WP 8 SERVICES
Assessment of current freshwater ecosystem services and integration in RBMPs

ICRA, UPM, UPV, URV, UVEG
Main goals of WP8 are:

- Model and map the delivery, distribution, and economic value of ecosystem services in 4 Mediterranean basins (Iberian Peninsula).
- Among all services, focus on hydrological services, aiming to provide decision support for integrated River Basin Management Plans (RBMP).
- Assess the effects of the implementation of the RBMP in terms of ecosystem services, and propose alternative measures to maximize provisioning of ecosystem services.
- Assess the effects of climate extremes typical of the Mediterranean climate, as well as of global change. Propose Global Change mitigation measures to be implemented in the RBMP.
APPREACH

1. Selection of ecosystem services and modeling approach (InVEST)
2. Adaptation of terrestrial modules of InVEST in a Med basin (Llobregat).
3. Quantification of selected ecosystem services for the Llobregat and Ebro basins under current and future conditions.
4. Development of the aquatic modules of InVEST.
5. Extension of the considered services.
6. Development of a calibration and sensitivity modules for InVEST.
8. Cost-benefit analyses of the implementation of the measurement plans at the basin scale.
PROGRESS REPORT

1. Selection of ecosystem services and modeling approach (InVEST)
2. Adaptation of terrestrial modules of InVEST in a Med basin (Llobregat).
PROGRESS REPORT

Water provisioning for hydropower

Water provisioning for drinking (potential)

Water purification

Erosion protection
3. Quantification of selected ecosystem services for the Llobregat and Ebro basins under current and future conditions.

**Terrado** M. and others (2013) Impact of climatic extremes on hydrological ecosystem services in a heavily humanized Mediterranean basin. Ecological Indicators

**Bangash** R. and others (2013) Ecosystem services in Mediterranean river basin: Climate change impact on water provisioning and erosion control. STOTEN

**Boithias** L. and others (2013) Assessment of the water supply: demand ratios in a Mediterranean basin under different global change scenarios and mitigation alternative. STOTEN


**Solera** A. and others (2014-2015) Assessment of climate change effects on water management in the Ésera River Basin: Simulation with discharge temporal series generated under different climate change scenarios. *In preparation*
Hydrological ES are very sensitive to climatic extremes, suggesting they will be vulnerable to future climate change conditions.

- Flow of services reduced in dry conditions and increased in wet conditions except for water purification.

Terrado M. 2013.
PROGRESS REPORT

- Bangash R. 2013.
PROGRESS REPORT

- Bangash R. 2013.
PROGRESS REPORT

- Boithias 2013.
PROGRESS REPORT

- Boithias 2013.
PROGRESS REPORT


provided by UPV-GIHMA *(interaction with WP6).*
4. Development of the aquatic modules of InVEST (task within 6.3, and in collaboration with 5.1 and 5.3).


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**Simple model**

![Simple model graph](image)

*Figure 3* Trap efficiency related to capacity/annual inflow ratio

**Two sources model**

![Two sources model graph](image)

*Figure 7* Revision of the Churchill (1948) curves by Trimble and Bube (1990)

Sediment retention in reservoir/lakes pixel types. Empirical curves vs trapping eff...
PROGRESS REPORT

5. Extension of the considered services.

5.1. Improvement of services:

- Value water purification ES with other pollutants (not only TN and TP).

Boithias L. and others (2014) Assessment of the water purification ecosystem service regarding in-stream pharmaceutical residues: Exploring the GREAT-ER model parameters based on data uncertainty. *In preparation*

5.2. Inclusion of new services:

- Habitat quality and rarity

Terrado M. and others (2013-4) A tool to assess habitat quality in river basins considering terrestrial and aquatic threats. *Soon in revision FEE*
PROGRESS REPORT

- Boithias 2014.

Annual emissions (kg cap⁻¹ yr⁻¹)

River removal rates (h⁻¹)

Uncertainty in the model input data
Boithias 2014.

GREAT-ER simulations of 13 molecules.
PROGRESS REPORT

- Terrado 2014.
PROGRESS REPORT

- Terrado 2014.

\[ R^2 = 0.7579 \]
\[ n = 122 \]
\[ y = 3.093x + 1.5247 \]

\[ R^2 = 0.3320 \]
\[ n = 66 \]
\[ y = 2.7737x + 0.5923 \]
PROGRESS REPORT

- Terrado 2014.
PROGRESS REPORT

6. Development of a calibration and sensitivity modules for InVEST.


PROGRESS REPORT

- Sánchez-Canales 2012.

Mean of absolute values $\mu^*$

Standard deviation $\sigma$
PROGRESS REPORT

- Sánchez-Canales 2012.

  - *Rainfall*: a poor fit in this input would imply non-realistic results.
  - *ET*: its interaction with precipitation has a huge importance in some particular areas.
  - *Z*: irrelevant in a range of values that it makes sense in the area.

The integration of a SA module in the InVEST software will allow the identification of the most important variables of the model

It will provide insight and guidelines into the potential applicability of the model to other Mediterranean river basins.
Sánchez-Canales 2014. *Soon in revision*

**SEDIMENT RETENTION (wq & dr)**

- Precipitation erosivity (R)
- Soil erodibility (K)

Factors almost independent.
PROGRESS REPORT

- Sánchez-Canales 2014. *Soon in revision*

**Most relevant:**
- Precipitation erosivity (R)
- Soil erodibility (K)

**Also relevant (depends on the LULC composition):**
- Crop-vegetation & management (C)
- Support practice (P)

**SEDIMENT EXPORTED**

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SCARCE 4th Annual meeting, Cádiz, 27 Nov 2013

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<table>
<thead>
<tr>
<th>Biophysical structures or processes</th>
<th>Functions</th>
<th>Services</th>
<th>Benefits</th>
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<tbody>
<tr>
<td>Water availability</td>
<td>Water regulation</td>
<td>Water provisionning</td>
<td>Water for drinking purposes</td>
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<td>Water for irrigation purposes</td>
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<td></td>
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<td>Hydropower production</td>
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<tr>
<td>Vegetation and geomorphology</td>
<td>Sediment retention</td>
<td>Erosion control</td>
<td>Higher surface water quality</td>
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<td>Avoided soil losses</td>
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<td>Extension of water management structures lifetime</td>
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<td>Soil carbon storage</td>
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<td>Enjoyment of recreational areas</td>
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<tr>
<td>Eiota and abiotic processes</td>
<td>Removal or breakdown of OM, xenic nutrients and compounds</td>
<td>Water purification</td>
<td>Higher surface water and groundwater quality</td>
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<td></td>
<td></td>
<td>Enjoyment of recreational areas</td>
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<tr>
<td>Habitat availability</td>
<td>Refugium for species and maintainance of genetic diversity</td>
<td>Habitat for species</td>
<td>Existence/conservation of genetic and species diversity</td>
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<td>Conservation of natural habitat</td>
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<td></td>
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<td></td>
<td>Habitat restoration</td>
</tr>
</tbody>
</table>

**Boithias L. and others (2014) Ecosystem service Total Economic Value: analysis of the uncertainty. In preparation.**

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Valuation approach</th>
<th>Value</th>
<th>NPV/MV</th>
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<tbody>
<tr>
<td>Water for drinking purposes</td>
<td>Market price</td>
<td>Per capita consumption cost for increase in supply (Demand function)</td>
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<td></td>
<td>Contingent valuation</td>
<td>WTP for secured water supply for drinking water per household</td>
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<td>Mitigation cost</td>
<td>Cost of alternate water supply</td>
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<tr>
<td>Water for irrigation purposes</td>
<td>Contingent valuation</td>
<td>WTP for secured water supply for irrigation</td>
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<tr>
<td></td>
<td>Market price</td>
<td>Production function</td>
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<td>Hydropower production</td>
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<tr>
<td></td>
<td>Mitigation cost</td>
<td>Cost for ecosystem services for sustainable hydropower development</td>
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</tr>
</tbody>
</table>

**Case of water supply: 12 combinations of the TEV**
8. Cost-benefit analyses of the implementation of the measurement plans at the basin scale.


- Multiple criteria analysis with ELECTRE III-H to solve group ranking problem multi-objective scenarios.
- Pilot-study on integrated decision support system for aquatic ecosystem valuation.
2014. WHAT’S UP?

Expected outcomes:

- Published outlined manuscripts (2014-2015) (8).
- Develop trade-off analysis with ACA stakeholders.
- Hydrological ES assessment in the Llobregat basin using AQUATOOL.
- Develop the joint estimation of services between AQUATOOL and InVEST (interaction CSIC-IDAEA, UPV, URV, ICRA) – Scheduled meeting Jan 2013.
- Publish the most interesting manuscripts once everything is done (2015-6).