Visualisation of habitat measures by means of photo scenarios

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NINA Lillehammer

EcoManage project
In cooperation with:
David N. Barton, NINA
Bjørnar Dervo, 3D smia
Hans-Petter Fjeldstad, Ana Adeva Bustos, Peggy Zinke, SINTEF
Svein Haugland, Aleksander Andersen, Agder Energi
EcoManage (2012-2015)

**Main objective:**

test, evaluate and adapt new concepts & methods for the improved development & management of energy and water resources.

Project lead: Håkon Sundt (SINTEF)

**NINA part:** decision support for habitat restoration and environmental flow measures in regulated rivers

→ method development

Case study: Mandalselva (Laudal/Bjelland)

Project lead NINA part: David N. Barton
EcoManage case study Mandalselva

Mandalselva Basin located in Southern Norway

Mandalselva is regulated by 6 power plants (Agder Energi).
EcoManage case study Mandalselva

Mandalselva Basin located in Southern Norway

Mandalselva is regulated by 6 power plants (Agder Energi).
EcoManage case study Mandalselva

Laudal HPP
1977: License
1981: In operation
No salmon production

1997: Liming program
Re-stocking strategy

2001: 11 tons of salmon
Salmon production back

Until 2012
• 1.5 m³s⁻¹ in winter
• 3 m³s⁻¹ in summer

NVE suggestion:
• 6 m³s⁻¹ in winter
• Spill during smolt migration
• 8-25 m³s⁻¹ summer
• 5 years trial period (2013-2017)
EcoManage Method development for MCDA support

Off-Setting
How much can measures in the minimal release sections Bjelland and Laudal compensate each other?

MCDA
Ranking of habitat restoration and flow regulation measures

- 10 weirs Laudal
- 2 weirs Bjelland
- Bjelland bypass section
- Downstream Bjellad outlet
- Laudal bypass section
- Sunde weir
- Fossekilen weir
- Weir 5
- Weir 6
- Weir 7
- Kleveland weir

CEDREN Centre for Environmental Design of Renewable Energy
Multi-criteria decision analysis (MCDA)

MCDA: Systematic structuring of decisions in a hierarchy of aims, criteria & alternatives
EcoManage: Multi-criteria decision analysis for Mandalselva

Main aim
- Good ecological potential without disproportionate cost

Partial Aims
- Maximise profit
- Maximise salmon production
- Maximise other user interests

Criteria
- Power
- Restoration costs
- Smolt product -ivity
- Aesthetics
- Fishing experience

Impacts

Alternatives
- 1. Stream flow
- 2. Weir removals
- 3. Spawning habitat

Utility
Weighting
Weighting
Scaling
EcoManage: Photo scenario development for Mandalselva

**WFD aim**

- Good ecological potential without disproportionate cost

**Partial aims**

- Maximise profit
- Maximise salmon population
- Maximise other user interests

**Criteria**

- Power
- Restoration costs
- Smolt productivity
- Aesthetics
- Fishing experience

**Impacts**

- Measure stakeholder preferences

**Alternatives**

1. Stream flow
2. Weir removals
3. Spawning habitat

**Utility**

- Weighting
- Scaling

CEDREN Centre for Environmental Design of Renewable Energy
Photo scenario method

• Aesthetic preferences as visual evaluation of sites

• No detour of evaluation through textual description or maps of sites

• Series of computerized visual simulations of scenarios depicting concrete management alternatives for the status quo situation in a standardized way
Example from Swiss study on river restoration

representative photo test survey of attitudes towards river restoration

computer-aided editing of one basis-photo

ecological integrity measured by eco-morphological quality

here: classification according to Swiss Module-Step Concept (MSC),

and expert validation

use in a Switzerland-wide representative survey

EcoManage: Photo scenario development for Mandalselva

1. step: baseline photos of all 12 existing weirs (July 2014)
EcoManage: Photo scenario development for Mandalselva

1. step: baseline photos in July 2014 of all existing weirs

Standardized: perspective / distance to weirs / angles / weather / light / no people.
2. step: reduction of sites for scenario development

5 sites:
- highest conflict potential
- management decisions to become relevant

Photos: Berit Kohler
EcoManage: Photo scenario development for Mandalselva

3. step: decision on scenario simulation criteria (habitat measures)

<table>
<thead>
<tr>
<th>Location</th>
<th>Weir Removal Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fossekilen weir</td>
<td>6m³/s discharge</td>
</tr>
<tr>
<td>weir</td>
<td></td>
</tr>
<tr>
<td>weir 3</td>
<td>6m³/s discharge</td>
</tr>
<tr>
<td>weir 4</td>
<td>6m³/s discharge</td>
</tr>
<tr>
<td>weir 5</td>
<td>6m³/s discharge</td>
</tr>
<tr>
<td>Klevland bru</td>
<td>6m³/s discharge</td>
</tr>
</tbody>
</table>

- Weir removal 6m³/s discharge
- Weir removal 3m³/s discharge
- Weir removal 15m³/s discharge
### 4. step: photo scenario development

<table>
<thead>
<tr>
<th>Habitat measure</th>
<th>Parameter</th>
<th>Type of inputdata/model used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stream flow adjustment (3,6 or 15 m³/s)</td>
<td>wetted area</td>
<td>Data from field work Miljødesign Mandalselva → HEC-RAS* 1D model &amp; GIS (HEC-GeoRAS) **</td>
</tr>
<tr>
<td></td>
<td>water level</td>
<td>Data from field work Miljødesign Mandalselva → HEC-RAS 1D model &amp; GIS (HEC-GeoRAS) **</td>
</tr>
<tr>
<td></td>
<td>water velocity</td>
<td>Data from field work Miljødesign Mandalselva → HEC-RAS 1D model &amp; GIS (HEC-GeoRAS) **</td>
</tr>
<tr>
<td></td>
<td>water depth</td>
<td>Data from field work Miljødesign Mandalselva → HEC-RAS 1D model &amp; GIS (HEC-GeoRAS) **</td>
</tr>
<tr>
<td></td>
<td>water surface structure</td>
<td>Qualitative expert knowledge (Hans-Petter Fjeldstad)</td>
</tr>
<tr>
<td></td>
<td>light, colour, shadow</td>
<td></td>
</tr>
</tbody>
</table>

*HEC-RAS: Hydrologic Engineering Centers River Analysis System.
**expert knowledge (H-P. Fjeldstad) also used for data gaps
4. step: photo scenario development

Changes in wetted area, water velocity and water depth: HEC-GeoRAS modeling

Modeling illustration examples of data input to photo scenario development

4. step: photo scenario development

* The original discharge was 2 m³/s; 6 m³/s scenario exists

Scenarios: Bjørnar Dervo, 3D smia
Klevland bru
original, with weir
6 m³/s

Photo: Berit Kohler
Klevland bru without weir
6 m³/s

Scenario: 3D smia
Klevland bru
without weir
3 m³/s
Klevland bru without weir
15 m³/s
Weir 5
original, with weir
6 m³/s

Photo: Berit Kohler
Scenario: 3D smia

Weir 5
without weir
6 m³/s
Weir 5
without weir
3 m³/s

Scenario: 3D smia
Weir 5
without weir
15 m³/s
Fosseiklen weir
original, with weir
2 m$^3$/s

Photo: Berit Kohler
Fossekilen weir
without weir
3 m³/s

Scenario: 3D smia
Fosseken weir
without weir
6 m$^3$/s
Scenario: 3D smia

Fossekiilen weir
without weir
15 m³/s
EcoManage: use of photo scenarios Mandalselva

5. step: application in focus group interviews with local stakeholders

<table>
<thead>
<tr>
<th>3 m3/s</th>
<th>6 m3/s</th>
<th>15 m3/s</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image 1" /></td>
<td><img src="image2.png" alt="Image 2" /></td>
<td><img src="image3.png" alt="Image 3" /></td>
</tr>
</tbody>
</table>

Ex. question: «Please rank the following scenes on a scale from 1 (worst) to 9 (best) according to how attractive they are for you!»

Slide adapted from: David N. Barton (work in progress)
EcoManage: use of photo scenarios Mandalselva in MCDA

5. step: application in focus group interviews with local stakeholders

<table>
<thead>
<tr>
<th>3 m3/s</th>
<th>6 m3/s</th>
<th>15 m3/s</th>
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</thead>
<tbody>
<tr>
<td><img src="0" alt="Image" /> scaled impact</td>
<td><img src="1" alt="Image" /> scaled impact</td>
<td><img src="1" alt="Image" /> scaled impact</td>
</tr>
</tbody>
</table>

Q: How do we scale impact in MCDA?

Slide adapted from: David N. Barton (work in progress)
EcoManage: use of photo scenarios Mandalselva in MCDA

Without weir 3m³/s
wetted area = 4.86 m²

Without weir 6m³/s
wetted area = 40.33 m²

Without weir 6m³/s
wetted area = 7.77 m²

Without weir 15m³/s
wetted area = 14.67 m²

Interviews stakeholders

**Wetted area (m² intervals) input table Hugin/BBN**

<table>
<thead>
<tr>
<th>Wetted Area (m², spring, Leudos)</th>
<th>0-0.1</th>
<th>0.1-0.2</th>
<th>0.2-0.3</th>
<th>0.3-0.4</th>
<th>0.4-0.5</th>
<th>0.5-0.6</th>
<th>0.6-0.7</th>
<th>0.7-0.8</th>
<th>0.8-0.9</th>
<th>0.9-1</th>
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</thead>
<tbody>
<tr>
<td>2773000 - 2863400</td>
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<td>2863400 - 2953700</td>
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<td>2953700 - 3044100</td>
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<td>3044100 - 3134400</td>
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<tr>
<td>3134400 - 3224800</td>
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</tbody>
</table>

Scaled impact (0-1)

Slide adapted from: David N. Barton (work in progress)
Scenario: 3D smia

Visualisation of habitat measures by means of photo scenarios

Fossekilen weir
scenario
6m3/s

Thank you! Comments, questions?

Scenario: 3D smia
Industrial partners

agder energi  
BKK  
ECO  
Eidsiva  
EnergiNorge  
HYDRO  
ICH  
Sira-Kvina kraftselskap  
Statkraft  
Statnett  
TrønderEnergi  
NVE