Hydropower Planning Around Ecologically Sensitive Areas

ISH01 STUDY: IDENTIFICATION OF ECOLOGICALLY SENSITIVE SUB-BASINS FOR SUSTAINABLE DEVELOPMENT OF HYDROPOWER ON TRIBUTARIES

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Content

- ISH01 goals, tools and potential
- Overview on the ISH01 approach
- Implementing the ISH01 approach in the Sre Pok sub-basin
- Benefits of ISH01 implementation for decision making
ISH01 GOALS, TOOLS AND POTENTIAL
ISH01 Products and Outcomes

ISH01 Study has been implemented during the last 2 years along 3 project components and 17 activities

<table>
<thead>
<tr>
<th>ISH01 STUDY OUTCOMES IN BRIEF</th>
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<tr>
<td><strong>AN APPROACH</strong></td>
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<td><strong>EASY-TO-APPLY</strong></td>
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<td><strong>FRAMEWORK</strong></td>
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<tr>
<td><strong>FINDINGS</strong></td>
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<tr>
<td><strong>A PROPOSAL</strong></td>
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</table>
ISH01 Framework and Tools

ISH01 provides an *Integrated Decision Making Tool*

Planning and management framework for sustainable hydropower in LMB tributaries
Combination into a Holistic Approach

The approach and tools of ISH01 have potential to support:

- **Operation and development** of sustainable LMB hydropower
- **Protection and conservation** of Ecologically Sensitive Areas
- **Socio-economic benefit** from (i) energy generation and (ii) functioning ecosystem services
**ISH01 Focus**

**Sub-Basin Level**
- Pilot basin testing
- Sre Pok river basin
- Local/national scale in the regional context

**Indirectly: 104 LMB sub-basins**
- Proposal for up-scaling
- Basin-wide/regional scale
ISH01 APPROACH
ISH01 approach follows a coherent scheme:

3 Modules consisting of 10 steps

<table>
<thead>
<tr>
<th>MODULE 1</th>
<th>IDENTIFICATION OF ECLOGICALLY SENSITIVE AREAS and THEIR FRAGILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEP 1</td>
<td>Basic abiotic characterisation and typology of LMB sub-basins</td>
</tr>
<tr>
<td>STEP 2</td>
<td>Identification of Candidate Ecological Area (CEAs) in LMB sub-basins based on national planning/policy documents and allocation of spatial importance</td>
</tr>
<tr>
<td>STEP 3</td>
<td>Identification of sensitivity of the Candidate Ecological Areas to selected human pressures in LMB sub-basins</td>
</tr>
<tr>
<td>STEP 4</td>
<td>Final Identification of Ecologically Sensitive Areas (ESAs) in LMB sub-basins</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>MODULE 2</th>
<th>CLASSIFICATION OF HYDROPOWER AND PRESSURE TYPES</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEP 5</td>
<td>Classification of hydropower schemes in sub-basins according to specifications</td>
</tr>
<tr>
<td>STEP 6</td>
<td>Identification of key pressure types from hydropower that may impact on ESAs and related river reaches</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MODULE 3</th>
<th>MERGING OF IDENTIFIED ESAs AND HYDROPOWER</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEP 7</td>
<td>GIS merging and analysis of information: Location ESAs and hydropower</td>
</tr>
<tr>
<td>STEP 8</td>
<td>Risk assessment of possible impacts from hydropower on ESAs based on criteria</td>
</tr>
<tr>
<td>STEP 9</td>
<td>Combination and interpretation of results towards sustainable hydropower planning</td>
</tr>
<tr>
<td>STEP 10</td>
<td>Integration of all ten steps into an easy-to-apply hydropower planning and management framework for sustainable and coherent decision making</td>
</tr>
</tbody>
</table>

Up-scaling of the developed approaches to the LMB basin-wide scale
Overall ISH01 Approach at One Glance

CONCEPT OF THE PLANNING AND MANAGEMENT FRAMEWORK TOWARDS SUSTAINABLE LMB HYDROPOWER

STEP 1
LMB River Typology

STEP 2
Candidate LMB Ecological Areas that may be ecologically sensitive to Impacts

STEP 3
Perform identification based on the key question:
Are the Candidate Ecological Areas ecologically sensitive?
Application of relevant identification criteria

STEP 4
Further investigation: Undertake Risk Estimation

- Yes
  - Identified ESA
  - Further investigation

- No
  - No ESA Identified
  - No further investigation

STEP 5
LMB Hydropower Schemes classified (e.g. regarding operation) and located

STEP 6
Identify Pressure Types stemming from hydropower

Perform Risk Estimation based on the key question:
Do the identified pressure types impact on the ESA related river reaches?
Implementation of risk criteria

STEP 7
GIS merging of ESAs and hydropower

STEP 8

Not at Risk
At Risk
Possibly at Risk
Unclear

STEP 9
GIS illustration, interpretation and integration of all 10 Steps

STEP 10
Fill data gaps / Increase information / Repeat Risk Estimation

*T unclear risk estimation due insufficient information
Key Benefits of the ISH01 Approach

- ISH01 approach has strong potential to support sustainable hydropower planning and management.
- Basis for first stage decision making.
- Simple GIS overlay of ESAs and hydropower schemes.
  - First and informative indication on potential areas of conflict.
- Transparent risk assessment applying ISH01 criteria.
  - Concrete conclusions on hydropower impacts on river reaches.
  - Good overview on existing AND future situation in a river basin.

Decision making possible before investing in EIAs

(ISH01 approach does not replace an EIA)
Key Benefits of the ISH01 Approach

Integrative Planning and Management Tool

- **Integration of all dams** (existing/planned) into one assessment
- **Not only case-by-case** consideration
- Considerations on **transboundary and cumulative impacts** possible
- Approach and results **transparent** to all involved
  - Decision makers, water managers, hydropower operators/developers
  - Establishment of common understanding to meet the right decisions
IMPLEMENTING THE ISH01 APPROACH
WHAT CAN BE ACHIEVED?
Step-by-Step Presentation using pilot testing result from the Sre Pok sub-basin

First: Identification of Ecologically Sensitive Areas (ESAs)
ISH01 ESA Definition for the LMB Context

A functioning ‘Ecologically Sensitive Area’ in the LMB context is defined as an area that
• contains high ecological value/importance,
• supports sustainable ecological processes in support of socio-economical and ecological value,
• supports the sustainability of ecosystem services and, hence, livelihoods (ecosystem services),
• is fragile to impacts no matter if human and/or natural, and, hence
• is at possible risk to lose its support of ecological value and processes by these impacts.
Following a Basin Characterisation: Identification of Candidate Ecological Areas

- Based on national and regional planning docs and existing LMB sub-basin studies

- Compilation of a catalogue of a sub-basin’s *Candidate Ecological Areas*

- The CEA Catalogue forms the basis for identifying ecological importance and sensitivity
Assigning Spatial Importance to CEAs

There are four levels of spatial importance:

<table>
<thead>
<tr>
<th>Spatial Importance</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Global:</strong></td>
<td>e.g. if a CEA/stream supports the last stronghold of a globally endangered species.</td>
</tr>
<tr>
<td><strong>Regional, or basin-wide:</strong></td>
<td>e.g. if a CEA/stream contains a characteristic of importance to basin-wide processes, such as Tonle Sap, or the only spawning site for a fish species. Includes Key Biodiversity Areas</td>
</tr>
<tr>
<td><strong>National:</strong></td>
<td>e.g. if a CEA/stream contains the last surviving population of species in a country, or if a wetland acts as a water source for a city.</td>
</tr>
<tr>
<td><strong>Local, or sub-basin-wide:</strong></td>
<td>e.g., if a CEA/stream act as a corridor between two important sites, or contains a fishing zone.</td>
</tr>
</tbody>
</table>
Spatial Importance of Fish Migration

Fish migration takes an important role and needs reflection. Pragmatic, preliminary approach due to significant information gaps:

- Gaps need to be filled!!
Identifying Sensitivities in Sub-Basins to Selected Human Pressures

Sensitivity in terms of human pressures is captured by defining and verifying spatial and upstream criteria ranges regarding different human pressures:

<table>
<thead>
<tr>
<th>Human pressures</th>
<th>close to pristine - low pressure</th>
<th>medium level of pressure</th>
<th>high level of pressure</th>
<th>too impacted to be considered as a high ESA</th>
<th>unit</th>
<th>source of criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>human population density</td>
<td>upstream population density</td>
<td>&lt; 10</td>
<td>10 - 50</td>
<td>50 - 500</td>
<td>500 &lt;</td>
<td>people/km²</td>
</tr>
<tr>
<td></td>
<td>upstream urban area</td>
<td>&lt; 2%</td>
<td>2 - 10%</td>
<td>10 - 50%</td>
<td>50% &lt;</td>
<td>percentage of total upstream area with density &lt;500 people</td>
</tr>
<tr>
<td>land cover</td>
<td>upstream natural area</td>
<td>85% &lt;</td>
<td>50 - 85%</td>
<td>10 - 50%</td>
<td>&lt; 10%</td>
<td>percentage of total upstream area</td>
</tr>
<tr>
<td></td>
<td>upstream agricultural area</td>
<td>&lt; 2%</td>
<td>2 - 10%</td>
<td>10 - 50%</td>
<td>50% &lt;</td>
<td>percentage of total upstream area</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>roads</td>
<td>0.05</td>
<td>0.05 - 0.1</td>
<td>0.1 - 0.5</td>
<td>0.5 &lt;</td>
<td>density km/km²</td>
</tr>
<tr>
<td></td>
<td>irrigation</td>
<td>0</td>
<td>0 - 5%</td>
<td>5 - 10%</td>
<td>&lt; 10%</td>
<td>percentage of total upstream area</td>
</tr>
</tbody>
</table>

Implemented through GIS analysis
Identifying Sensitivities in Sub-Basins to Selected Human Pressures

- Population density
- Urban areas
- Agricultural areas
- Deforestation

Data Source:
- WorldPop
- 2000 Un-Adjusted Estimates
- Downloaded March, 2014

Screening Criteria:
- On the River Network
  - 0 - 10 people per km²
  - 10 - 50 people per km²
  - 50 - 100 people per km²
  - 100 - 500 people per km²
- On the Ground
  - 0 - 10 people per km²
  - 10 - 50 people per km²
  - 50 - 100 people per km²
  - 100 - 500 people per km²
Step 3: Combined Human Pressures on Candidate Ecological Sensitive Areas

Legend

- High Level
- Low Level
- Medium Level
- Too Impacted

Data Source:
- Protected Areas
- Key Biodiversity Areas
- HydroSHEDS
- WorldPOP
- MRC Landsat Land Cover 2001
Identifying Final Ecologically Sensitive Areas

Three classes regarding ecological sensitivity

<table>
<thead>
<tr>
<th>Classes of Ecological Sensitivity</th>
<th>ESA Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Ecological Sensitivity</td>
<td>Identification as ESA</td>
</tr>
</tbody>
</table>
| Medium Ecological Sensitivity     | Identification as medium/possible ESA  
Besides medium ranked ESAs, this category also includes ESAs that can currently not be identified due to data gaps; identification need to be repeated |
| Low Ecological Sensitivity        | No identification as ESA |
Identifying Final Ecologically Sensitive Areas

Combination of spatial importance and sensitivity to human pressures, Candidate Ecological Areas are identified as ESAs according to a coherent scheme:

<table>
<thead>
<tr>
<th>Spatial Importance</th>
<th>Human Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Local</td>
<td>High ESA</td>
</tr>
<tr>
<td>National</td>
<td>High ESA</td>
</tr>
<tr>
<td>Regional</td>
<td>High ESA</td>
</tr>
<tr>
<td>Global</td>
<td>High ESA</td>
</tr>
<tr>
<td>Unidentified</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>Medium ESA</td>
</tr>
<tr>
<td>National</td>
<td>Medium ESA</td>
</tr>
<tr>
<td>Regional</td>
<td>High ESA</td>
</tr>
<tr>
<td>Global</td>
<td>High ESA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>Low ESA</td>
</tr>
<tr>
<td>National</td>
<td>Low ESA</td>
</tr>
<tr>
<td>Regional</td>
<td>Medium ESA</td>
</tr>
<tr>
<td>Global</td>
<td>High ESA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Too impacted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>Low ESA</td>
</tr>
<tr>
<td>National</td>
<td>Low ESA</td>
</tr>
<tr>
<td>Regional</td>
<td>Low ESA</td>
</tr>
<tr>
<td>Global</td>
<td>Medium ESA</td>
</tr>
</tbody>
</table>
Step 4: Identification of ESAs

ESAs also related to river reaches

Legend
- High ESA
- Medium ESA
- Low ESA

Coordinate System: WGS 1984 UTM Zone 48N
Projection: Transverse Mercator

Data Source:
Protected Areas
MERGE ESAs WITH HYDROPOWER, DEFINE HYDROPOWER Pressures AND UNDERTAKE RISK ASSESSMENT FOR DECISION MAKING
Step 7: GIS merging and analysis

Merged ESAs with Hydropower Schemes in the Sre Pok Sub-Basin

Legend
- Existing hydropower schemes
- Planned hydropower schemes

High ESA
Medium ESA
Low ESA

Reservoirs
National Boundary
Provincial boundaries
Provincial Capitals

Data Source: MRC, Protected Areas, Key Biodiversity Areas, Fish Migration Routes
## Identifying Key Pressure Types

<table>
<thead>
<tr>
<th>#</th>
<th>Pressure Type</th>
<th>#</th>
<th>Allocated pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fish migration barrier</td>
<td>1a</td>
<td>Interruption of river, habitat and fish migration continuity</td>
</tr>
<tr>
<td>2</td>
<td>Sediment transport barrier</td>
<td>2a</td>
<td>Interruption of sediment transport continuity</td>
</tr>
<tr>
<td>3</td>
<td>Alteration of characteristic water quality parameters</td>
<td>3a</td>
<td>Nutrient increase / eutrophication (N/P);</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3b</td>
<td>Alteration of water temperature;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3c</td>
<td>Alteration of oxygen;</td>
</tr>
<tr>
<td>4</td>
<td>Hydrological and hydraulic alterations (= changes regarding natural flow regime and patterns upstream and downstream a dam)</td>
<td>4a</td>
<td>Significant fluctuations in water level and current velocity downstream of the dam due to peaking operation (short term);</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4b</td>
<td>Altered/reduced downstream flooding and inundation areas (long term/annual);</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4c</td>
<td>Insufficient ecological flow below the dam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4d</td>
<td>Shift to lake-like character upstream the dam due to reservoir effect causing changes in flow velocities, habitat structure and possible continuity interruption</td>
</tr>
<tr>
<td>5</td>
<td>Reservoir area inundation</td>
<td>5a</td>
<td>Inundation of areas in new reservoir area through impoundment</td>
</tr>
</tbody>
</table>
Risk Assessment of Hydropower Impacts Stemming from Hydropower Pressures

....on ESA related river reaches

Stepwise risk assessment approach applying risk criteria aligned to best practices

Risk criteria in place for EACH hydropower pressure type
Risk Assessment of Hydropower Impacts Stemming from Hydropower Pressures

....on ESA related river reaches

Allocation to 3 risk categories: at risk; possibly at risk; not at risk

Perform Risk Estimation based on the key question:
Do the identified pressure types impact on the ESA related river reaches?
Implementation of risk criteria
Overall Risk Assessment

Sre Pok Sub-Basin

Overall Risk
- Existing dam
- Proposed dam

At dam sites:
- Green: Not at risk
- Red: At Risk
- Orange: Possibly at Risk

On river:
- Green: Not at risk
- Red: At risk
- Orange: Possibly at risk
- Pink: High ESA
- Light Green: Medium ESA
- Purple: Low ESA
- Water bodies:
  - Reservoirs
  - Tailrace
  - Channel
  - National Boundary
  - Provincial boundaries
  - Provincial Capitals

Coordinate System: WGS 1984 UTM Zone 48N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000,0000
False Northing: 0.0000
Central Meridian: 105.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
Combination & Interpretation of Risk Assessment Results

Overall Risk
- Fish migration barrier
- Sediment interruption
- Sediment flushing effect
- Hydropeaking impacts
- Reduced inundation
- Insufficient env. flow
- Reservoir effect
- Impacted water quality
- Altered habitats

Initial Basis for strategic decision making regarding hydropower
Decision Making, Planning an Management

.....towards sustainability. Adding up to the benefits presented earlier.

**Planned hydropower projects**
- Planning basis to address mitigation measures & compensate impacts
- Basis to decide if alternative sources and sites should be identified

**Existing hydropower projects**
- Understand their contribution to impacts in a basin
- Enables considerations to set ‘retrofitting measures’ to reduce impacts
THANK YOU.

In case of questions please contact:
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