Environmental Valuation

Natural Resource Economics

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Outline

Introduction

Introduction 1

- Rational use of natural capital is fundamental to sustainable development.
- Economic development without environmental conservation leads to depletion and degradation.
- Environmental valuation measures the value of goods/services not traded in markets but vital for well-being.

Introduction 2

- Historically, the environment was treated as a free good; now, valuation is crucial.
- **Natural resource curse!** Countries with rich natural resources are the poorest. Example: Dominic Republic of Congo and Nauru country.
- Nauru country is a classic example for both the curse and need for evaluation and management.
- Country is west pacific, 21 square km: Became independent in 1968- large scale mining.
- Became richest by 1975 - no taxes, all public services free.
- Right now, it is diabetic capital of the world, and one of the poorest

Introduction 3

- **What we measure?** Measure change in flow of services and its effect on human welfare, not absolute value.
- **Key objectives:**
  - Inform policy and investment decisions.
  - Integrate into cost-benefit analyses.
  - Design compensation schemes.
  - Set user charges, taxes, and incentives.
  - Support efficient and equitable allocation of resources.

Economic Value of Environmental Goods and Services

What is Environmental Value?

- Monetary worth of environmental goods and services, as reflected in preferences.
- Value arises from interaction between people and the environment (Pearce and Turner).
- Value exists only if it contributes to someone's utility or production.

Total Economic Value (TEV) Framework

- **Use Values:** Derived from actual use (direct or indirect).
    - **Direct Use:** Timber, fishing, recreation, scenic beauty.
    - **Indirect Use:** Water purification, flood control, nutrient cycling.
- **Non-Use Values:** Not associated with current or planned use.
    - **Existence Value:** Knowing a resource exists (e.g., endangered species).
    - **Bequest Value:** Preserving for future generations.
    - **Option Value:** Preserving the option for future use.
- **Example:** Forests provide timber (direct), regulate climate (indirect), offer existence and bequest values.

Market Failure and the Need for Valuation

Market Failure in Environmental Context

- Markets often fail for environmental goods/services due to:
  - **Externalities:** Costs/benefits not in market prices (e.g., pollution).
  - **Public Goods:** Non-excludable, non-rival (e.g., clean air).
  - **Lack of Property Rights:** Open-access leads to overuse (tragedy of the commons).
  - **Space and Time:** Benefits/costs cut across space and time.
- Result: Negative externalities overproduced, positive underprovided; market outcome not socially optimal.

Role of Environmental Valuation

- Makes invisible values visible by assigning monetary values to non-market goods.
- Informs cost-benefit analysis for policy/investment.
- Designs compensation/incentive mechanisms (e.g., payments for ecosystem services).
- Sets user charges, taxes, subsidies to correct market failures.
- Supports sustainable resource management and intergenerational equity.

Classification of Environmental Values

Classification of Environmental Values- Ex. Forest

- **Use Values**
  - **Direct Use:**
    - **Consumptive:** Timber, fishing, NTFPs, water extraction.
    - **Non-Consumptive:** Recreation, aesthetic enjoyment, vicarious consumption.
  - **Indirect Use:** Ecosystem services (flood control, water purification, climate regulation, pollination).
- **Non-Use Values**
  - **Existence Value:** Knowledge that a resource exists.
  - **Bequest Value:** Preserving for future generations.
  - **Option Value:** Maintaining the option for future use.

Types of Environmental Values in Forests

Value Type	Examples in Forests
Direct Use (Consumptive)	Timber, fuelwood, medicinal plants, food
Direct Use (Non-Consumptive)	Recreation, spiritual value, landscape beauty
Indirect Use	Carbon sequestration, water regulation, soil fertility
Existence Value	Value of rare/endangered species, old-growth forests
Bequest Value	Preserving forests for future generations
Option Value	Potential future use of genetic resources, medicines

Methods of Environmental Valuation

Overview of Valuation Methods

- **Revealed Preference Methods:** Infer values from observed behavior in related markets.
- **Stated Preference Methods:** Use surveys to elicit values directly.
- **Benefit Transfer:** Uses values from one context for another.

Revealed Preference Methods

1. **Production Function Approach**
   - Measures contribution of environmental inputs to production.
   - Example: Water quality's effect on crop yields.
   - Limitation: Needs detailed data, risk of double-counting.

2. **Cost-Based Methods**
   - **Averting Expenditure:** Costs to avoid harm (e.g., water filters).
   - **Cost of Illness/Human Capital:** Medical costs, lost productivity.
   - **Restoration Cost:** Cost to restore asset after damage.
   - Limitation: May not reflect full value or welfare loss.

3. **Travel Cost Method (TCM)**
   - Estimates recreational site value from travel expenses.
   - Types: Zonal, Individual, Random Utility TCM.
   - Limitation: Hard to model multi-site visits.

4. **Hedonic Pricing Method (HPM)**
   - Uses property price differences to infer value of environmental attributes.
   - Limitation: Captures only value reflected in market transactions.

Stated Preference Methods

1. **Contingent Valuation Method (CVM)**
   - Constructs a hypothetical market; asks WTP or WTA.
   - Elicitation: Bidding game, payment card, discrete choice, follow-up.
   - Steps: Define scenario, select payment vehicle, design survey, analyze data.
   - Limitations: Susceptible to biases (starting point, hypothetical, strategic, information).

2. **Choice Modelling/Discrete Choice Experiments**
   - Respondents choose between alternatives with different attributes and costs.
   - Can value multiple attributes simultaneously.

3. **BDM auction**
   - Becker- Degroot -Marschak Auction method
   - Steps: Arrange product, explain the bidding rule (every participant provide a closed bid), pick a random bid, bidders price $>$ random price, has to pay and buy.
   - Limitation: Difficult to implement.

1. **Benefit Transfer**
    - Uses values from one context for another, with adjustments.
    - Steps: Identify studies, gather info, adjust values, apply, estimate total benefits/costs.
    - Limitation: Accuracy depends on similarity of contexts.

Welfare Measures: WTP and WTA

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- **Compensating Variation (CV):** Income needed to compensate for a price change, returning to original welfare.
- **Equivalent Variation (EV):** Income change yielding same utility change as a price change.
- **Willingness to Pay (WTP):** Maximum amount willing to pay to secure a gain or prevent a loss.
- **Willingness to Accept (WTA):** Minimum amount willing to accept to tolerate a loss or forego a gain.
- WTP and WTA often diverge due to income effects and loss aversion; typically, WTA > WTP.

Selected Valuation Techniques

Production Function Method

- Values environmental inputs by measuring their effect on production output.
- Example: Impact of improved water quality on crop yields.
- Used in agriculture, fisheries, and forestry.
- Limitations: Difficult to isolate effects, risk of double-counting, often static.

Cost-Based Methods

- **Averting Expenditure:** Costs to avoid negative impacts (e.g., bottled water, air purifiers).
- **Cost of Illness/Human Capital:** Medical costs, lost earnings, reduced life expectancy.
- **Restoration Cost:** Cost to restore an asset as value proxy.
- Limitations: May underestimate or overestimate welfare cost; restoration may not be feasible.

Travel Cost Method (TCM)

- Values recreational sites by analyzing travel expenses.
- Types: Zonal TCM (aggregate data), Individual TCM (survey data), Random Utility TCM (site choice).
- Assumptions: Homogeneous populations, travel cost as entry fee.
- Steps:
  1. Define zones around the site.
  2. Collect visitor data from each zone.
  3. Calculate visitation rates and average travel cost.
  4. Regress visits per 1000 population against travel cost.
  5. Calculate area under demand curve for total value.
- Limitation: Difficult to model multi-site visits.

Zonal TCM

- Derive zones around the site (based on distance)
- Obtain data on visits (Visits, distance, demography)
- Obtain visitation rate
- Obtain cost (travel cost + opportunity cost)
- Regress Visitation rate against travel cost (trip generation function)
- Obtain the area under the curve- Consumer surplus

TCM- Individual

- Obtain data- number of visits, travel cost etc
- Regress visit frequency against travel cost (usually log linear)
- Obtain the consumer surplus $CS = -\left(\frac{1}{B_{tc}}\right)$
- This formula is for estimating the area under demand curve (Derive by integrating demand function over Zero TC and Choke TC)

TCM - Random Utility

- Obtain attributes of different sites
- Obtain visitation preference in the form of choice cards
- Run a mixed logit model
- Obtain the WTP (Divide attribute wise coefficient with the coefficient of travel cost)

Hedonic Pricing Method (HPM)

- Uses property price differences to estimate value of environmental attributes.
- Steps:
    1. Estimate hedonic price function (property price as function of attributes- usually log linear).
    2. Include environmental variables.
    3. Derive implicit prices (marginal effect)
    4. Estimate inverse demand function for heterogeneous preferences (estimate marginal effect as a function of other parameters).
    5. Estimate consumer surplus (area under demand curve)
- Limitations: Assumes zero transaction costs, perfect information; only captures value in market transactions.

Contingent Valuation Method (CVM)

- Constructs a hypothetical market to elicit WTP/WTA for non-market goods.
- Elicitation: Bidding game, payment card, discrete choice, follow-up.
- Survey: Phone, mail, interviews.
- Biases: Starting point, payment vehicle, hypothetical, strategic, embedding, information.
- Steps:
    1. Define scenario and payment vehicle.
    2. Choose elicitation method.
    3. Design and administer survey.
    4. Analyze data to derive WTP/WTA.
    5. Interpret results and conduct scope/price tests.

Benefit Transfer

- Uses values estimated in one context for another, with adjustments.
- Steps:
    1. Identify and select relevant original studies.
    2. Gather background information.
    3. Adjust values for context differences.
    4. Apply transferred values to new context.
    5. Estimate total costs and benefits.
- Limitation: Accuracy depends on similarity between study and policy sites.

Environmental Impact Assessment (EIA)

Environmental Impact Assessment (EIA)

- **Definition:** Assessment of the impact of planned activities on the environment.
- **Objectives:**
  - Integrate environmental considerations into decision making.
  - Anticipate and avoid adverse effects.
  - Protect productivity and capacity of natural systems.
  - Promote sustainable development.

Basic Steps in EIA

1. **Screening:** Decide if EIA is needed.
2. **Scoping:** Identify key issues, set boundaries, engage stakeholders.
3. **Impact Assessment and Mitigation:** Assess impacts, suggest mitigation, conduct economic analysis.
4. **Impact Management:** Plan and monitor mitigation measures and risks.

Methods Used in EIA

- Expert Judgement (e.g., Delphi approach)
- Rapid Impact Assessment Matrix (RIAM)
- Battelle Environmental Evaluation System
- Benefit-Cost Analysis
- Cost-Effectiveness Analysis
- Threshold Value Analysis
- Trade-Off Analysis and Multi-Criteria Analysis

Summary Table: Key Methods

Summary Table: Key Environmental Valuation Methods

Method	Type	Key Features / Applications
Production Function	Revealed Preference	Values input via output; agriculture, fisheries
Averting Expenses	Cost-Based	Costs to avoid harm as proxy for value
Cost of Illness	Cost-Based	Health impacts via medical costs, lost produc
Restoration Cost	Cost-Based	Cost to restore asset as value proxy
Travel Method	Revealed Preference	Values recreation via travel expenses
Hedonic Pricing	Revealed Preference	Infers value from property prices
Contingent Valuation	Stated Preference	Elicits WTP/WTA via surveys
Benefit Transfer	Transfer	Applies values from past studies

Assignments

Assignments

1. List all the different types of environmental values offered by forests (e.g., timber as direct use value, scenic beauty as non-consumptive use value).

2. Prepare a list of research papers using one of the environmental valuation methods described in this section.

3. Design a research plan to estimate willingness to pay for pesticide residue-free grapes using the contingent valuation format.

4. Write a one-page summary of Costanza (1997), "The value of the world's ecosystem services and natural capital".