Value of Water Quality Improvements

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Economic (monetary) values of non-market goods and ecosystem services are a suitable means to facilitate their recognition, demonstration and consideration in decision-making.

The values economists are mainly concerned with are the subjective values people attribute to the sources of their satisfactions [...] Our interest in the public’s subjective value judgements is due to our concern with the economy’s ability to allocate resources so as to the greatest benefit to society (Scitovsky 1993).
Outline

The value of water quality (improvements)....

1. Why do we need an economic perspective in water management
2. What is the (economic) benefit of water quality and how it contributes to human well-being
3. How economists conceptualize value and how the value can be measured
4. How to apply valuation methods in practice
5. What an economic valuation can contribute to societal and political decision-making processes
The problem

Clean fresh water is a scarce resource
- Overconsumption aggravates scarcity
- Pollution deteriorates water quality

Given scarcity, use of water is characterized by resource use conflicts
- Input for production and consumption purposes
- Absorption of pollutants
- Shipping, flood protection, irrigation
- Recreational use of riverine landscapes

⇒ Need to make choices among available alternatives
Dealing with public goods

- Challenge
  - Water is mobile (upstream and downstream costs and benefits of water use)
  - Environmental goods are public goods

Economic benefits provided by (river) water quality

<table>
<thead>
<tr>
<th>Rivalry</th>
<th>Excludability</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Private good</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>Common good</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
<td>Club good</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>Public good</td>
</tr>
</tbody>
</table>

Off-stream uses: consumptive (household, industry, agriculture)

Instream uses: non-consumptive (hydropower, shipping, active or passive recreation, regulation)
The economic perspective on environmental problems

- Economic value is different than the market price of a good or service; market prices do not reflect the true value of a commodity.
- Existence of externalities (positive or negative effects of economic activities, which do not impact market prices).
- Economics explains why markets fail and water-related problems occur.

Source: Rogers et al. (2002)
The economic conception of value

- All humans assign certain values to objects; not always explicitly
- Value judgements vary according to peoples’ interests, attitudes, knowledge and use; according to their individual preferences
- Paradox: value in exchange ↔ value in use

The value in use (utility) of water obviously differs from its value in exchange (price) => modern economics focus on the value in use

- Meaning of economic value
  - Importance, worth, usefulness ↔ held values, principles, moral duties
  - Self-interested values ↔ (?) social values
  - Use and non-use values
Total Economic Value (TEV)

Use values
- Direct use
  - Consumptive: Crops, Fisheries, Transport, Energy, Water supply
  - Non-consumptive: Recreation, Aesthetics
- Indirect use
  - Flood control, Nutrient retention, Climate regulation
  - Potential future use of direct and indirect values

Option value

Non-use values
- Bequest value
- Altruist value
- Existence value
- Satisfaction of knowing that an ecosystem exists
- Satisfaction of knowing that other people have access to nature’s benefits
- Satisfaction of knowing that future generations will have access to nature’s benefits

The array of values potentially captured by economic valuation is broader than often assumed by non-economists.
Economic theory and conceptual basis

Economic values are expressed in terms of individual preferences.

Monetary measure of benefits is the individual maximum willingness to pay.
Economic Valuation methods

Monetary Valuation Methods

Cost / market-based approaches (non-demand curve approaches)
- Market Prices
- Damage Costs
- Avoidance Costs
- Replacement Costs

Benefit / preference-based approaches (demand curve approaches)
- Contingent Valuation
- Choice Experiments
- Travel Cost Method
- Hedonic Price Method

⇒ No true welfare measure
⇒ But useful information for policy-makers
⇒ Welfare measure
⇒ Non-market goods and services
Case study: the 'Blue rivers' in Germany
The 'Blue Rivers’

- Survey part of the last environmental awareness study (2,023 interviews)
- Near-natural development of selected rivers until 2030 (total lengths ca. 6,300 km)
- Survey included a *stated preference* study to estimate the economic benefits of river quality improvement
- CE: direct method of eliciting preferences: stated willingness-to-pay on hypothetical market

Near-natural rivers and floodplain development:
Increase in floodable area and floodplain forest

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<table>
<thead>
<tr>
<th>Attributes</th>
<th>Option A</th>
<th>Option B</th>
<th>Option C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodable area</td>
<td>25,000 ha</td>
<td>10,000 ha</td>
<td>10,000 ha</td>
</tr>
<tr>
<td>Near-natural riverbanks</td>
<td>1,000 km lengths</td>
<td>3,000 km lengths</td>
<td>1,000 km lengths</td>
</tr>
<tr>
<td>Floodplain forest</td>
<td>50% of floodable area</td>
<td>50% of floodable area</td>
<td>10% of floodable area</td>
</tr>
<tr>
<td>Longitudinal connectivity (fish migration)</td>
<td>100% connectivity</td>
<td>50% connectivity</td>
<td>50% connectivity</td>
</tr>
<tr>
<td>Bathing</td>
<td>Good (suitable for bathing)</td>
<td>Bad (not suitable for bathing)</td>
<td>Bad (not suitable for bathing)</td>
</tr>
<tr>
<td>Payment for river development</td>
<td>50 €</td>
<td>100 €</td>
<td>0 €</td>
</tr>
</tbody>
</table>

I choose: [ ] Option A [ ] Option B [ ] Option C

Respondents choose most preferred alternative.
The results

<table>
<thead>
<tr>
<th>Willingness to pay for renaturation measures in Germany (*40.188.000 households)</th>
<th>WTP (€ / hh) (change to SQ)</th>
<th>Mio. € / year*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodable Area</td>
<td>25.000 ha</td>
<td>25.77</td>
</tr>
<tr>
<td></td>
<td>50.000 ha</td>
<td>51.54</td>
</tr>
<tr>
<td>Floodplain Forest</td>
<td>30 % of floodable area</td>
<td>20.96</td>
</tr>
<tr>
<td></td>
<td>50 % of floodable area</td>
<td>41.92</td>
</tr>
<tr>
<td>Near-natural riverbanks</td>
<td>2.000 km of the rivers</td>
<td>24.01</td>
</tr>
<tr>
<td></td>
<td>3.000 km of the rivers</td>
<td>48.02</td>
</tr>
<tr>
<td>Connectivity for fish migration</td>
<td>75 % connectivity</td>
<td>35.87</td>
</tr>
<tr>
<td></td>
<td>100 % connectivity</td>
<td>71.74</td>
</tr>
<tr>
<td>Bathing</td>
<td>Moderate suitable</td>
<td>41.01</td>
</tr>
<tr>
<td></td>
<td>Suitable</td>
<td>82.02</td>
</tr>
</tbody>
</table>
Total benefit of different scenarios

<table>
<thead>
<tr>
<th>Used attribute levels</th>
<th>I: Flood protection</th>
<th>II: Biodiversity</th>
<th>III: Bathing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodable area</td>
<td>50,000 ha</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Floodplain forest</td>
<td>--</td>
<td>50% of floodplain area</td>
<td>--</td>
</tr>
<tr>
<td>Near-natural banks</td>
<td>--</td>
<td>3,000 km lengths</td>
<td>--</td>
</tr>
<tr>
<td>Connectivity</td>
<td>--</td>
<td>100%</td>
<td>--</td>
</tr>
<tr>
<td>Bathing water quality</td>
<td>--</td>
<td>--</td>
<td>Good</td>
</tr>
<tr>
<td><strong>Total Benefit (Mio. €/a)</strong></td>
<td>2,100</td>
<td>6,587</td>
<td>3,341</td>
</tr>
<tr>
<td><strong>Net present value (billion €)</strong></td>
<td>22</td>
<td>70</td>
<td>36</td>
</tr>
</tbody>
</table>

*40.188.000 households in Germany
** 13 years, 3% discount rate

Investment costs for renaturation of 6,337 km river: approx. **11,2 billion €**
Economic values in the decision-making framework

- Is it a good idea to estimate the economic values of environmental goods and make it the basis for political and societal decisions?
  - Yes!
    - Providing additional information for policy-makers
    - Balancing costs and benefits for society
    - Identify winners and losers of alternative options
    - Addressing trade-offs and making them more obvious
    - Contributing to the efficiency of water-related policies
    - Part of cost-benefit analysis or multi-criteria analysis

- Creating awareness for the costs of using ecosystems and values of ES and their benefits for human well-being

- Applicable for a number of different decision contexts
Limits of the economic approach

• But...
  – Economic values as **one** decision criterion for policy-making: Economic efficiency next to other legal, ethical, political rules of weighting
  – Environmental policy frameworks (long-term, precautionary) still exist

• Boundaries
  – Non-substitutability of ecosystem services
  – Irreversible changes
  – Impact on future generations
  – Instrumental values ↔ intrinsic values

• *Policy-related* challenge: acceptance of integrating economic thinking into policy-making (preference-based vs. expert-based judgements)
Added value of the economic perspective

• ‘Better’ environmental decision-making

One-dimensional vs. multidimensional perspective: land use change in floodplains

• *Science-related* challenge: still more attention needed for the quantification of the effects as well as for the benefit estimates => integration of social, ecological, economic, engineering disciplines
Actual impact on policy-making (limited?!)  

- Cost-benefit analysis and water policy  
  - History of CBA and non-market valuation in the USA intertwined with water projects: e.g. Flood Control Act (1936). “…the benefits to whosoever they may accrue are in excess of the estimated costs.”  
  - Paradigm change in the EU water policy (European Water Framework Directive): requires an integrated water resource management approach and cost-benefit analysis (disproportionate costs)

- Non-market valuation in the USA  
  - Natural Resource Damage Assessment  
  - Oil spill caused by the accident or Exxon Valdez (1989): non-use values were included in damage assessment by a CV study ($2.8 billion)  
  - Controversial debate on reliability of CV estimates => guidelines

- Economic valuation of ecosystem services  
  - Increased social and political awareness (TEEB)  
  - Growing attention on institutional requirements and methodological soundness for applying economic valuation
Many thanks!
The value of water

“Water is the driver of nature.”
(Leonardo da Vinci)

“When the well's dry, we know the worth of water.”
(Benjamin Franklin (1706-1790), Poor Richard's Almanac, 1746)

“We forget that the water cycle and the life cycle are one.”
(Jacques Cousteau)

“Water is the driver of nature.”
(Leonardo da Vinci)

„First Nations recognize the inherent value in water for water’s sake rather than for what water can provide to humans. [...] water management decisions need to value the inherent wealth in water.”
(www.rethinkingwater.ca)
Aquatic ecosystem services
Value judgements in the decision framework

Riparian Ecosystems

- Ecosystem structures and processes

Ecosystem services

- Provisioning services: Drinking water, Food, fish, timber
- Regulating services: Flood protection, Climate regulation, Nutrient retention
- Cultural services: Recreation, Education, Aesthetics

Benefits
- Increased water quality
- Reduced flooding risk
- Recreational potential

Values
- e.g. Willingness-to-pay for floodplain restoration
- Reduced damages

Societal value judgement

- Cost-benefit analysis
- Recommendations for policy-making

Water quality improvement

Project costs

Changes due to policy actions (marginality principle)

Considering the value of multiple ESS

Preference-based valuation methods

Cost-based valuation methods

Project costs

Preference-based valuation methods

Cost-based valuation methods

Recomm
Economic terms and concepts

• Theoretical foundation: neo-classical welfare economics
  – Based on a conceptualization of human beings as rational actors that aim to satisfy their substitutable preferences and make choices that would maximize their utility, considering all costs and benefits
  – Changes in society’s welfare due to marginal provision changes
  – Alternative with the highest benefit compared to the cost is preferable

• Methodological standard: Economic values are expressed in terms of individual preferences

• Monetary measure of benefits is the individual maximum willingness to pay
## Attributes

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Shortcut</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodable area</td>
<td>FLOOD</td>
<td>10.000 ha</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20.000 ha</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50.000 ha</td>
</tr>
<tr>
<td>Near-natural banks</td>
<td>BANK</td>
<td>1.000 km of the river</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.000 km of the river</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.000 km of the river</td>
</tr>
<tr>
<td>Floodplain forest</td>
<td>FORR</td>
<td>10 % of floodable area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 % of floodable area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50 % of floodable area</td>
</tr>
<tr>
<td>Longitudinal connectivity</td>
<td>FISH</td>
<td>50 % consistency</td>
</tr>
<tr>
<td>(fish migration)</td>
<td></td>
<td>75 % consistency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100 % consistency</td>
</tr>
<tr>
<td>Swimming</td>
<td>SWIM</td>
<td>bad: unsuitable for swimming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>moderate: limited suitable for swimming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>good: suitable for swimming</td>
</tr>
<tr>
<td>Payment for river development</td>
<td>PAYM</td>
<td>0 / 15 / 25 / 50 / 100 / 175 / 250</td>
</tr>
</tbody>
</table>