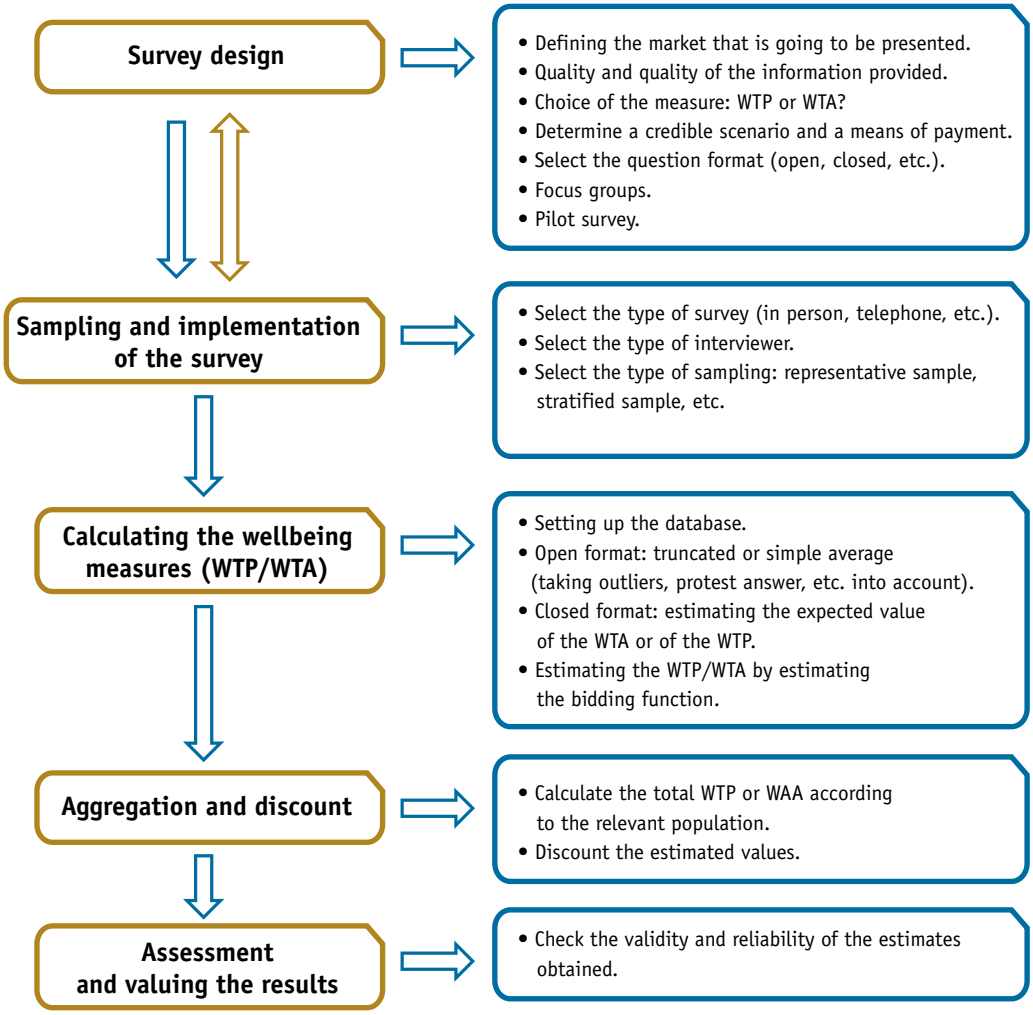
- **ONLY ONE TO VALUE NO-USE**: it is the only method that can measure the option and existence values and contributes a real TEV measurement.
- **VERSATILE:** It allows values of hypothetical situations to be measured.

Weaknesses

- **PRACTICAL DIFFICULTY**: results sensitive to many factors that result in application and design biases[23]. Such as:
  - Its hypothetical nature can lead to individuals expressing higher values when indicating their WIP.
  - Lack of familiarity with the commodity, therefore there is no experience as a consumer.
  - Errors associated to the measurement: different formats, different means of payment, etc.
- **EXPENSIVE:** The cost of applying this method is expensive.
- **DURATION:** The time required to carry out a study of this kind is significant.

[23] The NOOA panel recommendation (Arrow *et al.*, 1993) seeks to establish lines of action to avoid those possible biases. Therefore, prior to conducting a study of these characteristics, all those aspects need to be taken into account.

Steps to be followed



The steps to be followed are:

- **STEP 1:** This is one of the most important steps of the study. The questionnaire needs to be designed in such a way that the information sought is obtained, that this information is not biased and to do so, prepare a credible and doable survey for the people being surveyed. Directly related with this step would be the consideration of the population affected or the target population of our study (which will be fine-tuned in the subsequent step). For example, if the aim is to value the existence of the Iberian lynx, the target population could be the whole of Spain. When designing the survey, aspects the payment format, the means of payment and the specific valuation question must be decided. Following of the recommendations of the NOOA Panel, these are some of the considerations to be taken into account:
  - WTP questions allow more conservative results and are therefore preferable.
  - The binary (Yes, No) or referendum format is preferable.
  - Include in the payment question, the reminder that the individuals have a limited income and therefore a payment restriction.
  - Allow the "no answer" option, along with "Yes" or "No". Along with this option, an open question must be include as follows: "Why have you chosen this answer?" This will allow a deeper assessment of those answers.

- Conduct pilot studies or **focus groups** to see whether the people being surveyed understand the programme, the means of payment, the influence of including photos in the exercise, etc., in other words, the questionnaire itself.
- The structure of the surveys is usually divided into different parts. A first that can include general questions or specific questions that allow information to be obtained about the knowledge of the individuals on the topic in question or introduce them to the problem being assessed. The second part contains the economic valuation questions. First of all, information is provided on the question being studied to subsequently raise the market or situation to be valued. The question of willingness to pay (or willingness to accept compensation) is raised. Finally, socio-economic questions are asked in the third section, which will help in the explanation of the WTP (or WTA) of the individual for the valued action. Finally, a series of questions are introduced that must be completed by the interviewer (in the case of in-person surveys), such as: sex, place of the interview, length of the interview, etc.

Once this has been decided, a series of pilot surveys must be included if the whole survey is understood correctly. The final survey would be prepared after this pilot phase.

- **STEP 2:** This step is closely related to the previous one, and many of the decisions of step 1 will have to be taken according to this step. For example, the selection of final questions of the survey will be different according to the type of survey that will be conducted, i.e., telephone, in person, online, etc. The type of sampling that will be carried out will also have to be decided at this time. On the one hand, it is necessary to decide which the target study population is (also closely related to the first step, in other words, this must be borne in mind from the start of designing the survey), that is the population of a certain region, municipality, Autonomous Region, country, etc.

  On the other hand, the type of sampling to be carried out must also be established. The type of sampling can be random[24] (or probabilistic) or not random[25] (or not probablisitic). There are different types within the first: simple random, stratified, systematic sampling, or by conglomerates or areas. A type of sampling will be chosen according to the study targets. The most common in the contingent valuation exercises are the two first, but that does not mean that another type of sampling cannot be carried. Therefore, only the most common are mentioned.

  In a simple random sampling, all the individuals have the same probability of being included in the sample. For example, the aim is to extract a sample of 20 individuals out of a population of 600 individuals. The 20 individuals of the sample are selected using random numbers. While, in a stratified random sampling all the strata or subpopulations have the same probability of being selected. What the criterion to identify the strata (maximum uniformity between the individuals of a single stratum, and maximum heterogeneity between the different strata) is going to be and the allocation criterion, that is the distribution of the size of the sample in the different strata[26] has to be taken into account here. For example, suppose a population in which the introduction of a forestry protection policy is to be assessed. We believe that there can be differences in the answers of the individuals according to the zone where they live. Suppose that there are 4 differentiated zones according to the distance to the forestry zone, Zone A, with 350 residents, Zone B with 300, Zone C, with 250, and Zone D, with 300 neighbours. If a sample of 80 neighbours is to be taken, for all of them to be represented we can select according to the proportion that each stratum represents in the total population (proportional allocation. The total of the sample is therefore divided by the size of the population (1,100

[24] All the individuals of the population can form part of the sample, they have a positive probability of forming part of the sample.

[25] There can be a clear influence of the person or persons who select the sample or it is simply performed according to reasons of convenience. Except in specific cases, it is not recommended to perform this type of sampling for a contingent valuation exercise.

[25] There are different allocation criteria. Two of the most simple are:
Equal allocation: each of the strata of the sample is made up of the same number of individuals.
Proportional allocation: each of the strata of the sample is made up of a number of individuals proportional to its size.

inhabitants) and is multiplied by the size of each stratum. For example, (80/1100)*350= 25 individuals must be chosen from Zone A.

- **STEP 3:** Once the surveys have been conducted, all the information must be collected in a database for its subsequent analysis. Excel can be used to carry it out. Each of the individuals would be entered as a row on the Excel spreadsheet and the different questions codified in each column. For example, as follows:

Individual	Zone	Recycles (Always=2; A times=1; Never=0)	WTP (Yes=1; No=0)	WTP reply reasons: I may many taxes (Greatly agree=4; Agree=3; Don't agree or disagree=2; Disagree=1; Greatly disagree=0)	Sex (Female=1; Male=0)	Others
1	A	2	1	1	0	
2	A	0	0	4	1	
3	B	1	0	2	1	
...						

The assessment carried out will need to be different according to the format defined in **Step 1**, i.e., we will use different models. For example, if our WTP question is open (How much would be the maximum you would be willing to pay to carry out the previously described actions?) an ordinary squared **minimum regression could be carried** out. However, if the WTP question is closed (Would you be willing to pay €100 to carry out the previously described actions?) a l**ogit model** could be carried out.

- **STEP 4**: Once the monetary valuation of the average individual or representative of the sample has been obtained and the relevant population determined, the monetary aggregation will be carried out. Suppose that the relevant population of our case study is the population of the municipality of Vitoria, then the residents in this zone are the potential beneficiaries of the measures to be carried out. On the other hand, suppose that the average estimated WTP is €30 per individual. Therefore, the benefits of carrying out a certain action (suppose that this is what is being valued) would reach 6 million euros (€30/individual x 200,000 inhabitants over 18 years old). In this example, it has been assumed that the payment would be one-off and would only be made in that year. However, the actions can imply payment in a certain number of years and may involve performing a cost-benefit analysis. When that occurs, the values need to be discounted or updated to the current year[27]. Regarding the discount rate to be applied, there is important debate with numerous options. Some

[27] $$V_t = Z_t + \frac{1}{(1+i_t)} Z_{t+1} + \frac{1}{(1+i_t)(1+i_{t+1})} Z_{t+2} + \ldots$$

Suppose that the WTP is constant each year (30 €/individual) and the interest rate is also constant (3% annual), then the expression and the result is:

$$\text{Updated WTP}_t = \text{WTP}_t \left[1 + \frac{1}{(1+i)} + \ldots + \frac{1}{(1+i)^{n-1}} \right]$$

$$\text{UpdatedWTP}_t = \text{WTP}_t \frac{1 - \left[\frac{1}{(1+i)^n} \right]}{1 - \left[\frac{1}{(1+i)} \right]} = 30 \frac{1 - \left[\frac{1}{(1+0,3)^{10}} \right]}{1 - \left[\frac{1}{(1+0,3)} \right]} = 263.18 \text{ € individual}$$

exercises use a zero discount rate as they argue that future generations should not be penalised, as they live in the moment that they live, have the same rights and the future value must not be lower. Thus, due to the difficulty to find a discount rate, we can use those used by a group of experts that worked on the Externe project (European Commission, 1998) when they updated the damage caused by greenhouse gases on a 100 year time scale. These rates range between 1 and 3%.

- **STEP 5:** This last section is closely related to all the previous steps, as when making the questionnaire, its application and the estimation of the monetary measures (WTP/WTA) are aspects that must be taken into account. Questions that we can highlight are:
  - Do the signs of the estimated coefficient coincide with what economic theory predicts? For example, if a significant and positive coefficient is associated to the income of the individual means that the higher the income, the greater the WTP is, coinciding with what economic theory predicts.
  - Have we designed a survey following the NOOA lines? In other words, have we used the WTP (to the contrary, what is the reason to use the WTA?) or conducted personal surveys, etc.?
  - Are statistics presented to check the validity and reliability of the results? A series of statistics (which are usually provided by the econometric programme itself) need to be presented together with the results to observe how they are the same. For example, the squared R, the BIC criterion, etc.
  - In the best of cases, and with time and resources available, it could be measured by the stability of the results over time. Therefore, we can use the test-retest techniques, i.e., to survey the same individuals on two different occasions, with a sufficiently large time difference as not to remember the valuation given the first time, or, by using two independent samples separated time wise but with a similar composition.

Practical examples

- Loureiro & Barrio, 2009. **Landscape, cultural and environmental valuation of Galician rural spaces: an economic perspective.** CIEF

Abstract: The fourth chapter performs an environmental-economic assessment of the change in the forest landscape as a result of the catastrophic fires in Galicia in 2006. The Annex also contains the survey conducted in this study.

Link: http://www.obrasocialncg.com/fundacion/portal/site/WINS001/menuitem.9f6721d90f15feac1b931b9351d001ca/index4dd9.html?vgnextoid=898c902a16ec0210VgnVCM1000000b0d10acRCRD&vgnextchannel=86aec2ab5d2fa110VgnVCM1000000b0d10acRCRD

- Martín-Ortega, J., Berbel, J. & Brouwer, R. (2009): **"Economic valuation of the no-market environmental benefits arising from improving the water quality: an estimate applying the Water Framework Directive to the Guadalquivir"**, Economía Agraria y Recursos Naturales, 9 (1): 65-89

Abstract: practical definition of the environmental benefit concept and a valuation scenario of the benefits of improving the water quality that are not reflected in the market are considered. This valuation is necessary, among other aspects, to assess the disproportionality of the costs of the Water Framework Directive. The methodology is applied to a practical case in the River Guadalquivir in a contingent valuation exercise.

Link: http://ageconsearch.umn.edu/bitstream/57281/2/4-Martin%20Ortega.pdf

- Loureiro, Loomis and Vázquez (2009). **Economic Valuation of Environmental Damages due to the Prestige Oil Spill in Spain. Environmental Resources Economics**, 44: 537-553

Abstract: These authors present an analysis of the data obtained using a contingent valuation to estimate the losses of use values and passive use values arising from the Prestige oil spill. A personal survey was therefore conducted, obtaining similar results to those obtained in the study of the losses from the Exxon Valdez in Alaska.

Link: http://www.springerlink.com/content/x048251n82h60572/?MUD=MP

- Aviles-Polanco, Gerzaín et al. 2010. **Economic valuation of the hydrological service of the La Paz aquifer, B.C.S.: A contingent value of the use of municipal water.** Frontera norte, vol.22(43): 103-128

Abstract: This paper seeks to perform the economic valuation of the La Paz aquifer, Baja California Sur. The contingent valuation method was used to discover the WTP of the households for water supply. The results reveal that the daily water consumption determines the WTP, implying that households with greater consumption have a lower WTP. The households with water restrictions have a greater WTP, compared to those with a constant flow.

Link: http://www.scielo.org.mx/scielo.php?pid=S0187-73722010000100005&script=sci_arttext

Resources

1. **Database of existing international studies or practical guides**

- NOOA, 1993. Report of the NOAA Panel on Contingent Valuation. http://www.darrp.noaa.gov/library/pdf/cvblue.pdf: panel of experts that create a guide framework, which directs the conducting of those studies covering all the stages involved. Important guide when performing a contingent valuation exercise.
- Riera, 1994. Manual de Valoración Contingente. http://pagines.uab.cat/pere.riera/content/manual-de-valoraci%C3%B3n-contingente: the appendix of this manual (in pdf) contains a contingent valuation questionnaire applied to the valuation of the Pallars Sobirá spaces included in the PEIN. Commands are also offered to estimate the Willingness to Pay for the LIMDEP programme and to estimate the Confidence Intervals.

7.7. Election Experiments

What is it?

In the same way as the contingent valuation method, the election experiments use surveys to simulate a market and the demand for a hypothetical change in the provision of ecosystemic services that the individuals are rating. However, in this case and unlike the contingent valuation method where the aim is to assess a specific scenario, this method allows different attributes or characteristics of environmental assets to be valued. Therefore, more than one variation in the quality or quantity of an asset are included. Using this questionnaire, the individuals are asked about their preferences regarding different alternatives, including an option where the current status or "status quo" of each of the attributes is considered. In the same way as contingent valuation, it is a hypothetical method, even though in this case, the values are obtained from hypothetical choices or tradeoffs that people make. As it is focused on the exchange or offsetting between scenarios with different characteristics, this method is particularly appropriate for social perception and political decision making, where a set of possible actions could result in different impacts on ecosystemic services or natural resources. For example, carrying out actions to improve the water quality of a lake may improve the quality of different services provided by the lake, such as supplying drinking water, fishing, biodiversity, etc.

There are different methods when applying this method (related to the way of asking the individual for their preferences:

- **CONTINGENT RANKING:** different alternatives are presented, with each of them are composed of different attributes with different levels, including cost. The people interviewed must rank the alternatives in order of preference.
- **DISCRETE ELECTION**:in the same way as the above case, the people interviewed must select the preferred alternative of the ones presented.
- **PAIRS SCORING:** it is a variation of the discrete election format, where the people interviewed are asked to compare two alternative situations and score them in terms of strength of their preferences (strong, moderate or slightly preferable to the other programme or alternative).

Regardless of the selection format, the choices of the people interviewed are assessed using statistical techniques to determine the relative values of the different characteristics or attributes. If one of the attributes is the price, the willingness to pay for the other attributes can be calculated. In the same

way as the contingent valuation, in order to collect information and provide significant results, the survey must be adequately designed, pre-tested and implemented (see this process in the contingent valuation).

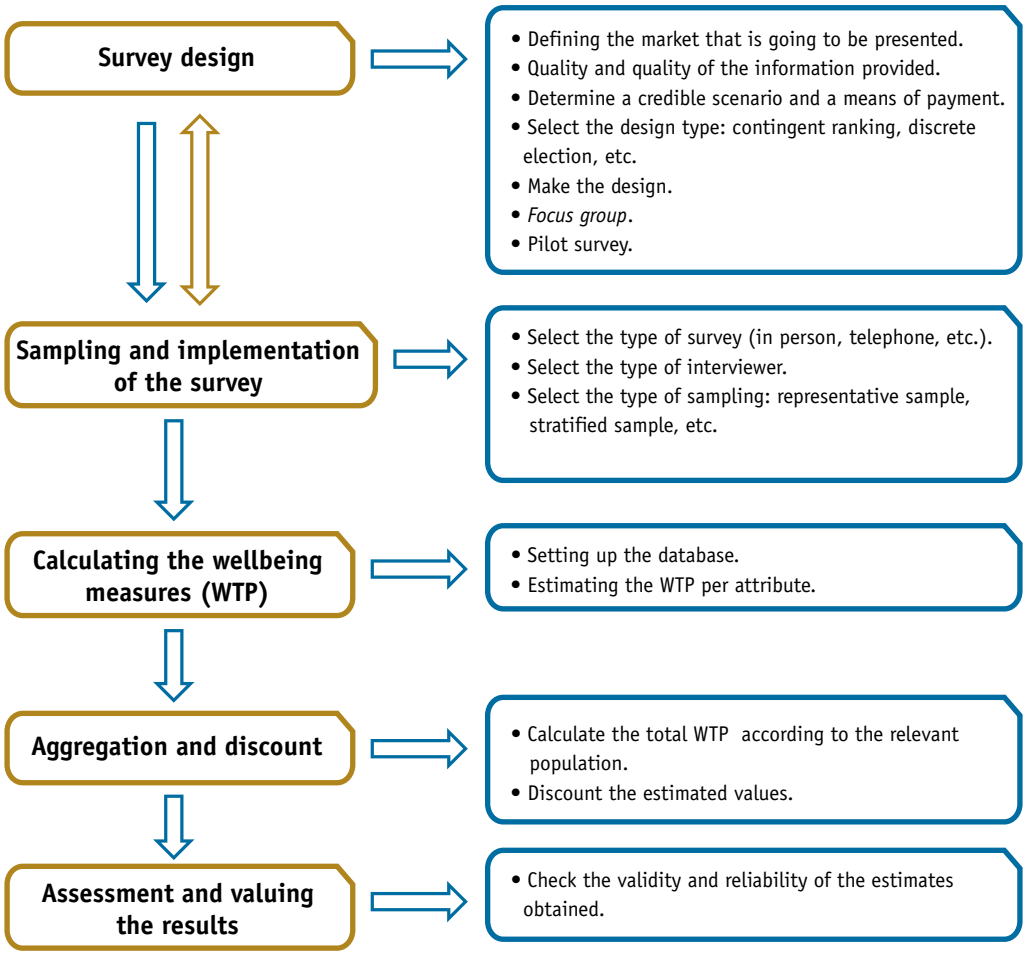
Strengths

- **VALUING NO-USE VALUES**: along with the contingent valuation method, it is the only method that can measure the existence and option values and provide a real TEV measurement.
- **COMPLETE:** it can be used to value both the results of an action and a whole, along with the different attributes or effects of the action.
- **THE PRICE iS RELATIVISED:** The people surveyed are generally comfortable about providing rankings or qualitative scores of different attributes that include the prices, instead of monetarily valuing different actions. Therefore, emphasis is shifted away from the prices by including them simply as another attribute.
- **VERSATILE:** It allows values of hypothetical situations to be measured.
- **RELATIVE VALUES:** the inclusion of relative values can facilitate the responses of the individuals, as it is easier to think in relative than absolute terms.
- **MINIMISING BIASES OF OPEN FORMATS:** establishing specific prices avoids the complication of the open format (in the same way as a closed format in the Contingent Valuation).

Weaknesses

- **PRACTICAL DIFFICULTY:** results sensitive to many factors that impact design and application biases. Such as:
  1. Lack of familiarity with the commodity, therefore there is no experience as a consumer.
  2. Errors associated to the measurement: different means of payment, etc.
- E**XPENSIVE**: The cost of applying this method is expensive.
- **DURATION:** The time required to carry out a study of this kind is significant.
- **PERCEIVED DIFFICULTY:** the people surveyed could find it difficult to make tradeoffs between the different attributes and levels, due to lack of familiarity.
- **DIFFICULTY IN THE DESIGN:** this method involves a complicated design of the scenarios presented (election experiments). Furthermore, if the number of attributes and the number of levels are greater, the number of scenarios increases and they become more complex.
- **SIMPLICITY IN ALTERNATIVES:** providing a limited number of options could result in the individual make choices that they would not select in a normal situation.
- **LOSS OF INTEREST:** if the number of election experiments is very high, the people surveyed may lose interest leading to a poor quality of the data. The individuals make likewise resort to simple decision rules if they find the choice to be too complicated, which could bias the results.
- **DIFFICULTY IN THE CALCULATION:** complex technical statistics are required to estimate the WTP.

Steps to be followed



The steps to be followed are:

- **STEP 1:** In the same way as in the contingent valuation method, this is one of the most important steps of the study. The questionnaire needs to be designed in such a way that the information sought is obtained, that this information is not biased and to do so, prepare a credible and doable survey for the people being surveyed. Directly related with this step would be the consideration of the population affected or the target population of our study (which will be fine-tuned in the subsequent step). For example, if the aim is to value the existence of the Iberian lynx, the target population could be the whole of Spain.

  The structure of the surveys is usually divided into different parts. A first that can include general questions or specific questions that allow information to be obtained about the knowledge of the individuals on the topic in question or introduce them to the problem being assessed. The second part contains the economic valuation questions. First of all, information is provided on the question being studied to subsequently raise the market or situation to be valued. The different scenarios, in which the price attribute is included are set out below[28]. As has been mentioned in the description of the method, according to the number of attributes to be valued, the number of cards shown to each

[28] The design of the election experiments is very complex and important. A poor design can cause the results to be null and void. Therefore, the input of an expert should be sought where preparing it.

individual will be different. It will be the very design process of the experiment that allows the final choice of the different levels of each attribute and the number of cards or experiments presented. An example of a card could be as follows:

	Alternative 1	Alternative 2	Current Status
Wolf protection programme	Yes	No	No
River Nalón cleaning programme	Yes	Yes	No
Conserving the native forest species	No	Yes	No
Tax (only this year)	20€	40€	0€
Indicate the preferred alternative			

Finally, socio-economic questions are asked in the third section, which will help of the individual for the valued action. Finally, a series of questions are introduced that must be completed by the interviewer (in the case of in-person surveys), such as: sex, place of the interview, length of the interview, etc.

Once this has been decided, a series of pilot surveys must be included if the whole survey is understood correctly. The final survey would be prepared after this pilot phase.

- **STEP 2:** This step is closely related to the previous one, and many of the decisions of step 1 will have to be taken according to this step and at the same time. For example, the selection of final questions of the survey will be different according to the type of survey that will be conducted, i.e., in person, online, etc.[29] The type of sampling that will be carried out will also have to be decided at this time. On the other hand, it is necessary to decide which is the population to be studied (an aspect directly related to the first step, i.e., this must be taken into account from the start of designing the survey), i.e., the population of a certain region, municipality, Autonomous Community, country, etc.

  On the other hand, the type of sampling to be carried out must also be established. The type of sampling can be random[30] (or probabilistic) or not random[31] (or not probabilistic). There are different types within the first: simple random, stratified, systematic sampling, or by conglomerates or areas. A type of sampling will be chosen according to the study targets. In the same way as in the contingent valuation, the most common are the two first, but that does not mean that another type of sampling cannot be carried. Therefore, only the most common are mentioned.

  In a simple random sampling, all the individuals have the same probability of being included in the sample. For example, the aim is to extract a sample of 20 individuals out of a population of 600 individuals. The 20 individuals of the sample are selected using random numbers. While, in a stratified random sampling all the strata or subpopulations have the same probability of being selected. What the criterion to identify the strata (maximum uniformity between the individuals of a single stratum, and maximum heterogeneity between the different strata) is going to be and the allocation criterion, which is the distribution of the size of the sample in the different strata[32] has to be taken into account here. For example, suppose a population in which the aim is to assess the implementation of

[29] The telephone survey is not appropriate for this method, as the presentation of the valuation scenarios is complex.
[30] All the individuals of the population can form part of the sample, they have a positive probability of forming part of the sample.
[31] There can be a clear influence of the person or persons who select the sample or it is simply performed according to reasons of convenience. Except in specific cases, it is not recommended to perform this type of sampling for a contingent valuation exercise.
[32] There are different allocation criteria. Two of the most simple are:
Equal allocation: each of the strata of the sample is made up of the same number of individuals.
Proportional allocation: each of the strata of the sample is made up of a number of individuals proportional to its size.

a forest protection policy. We believe that there can be differences in the answers of the individuals according to the zone where they live. Suppose that there are 4 differentiated zones according to the distance to the forestry zone, Zone A, with 350 residents, Zone B with 300, Zone C, with 250, and Zone D, with 300 neighbours. If the aim is to select a sample of 80 neighbours, so that all of them can be represented, we can chose according to the proportion that each stratum represents in the total population (proportional allocation). The total of the sample is therefore divided between the size of the population (1,100 inhabitants) and is multiplied by the size of each stratum. For example, (80/1100)*350= 25 individuals must be chosen from Zona A.

- **STEP 3:** Once the surveys have been conducted, all the information must be collected in a database for its subsequent analysis. Excel can be used to carry it out. Depending on the econometric programme and the type of model used to estimate the results, the data can be entered in different ways. The case for the NLOGIT 4.0 econometric programme and a conditional logit model (the simplest) is considered below by way of an example. Suppose that each individual answers 4 different cards or experiments like the one indicated in step 1. Therefore, we have 4 different valuations for each individual. Therefore, each of the individuals would be entered as a row on the Excel spreadsheet and the different questions codified in each column. Variables will be created, for example "**individual**", which indicates the individual to which the row corresponds. Another will be likewise created, for example "**idelection**", which will indicate to which experiment that response corresponds. In the same way, to include each of the attributes (in our example from step 1: wolf protection, river cleaning, conserving the native forest surface and payment, we will have to create variables indicating the level[33] (yes or not; or amount in euros paid in our example) corresponding to each alternative (alternative 1, alternative 2 and current situation). The variables will be called as follows: Wolf1protection (contains the protection level yes or no, of alterative 1), Wolf2protection (contains the protection level yes or no, of alterative 2), WolfSAprotection (contains the protection level yes or no, of the current situation), …, payment1 (contains the tax amount, €60, €40, €20 and €0, of alternative 1), payment2 (contains the tax amount, €60, €40, €20 and €0, of alternative 2), paymentSA (contains the tax amount, €0, of the current situation alternative, as there is no cost as no measure is currently being implemented). The other variables, in the same way as in the case of the contingent valuation, will be included in the following columns. Given that each individual is represented in 4 rows, the answers to those questions will have to be repeated 4 times (see the example of the **sex** variable)[34].

Individual	Idelection	Protection Wolf1 (Yes=1; No=-1)	Protection Wolf2 (Yes=1; No=-1)	Protection WolfSA (Yes=1; No=-1)	Cleaning River1 (Yes=1; No=-1)	Cleaning River2 (Yes=1; No=-1)	Cleaning RiverSA (Yes=1; No=-1)	Protection Forest1 (Yes=1; No=-1	Protection Forest2 (Yes=1; No=-1	Protection ForestSA (Yes=1; No=-1	Payment1	Payment2	PaymentSA	Sex (Female=1; Male=0)	…
1	1	1	-1	-1	1	1	-1	1	-1	-1	20	40	0	1	
1	2	-1	1	-1	1	-1	-1	-1	-1	-1	20	20	0	1	
1	3	-1	-1	-1	-1	1	-1	1	1	-1	20	40	0	1	
1	4	1	1	-1	1	1	-1	1	-1	-1	60	40	0	1	
2	1	1	-1	-1	1	1	-1	1	-1	-1	20	40	0	0	
2	2	-1	1	-1	1	-1	-1	-1	-1	-1	20	20	0	0	
2	3	-1	-1	-1	-1	1	-1	1	1	-1	20	40	0	0	
2	4	1	1	-1	1	1	-1	1	-1	-1	60	40	0	0	
3	1	1	-1	-1	1	1	-1	1	-1	-1	20	40	0	0	
3	2	-1	1	-1	1	-1	-1	-1	-1	-1	20	20	0	0	
3	3	-1	-1	-1	-1	1	-1	1	1	-1	20	40	0	0	
3	4	1	1	-1	1	1	-1	1	-1	-1	60	40	0	0	
…															

[33] The selection of the levels that each attribute will have is a very important step and will be performed beforehand. Specifically in Step 1. On the other hand, the codifying needs to be taken into account when introducing the variables.

[34] The example included here is invented and it is therefore not a valid, but merely explanatory design.

- **STEP 4:** Once the monetary valuation of the average individual or representative of the sample has been obtained and the relevant population determined, the monetary aggregation will be carried out. Suppose that the relevant population of our case study is the population of the municipality of Vitoria, then the residents in this zone are the potential beneficiaries of the measures to be carried out. On the other hand, suppose that the average estimate WTPs to carry out the actions mentioned to the inhabitants of the zone are:

	WTP	95% Confidence Interval
Wolf protection programme	5.42	(4.21; 6.63)
River Nalón cleaning programme	17.75	(5.50; 30.00)
Conserving the native forest species	12.28	(2.70; 21.86)

This means that the residents of the zone are willing to pay 5.42 €/year to implement the wolf protection programme, while this willingness rises to 17.75 €/year for a programme to clean the River Nalón. Finally, the willingness to pay of the local residents rises to 12.28 €/year to conserve the native forest species. Therefore, the benefits of carrying out a certain action (suppose that this is what is being valued) would reach different values according to the action to be carried out (WTP €/individual x 10,000 local residents over 18 years old). In this example, it has been assumed that the payment would be annual and one-off. However, the actions can imply payment in a certain number of years and may involve performing a cost-benefit analysis. When this occurs, the values need to be discounted or updated to the current year (see the example given in the contingent valuation method). There is a wide range of opinions about the discount rate to be applied. Some exercises use a zero discount rate as they argue that future generations should not be penalised, as they live in the moment that they live and have the same rights and the future value must not be lower. Thus, due to the difficulty to find a discount rate, we can use those that use a group of experts that worked on the Externe project (European Commission, 1998) when they updated the damage caused by greenhouse gases on a 100 year time scale. These rates range between 1 and 3%.

- **STEP 5:** This last section is closed related to all the previous steps, as when making the questionnaire, its application and the estimation of the monetary measures (WTP) are aspects that must be taken into account. Questions that we can highlight are:
  - Do the signs of the estimated coefficient coincide with what economic theory predicts? For example, if a significant and positive coefficient is associated to the income of the individual means that the higher the income, the greater the WTP is, coinciding with with economic theory predicts.
  - Have we designed an adequate experiment? Does the survey design follow the recommendations of the established literature?
  - Are statistics presented to check the validity and reliability of the results? A series of statistics (are usually provided by the econometric programme itself) need to be presented together with the results to observe how they are the same. For example, the squared R, the BIC criterion, etc. (these criteria depend on the model used). For example, the presentation of the confidence intervals when estimating the willingness to pay is essential.
  - In the best of cases, and with time and resources available, it could be measured by the stability of the results over time. Therefore, we can use the test-retest techniques, i.e., to survey the same individuals on two different occasions, with a sufficiently large time difference as not to remember the valuation given the first time, or, by using two independent samples separated time wise but with a similar composition.

Ejemplos prácticos

● Loureiro & Barrio, 2009. **Landscape, cultural and environmental valuation of Galician rural spaces: an economic perspective.** CIEF

Abstract: Chapter Two applies the election experiment methods in the River Eo-Oscos Biosphere Reserve. The willingness to pay is calculated of the local population affected by this reserve as regards different policy measures that would improve the cultural and natural state of the region. It can be seen that the population positively valued and gave priority to the measures to improve the river, followed by conserving the cultural heritage. A latent class model showed that the preferences notably differ between individuals. The Annex also contains the survey conducted in this study.

Link: http://www.obrasocialncg.com/fundacion/portal/site/WINS001/menuitem.9f6721d90f15feac1b931b9351d001ca/index4dd9.html?vgnextoid=898c902a16ec0210VgnVCM1000000b0d10acRCRD&vgnextchannel=86aec2ab5d2fa110VgnVCM1000000b0d10acRCRD

● Barrio & Loureiro. (2011): **"Perception of the residents and tourists towards the Maritime-Terrestrial National Park of the Atlantic Islands: presences regarding different management alternatives"**, in Research Projects in National Parks: 2007-2010. Monograph

Abstract: The paper seeks to establish the preferences both of the visitors and of the residents in the proximity of the Atlantic Islands National Park, regarding different management alternatives. The election experiment methodology is used. There are four actions to be valued: expanding the surface area, creating areas for smokers, controlling the number of visitors and activities to control non-native species. The results indicate that both populations show similarities as regards the possible expansion of the area of the park, reducing non-native species, and setting up specific areas for smokers within the park. As regards the measure that limits the number of daily visitors to the park, the tourists value it as a positive and significant action, while the residents consider it to be negative, even though it is no statistically significant. The results obtained can be used as a guide the national park managers.

Link: http://www.magrama.gob.es/es/organismo-autonomo-parques-nacionales-oapn/prog-inv-pn/divulgacion/15_investigacion_ok_tcm7-180282.pdf - http://www.magrama.gob.es/es/organismo-autonomo-parques-nacionales-oapn/prog-inv-pn/divulgacion/15_investigacion_o

● Riera & Mogas (2006). **An application of the election experiments for valuing the multi-functionality of the forests**. NCI [online]. 31 (2): 101-109 [citado 2012-10-13].

Abstract: An application of the election experiments is described. The empirical analysis consists of calculating the values associated to potential changes in the recreational, CO_2 absorption and erosion prevention functions as the result of a reforesting programme in Catalonia.

Link: http://www.scielo.org.ve/scielo.php?script=sci_arttext&pid=S0378-18442006000200006&lng=es&nrm=iso&tlng=es - http://www.scielo.org.ve/scielo.php?script=sci_arttext&pid=S0378-18442006000200006&lng=es&nrm=iso&tlng=es

8. CASE STUDY: THE IBERDROLA BIOVALORA PROJECT*

Iberdrola, with the support of this guide, has run a "**corporate assessment of ecosystem**s" **pilot scheme** as a tool to support business decision making including the environmental variable, as part of a long term vision to develop and implement an Iberdrola Biodiversity Strategy. This seeks to be an Iberdrola flagship policy to increase its competitiveness and environmental improvements; to guide and govern the Iberdrola actions in biodiversity in order to effectively reduce their impact but also including economic and social variables. The pilot scheme involved analysing the ecosystemic services as part of the Sistema Tera, Cernadilla - Valparaíso - Nª Sra de Agavanzal

In order to determine the services of the Sistema-Tera, an artificial reservoir, the generally valued services in comparable ecosystems (wetlands, and rivers and lakes) and a pre-selection of possible services was carried out. The presence and importance of those services were subsequently validated in field visits and interviews with technical staff at the power stations and local environmental experts and professionals. Important services that could be found in the study zone and which had not been included in the first list were also identified. Based on the review, it was decided to value six assets and ecosystemic services, that would allow the current management scenario to be compared to a scenario without reservoirs:

- Supply of drinking water.
- Supply of irrigation water for agriculture.
- Mitigation of damage caused by fires.
- Flood mitigation.
- Angling and recreational cultural service.
- Valuing flooded forest areas.

The services identified as potential waste treatment, maintaining the life cycles of migratory species and conserving the genetic variability were not valued as after visiting the zone and speaking with local experts, it was deemed that even if they were present, their relative weight was low.

The most commonly applied evaluation methodologies were identified with the help of the second part of the guide for each of the services identified and it was decided which to apply in each case using the available information and resources. The services that would be found in the alternative scenario were also valued to facilitate the comparison of scenarios. The annual value, along with the stock value over a 20-year period and with a discount rate of 3%, was valued for each service. The value of each service was also compared in the current scenario with respect to alternative scenarios to detect services that could have been harmful and thus be able to direct mitigation actions.

The main results are shown in Tables 9 and 10. The study pinpointed the strength in the region of some ecosystemic services and revealed the importance of some others that were not clear. For example, the reservoirs create a constant sheet of water and the topography of the place mean that it is the only place in the zone where fire-fighting hydroplanes can take up water. This means that the local fires are put out more effectively, and it has been estimated that the disappearance of forests to the tune of €800,000 is avoided every year.

* Case study in which the guide has been applied.

SERVICE	METHOD	CURRENT	PREVIOUS	PREVIOUS EIA	DIFFERENCE
Drinking water (1)	Market Value	464,855			**464,855**
Agriculture (irrigation) (2)	Market Value	509,630	147,563	265,343	**303,177**
Fire Mitigation (3)	Cost prevented	817,900			**817,900**
Regulación Avenidas (4)	Cost prevented	20,708			**20,708**
Flood Regulation	Benefit transfer	16,659	11,764	11,764	**4,895**
Forest zone value flooded	Benefit transfer		230,230	230,230	**- 230,230**

Table 9: Annual flow values.

Current net value	Scenario		
Service	Reservoir	Prior (data pres. study)	Prior (EIA data)
Drinking water	6,915,869		
Agriculture (irrigation)	7,582,008	2,195,365	3,947,634
Fire Prevention	12,168,287		
Flood Regulation	308,083		
Cultural services	247,844	175,019	175,019
Flood zone forest value		3,425,245	
TOTAL	27,222,091	5,795,628	4,122,652

Table 10: Estimated stock values.

The main conclusions extracted from this pilot scheme have been:

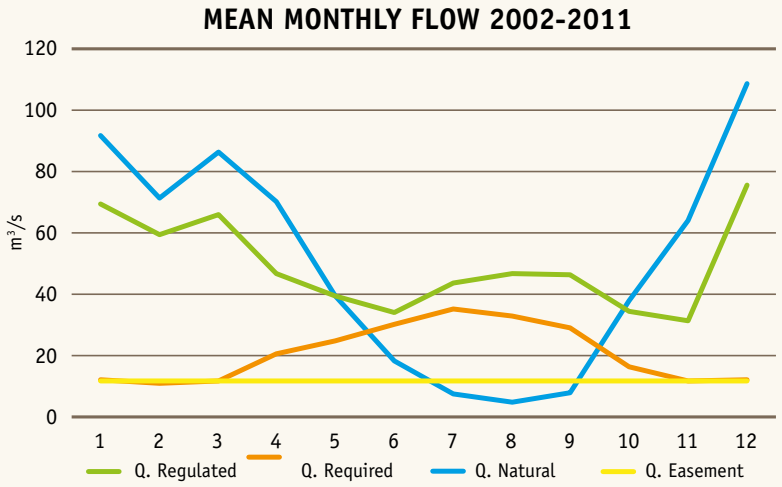
Tera River Basin application conclusions

- They stress the services to supply the drinking water during the summer, supply of irrigation water and availability of water to put out fires.
- Another service that is worth consideration is the mitigation of flooding carried out by means of the flow abatement. The abatement eliminates 50% of the flooding flows and mitigates 31% of their impact. The damage avoided by means of this service could only be partially valued and it is undeniably greater.
- Part of the ecosystemic services of the Tera River Basin go beyond the reservoirs in a geographical sphere of over 40 km in radius.
- The Tera River Basin provides cultural services associated to artificial beaches and angling. In the alternative scenario, the cultural services are considered to be associated to trout fishing and game hunting. The Tera River Basin provides opportunities to diversify the tourist activities in the region.
- In the case of the two services, agriculture and cultural services, which occur in the two scenarios (current and without reservoirs), the value is greater in the current scenario. Note that the specific characteristics of each service are different in each scenario.
- The only net value loss that has been detected is the one associated to the waterlogged surface, particularly in the forest. This information can help to guide future environmental improvement and/or offset actions in the zone.

- There are undeniably other ecosystemic services present in the Tera River Basin than have not be assessed in this study. In any event, their importance is considered to be lower and their contribution to the total value would be significantly scarce, and/or that their valuation is so complex that it is outside the scope of this study.

"Example of valuing a fresh water supply"

The Tera River Basin reservoirs, managed by Iberdrola, were created to supply electricity. However, the water from the system is used to supply drinking water to the local residents. The assessment of the river flows reveals that if the reservoirs did not exist, the average flow for July, August and September would not be sufficient to supply the ecological flow minimums. Therefore, the supply of drinking water, and other uses, would not be possible without the reservoirs. This service was valued using the water supply costs and rates and the average consumptions. The results showed a figure of 464 855 €/year.



Methodology conclusions

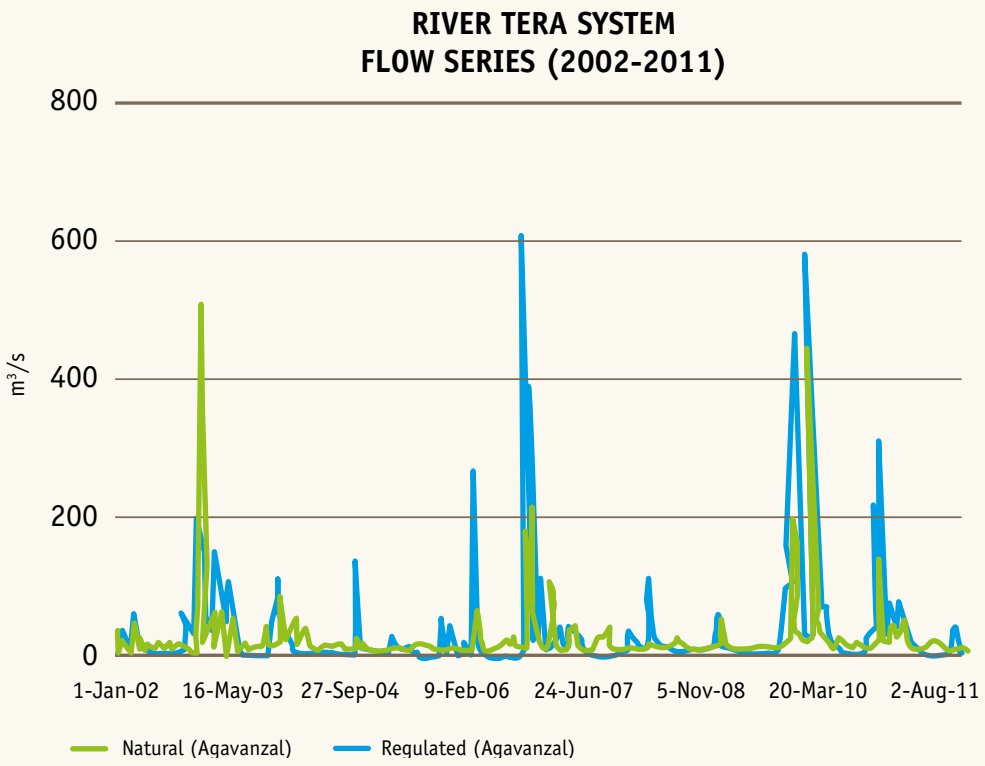
- The methodology used is traceable and facilitates the comparison between services and scenarios. The pitfalls detected include the difficulty to obtain economic data on some services, particularly from private stakeholders, and the scarcity or lack of availability of comparable original studies in our setting.
- The foreseeable fields of application of this methodology include:
  - Decision making considering different alternatives (constructing infrastructures…).
  - The analysis of the socio-economic and environmental impact of projects and infrastructures.
  - The expansion and improvement of the Environmental Impact Studies to provide a more real and global vision that facilitates third-party evaluation.
  - Alignment of biodiversity policies in companies with the impacts caused by them.
  - ElDesigning communication campaigns about the socio-economic and ecological effects of different premises, projects or policies.

This scheme has been very satisfactory and this guide is very useful and helps to design and implement the study. Iberdrola plans to continue to work in this line and give greater importance to its internal biodiversity policy.

"Costs avoided valuation example"

Iberdrola valued how the output flow management of the reservoirs of the Tera River Basin affects the damage caused by the floods downstream.

It compared the natural with the regulated flow and found that the flow regulation eliminated most of the flood peaks and modulated the others. The losses covered by the Insurance Compensation Consortium for cases of flooding in the days following peaks in flows were assessed in order to allocate an economic value to that modulation and a ratio was established between absolute flow and damage caused. This ratio was then used to estimate the amount of damage caused by different flow flooding, and the difference between the damage caused by the modulated flow (the water released from the reservoir) and that estimated for the absolute flow (the water that entered in the dam). This difference matches the costs avoided: the damage or costs which would have been incurred if it were not for the regulation services. In this case, there were 20,708 per year (with a typical deviation of €23,4069. The high variation was due to there being no or hardly any damage in most years, while highly destructive sporadic flooding occurs in medium-long return periods.



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