ENVIROMENTAL FLOWS
ASSESSMENT FOR RUNNING
WATERS IN SLOVENIA

NATASA SMOLAR-ZVANUT
DANIJEL VRHOVSEK
IAN MADDOCK

10th International Riversymposium & Environmental Flows Conference
Brisbane, 3-6 September 2007
CONTENTS

1. INTRODUCTION
2. DEFINITION AND BASIS FOR EF ASSESSMENT
3. CRITERIA AND METHODS
4. APPLICATION OF EF
5. CASE STUDY: THE SOCA RIVER
6. CONCLUSIONS
The permanent hydrographic network of streams and rivers measures over 26,000 km + 7,700 km of flash flood channels in Alps.
Water regime is very sensitive to all kinds of human impacts!
WATER ABSTRACTION

- Fish farming
- Technological purposes
- Irrigation
- Drinking water
- Energetic use

MOSTLY ON SMALL STREAMS
2. DEFINITION AND BASIS FOR DETERMINATION OF EF

- **Water Act 1976**: Biological minimum
- **New Water Act 2002**: ENVIRONMENTAL FLOW is the quantity and quality of water which preserve ecological balance in the stream and in the riparian zone and do not worsening the ecological status of running waters

**ENVIRONMENTAL FLOW: to protect river ecosystem**
There are complex effects between ecosystem parameters, these show that the ecosystem is able to adapt to relatively small changes which occur in nature. If the balance is interrupted by big changes then the ecosystem is not stable anymore.

→ interdisciplinary approach for EF determination and each section of the river should be treated separately
The starting points for selecting the criteria:

- the importance of preservation and protection of rivers, their habitats with flora and fauna and diversity of organisms

- EF should be determined before each impact in the river or in the area, which could have an influence on the structure and function of the river as the ecosystem.

- The necessary of selected hydraulic, hydrological, morphological and ecological parameters on the sections concerned should be checked.

- For each change of quality and quantity of water in the river a new assessment of EF is required.
3. CRITERIA AND METHODS

- Hydrological criteria
- Hydro-morphological criteria
- Ecological criteria
- Water abstraction

Rapid Assessment Method

Detailed Assessment Method

- If the running water is in a preserved or legally protected area, endangered or rare species
- If the river reach is affected by WA over a long river section (rivers with catchment area more than 100 km² and WA on more than 200m)
- If WA is larger than 20 % of MAMF
- If the public interest demands multi-designation use of the running water
- According to Inventarisation of habitats
RAPID ASSESSMENT METHOD

→ **Hydrological parameters** *(F, MDF, MAMF, MADF)*

→ **Hydro-morphological data** *(geology, depth, velocity, sediments)*

→ **Ecological data** *(aquatic flora and fauna, habitats, physico-chemical parameters, inventory of water polluters)*

→ **Water abstraction** *(length, duration, quantity)*

DETAILED ASSESSMENT METHOD

→ **Inventory of aquatic organisms** *(diversity, biomass, rare and endangered species)*

→ **riparian flora and fauna**
→ habitat mapping at different flows
→ water quality
→ sel. physico-chemical parameters
→ landscape evaluation
→ other uses of water

- The EF are determined → results of experts
- Priority: ecological parameters and aquatic organisms

- Evaluation of EF: for every water abstraction separately for different seasons
4. APPLICATION OF EF

From 1992 the EF was determined on more than 180 reaches of streams and rivers:

- mostly for HPP, 60% rapid assessment method
- the requirements of water users had to be considered
- limited scope for incorporating flow variation into EF

Existing water users

New water users

Q = 0 l/s

Q = 900 l/s
### Database of EF assessment for rivers in Slovenia

<table>
<thead>
<tr>
<th>River</th>
<th>Location</th>
<th>Purpose for abstraction</th>
<th>L(m)</th>
<th>Flow characteristics before the dam (m³ s⁻¹)</th>
<th>Qmin (m³ s⁻¹)</th>
<th>EF (m³ s⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q₉₅</td>
<td>Q₈₂</td>
<td>MDF</td>
</tr>
<tr>
<td><strong>Rapid Assessment Method Examples</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Krka</td>
<td>Dvor</td>
<td>FF</td>
<td>560</td>
<td>-</td>
<td>-</td>
<td>17.21</td>
</tr>
<tr>
<td>Sava Bohinjka</td>
<td>Soteska</td>
<td>HP</td>
<td>310</td>
<td>3.14</td>
<td>5.20</td>
<td>20.67</td>
</tr>
<tr>
<td><strong>Detailed Assessment Method Examples</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dravinja</td>
<td>Makole</td>
<td>HP</td>
<td>100</td>
<td>1.74</td>
<td>2.50</td>
<td>6.05</td>
</tr>
<tr>
<td>Kokra</td>
<td>Oljarica</td>
<td>HP</td>
<td>720</td>
<td>1.13</td>
<td>1.75</td>
<td>5.29</td>
</tr>
<tr>
<td>Rižana</td>
<td>Kubed</td>
<td>WS, FF, IR</td>
<td>14000</td>
<td>0.16</td>
<td>0.50</td>
<td>4.10</td>
</tr>
<tr>
<td>Sava Dolinka</td>
<td>Moste</td>
<td>HP</td>
<td>2470</td>
<td>6.44</td>
<td>8.22</td>
<td>13.53</td>
</tr>
<tr>
<td>Savinja</td>
<td>Podvin</td>
<td>FF, HP</td>
<td>7300</td>
<td>-</td>
<td>-</td>
<td>22.52</td>
</tr>
<tr>
<td>Selška Sora</td>
<td>Niko</td>
<td>HP</td>
<td>990</td>
<td>0.52</td>
<td>1.02</td>
<td>3.95</td>
</tr>
<tr>
<td>Soča</td>
<td>Doblar</td>
<td>HP</td>
<td>4320</td>
<td>20.04</td>
<td>27.43</td>
<td>80.00</td>
</tr>
<tr>
<td>Soča</td>
<td>Plave</td>
<td>HP</td>
<td>7950</td>
<td>21.22</td>
<td>29.70</td>
<td>86.20</td>
</tr>
<tr>
<td>Tržiška Bistrica</td>
<td>Tržič</td>
<td>HP</td>
<td>715</td>
<td>1.90</td>
<td>2.40</td>
<td>4.80</td>
</tr>
</tbody>
</table>
5. CASE STUDY: THE SOCA RIVER

Soca: the longest river flowing into the Adriatic (96 km in Slovenia) total: 136 km $F = 1612 \text{ km}^2$, limestone
As a consequence of power utilisation, there is no natural flow regime downstream of the Podsela Dam to inflow into Adriatic sea
RESULTS

- substantial changes in the **hydrological regime** (flow duration curve, current velocity, flow) and in **sediment structure**
- decrease in diversity of aquatic **habitats**

Hydrological parameters for the Soca River for the period 1961-1995 for water regimes with and without water abstraction.

<table>
<thead>
<tr>
<th>Cross-section</th>
<th>F (km²)</th>
<th>MDF (m³s⁻¹)</th>
<th>MADF (m³s⁻¹)</th>
<th>MAMF (m³s⁻¹)</th>
<th>Q82 (m³s⁻¹)</th>
<th>Q95 (m³s⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Podsela Dam</td>
<td>1244</td>
<td>80</td>
<td>16</td>
<td>10</td>
<td>27.43</td>
<td>20.04</td>
</tr>
<tr>
<td>SO2 - n</td>
<td>1254</td>
<td>80.6</td>
<td>16.1</td>
<td>10.0</td>
<td>27.47</td>
<td>20.08</td>
</tr>
<tr>
<td>SO2 - a</td>
<td>1254</td>
<td>22.5</td>
<td>0.13</td>
<td>0.12</td>
<td>0.64</td>
<td>0.25</td>
</tr>
<tr>
<td>SO4 - n</td>
<td>1345</td>
<td>86.2</td>
<td>17.8</td>
<td>10.5</td>
<td>29.70</td>
<td>21.22</td>
</tr>
<tr>
<td>SO4 - a</td>
<td>1345</td>
<td>33.1</td>
<td>1.0</td>
<td>1.0</td>
<td>1.41</td>
<td>1.12</td>
</tr>
</tbody>
</table>
Due to abstractions, the physico-chemical composition of water is defined by inflows downstream of the catchment.

Water temperature:
in the summer higher, in the winter lower

Concentration of oxygen:
in the summer lower, in the winter higher

BOD5 at sampling sites
- Low flow, favourable light conditions, nutrients and sediment structure were factors which made proliferation of algae possible.
- High biomass of phytobenthos can develop only after an extended period of habitat stability.
**TEST:**

Increasing flow downstream the dam
The impact of abstraction, especially in the time of low flows shows big changes in hydrological, physico-chemical and ecological parameters downstream of the dams.

- Improve the habitats: types and size
- Take into account: existing water abstraction (67 years)
- According to analyses of parameters

The EF below the Podsela dam = 1.0 m$^3$/s (before 0.2 m$^3$/s)
The EF below the Ajba dam = 2.5 m$^3$/s (before 0.5 m$^3$/s)
Q = 0.2 m³/s

Q = 1 m³/s
6. CONCLUSIONS

• Structure and function of the river should be protected – protect biodiversity

• Future:
  • River management plans
  • Good ecological status to 2015
  • Monitoring

• Water abstraction - where is ecologically and economically acceptable