



Mekong River Commission

P.O. Box 6101, 184 Fa Ngoum Road, Unit 18
Ban Sithane Neua, Sikhottabong District, Vientiane 01000, Lao PDR
Telephone: (856-21) 263 263. Facsimile: (856-21) 263 264

The ISH 0306 Study

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



Volume 6 – Final Closure Report

March 2018

The Draft Final Reports constitutes six volumes:

Volume 1: Version 3.0 – Hydropower Risks and Impact Mitigation Guidelines and Recommendations

Volume 2: Version 3.0 – Hydropower Risks and Impact Mitigation MANUAL – Key Hydropower Risks, Impacts and Vulnerabilities and General Mitigation Options for Lower Mekong

Volume 3: Version 2.0 – Final Knowledge Base and Supporting Documents

Volume 4: Final Case Study Report, Version 2.0 - Mainstream Dams Assessment Including Alternative Scheme Layouts

Volume 5: ISH0306 Proposed Update of the Preliminary Design Guidance (PDG) and Hydropower Development Strategy

Volume 6: Final Closure Report

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PREFACE

This document is part of the Final Phase (Phase 4) Report Volumes 1 to 6 of the ISH0306 Mekong River Commission study - ***Development of Guidelines for Hydropower Environmental Impact Mitigation and Risk Management in the Lower Mekong Mainstream and Tributaries***. It builds on the work and results from previous Phases and constitutes as follows;

- (i) Volume 1 - Hydropower Risks and Impact Mitigation Guidelines and Recommendations – Version 3.0;
- (ii) Volume 2 - Hydropower Risks and Impact Mitigation MANUAL - Key Hydropower Risks, Impacts and Vulnerabilities and General Mitigation Options for Lower Mekong – Version 3.0;
- (iii) Volume 3 - Final Knowledge Base and Supporting Documents – Version 2.0
- (iv) Volume 4 – Final Case Study Report– Version 2.0 – Mainstream Dams Assessment Including Alternative Scheme Layouts
- (v) Volume 5 - Discussion Note on Proposed Update of the Preliminary Design Guidance (PDG) and Hydropower Development Strategy
- (vi) Volume 6 – Final Closure Report**

The study is supervised and coordinated by the Initiative on Sustainable Hydropower (ISH)/Mekong River Commission Secretariat (MRCS) with the following key personnel:

- Mr. Voradeth Phonekeo
- Mr. Simon Krohn
- Ms. Pravian Limbanboon
- Mr. Palakorn Chanbanyoung

The project is executed by a team of experts from Multiconsult (Norway/UK) in association with Deltares (The Netherlands) plus experts on additional contracts (Australia and Austria). The following key-experts are involved:

- Mr. Leif Lillehammer (Team Leader, Multiconsult)
- Mr. Chris Grant (Hydropower Design and Operations Expert, Multiconsult)
- Mr. Jean-Pierre Bramslev (Hydropower Modeller and Economics Expert, Multiconsult)
- Mr. Ron Passchier (Hydrologist and Water Resources Modeller, Deltares)
- Dr. Kees Sloff (Hydraulic and Sediment Modelling Expert, Deltares)
- Dr. Lois Koehnken (Sediment and Water Quality Expert, Individual Consultant, Australia)
- Professor Stefan Schmutz (Fisheries and Aquatic Ecology Expert, BOKU University, Vienna)
- Mrs. Carina Seliger (Aquatic Ecologist, BOKU University, Vienna)
- Ms. Kristine Walløe-Lilleeng (Hydropower Engineer, Multiconsult)

The team includes also the following non-key experts and support staff:

- Ms. Jenny Pronker (Hydraulic Expert – Delta Assessment, Deltares)

- Dr. Jørn Stave and Mr. Jens Johan Laugen (Environmental and Social Impact Assessment and Safeguards Experts, Multiconsult)
- Mr. Bjørn Stenseth and William Greene (Power Economists, Multiconsult)
- Dr. Sanjay Giri (Hydraulic Expert, Deltares)
- Mr. Amgad Omer (Reservoir sedimentation expert, Deltares)
- Mr. Bernhard Zeiringer (Fish-Pass Eco-Engineer, BOKU University, Vienna)
- Ms. Ragnhild Heimstad (Terrestrial Ecologists, Knowledge Base Responsible, Multiconsult)
- Mrs. Irene N. Koksæter (Livelihoods Expert and Knowledge Base, Multiconsult)
- Ms. Kirty Manandhar (Knowledge Base, Multiconsult)

The following National Consultants also provided input to the study:

- Lao PDR: Ms. Thipsathiane Khamvongsa (Environment and Water Resources)
- Lao PDR: Mr. Lamphone Dimanivong (Hydropower and Energy)
- Cambodia: Dr. Heng Sokchay (Hydropower and Energy)
- Vietnam: Dr. Nguyen Quang Trung (Environment and Water Resources)
- Vietnam: Dr. Hoang Minh Tuyen (Hydropower and Energy)

1 Introduction

1.1 Background of ISH0306

1.1.1 Rationale

Hydropower is recognized as an important development opportunity for the Mekong River Basin and the people living within it. As set out in the Mekong River Commission's Strategic Plan (2011 to 2015) and the Basin Development Plan (BDP, approved January 2011), this basin development is to follow Integrated Water Resource Management (IWRM) principles. The need to improve the sustainability of the basin's hydropower developments is a key Strategic Priority in the Mekong Basin Development Strategy. With the significantly increasing scale and prevalence of this energy option, all MRC member countries are taking steps to understand and employ sustainable hydropower considerations.

The MRC has established the Initiative for Sustainable Hydropower (ISH) with the aim of seeking to embed sustainable hydropower considerations into the regulatory frameworks and planning systems of member countries and into project level planning, design, implementation and operational activities.

The ISH 2011-2015 Strategy emphasizes this requirement as well as the need to understand the scale and distribution of risks associated with hydropower development on the main stream and on tributaries. In addition, the Strategy seeks the exploration and documentation of possible avoidance, mitigation and benefit and risk sharing options. Necessary frameworks must be in place to provide assurance that risks can be effectively minimized.

Hydropower in the LMB is embedded in a closely woven social and environmental fabric. The region's people derive a substantial proportion of their livelihood and nutrition from the tributaries and mainstream of the Mekong. Ecosystems services support both these livelihoods and a rich and globally unique biodiversity. The planning and implementation of hydropower should aim to ensure that these livelihoods are preserved and enhanced and that the supporting biodiversity is maintained wherever possible.

Internationally, the socio-economic and environmental opportunities and impacts of power development plans are generally assessed using a Strategic Environmental Assessments (SEA) for multiple projects or plans or through individual project Environmental and Social Impact Assessments (ESIA). The effectiveness of these processes to highlight risks and vulnerabilities across the region is the subject of ongoing improvement effort in the approach and management capacity of responsible agencies.

In many cases the effectiveness of these SEA and EIA studies and subsequently proposed mitigation and risk management approaches is hampered by a lack of baseline data on the social and environmental situation in the location of the proposed hydropower scheme. This is being addressed through a range studies across the MRC (ISH has a specific study on this aspect ISH11¹).

¹ ISH11 is a study "Improved Environmental and Socio-Economic Baseline Information for Hydropower Planning", and commenced in July 2012.

The MRC has, in 2009, first produced the Preliminary Design Guidance for Mainstream Dams (PDG) in the Lower Mekong Basin; a document that outlines expectations of, and an approach to, mitigation of the major risks for hydropower dams in the Mekong mainstream.

The ISH is seeking to enhance these Guidelines and to provide more effective and detailed documentation of the options and methods that may be used to cover the mitigation of hydropower risks in the Mekong based on the latest research and practice from around the world and the region. In addition the MRC is seeking, as set out in the MRC Strategy 2011-2015, to expand the applicability of these Guidelines to the tributary developments.

The MRC/ISH will be seeking to work with developers and implementing agencies to get industry support for these methods. This work specifically supports ISH Goal which is aimed at ensuring:

“..... Sustainable hydropower practices are employed in project-level hydropower planning, preparation, design, implementation and operation practices.”

This should be done in a manner that accords with national policies and regulations and is realistic about likely capacities to implement such approaches within existing project implementation.



Picture 1. Near the Mekong and Tonle Sap River confluence at Phnom Penh, Cambodia (Source: ESA, Space Images).

1.1.2 Hydropower in the Development of the Mekong Region

The countries of the lower Mekong Basin, Cambodia, Lao PDR, Thailand and Viet Nam, are all experiencing rapid development that is transforming the region from a largely agricultural economy and rural population to become urban/industrial societies that are closely integrated into the global

economic system. The growth in demand for electricity reflects this, with sustained growth rates of over 10% a year across the region placing great strain upon the power generation system and necessitating high levels of investment in the construction of additional generating capacity. All countries see the ability to meet this growth of demand as an economic and political priority and will invest in whichever sources of generation capacity are the most economically rational.

Hydropower is one source of such additional generating capacity, alongside thermal power (coal, oil and gas), which dominates, and limited levels of non-traditional energy. All the countries in the region see hydropower as an important source of power generation, but each has a different perspective upon hydropower development. Cambodia has limited generating capacity and rapid growth of demand and sees hydropower as a means to meet these demands whilst limiting dependence upon imported fossil fuels. Lao PDR has more limited internal demand but sees hydropower as a major potential source of export earnings, with aspirations to become the “battery of Asia”. Thailand has already high levels of hydropower development and is seeking to develop the remaining potential capacity only where it can be done so in a sustainable manner. Viet Nam faces an increase in demand for power of over 15% per annum and is seeking to maximize the development of its hydropower potential. All countries are interested in a more integrated regional power sector and cross-border trade in electricity will increase in the coming decades.

The relationship of hydropower development to social and environmental issues has been identified as an issue of strategic concern by all governments and many other stakeholders in the region. This includes the potential impacts on water resources and associated ecosystems, on areas of high ecological value and sensitivity, the maintenance of the flows of ecosystems services from the hydrological system of the region, impacts on poverty reduction and social equality (with many ethnic minorities particularly affected by hydropower development) and the potential implications for regional integration and cross-border relationships that both water resources management and the power sector have.

The importance of power development in general and the hydropower sector in particular and of associated issues of water resources management are reflected in the programmes of a number of international organizations that are working with and supporting national governments in the region. These include ASEAN, the Asian Development Bank, the World Bank and various bilateral donors and other international organizations. There is also strong public and civil society concern over these issues that have, on a number of occasions, brought together academics, NGOs and other civil society agencies into multi-national discussions on the implications of hydropower development in the lower Mekong Basin.

1.2 Goal and Objectives

The Goal and Objectives was embedded in the Original ToR (MRC, 2014) and read as follows:

Goal:

To support the achievement of the vision of *an economically prosperous, socially just and environmentally sound Mekong River Basin* the project goals is:

Development of relevant measures and guidelines for hydropower impact mitigation and risk management in the Lower Mekong mainstream and tributaries

Objectives:

- a. Regionally relevant hydropower impact avoidance, minimisation and mitigation options for development of hydropower on the Mekong mainstream and Tributaries are thoroughly documented;
- b. Specific research is scoped and commissioned to improve technical and scientific understanding towards improved mitigation options and the adaptation of existing methods to the region; and
- c. Engineering and scientific options, for the avoidance, minimisation and mitigation of risks of mainstream hydropower dams are documented in consultation with regional agencies and developers.

1.3 Study Logical Framework

The study logical Framework is included in Annex 1. Essentially the approach to the study did follow the following steps:

- Understanding the baseline natural resource processes and conditions in the Mekong Basin and the nature of hydro developments proposed;
- Describing the potential impacts of these developments as assessed by existing studies;
- Research regional and global experience on mitigation options appropriate for these Mekong hydropower developments;
- Undertaking analysis and research into the effectiveness of these mitigation options;
- Making recommendations on improvements and new approaches to impact mitigation;
- Commissioning further research to cover significant knowledge gaps;
- Provision of guidelines and a substantial knowledge base on mitigation approach and solutions based on research and case studies suitable for dissemination through the MRC web site or other media; and
- Building capacity in all areas of assessment avoidance, minimisation and mitigation options within industry and line agencies.



Picture 2. Riverine forest and fish traps within 4000 Islands in the vicinity of Don Sahong dam site. (Photo: Kristine Walløe-Lilleeng, Multiconsult).

2 Project Process

2.1 Overall Process

The study constituted 4 Phases with defined outputs/activities. These were Inception Phase, 1st Interim Phase, 2nd Interim Phase and then Final Phase. The study was originally planned to be conducted over an 18-month period, from commencement 15 January 2015, however concurrent shifts in planning has led to delivery of Final Reports by end of March 2018, after the final Regional Workshop in late January 2018. The original planned process is portrayed in Figure 2.1 below. By the end of 1st Interim Phase, however it was agreed however that Output 5 should be refined, and that Output 6 and 7 was to be moved over to the Final Phase.

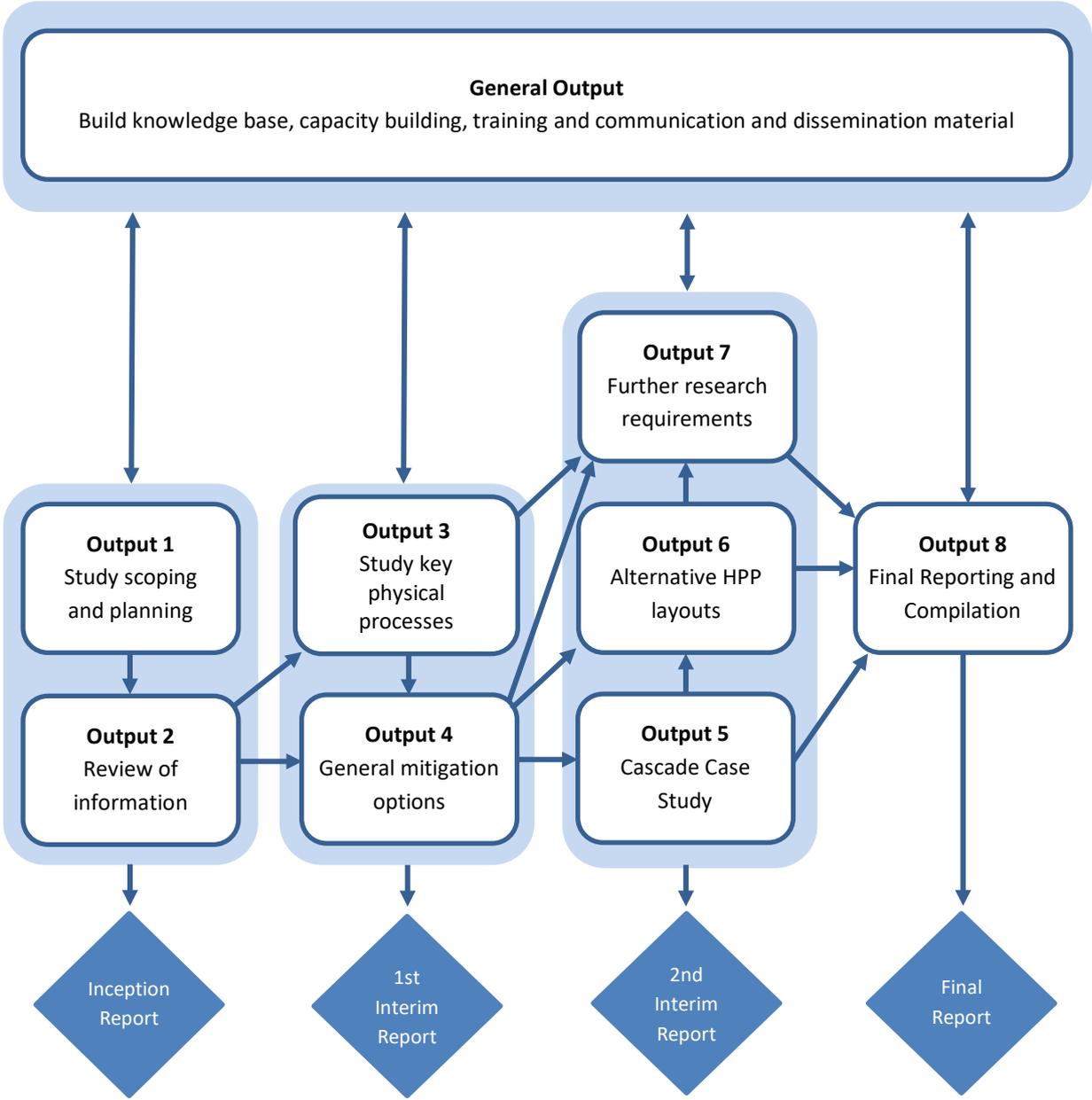


Figure 2.1. Main outputs for the ISH0306 study.

2.2 Process Adjustments Phase 3 and 4

It was decided by end of 1st Interim Phase (December 2015) that 2nd Interim Phase should concentrate on Output 5 (The Northern Lao Cascade Case Study), and that it should be refined from original planning according to ToR and Inception Planning. At the end of 2nd Interim Phase (November 2016), the Final Phase outputs were also refined and amended in a revised ToR, also for the reason to better align with the ongoing Council Study. Summary of outputs for the various phases are given in Chapter 3.

2.3 National and Regional Consultations

Besides various missions and fieldtrips conducted, national and regional consultations has been held at the end off each phase as follows:

1. Inception Phase: Regional Consultations
2. 1st Interim Phase: National and Regional Consultations
3. 2nd Interim Phase: National and Regional Consultations
4. Final Phase: National Consultations, whilst the Regional Consultation is still due in March 2018.

The consultations has provided comprehensive and valuable information and feedbacks to the outputs and deliverables. The feedback and proceedings of these are included in the Inception Report, 1st and 2nd Interim Reports as well as the Draft Case Study Report, Volume 4, for the Final Phase.



Picture 3. Visiting 4000 Islands in the vicinity of Don Sahong dam site. (Photo: Kristine Walløe-Lilleeng, Multiconsult).

3 Summary of Phases and Outputs

3.1 Phase 1 – Scoping and Literature Review

3.1.1 Output 1 – Study Scoping and Planning

Output was divided into two activities as follows:

Activity 1.1 – Through consultations with the Client and relevant stakeholders, a *detailed work and resource plan*, and a *stakeholder engagement plan* was elaborated. The latter includes timing of consultation with MRC programmes, National Mekong Committees (NMC's), national line agencies, the development sector and hydropower operators, including stakeholder's relationship to and modes of engagement in the ISH0306 study.

Activity 1.2 – Through consultations with ISH and MRC programmes a more *detailed methodology* was developed to cover the remaining outputs and deliverables of the study.

Activity 1.1 and 1.2 included 2 initial scoping visits to the region, as well as a mission for the 1st Regional Workshop in Phnom Penh.

3.1.2 Output 2 – Literature Review, Interviews and Options Assessment

This activity was undertaken to; (i) understand the baseline conditions in the Mekong basin and the nature of hydro developments, including its impacts; and (ii) research regional and global experience on mitigation options appropriate for the Mekong hydropower developments.

To cater for the above the assessment was divided into the following sub-activities;

Activity 2.a1 – *Status of the Mekong*. Elaboration of the status of the Mekong in relation to hydrology, water resources, HP, sediments, fisheries and aquatic ecology.

Activity 2.a2 – *Preliminary study of Completed SEAs, CIAs and EIAs*. This was undertaken through:

- Gathering of the available documentation on completed SEAs, CIAs and EIAs and related studies for planned and existing projects in the LMB. Besides gathering relevant baseline natural resources conditions and processes, documentation on the associated hydropower risks and impacts was included, and undertaken at project, cascade, sub-basin level and those of transboundary nature.
- Sourcing of the current research and study findings on LMB sub-basin socio-economic and environmental vulnerability from both a sub-basin and transboundary perspective (including the environmental studies, EIAs, CIAs and SEAs of Mekong Mainstream (and tributaries) dams.

Activity 2.a.3 – *Preliminary study of current practice and research on hydropower risk mitigation*. This will be undertaken through:

- Gathering of available information on current practice and research on hydropower risk mitigation (literature review and interviews and consultations) including existing case studies across the Greater Mekong Sub-region (GMS) and internationally.
- Gathering of information from regional/national agencies, institutions and NGOs who may be involved in research in this field.

This included existing case studies and areas that deal with a similar river ecology, hydrology, social environment as the Mekong in the Greater Mekong Sub-Region (GMS) and internationally. The sourcing of GSM and international documentation also feed directly into activity 2b below.

Activity 2.b – *Description of practical risk and impact mitigation options assessment.* This activity included a description and documentation a *simple and practical* risk and impact mitigation option assessment and implementation process, from international practice. A preliminary review of best and good industrial practise of the international experience was assessed, and further studied in the 1st and 2nd Interim Phases.

Activity 2.c – *Inception phase identification of knowledge gaps and research needs.* As part of the inception phase we identified preliminary knowledge gaps and research needs within geomorphology, sediment transport and water quality as well as fisheries and fish passages. The above was based on earlier work in the region by two of our team experts, and further extended based on the objectives of the ISH0306 study.

3.1.3 Deliverables

Base on the outputs and and activities described above, The Inception Phase deliverables constituted as follows:

- Inception Report – Vol. 1 – Main Report - Study Scoping and Planning
- Inception Report – Vol. 2 – Litterature Review and Knowledge Base
- Inception Report – Vol. 3 – Regional Inception Workshop Proceedings and Consultations

3.2 Phase 2 (1st Interim Phase) – Development of General Guidelines and Knowledge Base

3.2.1 Output 3 – Document Key Physical Processes behind Hydropower Risks, Impacts and Vulnerabilities

From the research under Activity 2 outlined under this Output 3 the priority hydropower risks, impacts and vulnerabilities on the Mekong mainstream, by using the following approach:

Activity 3.1 – *Definition and listing of the priority hydropower risks, impacts and vulnerabilities on the Mekong mainstream.* The description of natural resources processes was in a sufficient detail to allow for a more specific assessment of mitigation options (under Activity 4 and 5):

1. Impacts on specific mainstream local reaches and
2. Those associated with mainstream transboundary impacts

It further included a description of specific risks and vulnerabilities associated with:

1. Alterations of downstream flows related to multiple water use and abstraction (irrigation, water supply, navigation, Delta activities e.g.), environmental flows and requirements (including those for environmental services), flood and drought management;
2. Erosion, sediment and geomorphic issues, including local and transboundary impacts (e.g. river bed incision, impacts on lateral continuity, habitat loss, reservoir flushing);

3. Fish migration (up- and downstream, for all life-stages), diversity, productivity and also its link to livelihoods;
4. Alteration of fish habitats (incl. floodplains);
5. Biodiversity, natural resources and ecosystem services (also linked to livelihood); and
6. Water quality, nutrients, reservoir stratification and physico-chemical changes

The assessment included a description of the nature of the impacts, its relative importance and with details that allowed for mitigation design parameters to be determined.

Activity 3.2 – *Identify research needs to cover knowledge gaps.* Where there were insufficient details of understanding of the nature of the risks, impacts and vulnerabilities – outlined in 3.1 above – research needs were identified to cover these knowledge gaps. This also took into account the scope of other work being carried out by ISH, the MRC and regional agencies.

3.2.2 Output 4 – General Project Mitigation Options

This Output was undertaken to review and analyse the effectiveness of current mitigation options for LMB, and make recommendations for improvements.

The activity embarked from studies already undertaken, like the SEA process, the Xayaburi PNPCA, various feasibility studies and EIAs, and the PDG. It constituted the following sub-activities:

Activity 4.1 – *Determination of mitigation options for categories of risks and vulnerabilities.* The results from Activity 2 & 3 served as a starting point for the determination of mitigation options, and was tested for suitability against the particular development and categories of risks set out in Activity 3. The approach started at general project level, and included a comprehensive review, critique and recommendation of the alternative mitigation options for the structures as currently proposed. The consultant did draw on documented and well-proven mitigation options and guidelines, but also based the assessment on recent regional and international research, and thus proposed required adaptations and innovations. Information and options for the various stages of the project life cycle was given. Under this activity the ISH0306 Team developed the first version of the **Mitigation Guidelines and Recommendations Framework**.

Activity 4.2 – *Consideration of potential location of dams in the LMB reach and alternative hydropower scheme layouts.* Based on the activity undertaken in 4.1 the assessment the consultant considered the potential location and scheme layouts of the dams on the LMB reach, and the particular conditions of the locations (e.g. sediment load characteristics, fish migration and production, riverine ecology and hydrology – including habitat fragmentation and loss of connectivity, water uses requirements – including navigation, and food security and livelihood dependence amongst others).

Activity 4.3 – *Investigate state of the art in fisheries mitigation (up- and downstream passages, alternative systems, offsets, etc.) and sediment flushing (under consideration of ecological parameters as e.g. turbidity thresholds).* The Consultant undertook a detailed study with particular attention on the status of science and engineering for fish passage and sediment flushing, as well as the needs for further research as set out for Activity 7.

Activity 4.4 – *Study Joint Operation Rules alterations.* Joint operation rules were assessed for tributary systems on Mekong as well as international examples of best practice.

Activity 4.5 – Dam Safety Risks Assessment. Consideration of dam safety risks and related assessments was studied at a general level and resulted in a first version of suggested Dam Safety Guidelines.

Activity 4.6 – Set-Up of Case Study Modelling and Methodology for Assessment of the Northern Lao Cascade.

3.2.3 Deliverables

Based on the outputs and activities described above, The 1st Interim Phase deliverables constituted as follows:

- 1st Interim Report – Vol. 1 – The “Guidelines” (Version 1.0)
- 1st Interim Report – Vol. 2 – The “Manual” (Version 1.0)
- 1st Interim Report – Vol. 3 – Case Study – Objectives, Scope, Methodology and Modelling

3.3 Phase 3 (2nd Interim Phase) – Case Study and Guidelines Review

As mentioned earlier the scope for 2nd Interim Phase was revised to focus on the Case Study for the Northern Lao Cascade and constituted the following Outputs/Activities.



Picture 4. Near Luang Prabang dam site. (Photo: Kristine Walløe-Lilleeng, Multiconsult).

3.3.1 Output 5a – Mainstream Upper Cascade Operation and Cumulative Impact Mitigation Options

Consideration was given to the requirements for joint hydropower cascade operation/mitigation with focus on measures for sediment management and fish passages for the Northern Lao Cascade. Mitigation of cumulative impacts was also considered. To do the assessment rigorous hydrological, hydraulic, sediment/geomorphological as well as hydropower modelling was undertaken using a combination of MRC DSF models as well as Delft 3D and HecRes-Sim, the two latter for sediments and hydropower modelling respectively.

The study assessed and tested the effectiveness of specific mitigation measures for the Northern Lao Cascade and its impact on power production and revenues. This was undertaken by also defining and testing a specific set of scenarios that combined various mitigation techniques related to (i) Run-of-River operation; (ii) Hydro-Peaking Operation and (iii) Sediment Flushing/Sluicing Operation.

3.3.2 Output 5b – Second Interim Phase Reporting – Updated Guidelines

Based on the studies under 5a, the Guidelines and the Manual was updated, and a first version of the supporting Knowledge Base to these was constructed and elaborated.



Picture 5. *Khone Falls. (Photo: Kristine Walløe-Lilleeng, Multiconsult).*

3.3.3 Deliverables

Based on the outputs and activities described above, The 2nd Interim Phase deliverables constituted as follows:

- 2nd Interim Report – Vol. 1 – The “Guidelines” (Version 2.0)
- 2nd Interim Report – Vol. 2 – The “Manual” (Version 2.0)
- 2nd Interim Report – Vol 3 – Knowledge Base Report (Version 1.0), with supporting inventory and documentation
- 2nd Interim Report – Vol. 4 – Case Study Report (Version 1.0) – Modelling, Scenarios and Impact Mitigation Assessment

3.4 Phase 4 – Alternative Scheme Layouts, Case Study Version 2 and Final Guidelines and Training

The Phase 4 activities was revised, as mentioned earlier, by the end of the 2nd Interim Phase and Constituted as follows.

3.4.1 Output 6a – Alternative Hydropower Scheme Layouts

Exploration at conceptual level, alternative mainstream hydropower schemes layout options that could improve their sustainability, by looking at:

- Northern Lao Cascade: Based on the assessment from the 2nd Interim Phase, considering design and operational changes to the structures, and assessing the benefits of these changes to mitigating impacts. This included looking at lower head dams, lower gates, different fish passage options etc.
- Looking at the effects and benefits of partial development of the Northern Lao Cascade
- Assessing different layout options for the downstream dams (Latsua/Phun Noi, Don Sahong, Stung Treng and Sambor and effects and benefits from this.

The redesign included conceptual layout general arrangement drawings and initial commentaries on potential changes to energy production and economic feasibility. The effectiveness and importance of these options was also assessed against the criticality of environmental risks and vulnerabilities.

3.4.2 Output 6b – Review of Case Study Analysis with Additional Scenarios Including Layout Options

Based on 6a the consultant provided guidance on the practicality, environmental benefits and economics of these options, that again provided inputs to a revised and enhanced Case Study Report, and also including the Downstream Dams.

3.4.3 Output 6c – Inclusion of Assessment of Mitigation Operations in the MRC Council Study to Assess the Mitigation below Pakse

The consultant liaised thoroughly with the Council Study modelling team and defined their Hydropower Thematic Sub-Scenarios, including operating rules and inclusion of mitigation options for the mainstream dams. Some of the results from the Council Study modelling has also provided input to the revised and enhanced Case Study Report.



Picture 6. *Nam Ou 1 under construction. (Photo: Kristine Walløe-Lilleeng, Multiconsult).*

3.4.4 Output 7 – Further Research Requirements

Further research requirements and information gaps has especially been identified with regard to sediments, water quality and aquatic ecology and is part of the Final Phase Case Study Report (Vol. 4). Research and information requirements has also been highlighted in the “Manual” (Vol. 2), also within a wider array of themes. A review and suggestions for update of the MRC PDG and Hydropower Development strategy (Volume 5 of final delivery) was also included under this activity.

3.4.5 Output 8a – Training and Communication Documentation

Final training material has been delivered in conjunction with the Regional Workshop in late January 2018. Capacity building has however been undertaken throughout the project. Final communication material constitutes the Policy Brief, which is as separate document additional to Volumes 1-6.

3.4.6 Output 8b – Final Reporting – Deliverables Final Phase

Based on the outputs and and activities described above, the Final Phase deliverables, due in March 2018, constitutes as follows:

- ISH0306 – Vol. 1 – Final “Guidelines” (Version 3.0)
- ISH0306 – Vol. 2 – Final “Manual” (Version 3.0)
- ISH0306 – Vol 3 – Final Knowledge Base Report (Version 2.0), with supporting inventory and documentation – Physical Hanover to MRC.

- ISH0306 – Vol. 4 – Final Case Study Report (Version 2.0) – Mainstream Dams Assessment Including Alternative Schemes Layouts
- ISH0306 – Vol. 5 – Proposed Update of PDG and HSF
- ISH0306 – Vol. 6 – Final Closure Report (this report)
- ISH0306 – Policy Brief



Picture 7. *Sunset in 4000 Island. (Photo: Kristine Walløe-Lilleeng, Multiconsult).*

4 ISH0306 Project Closure and Handover

The Final Handover of documentation is described in Chapters 3.4.5 and 3.4.6, and henceforth constitutes the Closure of ISH0306, by which was undertaken between January 2015 and March 2018.