# Mekong River Commission

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## ISH0306 - Consultancy for the Development of Guidelines for Hydropower Environmental Impact Mitigation and Risk Management in the Lower Mekong Mainstream and Tributaries

## The Role of Guidelines for Sustainable Hydropower Practise

**Vientiane, Lao PDR,**
**August 10-11, 2017**

# Introduction - Process for for Risk and Impact Mitigation Assessment



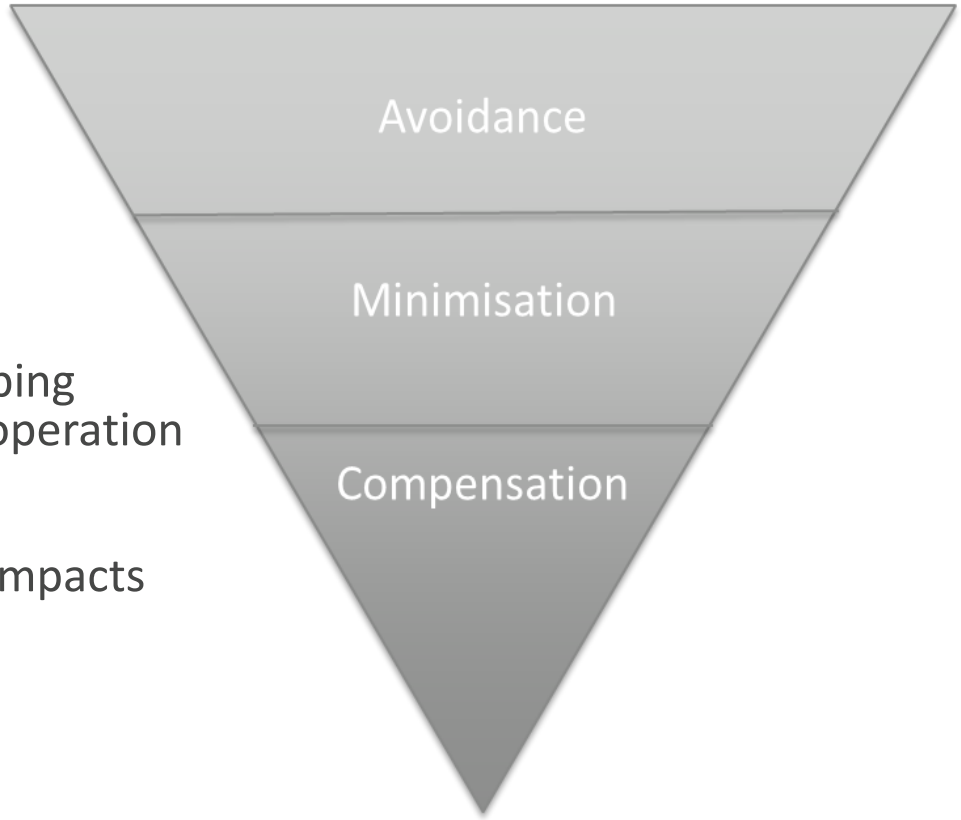
## Article 7 – Mekong Agreement (1995) «*To make every effort to avoid, minimize and mitigate harmful effects……*»

## Mitigation Hierarchy

**Avoidance =** Identifying alternative sites or technology to eliminate Impacts (Master plans, Pre-feasibility, Feasibility)

**Minimization =** most often used prescribing actions during design, construction and operation stage to minimize or eliminate impacts

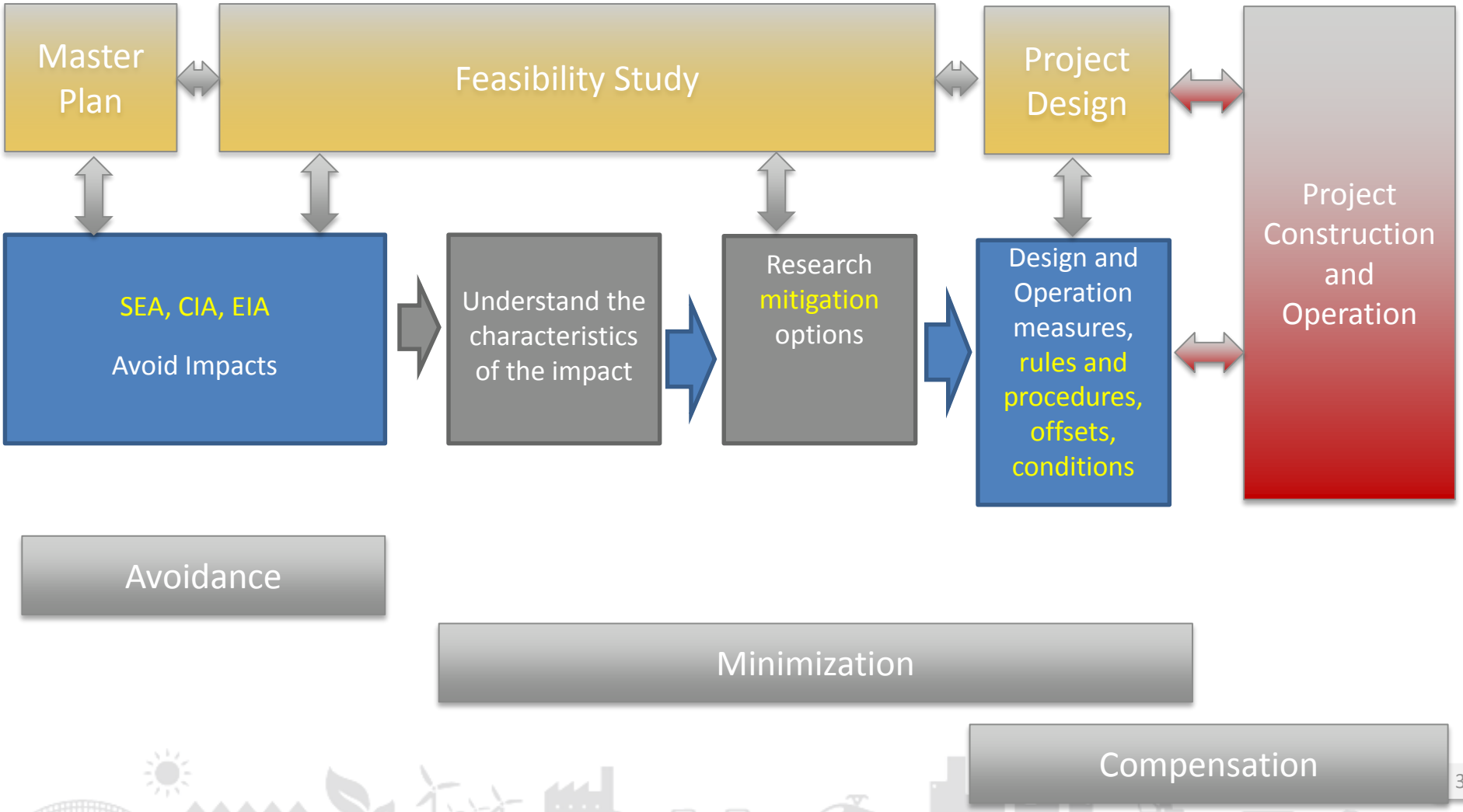
**Compensation =** used to offset residual impacts identified at different stages



# Introduction - Process for for Risk and Impact Mitigation Assessment



## MRC Generic Practical Process for Risk and Impact Mitigation - Project Life Cycle

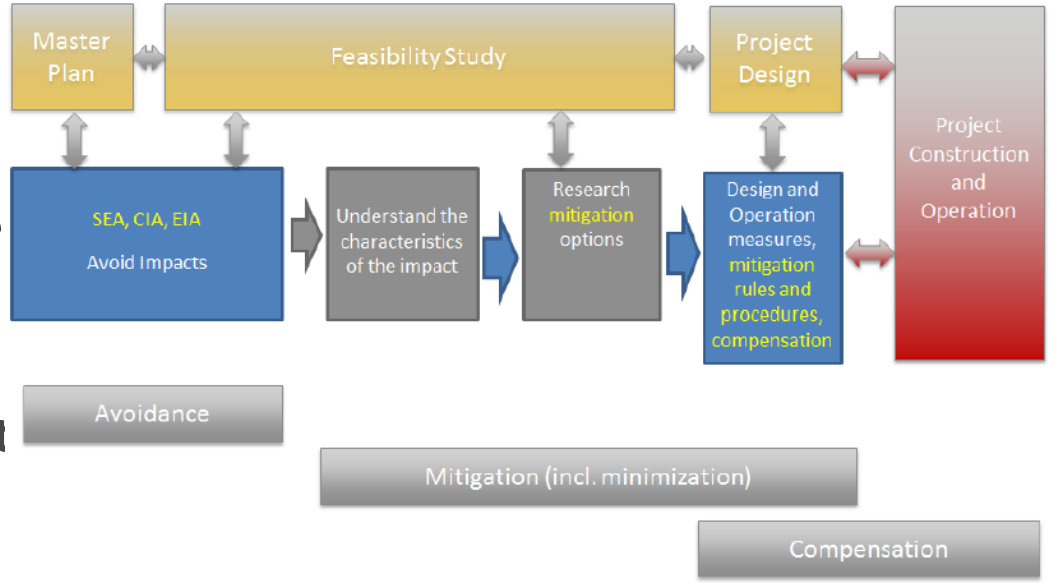


# Overall Structure of the Guidelines, Manual and Knowledge Base



## 1. The Guidelines (Volume 1)

- Key Lower Mekong Hydropower Risks, Impacts and Vulerabilities
- Guiding principles for mitigation
- Detailed Mitigation Options for the Different Project Phases




## 2. The Manual (Volume2) to support implementation of Guidelines

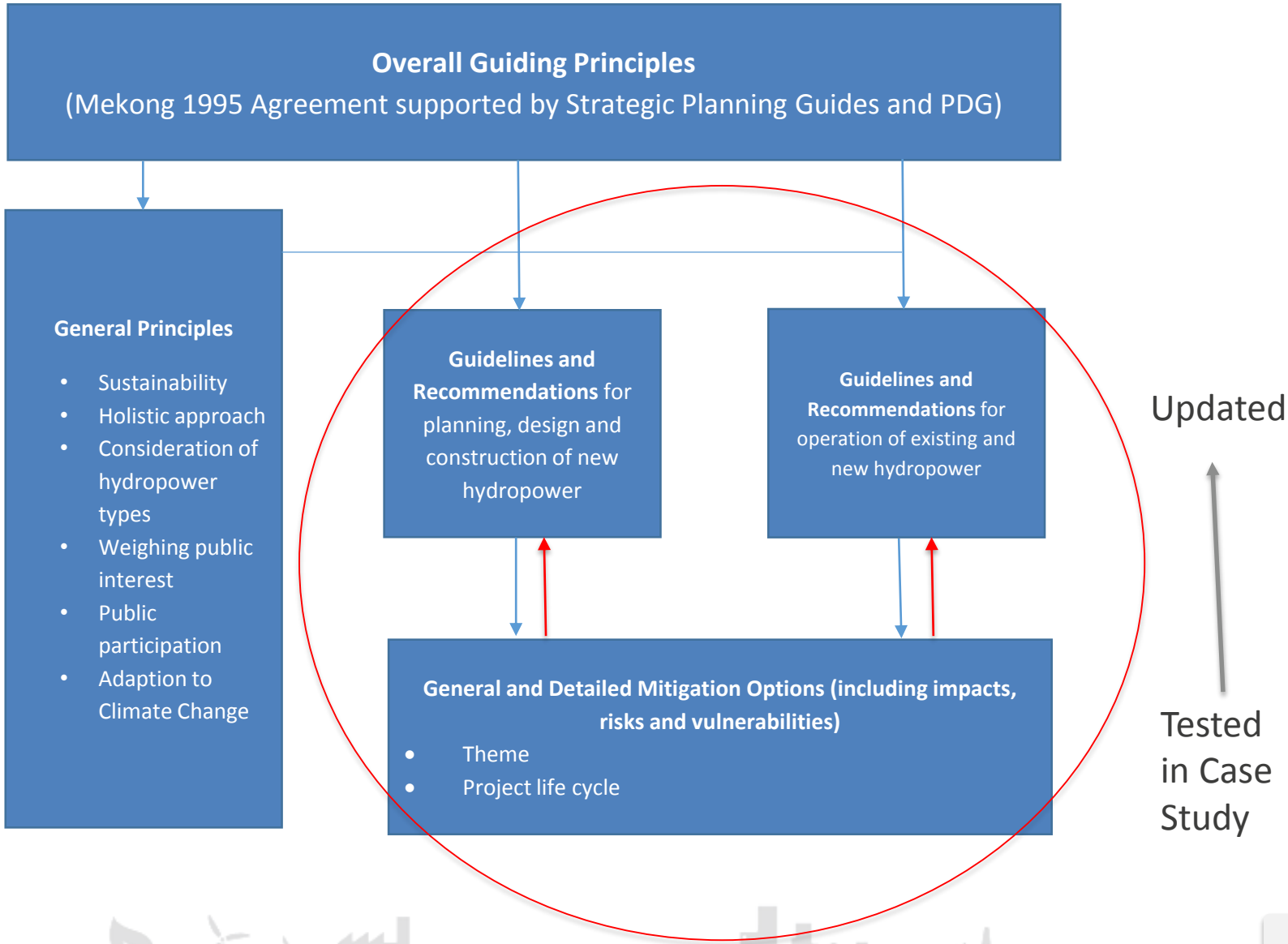
- How to choose the most tailored and right mitigation options proposed in the Guidelines.
- Describes in detail hydropower environmental risks and impacts for each theme and the effect of
- Examples and experiences of good industrial practice

## 3. The Knowledge Base (Volume 3)

- Searchable library on relevant litrature
- Connected to the guidelines and manual litterature

# Overall Structure of the Guidelines





# Overall Structure of the Guidelines and Manual



**Focus Themes:**

1. Hydrology and downstrean flows
2. Geomorphology and sediments
3. Water quality
4. Aquatic ecology and fisheries; and
5. Biodiversity, natural resources and ecosystem services
6. Engineering design and operation response to the above

**Related to defined**

# Guidelines Structure – Detailed Mitigation Measures

Structure based on five broad environmental risk areas:

- (I) Annual / Inter annual changes to flow
- (II) Short term flow fluctuations
- (III) Loss of river connectivity
- (IV) Impoundments
- (V) Diversions / intra basin transfers

Responses are provided in a matrix:

| Risks / Impacts | Table 5.2 (II) Short-term flow fluctuations / Hydro-peaking | | | |
|---|---|---|---|---|
| | Planning / design / construction | | Operation | |
| | Options | Indicators | Options | Indicators |
| **Hydrology and downstream flows**<br>1) Short term flow fluctuations<br>2) Safety and navigability | **(II.1) Avoidance** | | | |
| | (II.1.1) Dam siting in Master Plans to avoid risks and impacts in themes hotspot areas (MP)<br>(II.1.2) Selection of sites where impacts are reduced by entering tributaries (MP) | River length affected | | |
| **Geomorphology and Sediments**<br>1) Rapid wetting and drying of banks<br>2) Increase in shear stress on river channel<br><br>**Water quality**<br>1) Fluctuating temperature and water quality<br>2) Altered concentrations of downstream WQ parameters<br><br>**Fisheries and Aquatic Ecology** | **(II.2.) Mitigation** | | | |
| | (II.2.1) Development of flow rules (F and D)<br>(II.2.2) Design of re-regulation weir (D)<br>(II.2.3) Coordination of multiple hydropeaking HPP<br>(II.2.4) Design of aeration weir<br>(II.2.5) Avoidance of flow fluctuations during construction (C)<br>(II.2.6) Establish protected areas and evacuation paths for inundation zones (C)<br>(II.2.7) Flexible mooring structures for ports (D and C)<br>(II.2.8) River-bank stabilisation works (C) | Ramping frequency, amplitude, ramping rate, minimum flow temperature, dissolved oxygen, downstream damping of water-level fluctuations | (II.2.9) Re-regulation warning systems<br>(II.2.10) Operating rules to minimise flow changes, management of re-regulation weir to provide appropriate downstream flow<br>(II.2.11) Monitoring of impacts<br>(II.2.12) Use of high/low level outlets to mimic seasonal temperature and manage dissolved oxygen | Ramping frequency, ramping amplitude, ramping rate, minimum flow, changes to fish diversity/ biomass. Bank / bed erosion rates Downstream temperature, D.O. downstream damping of water-level fluctuations |
| | **(II.3) Compensation** | | | |
| | Plan for and implement;<br>(II.3.1) Habitat improvement (F and D)<br>(II.3.2) Floodplain and wetland rehabilitation (D and C) | Area of improved floodplain and wetland habitats | (II.3.3) Monitor habitat improvement and rehabilitation | Changes to fish diversity/ biomass |
| 1) Degradation of riparian and instream habitats<br>2) Thermopeaking<br>3) Increased fish/ macroinvertebrate drift and stranding<br>4) Offset of migration triggers<br><br>**Biodiversity, Natural Resources and Ecosystem Services**<br>1) Degradation of function, dynamics and ecosystem services of wetland and riparian habitats | **(II.4) Adaptation** | | | |
| | Monitoring, adaptive management (based on monitoring data)<br>Catchment management to maximise water quality in and discharged from impoundment | | | |
| | MP = Master Plan<br>F = Feasibility<br>D = Detailed Design<br>C= Construction | | | |

| Risk / impacts | Planning / design /construction | | Operation | |
|---|---|---|---|---|
| | Options | Indicators | Options | Indicators |
| | (1) Avoidance | | | |
| | (2) Mitigation | | | |
| | (3) Compensation | | | |
| | (4) Adaption | | | |

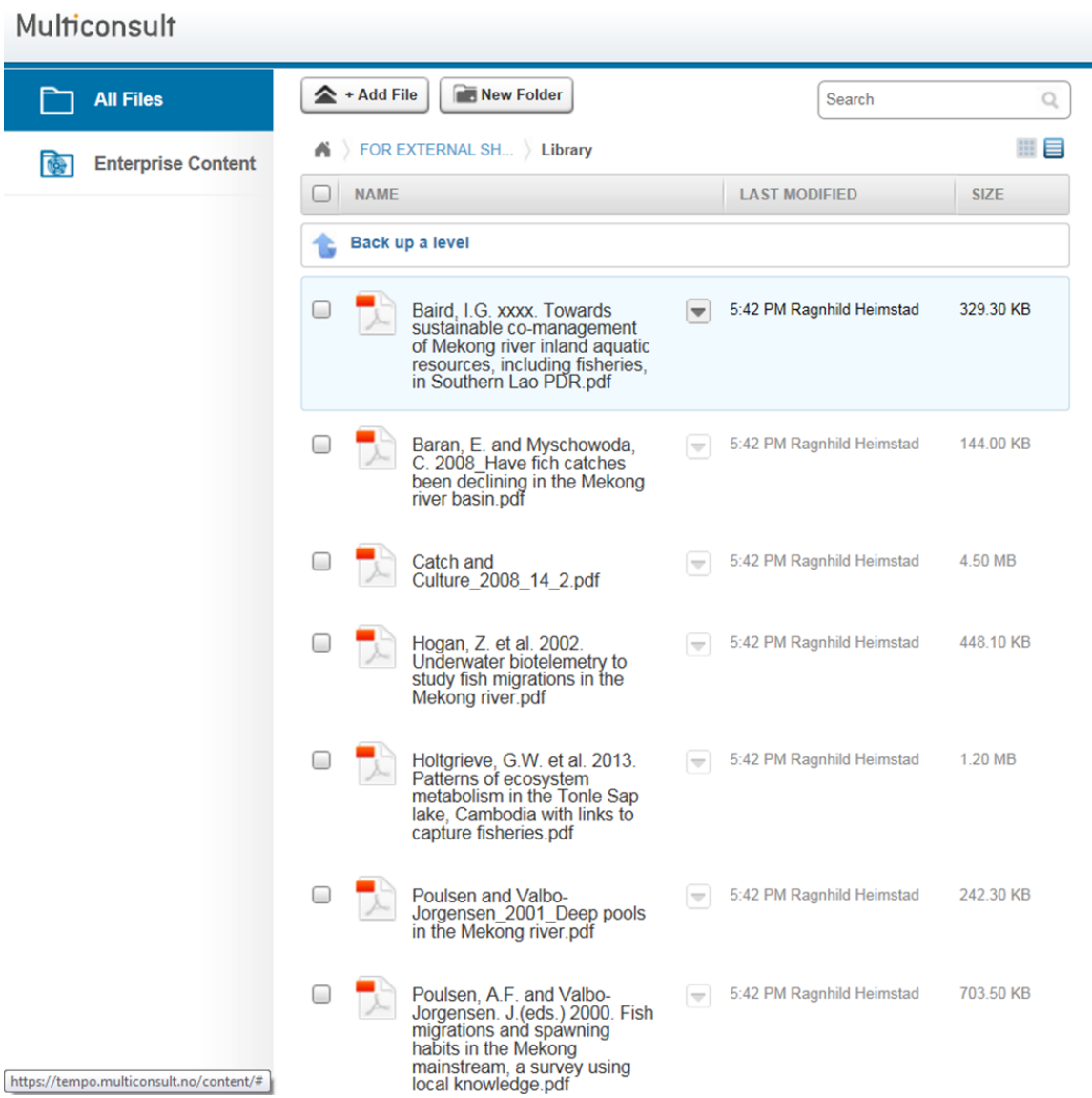
Each risk is given a reference number in the matrix eg (IV.2). Mitigations for that risk can then be found in the manual. eg (IV.2.1, IV.2.2, etc)

# Structure and usage of Knowledge Base

1) Knowledge Base Report

2) Document inventory sheet

3) Knowledge Base Library



# Structure and usage of Knowledge Base

multiconsult.no

## Data Inventory Sheet

- Complete overview of all articles/reports/publications that have been collected througout the project period
- Easy to navigate: Excel file to allow sorting/filtering and search function
- Contains more than 1000 organized references also reflected in the library

| First author | Year | Title | Journal | Other information | Geographic focus | Search word | Full Reference |
|---|---|---|---|---|---|---|---|
| Arai, N. | 2008 | Field informatics for co-existence between human beings and endangered species: sea turtles, Mekong giant catfish and dugongs | International Conference on Informatics Education and Research for Knowledge-Circulating Society. | | Mekong | | Arai, N. 2008. Field informatics for co-existence between human beings and endangered species: sea turtles, Mekong giant catfish and dugongs. International Conference on Informatics Education and Research for Knowledge-Circulating Society. |
| Arias, M.E. | 2013 | The flood pulse as the underlying driver of vegetation in the largest wetland ar | Ambio | | Tonle Sap | | Arias, M. et al. 2013. The flood pulse as the underlying driver of vegetation in the largest wetland and fishery of the Mekong Basin. Ambio 42:864-876, |
| Arias, M.E. | 2014 | Impacts of hydropower and climate change on drivers of ecological productivity of Southeast Asia's most important wetland | Ecological modelling | | Mekong | | Arias, M.E. et al. 2014. Impacts of hydropower and climate change on drivers of ecological productivity of Southeast Asia's most important wetland. Ecological Modelling 272: 252-263. |
| Arias, M.E. | 2012 | Quantifying changes in flooding and habitats in the Tonle Sap Lake (Cambodia) caused by water infrastructure development and climate change in the Mekong Basin | Journal of Environmental Management | | Tonle Sap | | Arias, M. et al. 2012. Quantifying changes in flooding and habitats in the Tonle Sap Lake (Cambodia) caused by water infrastructure development and climate change in the Mekong Basin. Journal of Environmental Management 112: 53-66. |
| Baird, I.G. | | Towards sustainable co-management of Mekong river inland aquatic resource | Proceedings of the International Workshop on Fisheries Co-management | | | | Baird, I. G., 2000, Towards Sustainable Co-Management of Mekong River Inland Aquatic Resources, including Fisheries, in Southern Lao PDR, Evaluating Eden Series Discussion Paper No. 15 |
| Baird, I.G. | 2005 | Irrawaddy dolphin Orcaella brevirostris in the Cambodian Mekong River: an initial survey | Oryx | | Cambodian Mekong River | | Baird, I.G. and Beasley, I.L. 2005. Irrawaddy dolphin *Orcaella brevirostris* in the Cambodian Mekong River: an initial survey. Oryx 39: 301-310. |
| Baird, I.G. | 2005 | Sesan River fisheries monitoring in Ratanakiri province, northeast Cambodia: Before and after the construction of the Yali Falls dam in the Central Highlands of Viet Nam. | 3S Rivers Protection Network and the Global Association for People and the Environment. | | Yali Falls dam, Sesan River, | | Baird, Ian G. and Meach Mean 2005. Sesan River fisheries monitoring in Ratanakiri province, northeast Cambodia: Before and after the construction of the Yali Falls dam in the Central Highlands of Viet Nam. 3S Rivers Protection Network and the Global Association for People and the Environment. Ban Lung, Ratanakiri, Cambodia, 92 pp |
| Baird, I.G. | 2011 | The Don Sahong Dam. Potential impacts on regional fish migrations, livelihoods, and human health. | Critical Asian Studies | | Don Sahong Dam | | Baird, I.G. 2011. The Don Sahong Dam. Potential impacts on regional fish migrations, livelihoods, and human health. Critical Asian Studies 43 (2): 211-235. |
| Baran, E. | 2008 | Have fish catches been declining in the Mekong river basin? | Water & Development Publications - Helsinki University of Technology | Part II: Making living out of nature, Modern myths of the Mekong | Tonle Sap | | Baran, E., Myschowoda, C., 2008, Have Fish Catches Been Declining in the Mekong River Basin?, Water & Development Publications – Helsinki University of Technology, ISBN 978-951-22-9102-1 |
| Baran, E. | 2006 | Fish migration triggers in the Lower Mekong Basin and other tropical freshwater systems. | MRC Technical Paper | Mekong River Commission, Vientiane | LMB and tropical freshwater systems | quantitative analysis, review | BARAN Eric (2006) Fish migration triggers in the Lower Mekong Basin and other tropical freshwater systems. MRC Technical Paper No. 14, Mekong River Commission, Vientiane. 56 pp |
| Baran, E. | 2003 | Approaches and tools for sustainable management of fish resources in the Mekong River Basin. | Cao M., Woods K., Hu H., Li L. 2003 Biodiversity management and sustainable development. China Forestry Publishing House, Kunming. | | | | Baran E., Baird I. G. 2003 Approaches and tools for sustainable management of fish resources in the Mekong River Basin. Pp. 78-87 in Cao M., Woods K., Hu H., Li L. 2003 Biodiversity management and sustainable development. China Forestry Publishing House, Kunming. 246 pp |

# Used to suggest updates of the 2009 PDG and 2001 HDS

- **PDG review/update**: Assess necessary updates of the 2009 version of the PDG, including planning principles taking into account mitigation throughout the whole hydropower life cycle, additional themes for consideration, updates of existing themes, inclusion of specific engineering design principles, inclusion of tributary dams development, planning and design as well as needed updates on dam safety.

- **HDS review/update**: Assess necessary updates of the 2001 version of the Hydropower Development Strategy taking into account; recent hydropower developments in the LMB, sustainable hydropower development principles, recent plans and strategies on the LMB as well as Guidelines and results from ISH0306.

# Review and Update of the PDG



## Aditional Themes for Consideration

**Principles for Engineering Design and Operation**

**The key design objectives that might be considered in the revised PGD include:**

1. **Adoption of lower dams so that effective fish upstream migration can take place.**
2. **Adoption of finer and larger power intake screens to improve fish exclusion and survival rates for downstream migration.**
3. **Smaller reservoirs to reduce residence time, water quality problems and sediment trap efficiency.**
4. **Introduce energy recovery on fish passage systems to reduce losses to commercially acceptable levels.**
5. **Avoid gated weir type spillways and adopt full height gated barrages so that the river can be retained in a natural condition during project construction and returned to natural conditions for sediment transport and fish migration.**

# Review and Update of the PDG



## Existing Themes Update

**Sediment Transport and River Morphology**

**Multiple comments on and corrections to existing clauses in PDG 2009, including lack of emphasis on considering the development in the 'bigger' catchment context. Main recommendations from ISH0306 as follows:**

- **Dam siting in master plans with regard to avoid sediment transport and river morphology hotspot areas (for example studied by Schmitt et al. 2017 in the 3S system).**
- **Design multiple large gated spillways/outlets at multiple levels, and low level sediment outlets**
- **Design sediment bypass channels.**
- **Under operation implement annual sediment sluicing to maintain seasonal pulse.**
- **Undertake riverbank stabilization works during construction.**
- **Introduction of annual sediments downstream of impoundments (however practically questionable on mainstream Mekong).**
- **Minimize sediment runoff through design of access roads and seasonal work schedules.**
- **Find mechanisms to support or implement catchment management measures to reduce sediment inputs.**
- **Limit rate of water level drop to prevent slope and dam instability**

# Review and Update of the PDG



## Existing Themes Update

**Fish Passage**

**Multiple comments on and corrections to existing clauses in PDG 2009, including that of height of functional fish passes. Main recommendations from ISH0306 as follows:**

- **Dam siting in master plans to avoid risks and impacts in fish migratory hotspot areas. Waiver of planned projects if they are in very sensitive locations and mitigation of negative effects cannot be ensured.**
- **Consideration of cumulative effects (not single effects per dam)**
- **Develop joint operation rules for flow releases, in periods important for migration, including maintaining seasonal patterns, artificial releases and environmental flows.**
- **Operating rules to minimize flow changes and management of re-regulation weirs to provide appropriate downstream flows**
- **Consider alternative hydropower designs to minimize impact on connectivity Design measures for fish protection, e.g. suitable rakes, adapted turbines, guidance systems etc.**
- **Ensure fish passage and connectivity during all phases of the project (incl. construction)**
- **Avoid high retention time in reservoirs and plan and implement large bypass systems where possible**
- **Reduce reservoir size to improve flow conditions (e.g. for supporting passive drift of eggs and larvae)**

# What are the possible usages of ISH0306 results?

For the Member Countries consideration:

- Data and information, Modeling Techniques and Outcomes will be useful for the **Council Study**
- To use for the Update of the **Hydropower Strategy, the Preliminary Design Guidance**, etc.
- They can be used to update the works in other sectors (*Hydrology and Flows, Sediments and Geomorphology, Water Quality, Fisheries and Aquatic Ecology, Hydropower Operations and Economics , etc.).*
- Refine/update the current BDS & SP.
- Prepare tasks/Outputs for the next BDS and MRC SP.
- Etc.

# Main Deliveries Final Phase

- Vol 1 - Updated Guidelines Version 3.0 (with Inputs from the Case Study)
- Vol 2 - Updated Manual Version 3.0 (with inputs inputs from the Case Study)
- Vol 3 – Knowledge Base (Structure, Usage, manual and Update on regional and international practise)
- Vol 4 - Case Study Report Version 2.0 (including downstream dams and inputs from Council Study
- Vol 5 – Discussion Note on Review of Update of PDG (2009) and HDS (2001)
- Vol 6 – Final Closure Report


http://www.mrcmekong.org/about-mrc/completion-of-strategic-cycle-2011-2015/initiative-on-sustainable-hydropower/guidelines-for-hydropower-environmental-impact-mitigation-and-risk-management-in-the-lower-mekong-mainstream-and-tributaries-ish0306/
Thanks for your attention