
European Sediment Research Network
Acronym: SedNet
EC contract No.: EVK1-CT-2001-20002
Key action: 1.4.1 Abatement of water pollution from contaminated land, landfills and sediments

Annexes to the MINUTES OF THE WORKSHOP ON

Societal Cost Benefit Analysis and Sediments

18th-19th March 2004 in Warsaw, Poland

Hosted by:
The Warsaw Agricultural University
Faculty of Engineering and Environmental Science
Department of Hydraulic Engineering and Environmental Recultivation (WAU)

Organized by:
Sediment management at the river basin scale (WP2)
And
Coordination, synthesis, dissemination and stakeholders panel (WP1)

AUTHORS: Philip N. Owens, Adriaan Slob, Gerald Jan Ellen.
Agreed by the workshop attendees and the WP2 Core Group

DATE: May 2004

Pages: 31
Annex I: Presentation on *A first attempt to approximate Europe’s sediment budget* by Ramon J. Batalla, University of Lleida, Catalonia, Spain and Philip N. Owens, National Soil Resources Institute, Cranfield University, UK

---

**A first attempt to approximate Europe’s sediment budget**

**Ramon J. Batalla**
University of Lleida, Catalonia, Spain
rbatalla@macs.udl.es

**Philip N. Owens**
National Soil Resources Institute, Cranfield University, UK
philip.owens@bbsrc.ac.uk

---

**Objective**

To enhance the awareness of the extend of the European sediment issue by providing a first approximation of Europe’s sediment budget

- The budget is based on estimates of soil erosion, sediment yield, sediment storage on river channels, floodplains and in reservoirs, and estimates of the sediment discharge to oceans and seas

- Estimates are based on typical values for select river catchments, which are then extrapolated to large geographical areas. Values represent order of magnitude approximations

- For simplicity, we have used a value of $6 \times 10^8$ km$^2$ to represent the surface area of the EU (Member States, New Member States and Applicant Countries)
How much is being eroded from rocks and soils and delivered to rivers?

- 100 t km⁻² year⁻¹ x 75% of Europe’s area (6 x 10⁶ km²) = 450 x 10⁶ t y⁻¹ (Humid Northern Europe)
- 500 t km⁻² year⁻¹ x 20% of Europe’s area (6 x 10⁶ km²) = 600 x 10⁶ t y⁻¹ (Mediterranean humid Mid-Southern Europe)
- 2500 t km⁻² year⁻¹ x 5% of Europe’s area (6 x 10⁶ km²) = 750 x 10⁶ t y⁻¹ (Semi-arid Southern Europe)

Total: 1800 x 10⁶ t y⁻¹

(bedload not included, generally 10%)
How much is being delivered from rivers to the seas?

- 40 t km\(^{-2}\) y\(^{-1}\) x 60% of Europe’s area (6 x 10\(^5\) km\(^2\)) = 144 x 10\(^6\) t y\(^{-1}\)
- 150 t km\(^{-2}\) y\(^{-1}\) x 30% of Europe’s area (6 x 10\(^5\) km\(^2\)) = 270 x 10\(^6\) t y\(^{-1}\)
- 500 t km\(^{-2}\) y\(^{-1}\) x 10% of Europe’s area (6 x 10\(^5\) km\(^2\)) = 300 x 10\(^6\) t y\(^{-1}\)

Total: 714 x 10\(^6\) t y\(^{-1}\)
(bedload not included, generally 10%)

How much is stored/extracted in between production and deposition areas?

- In-channel storage of fine-grained sediment = 5% to 10% of the sediment delivered to rivers = 90 to 180 x 10\(^6\) t y\(^{-1}\)
- Floodplain sedimentation of fine sediment = 10% to 50% of the sediment delivered to rivers = 180 and 900 x 10\(^6\) t y\(^{-1}\) (Owens et al., 1999)
- Average estimate of floodplain and channel storage = 540 x 10\(^6\) t y\(^{-1}\)

(assuming that within-channel sediment storage does not represent a net loss to the system at the annual timescale)
The average consumption of sediment as aggregate for construction is $2000 \times 10^2 \text{ t year}^{-1}$ (ca. $7 \text{ t person}^{-1} \text{ year}^{-1}$):

- at least $1/3$ is mined from rivers (bedload) and floodplains (both bedload and suspended sediment) = $600 \times 10^6 \text{ t year}^{-1}$
- $1/3$ can be replaced annually by rivers during floods ($200 \times 10^6 \text{ t year}^{-1}$)
- $2/3$ are mined from ancient river deposits (not included in the current annual budget)

The rest $346 \times 10^6 \text{ t year}^{-1}$ are deposited in reservoirs and lakes (e.g. Low values of siltation in reservoirs in Spain = $50 \times 10^6 \text{ t year}^{-1}$ (Batalla, 2003))

An approximate sediment budget for Europe (Original bottom sketch from Kondolf, 1997)

$1800 \times 10^3 \text{ t year}^{-1}$ as sediment production

- $540 \times 10^3 \text{ t year}^{-1}$ stored in river channels and on floodplains
- $346 \times 10^3 \text{ t year}^{-1}$ in reservoirs
- $200 \times 10^3 \text{ t year}^{-1}$ mined from fluvial active areas

$714 \times 10^3 \text{ t year}^{-1}$ as sediment yield from rivers, which is deposited in lowland zones (estuaries, harbours, deltas) and discharged into oceans and seas
Sediment eroded in European catchments on an annual timescale (100 units)

- 19 units deposited in reservoirs/lakes
- 11 units mined for aggregate
- 30 units deposited on floodplains (and channels)
- 40 units reach the lowermost deposition zones and the coast

Comparison with published values

✓ Sediment delivery for the major rivers in Europe (Milliman and Meade, 1983):

- Eastwards (Danube and Dnieper Rivers) = 133 \times 10^6 \text{ t yr}^{-1}
- Southwards (Po, Rhone, Tiber and Ebro Rivers) = 66 \times 10^6 \text{ t yr}^{-1}
- Westwards (Seine, Oder, Vistula, Rhine and Garonne Rivers) = 31 \times 10^6 \text{ t yr}^{-1}
- TOTAL = 230 \times 10^6 \text{ t yr}^{-1} (drainage area = 4.6 \times 10^6 \text{ km})

It is uncertain how this total value accounts for (or considers) potential floodplain storage, reservoir storage and sediment mining effects. It is also important to state that it is only based on selected rivers for parts of Europe.

✓ Values summarised in this report fits exactly to the estimate of the worldwide sediment delivery to oceans of between 15-20 \times 10^6 \text{ t yr}^{-1} (Milliman and Syvitski, 1992)
Final remarks

✓ Estimations indicate orders of magnitude of each of the main sediment-related processes in rivers of Europe, and so considerable caution should be used with these values

✓ Uncertainty is high due to the lack of extensive, reliable and homogeneous data on sediment production, transport and deposition for all European river catchments

✓ Because of the limitations associated with the values presented, there exists a need for a comprehensive Europe-wide assessment of sediment fluxes and transfers within European rivers, and the delivery of sediment to the coastal zone

References


Annex II: Presentation on *Societal Cost Benefit Analysis (SCBA) and Sediment Management* by Jaap van der Vlies TNO Strategy Technology and Policy, The Netherlands

**Contents**

- What is a Societal Cost-Benefit Analysis (SCBA)? and what is it not
- What steps do we have to take to conduct a SCBA?
- Possibilities and limitations in application of the SCBA.

---

**What is a SCBA?**

NOT ..........and......... what it is/should be

- Valuation method of functions
- Evaluation tool; weighing alternative actions against each other
- For all those wanting to make choices between alternatives
- An evaluation tool taking ALL societal aspects into account, including imponderables
- A tool with a long history (potentially) leading to transparent information processes & stakeholder involvement
- A gimmick/black box
What is Cost Benefit analysis & who uses it?

- An Evaluation tool for decisionmaking (companies, organisations, governments)
- Decisions about alternative actions (investments, infrastructural projects, policy actions)
  NB: alternatives, NOT functions
- For example: UN/Worldbank; Private companies, Ministries (eg Delta Works, Safety studies in NL)
- Taking into account ALL effects regardless of their nature and summarized for ALL of society

Steps to take in a SCBA (1)

- Problem analysis & definition of alternatives/actions/policy measures: understand the system & conditions
- Identification of the effects of the alternatives:
  - again: understand the system;
  - “doing nothing” = zero-alternative;
  - all effects are to be compared with the 0-alternative and are to be measured in changes;
  - from a societal perspective: ALL changes irrespective of their nature & where they occur.
Steps to be taken in a SCBA (2)

- Analysis of relevant exogenous developments
  (for the 0-alternative & sensitivity analysis)

- Quantification/valuation of the effects (costs & benefits) of
  the different alternatives; where possible in monetary terms
  - special attention for discounting
  - watch out for double counting & imponderables

- Ranking of alternatives according to Cost benefit ratio

Possibilities & limitations

- In principle many possibilities to make choices transparent

- Stake holder involvement
  (to get information about the system & generating alternatives)

- To help comparisons of alternatives;

- Combines Disciplines

- Profound understanding of the system one tries to influence
  (takes time)

- Stakeholders (& political agenda’s) also need time, timing
  & their specific setting

- A SCBA makes no choices: only a ranking

- Communication of results is important
Annex III: Presentation on *Economic Analysis and River Basin Management* by Carlos Mario Gómez, Department of Economics, University of Alcalá Madrid, Spain
Economic Analysis in the WFD

For achieving its environmental objectives, i.e. good water status for all waters, in the most effective manner. The Water Framework Directive clearly integrates economic analysis into water management and policy making.

The Directive calls for:

- The identification of the economic significance of water uses.
- The application of economic principles (e.g. the polluter pays principle),
- The use of economic approaches and tools (e.g. cost-effectiveness analysis)
- The consideration of economic instruments (e.g. water pricing)
- The analysis of the recovery of the economic costs of providing water for different economic activities (Cost recovery analysis).

To be useful for decision-making, the different elements of the economic analysis should be well integrated in the policy decision and management cycle.

Figure 3 – Economic Elements are Linked and Must be Integrated

Damage associated with the interruption of river sediment transport

River section

- Sediment deposition → Reducing reservoir capacity
- Gravel mining
- Channel incision → Undermining of structures
- Coastal erosion → Less beaches protection
- Bed coarsening
- Loss of spawning gravels for salmonids

Control Costs

Examples of Measures
- Gravel replenishment below dams
- Sediment sluicing and pass-trough from reservoirs
- Flushing flows
- Beach nourishment with imported sediments
- System of sand rights

Carlos María Gómez - UAH

Warsaw, 18-19 March 2004
[i] Cost-Benefit Analysis Theory

Costs and Benefits

Optimal Ecological Quality

Marginal control cost

Marginal damage

Current Ecological Quality

Ecological Quality

Carlos María Gómez - UAH

Warsaw, 18-19 March 2004

[ii] CEA From Theory to Practice

Main Steps

- Define Baseline
- Define Ecological Quality Objectives
- Identify and assess measures to close the gap
- Find the most cost effective set of measures RBMP
- Disproportionate Cost Analysis
- Analyse potential derogations
- Analyse Financial Viability and Cost recovery
- Analyse Distributive Impacts
- Analyse institutional constraints

Carlos María Gómez - UAH

Warsaw, 18-19 March 2004
Environmental quality objectives vs. River’s current state

Good Ecological Quality
- Stretch I - Stretch II - Stretch III

Baseline Ecological Quality
- Stretch I - Stretch II - Stretch III

Water quantity [flow]

Chemical water quality
- pH, Mat. Susp. mat., Conduct., DO₉₅, Nitre, Nitrate, Ammonia, Sulfate, Chloride

Environmental Quality
- Riverside forest, fluvial bed materials, beaches...

GAP

River water quality parameters
Illustration from the Ebro Pilot Study (Cidacos Sub-basin)

<table>
<thead>
<tr>
<th></th>
<th>STRETCH I</th>
<th>STRETCH II</th>
<th>STRETCH III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>RBMP</td>
<td>Target</td>
</tr>
<tr>
<td>Flow (l/s)</td>
<td>258</td>
<td>347.59</td>
<td>280</td>
</tr>
<tr>
<td>pH</td>
<td>8.18</td>
<td>5.95</td>
<td>5.5-9</td>
</tr>
<tr>
<td>Susp. Mat.</td>
<td>108</td>
<td>57.06</td>
<td>25</td>
</tr>
<tr>
<td>Conduct.</td>
<td>619</td>
<td>458.39</td>
<td>1000</td>
</tr>
<tr>
<td>DO₉₅</td>
<td>4.7</td>
<td>2.31</td>
<td>6</td>
</tr>
<tr>
<td>Nitre</td>
<td>0.16</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Nitrate</td>
<td>45.56</td>
<td>23.16</td>
<td>50</td>
</tr>
<tr>
<td>Ammonia</td>
<td>1.99</td>
<td>0.49</td>
<td>0.5</td>
</tr>
<tr>
<td>Sulfate</td>
<td>81.23</td>
<td>44.55</td>
<td>250</td>
</tr>
<tr>
<td>Chloride</td>
<td>111.67</td>
<td>81.25</td>
<td>250</td>
</tr>
</tbody>
</table>
[ii] Integrated Cost-efficiency analysis

- Identifying measures
- Determine measures' effect
- Estimate measures' cost
- Cost - efficiency indicators
- Simulate a flexible model
- River Basin Management Plan

- Aimed at increasing
  - water quantity
  - chemical quality or environmental quality

- Technical efficiency of measures
- Analysis of the tariff system as economic incentives
  - capital expenses,
  - operation and maintenance costs,
  - external costs and,
  - if available, induced costs

- By combining
  - Technical effectiveness of different measures
  - Economic costs

- By assessing
  - Synergies of different measures
  - Cross-effects

- Combining measures in a cost-efficient way

EXAMPLE 1:

Integrated Cost Effectiveness Analysis and Measures Assessment
[ii] Policy Measures to reduce the GAP

WATER QUANTITY (pressures; rate of flow) ➔ WATER QUALITY (phys-chem) ➔ RIVER ECOSYSTEM SERVICES (Habitat, biological potential)

- Demand management
- Increased efficiency
- Increased supply
- Treatment
- Control
- Recycling
- River bank restoration
- Restoring continuity of sediment transport

Economic Incentives

[ii] Measure appraisal

Economic costs
- Capital
- Operation and maintenance
- External environmental costs
- Resource costs

COVERAGE
- [Has; % losses; reduction in sediment extraction]

ANNUAL EQUIVALENT COST
- [t =30; r =0.02]

TECHNICAL EFFECTIVENESS
- [↑Rate of flow, ↓M³, ↓mg Part/L]

COST EFFECTIVENESS INDICATOR
- [€/m², €/ALts/sec, €/Km of restored bank forest]
[ii] Example of measure appraisal

**Water Body:**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Stretch 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency in Urban Distribution</td>
<td></td>
</tr>
<tr>
<td><strong>Actual Efficiency:</strong></td>
<td>70%</td>
</tr>
<tr>
<td><strong>Maximum Attainable Efficiency</strong></td>
<td>85%</td>
</tr>
<tr>
<td><strong>Maximum Water Saved [m³]</strong></td>
<td>695,258</td>
</tr>
<tr>
<td><strong>Cost Effectiveness Indicator 1 [€/m³]</strong></td>
<td>0.26</td>
</tr>
<tr>
<td><strong>Maximum Flow Increase [l/s]</strong></td>
<td>11.1</td>
</tr>
<tr>
<td><strong>Cost Effectiveness Indicator 2 [€/l.p.s.]</strong></td>
<td>5,232</td>
</tr>
</tbody>
</table>

Carlos Mario Gómez - UAH
Warsaw, 18-19 March 2004

[ii] Cost-effectiveness indicators of water saving measures in rural areas

<table>
<thead>
<tr>
<th>MEASURE</th>
<th>MAX. COVERAGE</th>
<th>AEC</th>
<th>MAX. WATER SAVINGS</th>
<th>MAX. WATER FLOW INCREASE</th>
<th>COST-EFFECTIVENESS INDICATORS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Houses)</td>
<td>(€)</td>
<td>(m³)</td>
<td>(l/sec)</td>
<td>[€/m³] [€/l/sec]</td>
</tr>
<tr>
<td>Irrigation Assistance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7,000-10,000 m³/ha</td>
<td>21</td>
<td>411</td>
<td>16,938</td>
<td>0.54</td>
<td>0.02 [766]</td>
</tr>
<tr>
<td>5,000-7,000 m³/ha</td>
<td>3</td>
<td>60</td>
<td>1,561</td>
<td>0.05</td>
<td>0.03 [1.077]</td>
</tr>
<tr>
<td>Less than 1,000 m³/ha</td>
<td>19</td>
<td>384</td>
<td>1,620</td>
<td>0.03</td>
<td>0.24 [74.2]</td>
</tr>
<tr>
<td>WSP (WATER SAVINGS PROGRAM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7,000-10,000 m³/ha</td>
<td>21</td>
<td>1,234</td>
<td>16,938</td>
<td>0.54</td>
<td>0.07 [2.297]</td>
</tr>
<tr>
<td>5,000-7,000 m³/ha</td>
<td>3</td>
<td>180</td>
<td>1,561</td>
<td>0.05</td>
<td>0.12 [3.675]</td>
</tr>
<tr>
<td>Less than 1,000 m³/ha</td>
<td>19</td>
<td>1,152</td>
<td>1,620</td>
<td>0.05</td>
<td>0.21 [23.266]</td>
</tr>
<tr>
<td>Efficiency in Channels</td>
<td>45</td>
<td>7,704</td>
<td>33,189</td>
<td>1.69</td>
<td>0.14 [4.568]</td>
</tr>
<tr>
<td>Change in Distribution</td>
<td>45</td>
<td>10,899</td>
<td>66,062</td>
<td>2.09</td>
<td>0.16 [5.184]</td>
</tr>
<tr>
<td>Change in Irrigation Technology</td>
<td>26</td>
<td>5,141</td>
<td>66,062</td>
<td>2.09</td>
<td>0.08 [2.454]</td>
</tr>
<tr>
<td>Change in Distribution - Irrigation Technology</td>
<td>26</td>
<td>11,342</td>
<td>110,220</td>
<td>3.51</td>
<td>0.1 [3.230]</td>
</tr>
</tbody>
</table>

Carlos Mario Gómez - UAH
Warsaw, 18-19 March 2004
[ii] Cost-effectiveness indicators of water saving measures in urban areas

<table>
<thead>
<tr>
<th>Measure</th>
<th>Maximum Water Saving</th>
<th>AEC €</th>
<th>AEC/m³</th>
<th>Maximum Flow Increase Lt/sec</th>
<th>AEC/Lt/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. New abstractions</td>
<td>1,000,000</td>
<td>100,000</td>
<td>0.100</td>
<td>31.7</td>
<td>6,307</td>
</tr>
<tr>
<td>2. Water imports</td>
<td>Unlimited</td>
<td>9,224</td>
<td></td>
<td>Unlimited</td>
<td>7,560</td>
</tr>
<tr>
<td>3. Efficiency in distrib. network</td>
<td>695,258</td>
<td>58,872</td>
<td>0.246</td>
<td>11.1</td>
<td>5,232</td>
</tr>
<tr>
<td>4. Installation of meters</td>
<td>89,989</td>
<td>25,376</td>
<td>0.208</td>
<td>2.8</td>
<td>6,993</td>
</tr>
<tr>
<td>5. Saving campaign consumers</td>
<td>163,826</td>
<td>17,744</td>
<td>0.170</td>
<td>3.3</td>
<td>5,390</td>
</tr>
<tr>
<td>6. Saving program households</td>
<td>136,330</td>
<td>20,865</td>
<td>0.156</td>
<td>4.3</td>
<td>8,013</td>
</tr>
<tr>
<td>7. Saving program firms</td>
<td>46,589</td>
<td>5,201</td>
<td>0.110</td>
<td>1.5</td>
<td>3,376</td>
</tr>
<tr>
<td>8. Saving program institutions</td>
<td>27,822</td>
<td>5,380</td>
<td>0.190</td>
<td>0.9</td>
<td>5,896</td>
</tr>
<tr>
<td>9. Water recycling</td>
<td>350,000</td>
<td>92,855</td>
<td>0.246</td>
<td>11.1</td>
<td>8,367</td>
</tr>
</tbody>
</table>

Cost-Eft. Ind. / Quality measures (NO₃) - Stretch I

<table>
<thead>
<tr>
<th>Stretch I</th>
<th>NO₃ Initial Concentration (mg/l): 35.61</th>
<th>Individual Efficiency (mgNO₃ / l)</th>
<th>AEC (€)</th>
<th>AEC/Saved unit (€/mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25 cattle raising</td>
<td>Quality control on cattle wastewater points</td>
<td>0.88</td>
<td>6,010</td>
<td>6,836</td>
</tr>
<tr>
<td>0.25 agric.</td>
<td>Quality control on drainage net</td>
<td>0.88</td>
<td>6,010</td>
<td>6,836</td>
</tr>
<tr>
<td>0.25 agric.</td>
<td>Contamination reduction Programme</td>
<td>1.76</td>
<td>15,020</td>
<td>8,543</td>
</tr>
<tr>
<td>0.25 agric.</td>
<td>Cattle wastewater control</td>
<td>2.2</td>
<td>24,040</td>
<td>10,938</td>
</tr>
<tr>
<td>0.25 agric.</td>
<td>Good Practices Campaign</td>
<td>1.32</td>
<td>18,030</td>
<td>13,673</td>
</tr>
<tr>
<td>0.25 cattle raising</td>
<td>River bank restoration</td>
<td>4.07</td>
<td>138,868</td>
<td>34,109</td>
</tr>
<tr>
<td>0.25 cattle raising</td>
<td>Cattle wastewater treatment</td>
<td>8.7</td>
<td>345,247</td>
<td>39,690</td>
</tr>
<tr>
<td>0.5 urb.</td>
<td>New wastewater treatment plant</td>
<td>0.35</td>
<td>20,807</td>
<td>59,170</td>
</tr>
</tbody>
</table>
Example 2:

Cost-effectiveness analysis in linked water bodies

“Improving quality in one stretch reduces total compliance costs”
EXAMPLE 3:

Interactions between quality and quantity

“Quantity measures reduce the quality target reaching cost”

[iii] Incremental cost of reducing nitrates

Strech III

Marginal Cost [€/Year]

Nitrate reductions [mg/l]
[ii] Avoided costs through the improvement of water quality upstream

'Mgood Ecological Status' Objective

\[ \text{Annual equivalent cost (€)} \]

\[ \text{MgC after increasing flow} \]

\[ \text{MgC after implementing water treatment measures in upper stretches} \]

\[ \text{Avoided costs} \]

\[ \text{Avoided costs in water treatment due to flow increases} \]

\[ \text{Avoided costs in water treatment, due to the implementation of water treatment measures in upper stretches} \]

Carlos Maria Gómez · UAH

[iv] Avoided costs through the improvement of water quality upstream

\[ \text{Thousands €/ano} \]

\[ \text{Nitrate concentration (mg/l)} \]

Carlos Maria Gómez · UAH
### River Basin Management Plan - Quantity and ecological measures

<table>
<thead>
<tr>
<th>Sector</th>
<th>Measures</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td>Assistance</td>
<td>60</td>
</tr>
<tr>
<td>Irrigation</td>
<td>Assistance</td>
<td>20</td>
</tr>
<tr>
<td>Irrigation</td>
<td>Assistance</td>
<td>411</td>
</tr>
<tr>
<td>Irrigation</td>
<td>Assistance</td>
<td>20</td>
</tr>
<tr>
<td>Irrigation</td>
<td>Assistance</td>
<td>384</td>
</tr>
<tr>
<td>Irrigation</td>
<td>Assistance</td>
<td>1,200-1,600</td>
</tr>
<tr>
<td>Water</td>
<td>Saving Program</td>
<td>180</td>
</tr>
<tr>
<td>Water</td>
<td>Saving Program</td>
<td>60</td>
</tr>
<tr>
<td>Water</td>
<td>Saving Program</td>
<td>1,200</td>
</tr>
<tr>
<td>Channel</td>
<td>Substitution, - Irrigation Techn.</td>
<td>11,342</td>
</tr>
<tr>
<td>New</td>
<td>abstractions</td>
<td>100,000</td>
</tr>
<tr>
<td>Water imports</td>
<td></td>
<td>22,400</td>
</tr>
<tr>
<td>Efficiency</td>
<td>distribution networks</td>
<td>158,320</td>
</tr>
<tr>
<td>Meters</td>
<td>instalation</td>
<td>25,326</td>
</tr>
<tr>
<td>Consumers</td>
<td>saving campaign</td>
<td>17,744</td>
</tr>
<tr>
<td>Households</td>
<td>Saving Program</td>
<td>70,806</td>
</tr>
<tr>
<td>Firms</td>
<td>Saving Program</td>
<td>5,207</td>
</tr>
<tr>
<td>Institution</td>
<td>Saving Program</td>
<td>5,207</td>
</tr>
<tr>
<td>River</td>
<td>bank restoration</td>
<td>64,805</td>
</tr>
<tr>
<td>River</td>
<td>bank restoration</td>
<td>111,094</td>
</tr>
</tbody>
</table>

### River Basin Management Plan - Quality measures

<table>
<thead>
<tr>
<th>Sector</th>
<th>Measures</th>
<th>Cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>Control</td>
<td>4,380</td>
</tr>
<tr>
<td>Urban</td>
<td>New wastewater treatment plant</td>
<td>28,552</td>
</tr>
<tr>
<td>Urban</td>
<td>Advanced technologies for waste water treatment</td>
<td>265,167</td>
</tr>
<tr>
<td>Urban</td>
<td>Cattle wastewater control</td>
<td>24,049</td>
</tr>
<tr>
<td>Urban</td>
<td>Quality control on cattle wastewater points</td>
<td>6,010</td>
</tr>
<tr>
<td>Cattle raising</td>
<td>Cattle wastewater treatment</td>
<td>348,000</td>
</tr>
</tbody>
</table>

### River Basin Management Plan - Financial instruments

<table>
<thead>
<tr>
<th>% Cost recovery</th>
<th>Measures</th>
<th>Cost (€/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>Agricultural tariffs increase</td>
<td>0,05</td>
</tr>
<tr>
<td>100%</td>
<td>Water supply tariff increase</td>
<td>0,27</td>
</tr>
<tr>
<td>100%</td>
<td>Cattle wastewater treatment tariff</td>
<td>5,2</td>
</tr>
<tr>
<td>100%</td>
<td>Households wastewater treatment tariff</td>
<td>0,17</td>
</tr>
<tr>
<td>100%</td>
<td>Industrial wastewater treatment tariff</td>
<td>0,18</td>
</tr>
</tbody>
</table>
EXAMPLE 4:

Incorporation of environmental impacts

[iii] Deciding with limited information

If there is no reliable monetary data: describe the environmental impact and temporarily ignore the environmental cost.

Cost Effectiveness Appraisal

Lowest Cost Policy Package

Sensitivity Analysis

Estimate threshold values

Information from secondary sources

Benefit transfer
Avoided Costs
Full cost of water services

May the cost value change the RBMP?

[No]

Is the potential cost saved in the RBMP high enough?

[No]

Conduct a valuation study
[ii] Hypothetical policy options to save water
[Long term marginal “financial” costs]

[a] Leak reductions

[b] Water recycling

[c] Water imports

[ii] Lowest cost plan
without considering environmental costs

RBMP to increase flow by saving 200,000 $m^3$

Marginal Cost

0.23

Leak reduction

40,000

Water savings [$m^3$]

Water imports

0.23
EXAMPLE 5:

Incentives Water Prices and the Least cost RBMP
### The Water Prices Needed for Full Recovery of the RBMP

<table>
<thead>
<tr>
<th>Economic Incentives [€/m³]</th>
<th>Current level</th>
<th>New tariff</th>
<th>% Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price of irrigation water</td>
<td>0.016</td>
<td>0.06</td>
<td>275</td>
</tr>
<tr>
<td>Drinking water price</td>
<td>0.6</td>
<td>0.87</td>
<td>45</td>
</tr>
<tr>
<td>Cattle wastewater treatment tariff</td>
<td>0</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Households wastewater treatment tariff</td>
<td>0</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>Industrial wastewater treatment tariff</td>
<td>0</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>Agricultural wastewater treatment tariff</td>
<td>0</td>
<td>0.006</td>
<td></td>
</tr>
</tbody>
</table>

### Sensitivity Analysis: The Overall RBMP Cost and the Cost Recovery Rate

![Graph showing the relationship between RBMP cost and cost recovery rate]

Carlos Mario Gómez - UAH
Warsaw, 18-19 March 2004
Cost benefit analysis [Stakeholder analysis]

Stakeholder analysis

Financial Viability
[Benefits > Costs]?

Yes

Cost recovery: Tariff system

No

Disproportionate cost?

Yes

Assessing distributive effects

Incentive measure

No

Derogation

Moderate ecological quality

[i] Environmental impacts and their relevance to the overall decision-making process

<table>
<thead>
<tr>
<th>Type</th>
<th>Relevant for</th>
<th>Valuation best at</th>
</tr>
</thead>
</table>
| A    | External costs or benefits associated with the ecological status of the river basin | Consultation and agreement on RBMP | - CBA
- Derogation analysis
- Stakeholder analysis |
| B    | External costs or benefits associated to implemented measures to achieve the ecological status of the river basin. | Measure appraisal | - Estimation of cost effectiveness indicators [CEI];
- Order different measures according to CEI. |
| C    | Environmental costs and benefits internalised within the river management plan. | Evaluating costs of alternative RBMP. | - CEA decisions at the basin level |