

The methods to estimate the monetary value of the environment

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Overview of the presentation

- Basic concepts of economic value
- Valuation of natural resources
- Overview of methods to assess monetary values of environmental and natural resources

Why estimate natural resource values?

- Government agencies must make decisions about how to allocate public investments to protect and restore the natural environment.
- Environmental program managers have to consider many objectives, including environmental quality, threats to natural resources, and effects on people's quality of life.
- Agencies must justify their decisions, not only in terms of benefits to the natural environment, but also in terms of fiscal accountability and public support.

Why do we need estimates of environmental benefits?

- To justify and decide how to allocate public spending on conservation, preservation, or restoration initiatives.
- To consider the public's values, and encourage public participation and support for environmental initiatives.
- To compare the benefits of different projects or programs.
- To prioritize conservation or restoration projects.
- To maximize the environmental benefits per euro spent.

Monetary measures of natural and environmental resources

- Measures of economic value should be based on *what people want*
- In a democratic state, *individuals* should be the judges of what people want
- A fair measure of the relative "value" of the two things to a person is the maximum amount of *one thing* a person is willing to give up to get more of *the other thing*.
- *Money* is a universally accepted measure of economic value because the amount that people are "willing to pay" for something reflects how much of all other for-sale goods and services they are willing to give up to get it.
- Measuring the value of something using euros does not require that it be bought and sold in markets.
- It only requires estimating how much purchasing power (euros) people would be willing to give up - willingness to pay – to get it, or would need to be paid to give it up – willingness to accept – if they were forced to make a choice.

The economic approach to valuing the environment

- Market failures
 - (i) environment provides services that are public goods;
 - (ii) many environmental services are affected by externalities;
 - (iii) property rights related to natural resources and their services are often not clearly defined.
- Valuation of natural resources and of the environment can help resource managers to deal with the effects of market failures, by measuring their costs to society, in terms of lost economic benefits.
- The costs to society can then be imposed, in various ways, on those who are responsible, or can be used to determine the value of actions to reduce or eliminate environmental impacts.
- Values of natural and environmental resources are measures of how important they are to people – what they are worth.
- It is not necessary for natural and environmental resources to be bought and sold in markets in order to measure their value in euros.

Methods to estimate monetary values

Market price method	Revealed preference
Production function	
Hedonic pricing method	
Travel cost method	
Damage cost avoided, Replacement cost, Substitute cost methods	Imputed willingness to pay
Contingent valuation	Stated preference
Choice experiments	

Revealed preference methods

=> past behaviour

- The values of some natural resources or services can be measured using market prices. Some ecosystem products, such as fish or wood, are **traded in markets**.
- Their values can be estimated by estimating consumer and producer surplus, as with any other market good.
- Other ecosystem services, such as clean water, are used as **inputs in production**, and their value may be measured by their contribution to the profits made from the final good.
- Some ecosystem or environmental services, like aesthetic views or many recreational experiences, **may not be directly bought and sold in markets**. However, the prices people are willing to pay in markets for related goods can be used to estimate their values. For example, people often pay a higher price for a home with a view of the ocean, or will take the time to travel to a special spot for fishing or bird watching.
- These kinds of expenditures can be used to place a **lower bound** on the value of the view or the recreational experience
=> only use values

Market price method

- Used to assess the economic value of natural resources or services that are bought and sold in **commercial markets** (commercial fish, timber).
- Used to value changes in either the quantity or quality of a good or service.
- It uses standard economic techniques for measuring the economic benefits from marketed goods, based on the quantity people purchase at different prices, and the quantity supplied at different prices.
- **Example:**
Water pollution has caused the closure of a commercial fishing area, and the government agency wants to evaluate the benefits of cleanup.
The market price method is selected because the primary resource affected is fish that are commercially harvested, and thus market data are available.

Production function method

- The productivity method is used to estimate the economic value of ecosystem **products or services that contribute to the production of commercially marketed goods.**
- Water quality affects the productivity of irrigated agricultural crops, or the costs of purifying municipal drinking water.
- The economic benefits of improved water quality can be measured by the increased revenues from greater agricultural productivity, or the decreased costs of providing clean drinking water.
- **Example:** A reservoir that provides water for a city's drinking water system is being polluted by agricultural runoff. Agency staff want to determine the economic benefits of measures to eliminate the runoff.
- The productivity method is selected because this is a straightforward case where environmental quality directly affects the cost of producing a marketed good—municipal drinking water. Thus, the benefits of improved water quality can be easily related to reduced water purification costs.

Applying the production function method

- Collect data regarding how changes in the quantity or quality of the natural resource affect:
 - costs of production for the final good
 - supply and demand for the final good
 - supply and demand for other factors of production
- Need to link the effects of changes in the quantity or quality of the resource to changes in consumer surplus and/or producer surplus, and thus to estimate the economic benefits.
- Example: the resource is a perfect substitute for other inputs. Increased water quality in a reservoir means that less chlorine is needed for treating the water. The benefits of increased water quality can be directly measured by the decreased chlorination costs.

Hedonic pricing method

- Used to assess the economic values of environmental aspects that directly affect market prices. It is most commonly applied to variations in housing prices that reflect the value of local environmental attributes.
- Used to estimate economic benefits or costs associated with:
 - environmental quality, including air pollution, water pollution, or noise
 - environmental amenities, such as aesthetic views or proximity to recreational sites
- The price of a marketed good is related to its characteristics, or the services it provides. The idea is to explain the price of the house with its characteristics (number of rooms, area, type of house, age, etc.) and the characteristics of the neighbourhood (environmental quality, census tract mean household income, etc.)
- Need to have **data on real estate transactions or rents.**

Application of the hedonic pricing method

- Collect data on residential property sales in the region for a specific time period:
 - selling prices and locations of residential properties
 - property characteristics that affect selling prices, such as lot size, number and size of rooms, and number of bathrooms
 - neighbourhood characteristics that affect selling prices, such as property taxes, crime rates, and quality of schools
 - accessibility characteristics that affect prices, such as distances to work and shopping centres, and availability of public transportation
 - environmental characteristics that affect prices
- Use regression techniques to estimate a function that relates property values to the characteristics:

$$\ln p_i = \alpha + \beta_1 x_{1i} + \beta_2 x_{2i} + \dots + \beta_k x_{ki} + \varepsilon_i$$

- The coefficients of the regression function give the implicit price, in natural logarithm terms, of the characteristics of the house
- The implicit price can be estimated for specific value of the characteristics of houses (for example, the average value)
- For the semi-log function, the implicit price of x_1 is given by:

$$\frac{\partial p}{\partial x_1} = p\beta_1$$

- β_1 gives the percentage change in the price of housing given a percentage change in x_1
- We usually estimate the implicit price at the average value of housing

Travel cost method

- Used to estimate **use values** associated with sites that are used for **recreation**.
- The method can be used to estimate the economic benefits or costs resulting from:
 - changes in access costs for a recreational site
 - elimination of an existing recreational site
 - changes in environmental quality at a recreational site
- The time and travel cost expenses that people incur to visit a site represent the “price” of access to the site.
- Peoples’ willingness to pay to visit the site can be estimated based on the number of trips that they make at different travel costs.
- Example: A site used mainly for recreational fishing is threatened by development in the surrounding area. Pollution and other impacts from this development could destroy the fish habitat at the site, resulting in a serious decline in, or total loss of, the site’s ability to provide **recreational** fishing services. Resource agency staff want to determine the value of programs or actions to₁₅ protect fish habitat at the site.

Applying the Travel Cost Method

- On average, people who live farther from a site will visit it less often, because it costs more in terms of actual travel costs and time to reach the site.
- The demand curve shows how many visits people would make at various travel cost prices, and is used to estimate the willingness to pay for people who visit the site.
- Other factors may also affect the number of visits to a site: income, personal interest in the type of site, or level of recreational experience.
- To apply the travel cost method, information must be collected about:
 - number of visits per respondent
 - Respondents' socio-demographics
 - travel expenses, including round-trip mileage for each respondent, the length of the trip, the amount of time spent at the site
 - the value of time spent travelling, or the **opportunity cost** of travel time
 - substitute sites that the person might visit instead of this site, and the travel distance to each
 - other locations visited during the same trip
 - other reasons for the trip

Damage Cost Avoided, Replacement Cost, and Substitute Cost Methods

- Methods that estimate values of natural resources based on either the costs of avoiding damages due to lost services, the cost of replacing ecosystem services, or the cost of providing substitute services.
- Do not provide strict measures of economic values, which are based on peoples' willingness to pay for a product or service.
- Assume that the costs of avoiding damages or replacing ecosystems or their services provide useful estimates of the value of these ecosystems or services.
- This is based on the assumption that, if people incur costs to avoid damages caused by lost ecosystem services, or to replace the services of ecosystems, then those services must be worth at least what people paid to replace them.
- Thus, the methods are most appropriately applied in cases where damage avoidance or replacement expenditures have actually been, or will actually be, made.
- Example: Valuing improved water quality by measuring the cost of controlling effluent emissions.
- Example: Valuing erosion protection services of a forest or wetland by measuring the cost of removing eroded sediment from downstream areas.

Applying the Damage Cost Avoided, Replacement Cost, and Substitute Cost Methods

- Assess the environmental service(s) provided.
 - This involves specifying the relevant service(s), how they are provided, to whom they are provided, and the level(s) provided.
 - For example, in the case of flood protection, this would involve predictions of flooding occurrences and their levels, as well as the potential impacts on property.
- Estimate the potential physical damage to property
- The final step for the *damage cost avoided* method is to calculate either the monetary value of potential property damage, or the amount that people spend to avoid such damage.
- For the *replacement or substitute cost* method need to identify the least costly alternative means of providing the service(s).
- Calculate the cost of the substitute or replacement service(s).
- Finally, public demand for this alternative must be established. This requires gathering evidence that the public would be willing to accept the substitute or replacement service(s) in place of the ecosystem service(s).

Stated preference methods

=> what I would do under hypothetical scenario(s)

- Many natural resources are not traded in markets, and are not closely related to any marketed goods.
- Thus, people cannot “reveal” what they are willing to pay for them through their market purchases or actions.
- Surveys can be used to ask people directly what they are willing to pay, based on a hypothetical scenario:
 - => contingent valuation
- Alternatively, people can be asked to make tradeoffs among different alternatives, from which their willingness to pay can be estimated:
 - => choice experiments
- I can assess both *use and non-use values*

Contingent Valuation Method (CVM)

- CVM method involves directly asking people, in a survey, how much they would be willing to pay for specific environmental services.
- “Contingent” because people are asked to state their willingness to pay, *contingent* on a specific hypothetical scenario and description of the environmental service.
- The fact that the contingent valuation method is based on asking people questions, as opposed to observing their actual behavior, is the source of enormous controversy.
- Results are highly sensitive to what people believe they are being asked to value, as well as the context that is described in the survey.
- Expensive methodology: survey must be properly designed, pre-tested, and implemented.
- NOAA Panel guidelines, referendum format, payment vehicle incentive compatible, debriefing questions
- CVM can be conducted as in-person interviews, telephone interviews or mail surveys.

Applying the Contingent Valuation Method

- Before designing the survey, learn as much as possible about how people think about the good or service in question.
- Determine the extent of the affected populations or markets for the good or service in question, and choose the survey sample based on the appropriate population.
- The hypothetical scenario must provide an accurate and clear description of the change in environmental services.
- If necessary, convey information using photographs, videos, or other multi-media techniques, as well as written and verbal descriptions.
- Clearly define the payment vehicle
- Remind respondents of budget constraints.
- If the household is the unit of analysis, the reference income should be the household's income.
- Debriefing questions to verify comprehension and acceptance of the scenario
- Interview a large, clearly defined, representative sample of the affected population.

Choice Experiments method (CE)

- CE does not directly ask people to state their values in euros. Instead, values are inferred from the hypothetical choices or tradeoffs that people make.
- In a *choice experiment* exercise, respondents are shown a set of alternative representations of a good and are asked to pick their most preferred.
- Similar to real market situations, where consumers face two or more goods characterized by similar attributes, but different levels of these attributes, and are asked to choose whether to buy one of the goods or none of them.
- Alternatives are described by attributes—the alternatives shown to the respondent differ in the levels taken by two or more of the attributes.
- If we want to use conjoint analysis techniques for valuation purposes, one of the attributes **must be the “price”** of the alternative or the cost of a public program to the respondent.
- If the “**do nothing**” (or “**status quo**” option—i.e., pay nothing and get nothing) is included in the choice set, the experiments can be used to compute the value (WTP) of each alternative.

Conjoint choice question from Hanley et al. (2001)

Which route would you prefer to visit in the summer, given the two routes described below?		
Characteristics of Route	Route A	Route B
Length of climb	100 meters	200 meters
Approach time	3 hours	2 hours
Quality of climb	2 stars	0 stars
Crowding at route	Crowded	Not crowded
Scenic quality of route	Not at all scenic	Not at all scenic
Distance of route from home	160 miles	110 miles
Prefer Route A?	<input type="checkbox"/>	
Prefer Route B?	<input type="checkbox"/>	
Stay at home? (Choose neither?)	<input type="checkbox"/>	

Benefit Transfer Method

- The benefit transfer method is used to estimate economic values for ecosystem services by transferring available information from studies already completed in another location and/or context.
- Thus, the basic goal of benefit transfer is to estimate benefits for one context by *adapting an estimate of benefits from some other context*.
- Benefit transfer is often used when it is too expensive and/or there is too little time available to conduct an original valuation study, yet some measure of benefits is needed.
- Benefit transfers can only be as accurate as the initial study.

Applying the Benefit Transfer Method

- Identify existing studies or values that can be used for the transfer.
- Select the appropriate studies considering whether
 - the service being valued is comparable to the service valued in the existing studie(s).
 - the characteristics of the relevant population are comparable.
- Evaluate the quality of studies to be transferred.
- Adjust the existing values to better reflect the values for the site under consideration, using whatever information is available and relevant.
- Estimate the total value by multiplying the transferred values by the number of affected people.

Which method to use?

- ...good question...
- Identify the object of the valuation exercise
- Identify whose welfare is affected (or whose welfare we are interested in)
- Consider your budget constraint, time, characteristics of the study and of the population affected